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Indwelling Urethral versus Suprapubic Catheters in Nursing Home Residents: Determining the Safest Option for Long-Term Use

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SUMMARY

Background: Long-term infectious complications associated with type of indwelling urinary catheter are unknown.

Aim: To compare catheter-associated urinary tract infection (CAUTI) rates and multidrug resistant organism (MDRO) colonization between nursing home (NH) residents with indwelling urethral and suprapubic catheters.

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Authors' contributions

Kristen Gibson, Jennifer Meddings, and Lona Mody contributed equally to this article. All other authors have reviewed and contributed to this submitted manuscript.

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Conflict of interest

The funders had no role in the design/conduct of the study, collection/management of the data, analysis, interpretation of the data, or preparation, review, or approval of the manuscript. The authors declare no conflicts of interest in the conduct or reporting of this project.

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Methods: Participants included 418 NH residents with an indwelling device enrolled in a prospective Targeted Infection Prevention (TIP) study between 2010–2013. Resident age, gender, function, comorbidities, and information on infections, antibiotic use, & recent hospitalizations were obtained at study enrollment, day 14, & every 30 days thereafter for up to 1 year. Microbiological samples were obtained from several anatomic sites at each visit. Cox proportional hazard models were adjusted for facility-level clustering and other covariates.

Findings: Two-hundred and eight study participants had an indwelling urinary catheter, contributing 21,700 device-days; 173 (83%) with a urethral catheter, 35 (17%) with a suprapubic catheter. After covariate-adjustment, the suprapubic group had a lower incidence of CAUTI (6.6/1000 device-days vs. 8.8/1000 device-days; $p = 0.05$), were half as likely to be hospitalized (*hazard ratio (HR)* = 0.46; $p < 0.01$) and 23% less likely to have antibiotics in the past 30 days ($HR = 0.77$; $p = 0.02$). Among residents catheterized 90 days, the mean number of MDROs isolated in the suprapubic group was significantly higher than the urethral group (0.57 vs. 0.44; $p = 0.01$). Ciprofloxacin-resistant Gram-negative bacilli were common in both groups.

Conclusion: Residents with a suprapubic catheter may have fewer CAUTIs, hospitalization and antibiotic use, but are more likely colonized with MDROs.

Keywords

Indwelling urethral catheter; Suprapubic catheter; Nursing homes; Catheter- associated urinary tract infection; Multidrug-resistant organisms

INTRODUCTION

Of the 1.6 million individuals receiving care in nursing home (NH) facilities, between 5% - 15% of all residents have an indwelling urinary catheter [1–3]. The indications for insertion of a urinary catheter are wide-ranging, from patients with pressure ulcers or wounds and low functional status to traumatic pelvic injury or neurogenic bladder disease, since such individuals are often unable to perform intermittent self-catheterization [3–4]. NH residents are often catheterized for weeks to months or longer. While urinary catheterization may simplify the daily care of these patients, catheterization significantly increases urinary tract infections (UTIs) and overall morbidity and mortality [3–5]. Microbial colonization occurs within five to seven days of urinary catheter placement and is frequently associated with the development of a bacterial biofilm, presumably the source of catheter-associated (CA-) UTI [6]. Furthermore, prior research from our group has shown that indwelling urinary catheter doubles the prevalence and new acquisition of MDROs [7–10].

Urethral catheters and suprapubic catheters are two types of indwelling urinary catheterization used in hospitals and other long-term settings including NHs, long-term acute care hospitals and inpatient hospice care [4]. Some studies have found a decreased risk of CAUTI with the use of a suprapubic catheter relative to a urethral catheter [11–13], but most of these focus on acute, post-operative patients with durations of catheterization substantially shorter than long-term settings. For example, the 2006 review from McPhail et al [13] focused on six studies of patients undergoing abdominal surgery, with duration of catheterization ranging from 4–8 days. Further, the patient populations in these studies are,

on average, younger and of higher functional status compared with patients receiving care at NHs. Thus, the findings from these studies may not be generalizable to patients in long-term care.

The goals of our study were to compare the incidence of clinically-defined and antibiotic treated CAUTIs, rates of hospitalization, and antibiotic usage between NH residents with indwelling urethral catheters and suprapubic catheters. Additionally, we examined rates and patterns of multidrug-resistant organism (MDRO) colonization between the two groups.

METHODS

Study Population and Design

This pilot study was nested within a larger, cluster-randomized Targeted Infection Prevention (TIP) study [14]. The goal of the parent study was to design, implement, and evaluate the efficacy of a multi-component TIP program in reducing MDRO prevalence and infections in high-risk NH residents. Components of this program included: active surveillance for infections and MDROs; barrier precautions; hand hygiene; and infection prevention education. The project was approved by the University of Michigan Institutional Review Board and was conducted in 12 (6 control, 6 intervention) community-based NHs in Michigan over the course of three years. Study inclusion criteria were: a) any short- or long-stay resident with an indwelling urinary catheter (urethral or suprapubic) and/or a feeding tube (nasogastric or percutaneous endoscopic gastrostomy tube) for >72 hours (residents with long-standing devices as well as new devices were included since all residents with devices were at risk for new MDRO acquisition or infection); and b) provision of informed consent. Residents receiving end-of-life care were excluded.

Upon enrollment, study visits occurred at baseline, day 14, and monthly thereafter for a maximum of one year (or until death, discharge, or device discontinuation). Residents who were admitted to acute care hospitals and returned to the NH remained in the study. Clinical and demographic data were obtained from the source documents at the participating facility and chart review conducted by trained research staff. Four hundred eighteen residents (control sites, $n = 215$; intervention sites, $n = 203$) were enrolled in the TIP study. For the current study, we focused on residents with an indwelling urinary catheter in place for more than one follow-up visit ($n = 208$).

Data Collection

Demographic data including age, race, and sex were recorded for each participant at study enrollment. The Charlson Comorbidity Index was calculated for each resident and the Lawton and Brody Physical Self-Maintenance Scale was used to assess patients' functional status at each study visit [15]. Clinical data such as device type, new infections, hospitalizations for any reason within the last 30 days (yes/no) and antibiotic usage within the last 30 days (yes/no, antibiotic, dosage, duration) were collected at enrollment and each subsequent study visit. CAUTIs were defined clinically, requiring a clinician's note documenting a UTI in a catheterized patient and the use of systemic antibiotics for 3 days to treat the infection.

Active surveillance cultures for MDROs were performed by obtaining microbiological samples from resident nares, oropharynx, enteral feeding tube and suprapubic device insertion sites, groin, peri-rectal area, and wounds at each follow-up visit, regardless of prior colonization status. Standard microbiologic methods were used to identify methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant enterococci (VRE), ceftazidime-resistant Gram-negative bacilli (CTZ-R GNB), and ciprofloxacin-resistant Gram-negative bacilli (CIP-R GNB) as previously described [9].

Statistical Analyses

We compared the incidence per 1000 device-days of three outcomes (CAUTI, antibiotic usage, and hospitalization) between residents with a urethral and a suprapubic catheter. A Coxproportional hazard model was used to determine the effect of catheter type on the three outcomes with and without adjusting for other covariates. We tested the proportional hazard assumption using Kaplan-Meier survival curves between the two groups. Since the outcomes are often recurrent events, we employed a counting process approach by considering the risk interval [16]. Covariate-adjusted hazard ratios adjusted for site intervention status, age, sex, race, comorbidity score, functional status, and the standard error for facility cluster. We also stratified our analysis by duration of catheter use (<90 days vs. ≥90 days). To compare catheter-type differences in MDRO colonization, we utilized the unpaired t-test; to compare the prevalence of MRSA, VRE, CTZ-R GNB, and CIP-R GNB positive samples, we used SAS 9.3 to run a generalized linear mixed model adjusting for facility-level clustering and intervention effect.

RESULTS

Study Population

Two hundred and eight NH residents had an indwelling urinary catheter in place during follow-up, contributing 21,700 device-days (Figure 1). Of these, 173 (83.2%) residents had an indwelling urethral catheter and 35 (16.8%) residents had a suprapubic catheter. Resident characteristics are shown in Table 1.

Rates of Infection, Hospitalization, and Antibiotic Usage

Table 2 shows incidence rates for CAUTI, recent hospitalizations, and recent antibiotic use in the total population and at the intervention vs. control sites. The unadjusted hazard ratio (HR) for CAUTI in suprapubic residents when compared to urethral catheter residents was 0.82 (95% CI, 0.61–1.11; $p = 0.21$). When adjusting for site intervention status, age, sex, race, comorbidity score, and functional status, the HR decreased to 0.73 (95% CI, 0.53–1.00; $p = 0.05$). The intervention did not change any of the observed differences between suprapubic and urethral catheters.

In an unadjusted model, patients with suprapubic catheters were 52% less likely to have been hospitalized in the past 30 days (HR, 0.48; 95% CI, 0.29–0.78; $p < 0.01$). After covariate-adjustment, suprapubic residents were still only half as likely to have been hospitalized in the previous 30 days than those with a urethral catheter (HR, 0.46; 95% CI, 0.32–0.67; $p < 0.01$).

The unadjusted HR for antibiotic use in suprapubic residents was 0.85 (95% CI, 0.711-0.02; $p = 0.08$). After covariate-adjustment, suprapubic residents were approximately 23% less likely to have been prescribed antibiotics in the previous 30 days (HR, 0.77; 95% CI, 0.62 – 0.96; $p = 0.02$).

Patients with Catheterization Extending Beyond 90 days

Because a major distinction between indwelling urinary catheterization in NH facilities and the acute care setting is duration of catheterization, we also analyzed infection outcomes in a subgroup of NH residents who were catheterized for ≥ 90 days. Sixty-six residents were catheterized for this length of time; 43 (24.9%) in the urethral catheter group and 23 (65.7%) in the suprapubic catheter group (Figure 1).

After covariate-adjustment, there was no statistically significant difference in CAUTI occurrence between residents with a suprapubic catheter in place for ≥ 90 days compared to those with a urethral catheter in place for ≥ 90 days (HR, 0.83; 95% CI, 0.61–1.16; $p = 0.29$). On the other hand, there remained a statistically significant reduction in hospitalizations among residents who had a suprapubic catheter compared to those with a urethral catheter for ≥ 90 days (HR, 0.53; 95% CI, 0.35–0.79; $p < 0.01$). There was no statistically significant difference in antibiotic usage in the past 30 days in suprapubic residents compared to urethral catheter residents (HR, 0.92; 95% CI 0.78–1.08; $p = 0.29$).

MDRO Colonization

We assessed MDRO colonization at different anatomic sites in residents with a urethral and suprapubic catheter, again stratifying by length of catheterization. For this analysis, we eliminated those residents who had both - a feeding tube and a urinary catheter, resulting in 124 residents with a urethral catheter only and 24 residents with a suprapubic catheter only (Figure 1). Among those catheterized for ≥ 90 days, residents with a suprapubic catheter had a significantly higher mean number of MDROs (0.57 vs. 0.44, $p = 0.01$) than residents with a urethral catheter. In particular, suprapubic residents were more commonly colonized at the groin and wounds (Table 3). Table 4 shows the specific organisms found in each group. CIP-R GNB were the most common organisms colonizing both urethral and suprapubic catheter residents (Table 4), specifically *Proteus mirabilis* and *Escherichia coli* (Table 5).

DISCUSSION

We compared rates of CAUTI, hospitalization, and antibiotic use among NH residents with either indwelling urethral or suprapubic catheter. We also examined MDRO colonization at various anatomic sites of residents with either types of catheter. We found that the use of a suprapubic catheter among NH residents was protective against CAUTI in residents catheterized <90 days, but this result did not reach statistical significance in those catheterized ≥ 90 days. We also found that residents with a suprapubic catheter were half as likely to be hospitalized, and 23% less likely to receive antibiotics in the past 30 days, when compared to residents with a urethral catheter. While suprapubic catheterization appeared to be advantageous in terms of clinical outcomes, NH residents with a suprapubic catheter were more likely to be colonized with MDROs.

Previous studies comparing urethral and suprapubic catheterization have revealed advantages and disadvantages to both [11,17–19]. In a systematic review and meta-analysis by Healy et al [11], suprapubic catheterization was associated with a significant reduction in postoperative UTIs (20% compared with 31%; pooled odds ratio [OR], 0.31; 95% CI, 0.185–0.512; $p < 0.01$) compared to urethral catheterization in gynecologic populations. However, suprapubic catheter patients had an increased risk of non-infectious complications including urine leakage, catheter blockage, haematuria and urinary retention (29% compared with 11%; pooled OR, 4.14; 95% CI, 1.33–12.9; $p = 0.01$). Another review by Hunter et al [19] identified studies comparing suprapubic catheterization to any other method of bladder emptying such as intermittent and indwelling urethral catheterization in adults. While the incidence of upper and lower urinary tract complications between urethral and suprapubic catheters was similar, suprapubic catheterization was associated with a lower incidence of urethral complications.

In our study, NH residents with suprapubic catheterization were less likely to be hospitalized, to receive antibiotics and to experience a CAUTI. This protective effect of suprapubic catheterization on hospitalization and antibiotic usage remained even after adjusting for covariates, including measures of comorbidity and functional status. It is possible that NH residents with suprapubic catheters are a different patient population with lower severity of illness. However, the parameters collected in our study suggest that the two groups had no significant differences in baseline characteristics other than female sex (the urethral catheter had a higher proportion of female patients) and length of catheterization (higher in the suprapubic group); both of these variables were adjusted for in cox regression models and the difference remained statistically significant. Importantly, there were no baseline differences in functional status or Charlson comorbidity scores and the results remained significant after adjusting for these indices. Our results call for future randomized prospective studies to evaluate differences in clinical outcomes based on catheter choices. Such studies can then inform choices made by practicing urologists.

It is possible that the protective effect of suprapubic catheters seen in this study signifies a true decreased risk of occult infection, urinary tract colonization, urosepsis, and other phenomena that may lead to clinical worsening or destabilization of a patient, requiring hospitalization and/or antibiotic usage. Care provision habits also differ between suprapubic and urethral catheters - suprapubic catheter sites are typically manipulated using sterile technique and only by nurses or advanced providers, while urethral catheters may be managed by nursing aides and with hand hygiene measures (hand washing, gloves), but not sterile technique [5].

Further, suprapubic catheters are visible in areas often examined (abdomen), while the perineal area may not be examined as frequently or with as much ease as the abdomen.

It is hypothesized that urethral catheters are associated with higher rates of CAUTI due to an increase in urethral trauma, catheter blockage, and manipulation of a device in close proximity to the perineal area and associated flora, of which many common species are known uropathogens [12,13]. While NH residents with a urethral catheter in our study did have higher rates of CAUTIs, they were less likely to be colonized with MDROs at the groin

and peri-rectal area compared to those with a suprapubic catheter, regardless of length of catheterization. Prospective culturing of multiple anatomic sites over prolonged period of time is a very unique strength of our study [7,8]. Previous studies involving MDRO colonization in device patients have not found significant differences between indwelling urethral and suprapubic catheter patients; however, these studies focus on microbiology reports of urine cultures rather than asymptomatic colonization [20,21]. Higher colonization with MDROs may play a role in transmission of MDROs from patient to environment, healthcare workers and other patients. Future studies should design interventions to reduce MDROs in this high-risk patients.

We acknowledge some limitations in our study. First, although we had substantial follow-up period as measured by device-days, the number of participants with a suprapubic catheter was low. Future studies should involve more facilities and study participants followed for a longer duration. Although beyond the scope of this study, future studies should also evaluate non-infectious complications related to suprapubic catheters, such as encrustation and blockage, skin and soft tissue infections, tissue erosion, and accidental removals. Lastly, we acknowledge that there are many different definitions used to define CAUTI. Prior work from our group has shown that there is a gap between clinically-defined CAUTIs and those defined by standardized criteria [9], such that only 20% of all clinically treated infections meet standardized criteria. We chose to use clinically-defined CAUTI because this measure represents actual antibiotic treated infections and antibiotic use remains a significant risk factor for MDRO colonization [2]. Major strengths of this study are its prospective longitudinal design that involved catheterized residents from multiple free-standing NHs. Data was collected and multiple anatomic sites of NH residents were cultured by trained research staff for an extended period of time. There are few studies assessing the effects of catheter type on infectious complications in the long-term care setting.

CONCLUSIONS

In a large prospective surveillance study focusing on NH residents with an indwelling device, 208 residents contributed 21,700 device-days with a urinary catheter in place. A larger percentage of these patients had a urethral catheter than a suprapubic catheter (83% vs. 17%). Suprapubic catheterization was associated with reduced rates of CAUTI, hospitalization and antibiotic usage. These findings suggest that suprapubic catheterization may be a safer alternative to indwelling urethral catheterization. Indwelling catheters and their management are a major source of urologic problems among NH residents. Our findings should lead to further investigations including randomized controlled trials to study safety of various urinary collection devices, increased communication between urologists and NH providers to improve urologic care and enhance comfort and quality of life of our aging populations.

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Abbreviations

NH	Nursing Home
UTI	Urinary Tract Infection
CAUTI	Catheter-Associated Urinary Tract Infection
MDRO	Multi-Drug Resistant Organism
TIP	Targeted Infection Prevention
PSMS	Physical Self-Maintenance Scale
MRSA	Methicillin-Resistant <i>Staphylococcus aureus</i>
VRE	Vancomycin-Resistant <i>Enterococcus</i>
CTZ-R GNB	Ceftazidime-Resistant Gram-Negative Bacilli
CIP-R GNB	Ciprofloxacin-Resistant Gram-Negative Bacilli
CI	Confidence Interval
HR	Hazard Ratio
OR	Odds Ratio

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Figure 1- Flow chart displaying the study participants.

The Targeted Infection Prevention (TIP) study included 418 residents from 12 different nursing home (NH) facilities who had an indwelling device in place (urinary catheter, feeding tube or both). Of these, 102 had only an initial study visit without subsequent follow-up. We excluded these patients from analysis. Of the remaining 316 residents, 91 had no catheter during the study period (i.e. had a feeding tube only) and 14 switched from one catheter type to another one. We also identified 3 residents with a catheter at the first visit only. These 108 residents were also excluded from the analysis, resulting in 208 NH

residents with an indwelling urinary catheter in place during follow-up. Of the 208 residents with an indwelling urinary catheter, 173 had a urethral catheter and 35 had a suprapubic catheter. We separated out those who had the device in place for <90 days or 90 days. For our analysis focusing on colonization with multi-drug resistant organisms, we excluded residents who had a feeding tube, isolating those residents who had a urinary catheter only (seen here under the black line).

Table 1.Baseline characteristics of nursing home residents with indwelling urethral and suprapubic catheters ($n = 208$)

Characteristic	Urethral Catheter ($n = 173$)	Suprapubic Catheter ($n = 35$)	Total ($n = 208$)	<i>p</i> value
Age, years, mean (SD)	74.7 (12.0)	71.0 (14.2)	74.1 (12.4)	0.11
Gender, Male	85 (49.1)	25 (71.4)	110 (52.9)	0.02
White	155 (89.6)	30 (85.7)	185 (88.9)	0.55
Baseline Weight, mean (SD)	186.9 (78.1)	175.7 (41.1)	185.0 (73.2)	0.23
Comorbidity Score, mean (SD)	2.9 (1.8)	3.0 (2.1)	2.9 (1.8)	0.85
PSMS ^a , mean (SD)	22.0 (3.9)	22.7 (3.5)	22.1 (3.9)	0.36
UC device-days				<0.001
90	43 (24.9)	23 (65.7)	66 (31.7)	
<90	130 (75.1)	12 (34.3)	142 (68.3)	
FT device-days				0.25
0 days	124 (71.7)	24 (68.6)	148 (71.2)	
1–30 days	11 (6.4)	2 (5.7)	13 (6.25)	
21–90 days	17 (9.8)	1 (2.8)	18 (8.7)	
>90 days	21 (12.1)	8 (22.9)	29 (13.9)	
Intervention site	90 (52.0)	16 (45.7)	106 (51.0)	0.50

Abbreviations: SD, standard deviation; PSMS, physical self-maintenance score; UC, urinary catheter; FT, feeding tube.

Data are no. (column %) of residents, unless otherwise indicated. *P* values were obtained using Student's *t*-test for continuous variables and chi-square test for categorical variables.^aThe Lawton and Brody scale assigns patients a score from 6 to 30, with 30 representing the highest level of physical dependence.

Table 2.

Clinical characteristics (i.e. infection, hospitalization and antibiotic rates)

	Rate, per 1000 device-days			Unadjusted Hazard Ratio	p value	Covariate-adjusted ^a Hazard Ratio	p value
	Urethral Catheter	Suprapubic Catheter					
Total population	n = 173	n = 35					
New CAUTI	8.8	6.6		0.82 (0.61 – 1.11)	0.21	0.73 (0.53 – 1.00)	0.05
Hospitalized in past 30 days	6.2	2.4		0.48 (0.29 – 0.78)	<0.01	0.46 (0.32 – 0.67)	<0.01
Antibiotic use in the past 30 days	20.2	15.7		0.85 (0.71 – 1.02)	0.08	0.77 (0.62 – 0.96)	0.02
Control sites	n = 83	n = 19					
New CAUTI	10.8	6.5		0.73 (0.47 – 1.15)	0.17	0.64 (0.44 – 0.94)	0.02
Hospitalized in past 30 days	6.9	3.0		0.51 (0.26 – 1.00)	0.05	0.43 (0.25 – 0.75)	<0.01
Antibiotic use in the past 30 days	21.5	15.6		0.81 (0.56 – 1.18)	0.28	0.73 (0.47 – 1.12)	0.15
Intervention sites	n = 90	n = 16					
New CAUTI	7.1	6.7		0.93 (0.60 – 1.43)	0.73	0.98 (0.71 – 1.34)	0.88
Hospitalized in past 30 days	5.6	1.7		0.39 (0.23 – 0.68)	<0.01	0.51 (0.26 – 1.02)	0.06
Antibiotic use in the past 30 days	19.2	15.8		0.89 (0.77 – 1.04)	0.15	0.81 (0.64 – 1.02)	0.07

Abbreviations: CAUTI, catheter-associated urinary tract infection.

^a Adjusted for site intervention status, age, sex, race, comorbidity score, functional status, and the standard error for facility cluster.

Table 3.

Mean number of multidrug-resistant organisms isolated from each anatomic site

Anatomic Site	Mean No. MDROs (95% CI)				<i>p</i> value ^a
	<90 days		90 days		
	Urethral Catheter (<i>n</i> = 91)	Suprapubic Catheter (<i>n</i> = 9)	Urethral Catheter (<i>n</i> = 33)	Suprapubic Catheter (<i>n</i> = 15)	
Nares	0.17 (0.11, 0.22)	0.22 (0.04, 0.40)	0.11 (0.07, 0.14)	0.15 (0.10, 0.20)	0.16
Oropharynx	0.21 (0.14, 0.29)	0.00 (-, -)	0.07 (0.03, 0.11)	0.03 (-0.00, 0.07)	0.19
Groin	0.46 (0.34, 0.58)	0.50 (0.05, 0.95)	0.69 (0.58, 0.80)	0.94 (0.76, 1.12)	0.02
Peri-rectal	0.93 (0.70, 1.17)	1.17 (-0.23, 2.56)	1.06 (0.90, 1.21)	1.22 (0.94, 1.50)	0.32
Wound	0.91 (0.28, 1.54)	2.33 (-1.46, 6.13)	1.14 (0.64, 1.65)	3.54 (2.07, 5.01)	<0.01
Total	0.39 (0.33, 0.44)	0.40 (0.19, 0.60)	0.44 (0.39, 0.49)	0.57 (0.48, 0.66)	0.01

Abbreviations: MDRO, multidrug-resistant organism; CI, confidence interval.

Data is from 148 residents who had a urinary catheter only (no feeding tube). The total number of swabs collected from each site include: 698 nares swabs; 647 oropharynx swabs; 719 groin swabs; 369 peri-rectal swabs; and 48 wound swabs. The 48 wound swabs were collected from 27 nursing home residents (22 urethral catheter; 5 suprapubic catheter).

^a P-values were obtained from unpaired t-test, unadjusted for clustering.

Table 4.

Microbial survey results for individual multidrug-resistant organisms in nursing home residents with a urethral catheter vs. suprapubic catheter

Organism	Number of MDRO Positive Samples No. Positive Samples/No. Samples Collected (%)			
	<90 days		90 days	
	Urethral Catheter (n = 91)	Suprapubic Catheter (n = 9)	Urethral Catheter (n = 33)	Suprapubic Catheter (n = 15)
MRSA	82/791 (10.4)	10/78 (12.8)	72/977 (7.4)	49/577 (8.5)
VRE	65/791 (8.2)	1/78 (1.3)	32/977 (3.3)	25/577 (4.3)
CTZ-R GNB	45/791 (5.7)	4/78 (5.1)	43/977 (4.4)	42/577 (7.3)
CIP-R GNB	96/791 (12.1)	12/78 (15.4)	227/977 (23.2)	155/577 (26.9)
Any MDRO	188/791 (23.8)	17/78 (21.8)	281/977 (28.8)	185/577 (32.1)
				<i>p</i> value ^a
				0.46
				0.33
				0.05*
				0.16
				0.22

Abbreviations: MDRO, multidrug-resistant organism; MRSA, methicillin-resistant *Staphylococcus aureus*; VRE, vancomycin-resistant enterococci; CTZ-R, ceftazidime-resistant; GNB, Gram-negative bacilli; CIP-R, ciprofloxacin-resistant.

Data is from 148 residents who had a urinary catheter only (no feeding tube).

^a *P* values were obtained using a generalized linear mixed model, adjusted for facility-level clustering.

Table 5.

Microbial survey results for ciprofloxacin-resistant gram negative bacilli in indwelling urethral catheters vs. suprapubic catheters

Organism	No. CIP-R GNB organisms/No. CIP-R GNB isolates (%)	
	Urethral Catheter	Suprapubic Catheter
<i>Acinetobacter baumannii</i>	17/393 (4.3)	17/216 (7.9)
<i>Escherichia coli</i>	147/393 (37.4)	66/216 (30.6)
<i>Klebsiella pneumoniae</i>	22/393 (6.0)	12/216 (5.6)
<i>Morganella morganii</i>	14/393 (3.6)	9/216 (4.2)
<i>Proteus mirabilis</i>	146/393 (37.2)	70/216 (32.4)
<i>Providencia stuartii</i>	13/393 (3.3)	14/216 (6.5)
<i>Pseudomonas</i> spp.	20/393 (5.1)	26/216 (12.0)
<i>P. aeruginosa</i>	15/393 (3.8)	17/216 (7.9)
<i>P. fluorescens</i>	0/393 (0)	4/216 (1.9)
<i>P. luteola</i>	3/393 (1.0)	1/216 (0.5)
<i>P. oryzihabitans</i>	2/393 (0.5)	3/216 (1.4)
<i>Pseudomonas</i> sp.	0/393 (0)	1/216 (0.5)
Other/Unknown ID	14/393 (3.6)	2/216 (1.0)

Abbreviations: CIP-R GNB, ciprofloxacin-resistant Gram-negative bacilli.