Clinical practices in catheter management vary widely and frequently are not evidence based (Smith, 2003). Indwelling urinary catheterization is often required in the acute stage of hospitalization after stroke and many stroke patients are transferred to rehabilitation with an indwelling catheter in place. The return of normal voiding is an important goal in rehabilitation and in assuring patients can fully participate in therapy; however, common sequella of urinary catheterization, including bacteruria, urinary tract infection (UTI), dysuria, and urine retention after removal, may interfere with quality of life and rehabilitation. Limited research has been conducted to evaluate the best practice for catheter removal to facilitate return of normal bladder function. The timing for catheter removal has primarily been based on unit policy and reflected the preferences of medical or nursing staff (Watt & Lillibridge, 1998). Studies to date have shown that catheter removal late in the evening results in a longer interval to the first void, larger volumes at first void, and a more rapid return to normal voiding in multiple patient populations (Crowe, Clift, & Bolton, 1994; Griffiths & Fernandez, 2005; Kelleher, 2002; Noble, Menzies, Cox, & Edwards, 1990; Smith, 2003). This study was designed to determine if the time of day a urinary catheter was removed impacted length of time to the first void after catheter removal, the amount of the first void, post-void residual urine, and the number of subjects requiring re-catheterization in stroke rehabilitation patients. A randomized two group comparative design was used. Study results did not indicate a difference in voiding based on whether the catheter was removed at 7:00 a.m. or 10:00 p.m. in this sample of stroke rehabilitation patients. This study is a beginning step in identifying parameters to consider when developing an individualized plan for indwelling urinary catheter removal in post-stroke patients.

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time of day a urinary catheter was removed influenced length of time to the first void after catheter removal, the amount of the first void, post-void residual urine, and the number of subjects requiring recatheterization in stroke rehabilitation patients.

Background

Bladder dysfunction is a common occurrence in the early days after stroke (Brittain, Peet, & Castleton, 1998; Nakayama, Jorgensen, Pedersen, Raaschou, & Olsen, 1997; Ween, Alexander, D’Esposito, & Roberts, 1996). Urinary retention, frequency, urgency, and urinary incontinence (UI) are among the problems frequently reported after stroke. Indwelling urinary catheters, often used in the acute care period, may contribute to the development of voiding problems upon catheter removal. For example, urinary retention has been identified as a common occurrence after indwelling urinary catheter removal in stroke subjects (Gross, 1990). If indwelling urinary catheter removal at night results in a longer interval to the first void, larger volumes at first void, and a more rapid return to normal voiding, the incidence of common bladder problems after stroke, in particular urinary frequency, retention, and UI may be reduced. Moreover, a more rapid return to a pre-stroke voiding pattern may also benefit stroke rehabilitation patients’ ability to participate in therapy and, in turn, lead to improvements in functional outcomes.

In randomized, comparative studies investigating the effect the time of day an indwelling urinary catheter is removed, hospitalized patients whose catheter was removed at midnight had greater volumes at the first void and a longer time interval to first void than the 6:00 a.m. group (Crowe et al., 1994; Noble et al., 1990). The subjects in both of these studies were primarily urologic and urologic surgical patients. The time of day the catheter is removed has not been shown to significantly affect the proportion of participants who develop urinary retention requiring catheterization (Crowe et al., 1994; Wyman, 1987). In one study, two groups did not differ on the proportion experiencing urinary retention 10 hours after catheter removal; however, approximately 24% of the total sample failed a voiding trial due to urinary retention (greater than 150 cc) or painful urinary retention necessitating recatheterization (Wyman, 1987). Subjects with a history of urinary retention prior to surgery were more likely to require recatheterization (Wyman, 1987).

More recently, Kelleher (2002) conducted a prospective clinical trial (N=160) to determine the impact midnight removal of indwelling urinary catheters would have on subjects’ voiding pattern and subsequent hospital discharge. Subjects were randomly assigned to either midnight or 6:00 a.m. indwelling urinary catheter removal. Subjects in the midnight removal group passed a greater volume of urine with both their first (268 ml compared with 177 ml; p<0.0001) and second voids (322 ml compared with 195 ml; p<0.0001) than subjects in the 6:00 a.m. removal group. Moreover, subjects in the midnight removal group were discharged earlier from the hospital than those in the 6:00 a.m. removal group.

Study Hypotheses

Systematic evaluations of the effects of catheter removal at different times of day in stroke patients have not been reported. Hypotheses for the study reported here were: Stroke patients whose indwelling urinary catheters are removed at 10:00 p.m. in comparison to those whose urinary catheters are removed at 7:00 a.m. were expected to have:

1. A longer time interval from catheter removal to first void.
2. A larger volume of urine in the first void after catheter removal.
3. Smaller post-void residual urine after their first void.
4. A smaller proportion of patients requiring intermittent catheterization after indwelling catheter.

Methods

Design. A randomized two group comparative design was used. Subjects were randomized to groups by drawing sealed envelopes indicating group designation. Group A subjects included those for whom indwelling urinary catheter removal occurred at 10:00 p.m. Group B subjects underwent indwelling urinary catheter removal at 7:00 a.m.

Sample and setting. The study was conducted on the stroke unit, a 34-bed unit, in a freestanding rehabilitation hospital. Patients admitted with a medical diagnosis of stroke who met inclusion criteria were recruited for possible study enrollment. Inclusion criteria included (a) presence of an indwelling urinary catheter on admission or inserted during the rehabilitation program, (b) age > 18 years, and (c) medical order for catheter removal. Institutional review board approval was obtained. Informed consent for study participation was obtained from the stroke patient and the patient’s physician. A medical order for “catheter removal per study protocol” was required for all subjects.

To detect differences between groups with a power of 0.80 at an alpha of 0.05, assuming a large effect size, it was determined that a sample size of 26 subjects per group was needed (Cohen, 1992). A total sample size of 62 was proposed to allow for attrition and the potential of missing data.

Measures. A data collection tool was developed by the investigators to record demographic information and data on dependent variables. Demographic data collected included age, gender, concurrent medical diagnosis, and medications on admission. A urologic history of previous voiding problems and urologic procedures or surgery was obtained from the
subject’s medical record and, when possible, from a face-to-face interview with the subject. The presence of a UTI prior to or upon admission was also determined from transfer information and urinalysis upon catheter removal. The Centers for Disease Control and Prevention criteria for UTI provided the defining characteristics to determine the presence of infection on admission to rehabilitation (Horan & Gaynes, 2004). Additional data collected on voiding behaviors after catheter removal included whether the void was continent or incontinent, the presence of urgency, frequency or discomfort with the void, and whether the patient or staff initiated the void. Data on dependent variables also were recorded on the data form. The dependent variables were defined and measured as described below.

**Length of time to first void** was recorded in minutes by calculating the number of minutes between the times of catheter removal and the first void. The **volume of the first void** was measured in cc of urine, using standard output graduates such as urinals or urine collection “hats” placed in commodes. To objectively document the presence and amount of urine loss with incontinent voids, a perineal pad test was used. Pads were pre-weighed in a labeled and sealed plastic bag. Worn pads were returned to the sealed plastic bags and weighed within 24 hours of collection on a digital electronic scale. The Scout electronic balance scale (Ohaus Corporation) is a precision weighing instrument, with the capacity to weigh up to 600 grams to the nearest 0.1 gram. The scale has calibration weights that were used to check accuracy of weights prior to use of the scale. The volume of urine lost was calculated from the differences in pad weight before and after use. A perineal pad test has acceptable reliability and validity in estimating the amount of urine lost during daily activities (Jorgensen, Lose, & Thunedburg, 1989).

A **post-void residual urine** (PVR) was obtained within 15 minutes of the subject’s first void using a noninvasive bladder scanner. The time and volume of PVR was recorded on the subject’s bedside chart. The BladderScan® BVI 3000J is a portable, automated three-dimensional ultrasound device for noninvasive determination of bladder volume and was reliable and valid across a range of 0 to 1,015 cc in 249 adult outpatients (0.90, p=0.001) (Marks, Dorey, Macairan, Park, & de-Kernion, 1997).

**Procedures**

Subjects who met study criteria and gave consent to participate were randomly assigned to Group A (indwelling urinary catheter removal at 10:00 p.m.) the day the order for removal was written or Group B (indwelling urinary catheter removal at 7:00 a.m.) the day after the order for catheter removal was written. The actual times selected for removal were comparable to those in the background studies, but modified to be congruent with subject’s routine bedtime (or time to complete evening shift care) and usual time for awakening in acute rehabilitation.

Preweighed pads were placed on subjects after catheter removal. Pads were checked hourly after catheter removal to determine if subjects had voided. During waking hours or if awake at night, subjects were asked regularly if they needed to use the bathroom. The exact time the catheter was removed and the time of first void were recorded on the bedside chart.

Usual care was followed for those who did not void for several hours after removal. If participants did not urinate upon arising in the morning (or after breakfast for 10 p.m. removal) or after lunch (by 1:00 p.m. for 7:00 a.m. removal), they were taken to the commode and given an opportunity to void. If subjects were unable to void and reported suprapubic discomfort or if a bladder scan revealed > 400 cc in the bladder, intermittent sterile urethral catheterization (ISC) was performed and documented. Subjects who did not void or were not catheterized at these times were evaluated every 1 to 2 hours until bladder emptying occurred or ISC was indicated.

**Data Analysis**

Independent t-tests were used to determine differences between Group A and Group B subjects with regard to the length of time to the first void, volume of first void, and PVR. Determination of differences in the proportion of subjects per group who required ISC was calculated using Chi square analysis.

**Results**

Forty-five subjects were recruited. Table 1 includes a description of the sample. Twenty-six subjects were assigned to Group A (10:00 p.m.) and 19 were assigned to Group B (7:00 a.m.) removal. The mean age for the sample was 70.3 years (SD=11.7). Indwelling urinary catheters had been in place an average of 18.2 days (SD=19.3), a time interval closely corresponding to the length of time since stroke onset (M=20.5 days, SD=21.3). There was no significant difference between subjects in the two groups in terms of the presence of a UTI or UI after catheter removal. The association between sedative/narcotic use and group was not significant.

There were no significant differences between the groups on time to void (t [35] = 0.94, p =0.3525), volume voided (t [32] = 0.55, p=0.5877), or post-void residual urine (t [39] = -0.32, p=0.7542) (see Table 2).

The proportion of subjects who were unable to void after urinary catheter removal did not differ between the two groups (χ² [df = 1] = 0.02, p=0.88). Nine of the 45 subjects (20%) did not void after indwelling urinary catheter removal. Further comparison of those who did not void after catheter removal with those who did void revealed the two groups did not differ according to gender, age, UTI, location of stroke, time from stroke onset, presence of diabetes mellitus, or use of a sedative/hypnotic the night of catheter removal.
Study results did not indicate a difference in voiding based on whether the catheter was removed at 7:00 a.m. or 10:00 p.m. in this sample of stroke rehabilitation patients. These findings conflict with the results of Crowe et al. (1994) and Noble et al. (1990) who reported subjects who had catheters removed at midnight returned to a more normal voiding pattern faster than those whose catheters were removed in the morning. It is possible that the failure to detect a difference in the voiding behaviors evaluated in our study is the result, at least in part, of sample size. An initial power analysis indicated 52 subjects were needed to have at least 80% power to detect a group difference. Recruitment became an issue after several months as referring facilities began to remove urinary catheters immediately prior to transfer to rehabilitation. Thus, a decision was made to halt recruitment at 45 subjects. An analysis given the preliminary mean and standard deviation estimates for the three outcome variables (time to void, PVR, and volume voided) revealed the need for a much larger sample than originally identified. The heterogeneity of stroke presents major challenges in the recruitment of an adequate number of subjects to evaluate interventions in stroke rehabilitation (Louw, 2002).

The difference in outcome may also reflect a difference in the nature of voiding dysfunction exhibited. The majority of subjects in the Crowe et al. (1994) and Noble et al. (1990) studies were urologic surgical patients where voiding problems were more likely to result from manipulation of the bladder. Bladder dysfunction after stroke is typically a result of interference in central nervous system control and/or coordination of voiding reflexes. Cerebral influence may not be impacted by catheter management strategies.

Further consideration of mechanisms by which the timing of catheter removal would influence voiding provides interesting insights and direction for practice and future research. Noble et al. (1990) suggested the use of sedation plus midnight removal enabled patients to return to sleep after removal. This could lengthen the time to the first void and allow the bladder to fill more fully through the night, and in turn, facilitate a more normal voiding pattern. In contrast, sedation the night before did not significantly alter anxiety and distress in those having their catheters removed at 6:00 a.m. Voiding often occurs opportunistically at convenient times or more frequently by choice to prevent UI. Hypervigilance on voiding (and the frequency and urgency that can result) may be less likely to develop if the individual delays voiding until the morning and empties the bladder upon arising in a more normal pattern. Research revealing a strong relationship between sleep apnea and stroke (Mohsenin, 2004) and demonstrating the impact of sleep apnea on nocturia (Chasens &

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### Table 1.
Demographic Description of the Sample (N = 45)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total Sample (N = 45)</th>
<th>Group A (n = 26)</th>
<th>Group B (n = 19)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>57.8% (25)</td>
<td>61.5% (16)</td>
<td>47.4% (9)</td>
<td>0.55</td>
</tr>
<tr>
<td>Male</td>
<td>42.2% (20)</td>
<td>38.5% (10)</td>
<td>52.6% (10)</td>
<td></td>
</tr>
<tr>
<td><strong>Location of Stroke</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right hemisphere</td>
<td>48.8% (21)</td>
<td>50.0% (13)</td>
<td>42.1% (8)</td>
<td>0.24</td>
</tr>
<tr>
<td>Left hemisphere</td>
<td>39.5% (17)</td>
<td>30.8% (8)</td>
<td>47.4% (9)</td>
<td></td>
</tr>
<tr>
<td>Brainstem</td>
<td>4.7% (1)</td>
<td>3.8% (1)</td>
<td>0.0 (0)</td>
<td></td>
</tr>
<tr>
<td>Not specified</td>
<td>7.0% (6)</td>
<td>15.4% (4)</td>
<td>10.5% (2)</td>
<td></td>
</tr>
<tr>
<td><strong>Sphincter Control</strong></td>
<td></td>
<td></td>
<td></td>
<td>0.79</td>
</tr>
<tr>
<td>Continent</td>
<td>44.4% (20)</td>
<td>53.8% (14)</td>
<td>57.9% (11)</td>
<td></td>
</tr>
<tr>
<td>Incontinent</td>
<td>55.6% (25)</td>
<td>46.1% (12)</td>
<td>42.1% (8)</td>
<td></td>
</tr>
<tr>
<td><strong>UTI</strong></td>
<td></td>
<td></td>
<td></td>
<td>0.58</td>
</tr>
<tr>
<td>Yes</td>
<td>55.6% (25)</td>
<td>53.8% (14)</td>
<td>57.9% (11)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>35.6% (16)</td>
<td>34.6% (9)</td>
<td>36.8% (7)</td>
<td></td>
</tr>
<tr>
<td>Not available</td>
<td>8.9% (4)</td>
<td>11.5% (3)</td>
<td>5.3% (1)</td>
<td></td>
</tr>
<tr>
<td><strong>Sedative</strong></td>
<td></td>
<td></td>
<td></td>
<td>0.10</td>
</tr>
<tr>
<td>Yes</td>
<td>51.1% (23)</td>
<td>61.5% (16)</td>
<td>36.8% (7)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>48.9% (22)</td>
<td>38.5% (10)</td>
<td>63.2% (12)</td>
<td></td>
</tr>
<tr>
<td><strong>Ability to Void</strong></td>
<td></td>
<td></td>
<td></td>
<td>0.88</td>
</tr>
<tr>
<td>Able to void</td>
<td>80.0% (36)</td>
<td>80.8% (21)</td>
<td>78.9% (15)</td>
<td></td>
</tr>
<tr>
<td>Unable to void</td>
<td>20.0% (9)</td>
<td>19.2% (5)</td>
<td>21.1% (4)</td>
<td></td>
</tr>
</tbody>
</table>
Umlauf, 2003) suggests another mechanism that may have influenced these findings. Nocturia is a common consequence of sleep apnea; the need to urinate during the night after catheter removal at 10:00 p.m. may have been influenced by sleep apnea rather than the time of catheter removal. Future research should include sleep apnea as a factor in findings and include information from the patient concerning the influence of anxiety and distress. In fact, review of the literature and emergence of data from our study concerning sleep apnea, stroke, and nocturia prompted a secondary analysis (Hardin-Fanning & Gross, 2007) (see this article elsewhere in this issue).

**Implications for Practice**

This study is a beginning step in identifying parameters to consider when developing an individualized plan for indwelling urinary catheter removal in post-stroke patients. The data reported here do not support an advantage to removing an indwelling urinary catheter at midnight compared to removal in the morning in stroke rehabilitation patients. Removal of an indwelling urinary catheter need not wait until morning, a typical practice, thus temporarily interfering with normal detrusor function in certain persons. Monitoring bladder capacity and instituting an intermittent catheterization routine to prevent over-distention remains an important component of a bladder management after stroke.

**References**


