

ORIGINAL ARTICLE

# Urinary tract infection and bacteriuria in children performing clean intermittent catheterization with reused catheters

Y Kanaheswari<sup>1</sup>, R Kavitha<sup>2</sup> and AMM Rizal<sup>3</sup>

**Study design:** This study was designed as a comparative cross-sectional cross-over trial on children performing clean intermittent catheterization (CIC) with reused catheters for 1 or 3 weeks.

**Objectives:** To determine the incidence of symptomatic urinary tract infection (UTI) and bacteriuria (defined as colony count of  $\geq 10^5$  colony forming units per ml of a single strain of organism) in these two different frequencies of catheter change.

**Setting:** Multidisciplinary children's neurogenic bladder clinics at two tertiary care hospitals in Kuala Lumpur Malaysia.

**Methods:** Forty children aged between 2 and 16 years performing CIC for at least 3 years were recruited. Medical and social data were obtained from case files. Baseline urine cultures were taken. All children changed CIC catheters once in 3 week for the first 9 weeks followed by once a week for the next 9 weeks. Three-weekly urine cultures were obtained throughout the study. Standardization of specimen collection, retrieval and culture was ensured between the two centers.

**Results:** At baseline, 65% of children had bacteriuria. This prevalence rose to 74% during the 3-weekly catheter change and dropped to 34% during the weekly catheter change (Z-score 6.218;  $P < 0.001$ ). Persistence of bacteriuria (all three specimens in each 9-week period) changed significantly from 60 to 12.5%, respectively ( $P < 0.005$ ). There was no episode of UTI during the 18-week study period.

**Conclusion:** Reuse of CIC catheters for up to 3 weeks in children with neurogenic bladders appears to increase the prevalence of bacteriuria but does not increase the incidence of symptomatic UTI.

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## INTRODUCTION

Children with neurogenic bladders comprise mainly those born with congenital defects such as spina bifida and sacral agenesis, and a few with spinal cord injury or disease. The majority of these newborns have normal upper urinary tracts. However, studies have shown that in those with neurogenic bladders without therapeutic intervention, 50–60% will develop progressive renal impairment mainly because of the recurrent urinary tract infections (UTI) and high bladder pressures.<sup>1,2</sup> Drawing from the experience of adult patients with spinal cord injury, the introduction of clean intermittent catheterization (CIC) by Lapedes *et al.*<sup>3</sup> in 1972, has revolutionized the management of neurogenic bladders in children and has led to the preservation of renal function as well as improved quality of life by achieving urinary dryness by school age.<sup>4</sup>

Intermittent catheterization is the method of choice for emptying the bladder in cases of neurogenic bladder dysfunction. To date, there is no consensus on the ideal technique or type of catheter for intermittent catheterization. The basic principles are as follows: the catheter should be introduced in a non-infecting and atraumatic way;<sup>5</sup> it should be removed when the entire collection of urine has been emptied from the bladder; and it should be performed at regular intervals several times a day. In the majority of cases a clean technique is all that is required. When resources are limited, catheters have been

known to be reused and this has been the case in many developing countries.<sup>6</sup> Our literature review indicates that to date, there has been no study, trial or guideline suggesting how often a reused catheter needs to be replaced.

In Malaysia there are two well-established multidisciplinary clinics, Institute Paediatrics Hospital Kuala Lumpur and Universiti Kebangsaan Malaysia Medical Centre; which provide services to children with neurogenic bladders from all over the country. Initially catheters were reused for up to 1–2 weeks in both centers, but over the years the Institute Paediatrics Hospital Kuala Lumpur patients have reduced the frequency of their catheter changes to 3-weekly. When reused, there is potential for increase in the prevalence of bacteriuria and symptomatic UTI (sUTI). However, Van Hala *et al.*<sup>7</sup> in his study on adults showed that reused catheters compared with single use catheters did not increase the likelihood of UTIs. With this in mind, we set out to determine the frequency of UTI in our population of children with neurogenic bladder who reused catheters for up to 3 weeks and compare it with the frequency of UTI in those reusing catheters for 1 week.

## MATERIALS AND METHODS

### Study population

This is a comparative cross-sectional cross-over trial on children with neurogenic bladders attending these two multidisciplinary clinics in Kuala

<sup>1</sup>Department of Paediatrics, Universiti Kebangsaan Malaysia Medical Centre, Kuala Lumpur, Malaysia; <sup>2</sup>Department of Paediatrics, Hospital Sulltanah Bahiyah, Alor Setar, Malaysia and <sup>3</sup>Department of Community Health, Universiti Kebangsaan Malaysia Medical Centre, Kuala Lumpur, Malaysia  
Correspondence: Dr Y Kanaheswari, Department of Paediatrics, Universiti Kebangsaan Malaysia Medical Centre, Jalan Yaakob Latif, Bandar Tun Razak, Kuala Lumpur 56000, Malaysia.

E-mail: kanahes@ppukm.ukm.edu.my

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Lumpur. The study was conducted between November 2012 and May 2013. Children aged between 1 and 18 years with a diagnosis of neurogenic bladder because of spina bifida, sacral agenesis, spinal cord injury or stable spinal cord disease who were performing CIC per urethra at least three times a day for at least 6 months prior to the recruitment and who consented to the study were eligible for inclusion. Children with neurogenic bladders due to other causes (for example, malignant disease or progressive spinal cord disease) and those performing CIC through a Mitrofanoff channel or practising overnight drainage were excluded. Children living beyond a 30-mile radius were also excluded as it was not possible to obtain urine specimens from these patients and deliver to the laboratory within the expected time frame. All healthcare needs of the patients were funded by the government and the cost of extra catheters was borne by the study grant.

### Study design

Patients were recruited as their own controls, all starting with a frequency of 3-weekly catheter change for 9 weeks followed by weekly catheter change for another 9 weeks. Patients were required to provide urine specimens once every 3 weeks for urine culture and microscopy, obtained during early morning CIC on the day of their catheter change (that is, with a new catheter). The specimen was deemed unsuitable for culture if kept at room temperature and delivered to the hospital laboratory beyond 2 h of the time of collection. The preferred method was to store the sample in an ice pack and hence it could still be cultured within 24 h from the time of collection. For the purpose of this study, transport of the urine sample was facilitated by providing patients with an ice pack and a styrofoam box in which the urine specimen bottle was placed. A courier service was arranged to facilitate transport to hospital and culture of urine within 24 h of obtaining the urine by CIC. In both of our laboratories, the standard practice followed was inoculation and incubation of the urine on CLED (Starplex Scientific INC, Etobicoke, ON, Canada) blood agar plate.

Prior to commencement of the study, a baseline urine specimen was obtained and those with sUTI were treated and urine re-cultured. Enrolment was done only when the UTI was cleared or the patient remained asymptomatic (Figure 1).

### Sample size

Getliffe *et al.*<sup>8</sup> in their review of current evidence for the relationship of reused catheters and the incidence of UTIs reported two studies with 37 and 53% sUTI, defined as  $>10^5$  colony forming units per ml of a single organism, in patients using clean reused catheters, thus giving an average of ~46%. There have been no studies on the frequency of UTIs in our patient cohort, and hence we used an estimated rate of 30% as reported figures were deemed to be too high. To achieve a power of 80% and a statistical significance of 5% the sample size required was 38 patients.

### Definitions and terminology

Asymptomatic bacteriuria (ABU) was defined as the presence of significant bacteriuria in a patient without signs or symptoms referable to the urinary tract. Several different definitions of bacteriuria are found in the literature.<sup>9–11</sup> For the purpose of this study, the definition of bacteriuria is taken as a colony count of  $\geq 10^5$  colony forming units per ml of a single strain of organism in the absence or presence of pyuria. This is in keeping with the clinical practice guidelines of the Infectious Diseases Society of America<sup>12</sup> and the standard operating procedure of the microbiology laboratories of both participating hospitals.

The Infectious Diseases Society of America guidelines define sUTI as a positive urine culture of  $\geq 10^5$  colony forming units per ml of a single type of 'usual pathogen' with pyuria of  $\geq 10$  leukocytes per high-power field and with any of the following symptoms: fever ( $\geq 38^\circ\text{C}$ ), general malaise, increased spasticity and/or autonomic dysreflexia characterized by flushing, sweating and an increase in blood pressure. 'Usual pathogens' were defined as *Escherichia coli*, *Enterobacteriaceae*, *Enterococcus* species, coagulase negative *Staphylococcus* and group B *Streptococcus*.

### Statistical analysis

Statistical analysis was performed using SPSS for Windows, version 20 (SPSS Inc, Chicago, IL, USA). The  $\chi^2$ -test and Fischer's exact test were used to

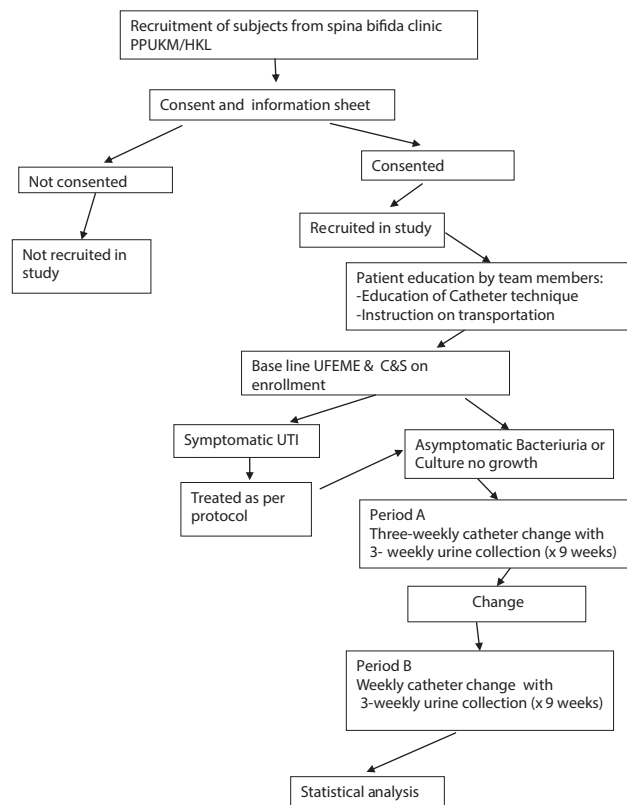


Figure 1 Patient recruitment and study flow.

determine the statistical significance of the incidence of sUTI and ABU between the two different frequencies of catheter change. Multiple logistic regression was performed using the 'enter' method to determine factors contributing to the persistence of ABU. A  $P$ -value  $<0.05$  was considered statistically significant.

### Ethics

Ethics approval was obtained from the Medical Research and Ethics committee of the Universiti Kebangsaan Malaysia Medical Centre and from the National Medical Research Registry of the Ministry of Health (for the Institute Paediatrics Hospital Kuala Lumpur). A research grant was allocated from the Universiti Kebangsaan Malaysia Medical Centre (FF-059-2011) for the cost of extra catheters and for the courier service.

### RESULTS

A total of 40 children with neurogenic bladder, aged between 2 and 16 years, were recruited from the two centers.

All recruited patients completed the 18-week study. Table 1 shows the socio-demographic and medical characteristics of the children. The majority of patients (90%) had spina bifida. The one patient with acute demyelinating encephalomyelitis had no progression of disease over the previous 3 years. The most common anatomical sites for the spina bifida lesions were the lumbo-sacral and sacral regions.

The majority of children had performed CIC for at least 3 years with 55% doing it for more than 5 years. Only 11 children were performing self-catheterization, whereas 42.5% were still totally dependent on a parent or caretaker and another 30% performed it with assistance. Nine of the children performing self-CIC were aged between 12 and 16 years; one was aged 11 years and one was aged 8 years. Thirty-five of the 40 children followed the recommended frequency of five catheterisations per day; however, only 30% were reliably dry between CICs.

Only 12.5% of children had reflux disease and notably, none had Grade IV or V reflux which carries a higher incidence of UTI. Among them, only nine patients had any evidence of bladder trabeculation.

**Table 1 Socio-demographic and medical characteristics of patients**

	n (%)
<i>Socio-demographic variable</i>	
<i>Gender</i>	
Males	16 (40.0)
<i>Ethnicity</i>	
Malay	29 (72.5)
Chinese	4 (10.0)
Indian	7 (17.5)
<i>Age (years)</i>	
1–6 (pre-school)	13 (32.5)
7–12	16 (40.0)
13–18	11 (27.5)
<i>Medical characteristics</i>	
<i>Type of Lesion</i>	
Spina bifida	36 (90.0)
Spinal cord Injury	2 (5.0)
Sacral agenesis	1 (2.5)
ADEM	1 (2.5)
<i>Anatomical level of lesion</i>	
Thoracic	2 (5.0)
Lumbar	2 (5.0)
Lumbo-sacral	21 (52.5)
Sacral	16 (37.5)
<i>Presence of hydronephrosis</i>	
Bilateral	2 (5.0)
Unilateral	7 (17.5)
None	31 (77.5)
<i>Bladder trabeculation</i>	
Present	9 (22.5)
<i>VUR</i>	
None	35 (87.5)
Grade I	2 (5.0)
Grade II	2 (5.0)
Grade III	1 (2.5)
Grade IV and V	0
<i>Duration of CIC (years)</i>	
1–2	6 (15.0)
3–4	12 (30.0)
> 5	22 (55.0)
<i>Who performs CIC</i>	
Self	11 (27.5)
Others	17 (42.5)
Self and others	12 (30.0)
<i>CIC done during school</i>	
Yes	20 (50.0)
No	17 (42.5)
Not applicable	12 (30.0)
<i>Frequency of CIC (per day)</i>	
Three times	1 (2.5)
Four times	4 (10.0)
Five times	34 (85.0)
Six times	1 (2.5)
<i>Dry between CIC</i>	
Yes	12 (30.0)
<i>On anticholinergic therapy</i>	
Yes	34 (85)

Abbreviations: ADEM, acute demyelinating encephalomyelitis; CIC, clean intermittent catheterization; VUR, vesico-ureteric reflux.

At the time of recruitment, baseline urine cultures showed that 26 out of 40 children (65%) had positive cultures but all patients were asymptomatic (ABU). Despite this, there was no episode of sUTI in any of the patients throughout the 18-week study period, either during 3-weekly catheter change or during weekly catheter change.

The prevalence of ABU rose to 74.2% (89/120 specimens) during the 3-weekly catheter change and dropped to 34.2% (41/120 specimens) during the weekly catheter change (Table 2), indicating a significant change in the prevalence rates on the Z-test (Z-score of 6.218;  $P < 0.001$ ). During the 3-weekly catheter change, 60% of patients had a persistence of ABU (defined as positive cultures in all three of the urine specimens collected over nine weeks) compared with only 12.5% of patients during the weekly catheter change. This difference was statistically significant on X<sup>2</sup>-analysis ( $P < 0.005$ ). Multiple logistic regression was then used to analyse factors contributing to the persistence of ABU during the 3-weekly catheter change period. Factors entered were age, gender, duration of CIC, person who performs the CIC, CIC performed during school hours, number of CICs per day, use of diapers, use of prophylactic antibiotics, use of anticholinergics, presence of bladder trabeculation and presence of reflux, soiling and constipation. It was noted that presence of bladder trabeculation increased the persistence of ABU, whereas the use of prophylactic antibiotics decreased the persistence of ABU (Table 3).

## DISCUSSION

Bacteriuria is common among patients with neurogenic bladders who are performing CIC. When resources are limited, catheters are often reused. However, it is not clear how frequently a catheter can be reused without leading to the development of an sUTI.

Schlager *et al.*,<sup>11</sup> in their weekly urinary surveillance of 14 children over 6 months, detected five with sUTI. In another study in 2001, the same researchers found no difference between the incidence of sUTI whether using a single sterile catheter or using a clean catheter reused for up to five times.<sup>13</sup> However the sample consisted of only 10 patients. In our hospital practice of reusing catheters for 1, 2 or even 3 weeks, the risk for sUTI is potentially increased. However, in this 18-week follow-up study, none of our 40 patients developed an sUTI. It is possible that patient's adherence to the 'clean technique' during this time was stricter as they and their caregivers knew that they were being surveyed.

Literature reports on the prevalence of ABU in spina bifida children performing CIC vary from 40 to 61%.<sup>14,15</sup> In keeping with these reports our prevalence rate was 65% at baseline. However, when catheters were reused for up to 3 weeks, this prevalence rose and it dropped during the more frequent weekly changes, suggesting that the frequency of catheter changes does influence the rate of ABU. Furthermore, our patients also showed a persistence of ABU during the 3-weekly catheter change, which was significantly affected by the presence of bladder trabeculation. However, the statistical significance of this finding is questionable as indicated by the wide confidence intervals and can perhaps be explained by the fact that the sample size was calculated for the incidence of UTIs and not for the prevalence of ABU.

However, despite the persistence of ABU in the 3-weekly catheter change, it is clinically important to note that none of these children developed sUTI. This finding further supports the recent proposal that bacterial colonization of the urinary tract may in fact be advantageous and may protect against invasion by other more virulent bacteria.<sup>16</sup>

In summary, we conclude that our practice of reusing of CIC catheters can be continued for up to at least 3 weeks without causing sUTIs. Second, 3-weekly catheter change appears to lead to the persistence of ABU and this may be providing some protection against

**Table 2** Prevalence of sUTI, ABU and persistence of ABU during 18 weeks of study

	At baseline	Period A	Period B, n (%)	Z-score	P-value
<i>No. of patients with symptomatic urinary tract infection (sUTI), n = 40</i>					
	Nil	Nil	Nil		
	At baseline, n (%)	Period A (3 weekly change × 9 weeks), n (%)	Period B (weekly change × 9 weeks), n (%)	Z-score	P-value
<i>No. of asymptomatic bacteriuria (ABU), n = 40</i>					
Urine 1	26 (65.0)	29 (72.5)	20 (50.0)	2.065	0.038
Urine 2		30 (75.0)	12 (30.0)	4.030	<0.001
Urine 3		30 (75.0)	9 (22.5)	4.697	<0.001
Total specimens (n = 120)		89 (74.2)	41 (34.2)	6.218	<0.001
		Period A, n (%)	Period B, n (%)	Z-score	P-value
<i>Persistence of ABU,<sup>a</sup> n = 40</i>					
		24 (60)	5 (12.5)	19.53 <sup>b</sup>	<0.005

<sup>a</sup>Defined as 3 of 3 positive urine cultures without symptoms. <sup>b</sup>Chi-square value.

**Table 3** Factors contributing to persistence of ABU during 3-weekly catheter change

Factors	Odds	95% CI	P-value
Age <sup>a</sup> (years)	15.15	0.23–983.15	0.20
Sex <sup>b</sup>	8.67	0.84–89.93	0.07
Duration of CIC <sup>c</sup> (years)	0.47	0.04–6.04	0.56
CIC by self <sup>d</sup>	8.23	0.65–104.19	0.10
Number of CIC <sup>e</sup> per day	0.12	0.005–3.32	0.21
Prophylactic antibiotics <sup>f</sup>	271.21	0.95–77191.81	0.05
Anticholinergic use <sup>g</sup>	6.62	0.10–435.37	0.38
Bladder trabeculation <sup>h</sup>	45.12	1.60–1270.21	0.03*
Presence of VUR <sup>i</sup>	0.026	0.001–1.29	0.07
Soiling <sup>j</sup>	15.68	0.25–986.96	0.19
Constipation <sup>k</sup>	0.35	0.04–3.33	0.36

Abbreviations: ABU, asymptomatic bacteriuria; CI, confidence interval; CIC, clean intermittent catheterization; VUR, vesico-ureteric reflux.

\* $P < 0.05$ . Multiple logistic regression analysis code given.

<sup>a</sup>Age: 6 years and below = 0, 7 years and above = 1.

<sup>b</sup>Sex: male = 0, female = 1.

<sup>c</sup>Duration of CIC:  $\geq 5$  years = 0,  $< 5$  years = 1.

<sup>d</sup>CIC by self+others = 0, CIC by self = 1.

<sup>e</sup>Number of CIC per day  $\geq 5$  = 0,  $< 5$  = 1.

<sup>f</sup>Prophylactic antibiotics: yes = 0, none = 1.

<sup>g</sup>Anticholinergic: none = 0, yes = 1.

<sup>h</sup>Bladder trabeculation: none = 0, yes = 1.

<sup>i</sup>Presence of VUR: none = 0, yes = 1.

<sup>j</sup>Soiling: none = 0, present = 1.

<sup>k</sup>Constipation: none = 0, yes = 1.

sUTI. This evidence is particularly important for medical professionals managing patients with neurogenic bladder in communities and healthcare systems with limited resources.

#### DATA ARCHIVING

There were no data to deposit.

#### CONFLICT OF INTEREST

The authors declare no conflict of interest.

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