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Testing a Model of Self-Management of Fluid Intake in Community-Residing Long-Term Indwelling Urinary Catheter Users

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Abstract

Background—Urinary tract infection and blockage are serious and recurrent challenges for people with long-term indwelling catheters, and these catheter problems cause worry and anxiety when they disrupt normal daily activities.

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Objectives—The goal was to determine whether urinary catheter-related self-management behaviors focusing on fluid intake would mediate fluid intake related self-efficacy toward decreasing catheter-associated urinary tract infection (CAUTI) and/or catheter blockage.

Method—The sample involved data collected from 180 adult community-living, long-term indwelling urinary catheter users. The authors tested a model of fluid intake self-management (F-SMG) related to fluid intake self-efficacy (F-SE) for key outcomes of CAUTI and blockage. To account for the large number of zeros in both outcomes, a zero inflated negative binomial (ZINB) structural equation model was tested.

Results—Structurally, F-SE was positively associated with F-SMG, suggesting that higher F-SE predicts more (higher) F-SMG; however, F-SMG was not associated with either the frequency of CAUTI's or the presence or absence of CAUTI. F-SE was positively related to F-SMG and F-SMG predicted *less frequency* of catheter blockage, but neither F-SE nor F-SMG predicted the presence or absence of blockage.

Discussion—Further research is needed to better understand determinants of CAUTI in long-term catheter users and factors which might influence or prevent its occurrence. Increased confidence (self-efficacy) and self-management behaviors to promote fluid intake could be of value in long-term urinary catheter users to decrease catheter blockage.

Keywords

community-dwelling; self-efficacy; self-management; urinary catheter; urinary tract infection

Indwelling catheters are used long-term by a large number of individuals with neurogenic bladder and persistent urinary retention who are not able to perform intermittent catheterization due to a lack of hand dexterity or difficulty in transferring to a toilet. Catheters are also used less often for incontinence at the end of life or to aid in treating perineal wounds (Cottenden et al., 2013). Long-term catheter users are primarily people with spinal cord injury (SCI), multiple sclerosis (MS), prostate obstruction, diabetes, or other neurological problems.

Many studies have indicated that training can improve self-management of chronic illness (Coyle, Francis, & Chapman, 2013; Iversen, Hammond, & Betteridge, 2010). Self-efficacy has been shown to be a strong predictor of behavior change which often improves healthcare outcomes (Marks & Allegrante, 2005); however, no studies have been conducted to assess whether improvements in self-efficacy lead to better urinary catheter-related self-management and health outcomes. In this report, we used a structural equation model to test direct and indirect (via fluid intake self-management) effects of fluid intake self-efficacy on two of the most frequent and persisting catheter-related problems: catheter-associated urinary tract infection (CAUTI) and catheter blockage. Data were obtained as part of a randomized clinical trial designed to test the impacts on health outcomes of a self-management intervention with indwelling urinary catheter users (Wilde et al., 2015a).

Background

Urinary tract infection and blockage are serious and recurrent challenges for people with long-term indwelling catheters; and these catheter problems cause worry and anxiety when they disrupt normal daily activities (Wilde, 2003a). While there is a paucity of epidemiological research in this area and no relevant Cochrane reviews (Cottenden et al., 2013), two recent studies provide evidence of the widespread prevalence of these problems. In our team's earlier study of 43 people with long-term indwelling catheters, self-report data were collected bimonthly over an eight-month period through use of a simple log of catheter problems. Seventy percent reported urinary tract infections (for a rate of 8.4/1000 days) and 74% had blockage of the catheter from encrustations within the lumen (Wilde et al., 2010). In a larger sample of 202 long-term catheter users (the parent study for the current analysis) in a two-month period prior to commencing the randomized clinical trial (RCT), 31% reported having had catheter-associated urinary tract infection (CAUTI) (for a full group rate of 6.2/1000 days and 24% had blockage; (Wilde et al., 2013a). A benchmarking group in Missouri tracks homecare-related CAUTI rates, but their rate of 1.7/1000 catheter device days includes both short- and long-term catheter users (Missouri Alliance for Home Care 2011) confounding comparisons. Catheter-related problems also contribute to excess healthcare utilization (Wilde et al., 2013a; Wilde et al., 2010). Associated healthcare utilization involves additional visits with a homecare nurse, clinic staff, or emergency department and/or lab and pharmacy expenses, as well as hospitalization for CAUTI (Wilde et al., 2013a).

Finally, long-term catheter users often have different issues and care practices, and, thus, guidelines for acute care settings are not always transferrable. For instance, despite the U.S. Centers for Disease Control Guidelines for Prevention of CAUTI which recommends change of the catheter for blockage (Gould et al., 2009), we found in the two months prior to beginning the parent RCT that 42% of the 202 study participants had irrigated their catheters to manage catheter encrustation and blockage (Wilde et al., 2013a). This report was consistent with our previous study of 43 persons over eight months in which 40% irrigated (Wilde et al., 2010).

Most intervention research in people with indwelling catheters has been related to preventing CAUTI through the use of coatings on the catheter, instillations to the drainage bag, or special cleaning of the urinary meatus. While silver or antimicrobial catheter coatings may be beneficial in acute care settings for up to two weeks, no studies have been conducted on the effectiveness of this method in long-term catheter users. Drainage bag instillations and meatal care have not had any effect in decreasing CAUTI (Parker et al., 2009). Neither catheter irrigation nor instillations have been shown to be effective in preventing blockage (Moore et al., 2009).

Description of the Parent Study and Key Results

The full parent sample involved 202 long-term indwelling urinary catheter users over age 18 from a northeastern U.S. state, with about 75% referred through a large city's homecare agency, and the remainder from homecare, hospital clinics, and private urological offices in the same state in urban/suburban, and rural areas. The study was an RCT designed to test the effectiveness of a catheter self-management intervention. The research took place in the homes of study participants who lived in the community, with an initial home visit interview and bimonthly assessments for 12 months. At baseline, the groups were not significantly different by age, sex, type of catheter (43% suprapubic, 57% urethral), catheter or balloon size, or length of use (Wilde et al., 2015a). The researchers present a full description of the sample of 202 persons elsewhere (Wilde et al., 2013a).

The self-management intervention was built inductively based on several prior descriptive (face-to-face interview) studies by the researchers in which catheter users stated that they had learned to pay attention to urine flow to prevent complications (Wilde, 2002), and that fluid intake helped prevent CAUTI (Wilde & Dougherty, 2006). Moreover, during the pilot study for the parent RCT, fluid intake was viewed by study participants to be the most helpful part of the self-monitoring intervention (Wilde & Brasch, 2008).

Persons randomized to the control group received usual care, which involved catheter-related care from a homecare agency and/or urological office staff, such as routine catheter changes or securing treatment for CAUTI. For the intervention group, trained study nurses conducted three home visits. Two intervention home visits took place in the first month—roughly a week apart—to teach self-monitoring and self-management, use of a urinary diary/journal, and to set goals. A follow-up phone call took place two weeks later to answer questions and revise goals and the action plan as needed. A final boost of the intervention took place with one more home visit at four months. Most home visit contacts took place, with 98% completion for home visit (HV)1, 95% for HV2, 93% for the phone call, and 91% for HV3. Full informed consent and organizational human subjects' approval was received for all study participants. Further details on the intervention are provided elsewhere (Wilde et al., 2013b).

Results of the trial indicate that the presence or absence of blockage decreased significantly in the first six months in the experimental group, but this result was not sustained over 12 months of the study; there was no group effect on CAUTI (Wilde et al., 2015a). Therefore, the present analysis for the structural equation model (SEM) involved testing a subsample (N = 180) taken from the full sample (see below in "Methods"), specifically examining relationships during the second six months of the study.

Theoretical Framework

Catheter Self-Management

Effective self-management could prevent catheter-related problems and improve quality of life. To prevent or minimize catheter-related problems, catheter users need to be aware of what to notice so that problems can be identified early and effective behaviors can be implemented.

Self-management skill is developed paying attention to the body and through periodic assessment of symptoms through observations and/or recordings (i.e., self-monitoring activities) (Wilde & Garvin, 2007). Learning to pay attention to bodily sensation and knowing what they mean for that person may be critically important in preventing problems in people with chronic conditions, such as those with catheter-related problems. Paying attention is an embodied process (Wilde, 2003b) which ties together awareness and self-monitoring activities, and it involves knowledge of living with a condition, including social contexts. People need to know what to notice (like typical symptoms) and use methods of observation or tools to keep track of changes (e.g., diaries, journals, or other recordings). Therefore, self-management is conceptualized as a combination of awareness (knowing what to notice), self-monitoring (routine observations or recordings, Wilde & Garvin, 2007), and self-management behaviors which are expected to minimize chronic problems or complications. Based on the study results from our pilot (Wilde & Brasch, 2008), a major intervention focus for the RCT was on preventing catheter problems through optimal and consistent levels of fluid intake (about 30 mL/kg body weight).

Self-efficacy is behavior specific, tested in research widely, and found to contribute to improved behavioral outcomes. Study nurses used a manualized intervention to enhance several sources of self-efficacy, including mastery experiences, vicarious observation, verbal persuasion, and knowledge of physiological status (Bandura, 1997).

CAUTI and Blockage

While bacteria are present in the urine of virtually all who have been catheterized for over 30 days, a life-threatening situation can occur if symptomatic CAUTI is not controlled and develops into deadly sepsis (Jacobsen, Stickler, Mobley, & Shirtliff, 2008). A systemic (and symptomatic) infection can develop if bacteria gain access to the bladder mucosa, first by adhering to it, and then by entering the bladder wall through abrasions or compromised areas (Girão, Baracat, & Lima, 2002). Trauma (i.e., tissue damage) to the bladder mucosa, can contribute to CAUTI by rough catheter insertion, traction on the urethra or bladder neck, suction forces created by improper positioning of the drainage bag (Glahn, Braendstrup, & Olesen, 1988), or blockage that increases intraluminal pressure and results in ischemia. Some people seem prone to persistent blockage, and those with higher urinary pH are likely to experience more blockages. *Proteus mirabilis* (the most common cause of blockage) is more prevalent in long-term catheter users, and a single strain can persist for many months despite repeated antibiotic treatments (Girão et al., 2002). In addition, resistance is common in people treated with antibiotics for CAUTI in community-dwelling catheter users (Roghmann, Wallin, Gorman, & Johnson, 2006), making the persistent organisms difficult to eradicate.

Fluid Intake in Preventing Blockage

Consistent and optimal levels of fluid intake might be able to alter the pH nucleation point in which calcium, phosphorus, and magnesium precipitate in urine (from urea) causing encrustation and blockage (Stickler & Morgan, 2006). Therefore, making consistent observations (self-monitoring), such as the color of urine, to indicate fluctuations in fluid intake could remind the person to increase fluids when indicated. This could decrease blockage and extend the length of the time with the catheter, which is considered of benefit. As blockage and CAUTI have been shown to be related, in the parent study and in our previous research (Wilde et al., 2013a; Wilde & Carrigan, 2003; Wilde et al., 2010), fewer blockages could also contribute to fewer episodes of CAUTI.

Methods for SEM Testing

Participants

Of the 202 persons in the parent study, 22 were missing all data used in the present modeling, resulting in a sample of 180 for model testing. Of the 180, 90 were men (50%), and ages ranged from 19 to 95 years (M = 60.58, SD = 17.43). Catheter use ranged from one month to 470 months (M = 75.12 months, SD = 86.51 months). In terms of race, 101 were White/Caucasian (57%), 57 were Black/African American (32%), and 22 were other races (12%). In relation to ethnicity, 21 were Hispanic (12%). The majority had a high school education or higher, including 36% with a college degree. Most were not employed (169; 94%); six were employed full time, and five part time. Additionally, 59 were never married (33%), 51 were married or living with a partner (28%), 37 were separated or divorced (21%), and 33 were widowed (18%). The number of people living in the household ranged from one (mode, 37%) to eight (M = 2.16, SD = 1.32). Urethral catheters were used 54% of the time and suprapubic 46%.

Measurement

Seventy-five percent of the sample completed the full 12 months of the study, with no differences in attrition rates across experimental or control conditions. Health status outcomes (CAUTI, blockage) were measured at baseline, for the prior two months through a home interview, and thereafter by phone call every two months, aided by a simple calendar in which catheter problems were noted (i.e., U for CAUTI, B for blockage). Key theoretical measures (catheter-related, self-efficacy and self-management) were measured at baseline, six and 12 months.

Catheter blockage and CAUTI were measured by slightly revised instruments originally developed in a pilot study (Wilde & Brasch, 2008). CAUTI was defined as a urinary infection which was treated with an antibiotic. Blockage was defined as an internal obstruction of urine flow through the catheter due to sediment or encrustation that requires additional efforts to reestablish steady and free passage of urine, namely through irrigation or catheter change. Kinks or twists in the catheter affecting urine flow were not viewed as blockage. Two new measures were created for this trial: urinary catheter self-efficacy (C-SE) and urinary catheter self-management (C-SMG). Catheter-related, self-efficacy and self-management scales were modeled on Stanford's Chronic Disease Programs (CDSMP [http://patienteducation.stanford.edu/programs/cdsmp.html]) and revised to reflect catheter users' issues. A manuscript reporting development and psychometric testing for both measures (C-SE and C-SMG) is available (Wilde et al., 2015b). Subscales of Fluid Intake Self-Efficacy and Fluid Intake Self-Management were used in the current study.

Fluid Intake Measures and Key Outcome Variables

Fluid Intake Self-Efficacy (F-SE)—A three-item subscale labeled Fluid Intake Self-Efficacy (F-SE) was used in the present study comprised the following items:

- drink adequate fluids throughout the day;
- make changes in fluids related to activity, temperature and travel; and
- keep intake of water and caffeine to a level that's good.

Participants were asked to rate how confident he or she felt in performing each item and responded on a visual analog scale from 1 = *not confident at all* to 10 = *totally confident*. Cronbach's alpha for this scale was 0.76 (Wilde et al., 2015b). Data were collected at six and 12 months (conclusion) of the study.

Fluid Intake Self-Management (F-SMG)—The five-item subscale labeled Fluid Intake Self-Management was used in the present study comprised:

- How often do you pay attention to amount of fluids consumed?
- How often do you keep track of fluid intake?
- How often do you pay attention to types of fluids consumed?
- How often do you keep track of information about urine?
- How often do you make changes in types and amounts of fluids depending on urine?

Participants rated each item using the following three-point scale: 1 = *Not at all*; 2 = *Sometimes;* 3 = *Most or all of the time*. Cronbach's alpha for this variable was 0.76 (Wilde et al., 2015b). Data were collected at six and 12 months (conclusion) of the study.

CAUTI and Blockage—Counts of both CAUTI and catheter blockage were based on information recorded by study participants over a two-month period for the last six months of the study using a calendar and reported to research staff at each bimonthly assessment. Within each two-month period, blockage was winsorized (minimized) to nine to adjust for outliers. For counts, a six-month rate was computed by summing the number of events across the three time points from six to 12 months and dividing by 180 days and multiplying by 1000 resulting in blockage and CAUTI rates/1000 catheter device days. For participants missing any of the time points, mean imputation was used (72% of the sample had all three data points; for CAUTI, eight of the 180 were missing all three data points, 13 were missing two data points, and 29 were missing one data point; for blockage, eight were missing all three data points, 14 were missing two data points, and 27 were missing one data point).

Analysis

A model of catheter self-management was tested with both direct and indirect effects, via associations with fluid intake self-management and fluid intake self-efficacy on each of the key outcomes of CAUTI and blockage. Our preliminary testing did not show any intervention effects on self-efficacy or self-management. In the parent study, there was no group effect on CAUTI and the decreased blockage which occurred in the experimental group in the first six months did not continue in the second six months of the study (Wilde et al., 2015a). Therefore, the model was tested making use of the complete sample, disregarding intervention status, testing the measures at six months, and the outcomes at six to 12 months.

M*plus* structural equation modeling software using robust standard errors was used to test the proposed model (Muthén & Muthén, 1998–2012). CAUTI and blockage data contained excess or frequent zeroes. While many persons did not experience the event, others were affected often, sometimes as much as several times a week (e.g., with blockage) (Wilde et al., 2013a). To handle the excess zeroes in the rate data, a zero inflated Poisson (ZIP) model as well as a zero inflated negative binomial (ZINB) model (Atkins & Gallop, 2007) was considered. However, the ZINB model significantly improved the fit of the model tested (change in log likelihood = 65.624, $df = 2$, $p < .001$) and each dispersion parameter was significant in the ZINB model (CAUTI: $\alpha = .235$, $p < .001$; blockage: $\alpha = .585$, $p = .001$). Thus, we used ZINB for final model testing.

We applied robust maximum likelihood (RML) estimation in our model, which is the estimator supported by M*plus* for our model (ZINB SEM). While weighted least squares (WLS) is generally the preferred estimator when dealing with categorical variables, such as our SMG indicator variables, bias tends to be noted within the measurement portion of the model (Rhemtulla, Brosseau-Liard, & Savalie, 2012). Examination of our measurement model under both estimators (not shown) demonstrated that bias is minimal, including in the correlation between fluid intake self-efficacy and self-management (.240 vs. .245). While approximate goodness-of-fit indices are not available for structural equation models involving zero-inflated count data, our measurement model under confirmatory factor analysis generated indices indicating good model fit: $\chi^2 = 26.58$, $p = .12$; $\chi^2/2 = 1.40$; Comparative Fit Index = 0.986; Tucker-Lewis Fit Index = 0.979; root mean squared error of approximation = 0.05, 90%C [0.000, 0.092].

Structurally, the model specifies that the association between self-efficacy and blockage or CAUTI is at least partially mediated by self-management of fluid intake. The indirect effects (product of the structural paths) were assessed using bias-corrected bootstrap confidence limits (MacKinnon, Lockwood, & Williams, 2004). Significance of the indirect effects was assessed by whether or not the 95% confidence interval contains zero. This approach takes the non-normality of the multiplicative distribution into account (resulting in asymmetric confidence limits) and has been shown to provide the most accurate confidence limits and greatest statistical power when compared with other approaches for detecting mediation (MacKinnon et al., 2004). The latent variables of Fluid Intake Self-Efficacy and Fluid Intake Self-Management were measured using the items as described above. The categorical Self-Management of Fluid Intake items were modeled as ordinal indicators using the delta parameterization method (Muthen & Asparouhov, 2002), which results in residual variances of the categorical indicators not being identified and are not part of the model; the measurement residuals of the categorical indicators are not free parameters, but instead reflect the remainder of 1 minus the squared the completely standardized factor loading. To provide a metric for the Fluid Intake Self-Efficacy latent variable and to identify the measurement model, the first construct loading for this latent construct was set to 1.0.

The full-information maximum likelihood estimation method was used as a means of efficiently incorporating all of the available information. Full-information estimation has been shown to provide more realistic parameter estimates than other missing data techniques (e.g., listwise, pairwise, mean imputation; Arbuckle, 1996). Though “missing at random” cannot be proven, we are reasonably confident that the data presented is at least missing at random, given that missingness among the items was fairly limited (rates of completion by item for the 180 participants ranged from 87% to 96%), and we have little reason to believe that missingness was systematic based on blockage or CAUTI rates or based on underlying self-efficacy or self-management. However, even if not missing at random (or missing completely at random), the use of full information estimation provides less biased estimates than do the more traditional listwise or pairwise approaches (Arbuckle, 1996). Despite this caveat, we do note that no substantive differences were found when running the model under listwise deletion of missing data (same pattern of statistically significant measurement and structural path coefficients).

Results

Tables 1 and 2 present the means, standard deviations, and correlations among the study variables. Examination of Table 1 suggests that over dispersion exists in both of the dependent variable rates, as the standard deviations exceed the mean in both instances. Over 60% of the sample (61.0%) had no CAUTI’s over the six-month period and close to 80% had no blockage (78.9%). Not surprisingly, the self-efficacy items were all moderately correlated (Table 2) as were the self-management items. Though not presented in Table 2, pairwise sample sizes ranged from a low of 148 (correlation between the third self-efficacy item and rate of blockage) to a high of 171 (correlation between rate of blockage and rate of CAUTI). Full-information estimation, however, makes use of the full sample size in providing parameter estimates.

Figure 1 presents results of the structural equation model predicting rates of CAUTIs and catheter blockage. Parameters for the measurement model are shown in standardized form; structural coefficients are presented in unstandardized log form for all parameters except those associated with paths leading to presence/absence components of the zero-inflated model, which are shown in log odds ratio form. Since the exogenous variables in the model are latent with an arbitrary scale, exponentiation of coefficients has little advantage for interpretation (exponentiated coefficients are nonetheless provided; see Supplemental Digital Content 1).

As shown, parameter estimates for the measurement parameters of fluid intake self-efficacy and fluid intake self-management were reasonably high, and all were significant (standardized loadings range from .57 to .94; $p < .001$). Structurally, fluid intake self-efficacy was positively associated with fluid intake self-management ($b = .37$; $p = .009$), suggesting that higher self-efficacy predicts more (higher) self-management. Fluid intake self-management, however, was not associated with either the frequency (count) of CAUTI’s ($b = -.04$, $p = .38$) or the presence or absence of CAUTI’s ($b = .06$, $p = .55$). The specific indirect effects of self-efficacy mediated by self-management on either the presence or absence of CAUTI (indirect effect total estimate = .02, 95% CI [−.03, .12]) or on the rate of CAUTIs (indirect effect total estimate = −.02, 95% CI [−.08, .02]) were not significant. Additionally, fluid intake self-efficacy was not directly related to the presence (b =−.19, p = .15) or frequency of CAUTI's (b = −.01, p = .95).

In terms of catheter blockage, fluid intake self-management did mediate the relationship between fluid intake self-efficacy and frequency of catheter blockage (indirect effect total estimate = −.09, 95% CI [−.22, −.02]). Self-efficacy was positively related to self-management and self-management, in turn, was related to the frequency of catheter blockage (b = −.24, p = .002)—higher self-management predicts less catheter blockage. Neither self-efficacy (b = .07, p = .70) nor self-management (b = −.07, p = .52) was significantly associated with the presence or absence of blockage. Not surprisingly, this indirect effect was also nonsignificant (indirect effect total estimate = −.03, 95% CI [−.17, .05]).

Discussion

The present study provides some evidence demonstrating the role of fluid intake self-efficacy and self-management in the prevention of two of the most prevalent problems associated with long-term indwelling catheters, CAUTIs and blockage. The model tested helps explain "how" self-efficacy and self-management might exert protective benefits in the prevention of catheter blockage. Specifically, our results suggest that that the relationship between fluid intake self-efficacy in catheter care and future blockage rates (frequency) is mediated by fluid intake self-management. This finding, however, was not associated with the presence or absence of blockage or for the presence or absence, or rates of CAUTIs. Implications for self- and nursing-care are discussed.

Structural equation modeling has been used to test models of self-management of other chronic conditions, for example in type 2 diabetes (Walker, Gebregziabher, Martin-Harris, & Egede, 2015). Self-efficacy or social cognitive theory, from which self-efficacy theory has been derived (Bandura, 1997), has been used also in SEM to examine key theoretical relationships as in a study to test whether depression and contraceptive self-efficacy were related and whether this relationship differs by pregnancy status (Carvajal et al., 2014). Results of SEM are often mixed, meaning some predicted hypotheses hold up and others do not, providing information for further key research questions. For instance, in the study of the effects of social determinants (social support, psychological distress) on the glycemic control (HbA1c) of type 2 diabetic patients (Walker et al., 2015), self-care did not mediate the effect of determinants on health (a somewhat unexpected finding). While determinants were related to both self-care and glycemic control (in the expected directions), the association between self-care and glycemic control was not significant after accounting for the effects of social determinants. The researchers (Walker et al., 2015) conclude that much more attention should be devoted to these social determinants in the care and treatment of persons with type 2 diabetes.

In our structural equation modeling, we too had mixed results. Our model focuses on fluid intake, which is a key component in self-management of catheter care to attain optimal and consistent levels of fluids. The results of the SEM model testing are consistent with our hypothesis that self-efficacy would be mediated by self-management and contribute to a primary outcome of decreased blockage frequency, but this result did not endure when testing for whether it occurred or not. We are not sure why this discrepancy, but the testing suggests that people with more frequent blockages (i.e., higher rates) may have been motivated to consume increased fluid intake. We believe that the counts represented in rates per 1,000 catheter days is a suitable six-month indicator of outcomes because rates account for the varying length of time the catheter was in situ and occurrence of adverse events over time.

Nevertheless, the results provide preliminary, though modest, evidence that confidence about fluid intake may contribute to self-management behaviors related to fluid intake, which relates to catheter blockage. Increased fluid intake can make the urine more diluted and, thus, decrease the pH nucleation point, which causes precipitation of urinary sediment causing blockage. In a study by Khan, Housami, Melotti, Timoney, and Stickler (2010), patients with blockage were given three drinks of one liter in addition to their usual fluids during a six-week crossover study. After a control period, the sample of 24 patients was allocated for one week in each treatment—lemon/water drink, potassium citrate/water drink, and plain water—with a washout period of one week in between. Each of the additional fluid drinks, including plain water, increased the pH nucleation point from baseline and the safety margin (pH nucleation minus voiding pH level) also dropped significantly (Khan et al., 2010). We had not considered use of a lemon/water drink nor potassium citrate because we did not administer any fluids as in the Khan et al. study (Khan et al., 2010), and we would not have been able to provide surveillance in the home settings of 101 persons during their 12 month participation. Importantly, our focus was to support and empower the experimental group participants to make their own decisions and better manage their health, related to their catheter. Encouraging optimal and consistent amounts of plain water throughout the day was sufficient, safe, and would be feasible for clinical practice. Also, in our study, because both groups were asked about their confidence (self-efficacy) and self-management behaviors related to fluids at baseline and six months, as well as the occurrence and details related to blockage bimonthly throughout the study, participants might have been motivated to drink more fluids. Self-monitoring through use of a catheter calendar related to the bimonthly phone calls also might have impacted the model testing results, as both intervention and control groups had significantly less blockage over the 12 months of the study (Wilde et al., 2015a).

While nurses routinely advise patients to drink fluids to help prevent catheter-related problems of both blockage and CAUTI, until now there has been little evidence-based research. While some persons might have received instruction about drinking a lot of fluids, such as those with spinal cord injuries who often learn this in rehabilitation (Fowler, Godfrey, Fader, Timoney, & Long, 2014), others may not have had much instruction. In one of our previous studies, catheter users said they knew they were to drink extra fluids, but they did not know how much to drink, nor were they given guidance on making behavior changes (Wilde & Dougherty, 2006). For instance, there was a wide range in the study participants' three-day fluid intake measurements, which ranged from 1380–8360 mL, and three people had consumed an average of 8000 mL/day, not knowing that this was too much and could "wash away" some of the urine's protective components. Drinking adequate amounts of fluids on a consistent basis might not be easy, however, and patients likely need support in this effort. We recommend the fluid intake guideline of 30 mL/kg body weight (Gray & Krissovich, 2003).

Results were not consistent with our hypotheses related to the outcome of CAUTI. It is likely that there are more factors contributing to CAUTI than fluid intake which could be related to a wide range of individual differences, such as changes which could have taken place in the bladder mucosa (urothelium) due to persistent CAUTI episodes or other factors. Physiological research related to urinary tract infection is promising, particularly in the study of biomarkers and urothelial defense mechanisms (Birder et al., 2012), but much more research will be required for a full understanding of the complex issues of CAUTI in persons with long-term indwelling urinary catheters.

The indwelling catheter seems to be a simple technology, but it is one that has been virtually unchanged for 75 years—outside of coatings like silver alloy and nitrofurazone, which have not been tested in long-term catheter users (Parker et al., 2009). Though smaller numbers of people need to use long-term catheters, for them, this is an area badly in need of innovation to improve catheter design and possibly decrease the incidence of CAUTI.

Limitations

There are several limitations to the present study. For our definition of CAUTI, we used the study participants' reports of provider diagnosis of CAUTI as having been treated with an antibiotic for urinary infections. We acknowledge that this is not the ideal way to define CAUTI in long-term catheter users; however, we did not have a way to know which criteria were used for treatment, such as the type and number of symptoms and knowledge of the patient. Standard definitions for CAUTI (http://www.cdc.gov/nhsn/pdfs/pscManual/7pscCAUTIcurrent.pdf.) are targeted to patients in acute care settings and assume no ongoing (long-term) catheter use. Furthermore, key CAUTI symptoms might not be predictors in this population, such as urgency or frequency (Wilde et al., 2013a), and urine cultures were not feasible in this study due to enrollment through multiple homecare agencies and urological or rehabilitation clinics. Also, while actual fluid intake had been measured by the first author previously (Wilde & Dougherty, 2006), this was not done in the parent RCT study. The purpose in the larger study was to improve catheter self-management, and only the experimental group measured their three-day fluid intake and urine output.

We applied robust maximum likelihood (RML) estimation in our model, which is the estimator supported by M*plus*. While weighted least squares (WLS) is generally the preferred estimator when dealing with categorical variables, bias tends to be noted within the measurement portion of the model (Rhemtulla et al., 2012). Examination of our measurement model under both estimators demonstrates that bias is minimal, including in the correlation between Fluid Intake Self-Efficacy and Self-Management (.240 vs. .245).

Though listwise deletion of missing data tends to produce more biased parameter estimates than other approaches (Graham, 2009; Roth, 1994), the amount of missing data in the present study is a limitation. We believe, however, that the mean imputation used in computing rates for the missing outcome data coupled with the full information maximum likelihood approach for the model tested makes efficient use of the data collected and adds to the generalizability of the findings. Also, while group differences did not impact major outcomes during the second half of the study (Wilde et al., 2015a), it is unclear whether the intervention might have contributed to the present results. Importantly, outcome data for both groups were self-reported through bimonthly telephone interviews and use of a simple catheter calendar to facilitate recall. Future research in a large homecare agency could incorporate objective indicators (e.g., medical records) to minimize self-report bias. Finally, the model is acknowledged as a simple one, and not all variables or subgroups of people were examined.

Conclusion

A structural equation model was tested in long-term indwelling urinary catheter users to determine whether self-management behaviors focusing on fluid intake would mediate the relationship between catheter self-efficacy and outcomes of catheter blockage and CAUTI. The model predicted the expected outcome in rates of blockage but not the presence/absence of blockage. The model did not predict CAUTI outcomes. The occurrence of CAUTI appears to be more complex, and further research is indicated. For instance, prospective studies which link biomarkers in persons with frequent CAUTI (i.e., more than one or two per year) could provide information about factors associated with this phenomenon. Notably, increases in fluid intake could have potential in decreasing catheter blockage in long-term indwelling urinary catheter users.

This is the first known test of a mediational model examining predictors of self-management of a long-term indwelling urinary catheter addressing catheter blockage and CAUTI outcomes. While the results are promising in how blockage might be affected by self-efficacy and self-management behaviors, more research is needed to better understand other determinants of catheter blockage, what might help decrease CAUTIs, and whether simple self-monitoring in tracking catheter problems would be of benefit.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References

Arbuckle, JL. Full information estimation in the presence of incomplete data. In: Marcoulides, GA.; Schumacker, RA., editors. Advanced structural equation modeling: Issues and techniques. Mahwah, NJ: Erlbaum; 1996. p. 243-277.

Atkins DC, Gallop RJ. Rethinking how family researchers model infrequent outcomes: A tutorial on count regression and zero-inflated models. Journal of Family Psychology. 2007; 21:726–735.10.1037/0893-3200.21.4.726 [PubMed: 18179344]

Bandura, A. Self-efficacy: The exercise of control. New York, NY: W. H. Freeman; 1997.

Birder LA, Ruggieri M, Takeda M, van Koeveringe G, Veltkamp S, Korstanje C, Fry CH. How does the urothelium affect bladder function in health and disease? ICI-RS 2011. Neurourology and Urodynamics. 2012; 31:293–299.10.1002/nau.22195 [PubMed: 22275289]

Carvajal DN, Ghazarian SR, Crowne SS, Brown PB, Pokras OC, Duggan AK, Barnet B. Is depression associated with contraceptive motivations, intentions, and use among a sample of low-income Latinas? Women's Health Issues. 2014; 24:e105–e113.10.1016/j.whi.2013.10.003 [PubMed: 24439935]

Cottenden, A.; Bliss, DZ.; Buckley, B.; Fader, M.; Gartley, C.; Hayer, D.; Wilde, MH. Management using continence products. In: Abrams, P.; Cardozo, L.; Khoury, S.; Wein, A., editors. Incontinence: 5th international consultation on incontinence. Arnheim, The Netherlands: Incontinence, International Consultation on Urological Diseases European Association of Urology; 2013. p. 1651-1786.

Coyle ME, Francis K, Chapman Y. Self-management activities in diabetes care: A systematic review. Australian Health Review. 2013; 37:513–522.10.1071/AH13060 [PubMed: 24018058]

Fowler S, Godfrey H, Fader M, Timoney AG, Long A. Living with a long-term, indwelling urinary catheter: Catheter users' experience. Journal of Wound, Ostomy, & Continence Nursing. 2014; 41:597–603.10.1097/WON.0000000000000069

Girão MJ, Baracat EC, Lima GR. Urinary tract infection: Immunological aspects. International Urogynecology Journal. 2002; 13:195–197.10.1007/PL00004048

Glahn BE, Braendstrup O, Olesen HP. Influence of drainage conditions on mucosal bladder damage by indwelling catheters. II. histological study. Scandinavian Journal of Urology and Nephrology. 1988; 22:93–99. [PubMed: 3206221]

Gould, CV.; Umscheid, CA.; Agarwal, RK.; Kuntz, G.; Pegues, DA. the Healthcare Infection Control Practices Advisory Committee (HICPAC). Guideline for prevention of catheter-associated urinary tract infections 2009. Atlanta, GA: Centers for Disease Control and Prevention; 2009.

Graham JW. Missing data analysis: Making it work in the real world. Annual Review of Psychology. 2009; 60:549–576.10.1146/annurev.psych.58.110405.085530

Gray M, Krissovich M. Does fluid intake influence the risk for urinary incontinence, urinary tract infection, and bladder cancer? Journal of Wound, Ostomy, & Continence Nursing. 2003; 30:126–131.10.1067/mjw.2003.117

Iversen MD, Hammond A, Betteridge N. Self-management of rheumatic diseases: State of the art and future perspectives. Annals of the Rheumatic Diseases. 2010; 69:955–963.10.1136/ard.2010.129270 [PubMed: 20448289]

Jacobsen SM, Stickler DJ, Mobley HLT, Shirtliff ME. Complicated catheter-associated urinary tract infections due to *escherichia coli* and *proteus mirabilis*. Clinical Microbiology Reviews. 2008; 21:26–59.10.1128/CMR.00019-07 [PubMed: 18202436]

Khan A, Housami F, Melotti R, Timoney A, Stickler D. Strategy to control catheter encrustation with citrated drinks: A randomized crossover study. Journal of Urology. 2010; 183:1390–1394.10.1016/j.juro.2009.12.024 [PubMed: 20171661]

MacKinnon DP, Lockwood CM, Williams J. Confidence limits for the indirect effect: Distribution of the product and resampling methods. Multivariate Behavioral Research. 2004; 39:99–128.10.1207/s15327906mbr3901_4 [PubMed: 20157642]

Missouri Alliance for Home Care (MAHC). Infection Surveillance Project. Jefferson City, MO: Author; 2011. Bladder catheter infection rate comparison Q32011.

Marks R, Allegrante JP. A review and synthesis of research evidence for self-efficacy-enhancing interventions for reducing chronic disability: Implications for health education practice (Part II). Health Promotion Practice. 2005; 6:148–156.10.1177/1524839904266792 [PubMed: 15855284]

Moore KN, Hunter KF, McGinnis R, Bacsu C, Fader M, Gray M, Voaklander DC. Do catheter washouts extend patency time in long-term indwelling urethral catheters?: A randomized controlled trial of acidic washout solution, normal saline washout, or standard care. Journal of Wound, Ostomy, & Continence Nursing. 2009; 36:82–90.10.1097/01.WON.0000345181.37656.de

Muthén, BO.; Asparouhov, T. Latent variable analysis with categorical outcomes: Multiple-group and growth modeling in M*plus*. M*plus* web notes: No. 4. 2002. Retrieved from https://www.statmodel.com/download/webnotes/CatMGLong.pdf

Muthén, LK.; Muthén, BO. Mplus user's guide. 7. Los Angeles, CA: Muthén & Muthén; 1998–2012.

Parker D, Callan L, Harwood J, Thompson DL, Wilde M, Gray M. Nursing interventions to reduce the risk of catheter-associated urinary tract infection. Part 1: Catheter selection. Journal of Wound, Ostomy, & Continence Nursing. 2009; 36:23–34.10.1097/01.WON.0000345173.05376.3e

Rhemtulla M, Brosseau-Liard PE, Savalei V. When can categorical variables be treated as continuous? A comparison of robust continuous and categorical SEM estimation methods under suboptimal conditions. Psychological Methods. 2012; 17:354–373.10.1037/a0029315 [PubMed: 22799625]

Roghmann MC, Wallin MT, Gorman PH, Johnson JA. Prevalence and natural history of colonization with fluoroquinolone-resistant gram-negative bacilli in community-dwelling people with spinal cord dysfunction. Archives of Physical Medicine Rehabilitation. 2006; 87:1305–1309.10.1016/j.apmr.2006.07.260 [PubMed: 17023238]

Roth PL. Missing data: A conceptual review for applied psychologists. Personnel Psychology. 1994; 47:537–560.

Stickler DJ, Morgan SD. Modulation of crystalline *proteus mirabilis* biofilm development on urinary catheters. Journal of Medical Microbiology. 2006; 55:489–494.10.1099/jmm.0.46404-0 [PubMed: 16585633]

Walker RJ, Gebregziabher M, Martin-Harris B, Egede LE. Quantifying direct effects of social determinants of health on glycemic control in adults with type 2 diabetes. Diabetes Technology & Therapeutics. 2015; 17:80–87.10.1089/dia.2014.0166 [PubMed: 25361382]

Wilde MH. Urine flowing: A phenomenological study of living with a urinary catheter. Research in Nursing & Health. 2002; 25:14–24. [PubMed: 11807916]

Wilde MH. Life with an indwelling urinary catheter: The dialectic of stigma and acceptance. Qualitative Health Research. 2003a; 13:1189–1204.10.1177/1049732303257115 [PubMed: 14606409]

Wilde MH. Embodied knowledge in chronic illness and injury. Nursing Inquiry. 2003b; 10:170–176. [PubMed: 12940971]

Wilde MH, Brasch J. Self-monitoring of urine flow in people with long-term urinary catheters: 2445. Journal of Wound, Ostomy, & Continence Nursing. 2008; 35:S73.10.1097/01.WON.0000319462.79427.8b

Wilde MH, Brasch J, Getliffe K, Brown KA, McMahon JM, Smith JA, Tu X. Study on the use of long-term urinary catheters in community-dwelling individuals. Journal of Wound, Ostomy, & Continence Nursing. 2010; 37:301–310.10.1097/WON.0b013e3181d73ac4

Wilde MH, Carrigan MJ. A chart audit of factors related to urine flow and urinary tract infection. Journal of Advanced Nursing. 2003; 43:254–262. [PubMed: 12859784]

Wilde MH, Dougherty MC. Awareness of urine flow in people with long-term urinary catheters. Journal of Wound, Ostomy, & Continence Nursing. 2006; 33:164–174.

Wilde MH, Garvin S. A concept analysis of self-monitoring. Journal of Advanced Nursing. 2007; 57:339–350. [PubMed: 17233653]

Wilde MH, McDonald MV, Brasch J, McMahon JM, Fairbanks E, Shah S, Scheid E. Long-term urinary catheter users self-care practices and problems. Journal of Clinical Nursing. 2013a; 22:356–367. [PubMed: 23301577]

Wilde MH, McMahon JM, McDonald MV, Tang W, Wang W, Brasch J, Chen DG. Self-management intervention for long-term indwelling urinary catheter users: Randomized clinical trial. Nursing Research. 2015a; 64:24–34.10.1097/NNR.0000000000000071 [PubMed: 25502058]

Wilde MH, McMahon JM, Tang W, McDonald MV, Brasch J, Fairbanks E, Shah S. Self-care management questionnaire for long-term indwelling urinary catheter users. Neurourology and Urodynamics. 2015b Advance online publication. 10.1002/nau.22735

Wilde MH, Zhang F, Fairbanks E, Shah S, McDonald MV, Brasch J. Perceived value of a urinary catheter self-management program in the home. Home Healthcare Nurse. 2013b; 9:465–473.10.1097/NHH.0b013e3182a89791 [PubMed: 24081128]

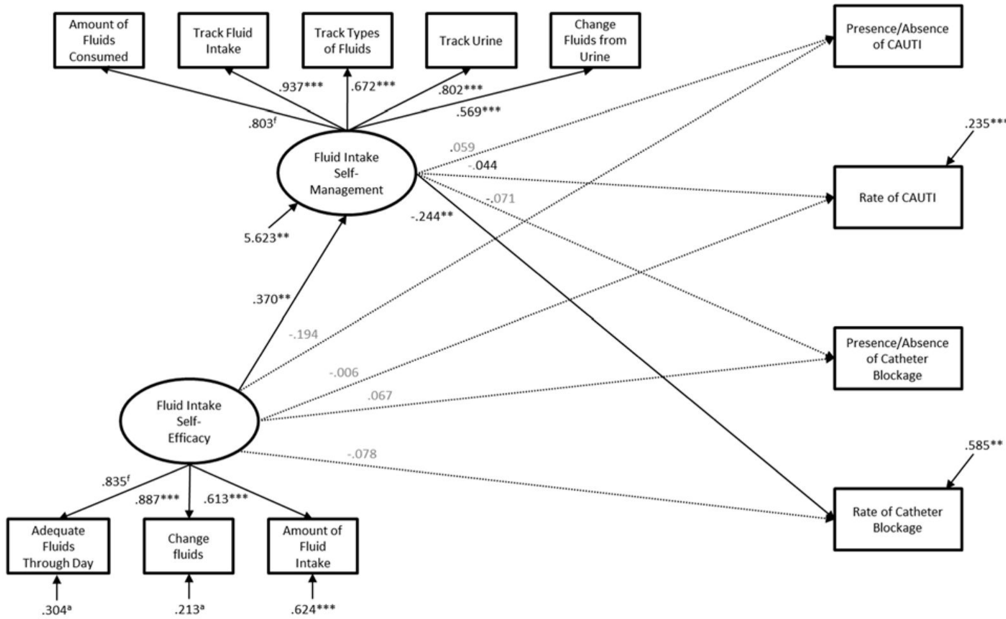

FIGURE 1.

Zero inflated negative binomial results of mediational model examining self-efficacy regarding fluid intake and self-management regarding fluid intake effects on presence/absence and rate of CAUTI's and presence/absence and rates of blockage. Latent constructs are shown in ellipses, observed variables are shown in rectangles, and non-connected arrows represent residual variances in the observed and latent variables (i.e., the dispersion parameter in the two count variables). In the model, structural parameters are presented in unstandardized format while measurement parameters are in standardized form. A superscript f indicates a parameter set to 1.0 in the unstandardized solution. Non-significant effects are shaded. $^{a}p < .10$. *$p < .05$. **$p < .01$. ***$p < .001$.

TABLE 1

Description of Study Variables

Variable	*n*	Range	*M*	(*SD*)
Fluid intake self-efficacy				
Drink adequate fluids throughout the day	158	(1–10)	8.59	(1.96)
Change fluids as needed[a]	158	(1–10)	8.42	(2.14)
Keep intake of water and caffeine to good level	157	(1–10)	8.68	(1.95)
Fluid intake self-management				
Pay attention to amount of fluids	159	(1–3)	2.55	(0.70)
Keep track of fluid intake.	159	(1–3)	2.26	(0.86)
Pay attention to types of fluids	159	(1–3)	2.73	(0.57)
Keep track of information about urine.	158	(1–3)	2.60	(0.72)
Make changes in fluid types/amounts based on urine	158	(1–3)	2.63	(0.67)
Rate per 1000 catheter days				
Blockages	171	(0–106)	4.80	(15.60)
Urinary tract infections	172	(0–50)	4.63	(7.70)

Note. SD = standard deviation.

[a]Related to activity, temperature, and travel.

TABLE 2

Correlations among Study Variables

Variable	1	2	3	4	5	6	7	8	9	10
Fluid intake self-efficacy										
1. Drink adequate fluids	–									
2. Change fluids as needed[a]	.74	–								
3. Water/caffeine intake good	.50	.55	–							
Fluid intake self-management										
4. Pay attention to amount of fluids	.18	.14	.09	–						
5. Keep track of fluid intake	.23	.15	.02	.64	–					
6. Pay attention to types of fluids	.06	.07	−.02	.44	.39	–				
7. Track information about urine	.18	.17	.11	.41	.56	.35	–			
8. Change fluids[b] depending on urine	.11	.15	.01	.26	.32	.40	.51	–		
Rate per 1000 catheter days										
9. Blockages	.00	−.08	−.24	−.01	−.15	−.06	−.08	−.10	–	
10. Urinary tract infections	.15	.03	.02	.01	−.10	−.01	−.03	−.01	.17	–

Note. Pairwise sample sizes ranged from 148 to 171.

[a]Related to activity, temperature, and travel.

[b]Types and amounts.