Original Article

Factors associated with successful clean intermittent catheterization in children with neurogenic lower urinary tract dysfunction

Attawat Angsupankosol[1], Thawatchai Mankongsrisuk[1], Akkrapol Mungnirandr[2], Kittipong Phinthusophon[1]

[1]Division of Urology, [2]Division of Pediatric Surgery, Department of Surgery, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand

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Abstract

Objective: Clean intermittent catheterization (CIC) is the standard treatment for children with neurogenic lower urinary tract dysfunction (NLUTD). Despite its effectiveness, many patients encounter obstacles such as the affordability of necessary instruments and finding a suitable location for CIC, which can impact treatment outcomes. This research aims to investigate factors associated with successful CIC in children with NLUTD.

Materials and Methods: This is an observational analytical study, focusing on patients under 18 diagnosed with NLUTD through urodynamic studies at our center from 2009 to 2020. Multivariate analyses were conducted to identify factors associated with successful CIC and prevalence of UTI in children with NLUTD.

Results: Between 2009 and 2020, 233 patients were recruited onto the study. Of these, CIC was successfully achieved in 148 (63.5%) cases. The effectiveness of performing CIC was high at 93.2%, with a cooperation rate of 94.6% in the unsuccessful group, numbering 85, 71 patients (83.5%) experienced UTI, with the mean occurring approximately 8 months after the diagnosis of neurologic bladder dysfunction. Multivariate analysis revealed that the ability to perform CIC effectively (OR 5.679; 95%CI 2.423-13.311) is an independent factor associated with successful outcomes. However, no significant differences were found between the successful and unsuccessful CIC groups regarding cooperation, socioeconomic status, caregiver, etiology of disease, medication use, number of CIC, school environment, healthcare provider access, and gender.

Conclusion: The ability to perform CIC effectively is the primary factor associated with successful CIC in children diagnosed with NLUTD. Improving the effectiveness of CIC is crucial for the achievement of success treatment of these patients.

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Corresponding author: Kittipong Phinthusophon

Address: Division of Urology, Department of Surgery, Faculty of Medicine Siriraj Hospital Mahidol University, 2 Wanglang Road, Bangkoknoi, Bangkok 10700, Thailand

E-mail: kittamm@hotmail.com

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Introduction

Neurogenic lower urinary tract dysfunction represents a diverse group of conditions caused by issues in the central or peripheral nervous systems.[1-5] Treatment may not always be effective with either or both medication or surgery, and in some instances, lifelong catheterization may be necessary. This dysfunction can lead to a range of complications of varying severity, including urinary tract infections, urinary reflux, and kidney failure.[5] Clean intermittent catheterization (CIC), introduced by Lapides et al in 1972[3], is now considered the gold standard for the management of urinary retention in neurogenic bladders to minimize these complications.[1,2]

A recent study by Hentzen et al examined the predictors of success in learning clean intermittent self-catheterization (CISC) among patients over the age of 65. In that study, out of 202 patients, 169 (83.7%) over the age of 65 successfully learned CISC. The findings suggest that the ability to learn CISC is not limited by age but is influenced by factors such as mobility, access to the perineum, and possibly cognitive disorders.[6] Costa et al investigated factors that influence the procedure of CIC, focusing on 55 cases of infants with meningomyelocele. Their research identified several factors that positively affect the catheterization process, including the age of the child, caregivers who do not work outside the home, receipt of continued income benefits, and supplies of catheterization materials from the local or state governments.[7]

Given the limited data on factors associated with successful clean intermittent catheterization in children with neurogenic lower urinary tract dysfunction, we conducted a study to clarify these factors. The results may contribute to improving the management plan for neurogenic lower urinary tract dysfunction in children within Thailand's healthcare framework.

Materials and Methods

Study design and subjects

This observational analytical study included patients under the age of 18 diagnosed with neurogenic lower urinary tract dysfunction by urodynamic studies at the Division of Urology, Department of Surgery, Faculty of Medicine Siriraj Hospital, from 2009 to 2020. Case record forms were collected for analysis. The follow-up schedule varied between three to six months and ultrasonography was routinely performed during each visit. Success in clean intermittent catheterization was evaluated after two years. Success was defined as the absence of urinary tract infections, no change in treatment mode, and no new occurrences of hydronephrosis.

All data were retrospectively collected from medical records. The initial data gathered included age, gender, etiology, medication (anticholinergic drugs), number of times CIC was performed, effectiveness of CIC, patient cooperation, caregiver identity (parent, grandparent, or relative), education level of the caregiver (primary, secondary, bachelor), socioeconomic status, school environment, and access to healthcare providers.

In this study, terms were defined as follows: performed CIC effectively: the patient or caregiver followed the CIC schedule correctly; cooperation: - the patient or caregiver was willing to perform CIC; school limitation: - there was no available space to perform CIC or the caregiver was unable to provide CIC to patient; healthcare provider access limitation: the caregiver was unable to follow hospital appointments or CIC instruments were not affordable or available.

Statistical analysis

Odds ratios (OR) with 95% confidence intervals (CI) were used to assess the association between potential risk factors and successful clean intermittent catheterization in children with neurogenic lower urinary tract dysfunction. An independent t-test was used to compare continuous variables, while the Chi-square or Fisher's exact test was used for analysis of discrete variables. Factors with a p-value less than 0.05 in univariate analysis were subsequently included in a logistic regression analysis. Data analysis was performed using the Statistical Package for Social Sciences (SPSS standard version 20.0; Chicago, Illinois, USA).

Study outcomes

The primary objective of this study was to investigate factors associated with successful clean intermittent catheterization in children with neurogenic lower urinary tract dysfunction. The secondary outcome was to determine the prevalence of urinary tract infections in children diagnosed with this condition.

Ethical approval

This study was approved by the Siriraj Institutional Review Board (SIRB protocol number 635/2565, COA number Si 114/2023). Data collection was authorized by the Medical Statistics Report Unit at the Faculty of Medicine, Siriraj Hospital.

Results

Between 2009 and 2020, 233 patients with NLUTD underwent urodynamic studies at our center. Of these, CIC was successfully achieved in 148 patients (63.5%). In this successful group, the effectiveness of performing CIC was high at 93.2%, and the cooperation rate was also high at 94.6%.

Table 1. Baseline characteristics and clinical outcomes of clean intermittent catheterization in children with neurogenic lower urinary tract dysfunction

Baseline characteristics	All (n=233)	Successful (n=148)	Unsuccessful (n=85)	P-value
Age (years); mean±SD	6.74±0.49	6.99±0.46	6.15±0.52	0.370
Gender; n (%)				
Male	111 (47.6)	67 (45.3)	44 (51.8)	0.413
Female	122 (52.4)	81 (54.7)	41 (48.2)	
Etiology; n (%)				
DESD	14 (6.0)	9 (6.1)	5 (5.9)	0.528
Meningomyelocele	141 (60.5)	92 (62.2)	49 (57.6)	
Kippel-Feil syndrome	2 (0.9)	2 (1.4)	0 (0.0)	
VACTREL	7 (3.0)	2 (1.4)	5 (5.9)	
Hydrocephalus	8 (3.4)	5 (3.4)	3 (3.5)	
Anorectal formation	17 (7.3)	11 (7.4)	6 (7.1)	
Other	44 (18.9)	27 (18.2)	17 (20.0)	
Medication (anticholinergic); n (%)				
No use	78 (33.5)	54 (36.5)	24 (28.2)	0.254
Use	155 (66.5)	94 (63.5)	61 (71.8)	
Number of CIC; mean±SD	3.55±0.144	3.56±0.132	3.75±0.156	0.252
Effective Performance of CIC				0.000
Effective	192 (82.4)	138 (93.2)	54 (63.5)	
Ineffective	41 (17.6)	10 (6.8)	31 (36.5)	
Co-operation; n (%)				
No	29 (12.4)	8 (5.4)	21 (24.7)	0.000
Yes	204 (87.6)	140 (94.6)	64 (75.3)	
Caregiver; n (%)				
Parent	218 (93.6)	137 (92.6)	81 (95.3)	0.207
Grand	14 (6.0)	11 (7.4)	3 (3.5)	
Relative	1 (0.4)	0 (0.0)	1 (1.2)	
Education of caregiver; n (%)				
Primary	102 (43.8)	62 (41.9)	40 (47.1)	0.114
Secondary	124 (53.2)	79 (53.4)	45 (52.9)	
Bachelor	7 (3.0)	7 (4.7)	0 (0.0)	
Socioeconomics (THB)				
< 10k	20 (8.6)	15 (10.1)	5 (5.9)	0.413
10-30k	199 (85.4)	123 (83.1)	76 (89.4)	
30-60k	14 (6)	10 (6.8)	4 (4.7)	
School limitations				
No	180 (77.3)	117 (79.1)	63 (74.1)	0.482
Yes	53 (22.7)	31 (20.9)	22 (25.9)	
Health care provider access limitations				
No	183 (78.5)	119 (80.4)	64 (75.3)	0.454
Yes	50 (21.5)	29 (19.6)	21 (24.7)	

SD = standard deviation, DESD = detrusor external sphincter dyssynergia, CIC = clean intermittent catheterization, OR = odds ratio

Table 2. Multivariate analysis of associated factors with successful clean intermittent catheter in children with neurogenic lower urinary tract dysfunction

Risk factors	All (n=233)	Successful (n=148)	Unsuccessful (n=85)	Adjusted OR (95%CI)	P-value
Perform CIC effectively					
Follow	192 (82.4)	138 (93.2)	54 (63.5)	5.679	< 0.001
Unfollow	41 (17.6)	10 (6.8)	31 (36.5)	(2.423-13.311)	
Co-operation; n (%)					
No	29 (12.4)	8 (5.4)	21 (24.7)	2.416	0.084
Yes	204 (87.6)	140 (94.6)	64 (75.3)	(0.887-6.583)	

OR = odds ratio, CI = confidential interval, CIC = clean intermittent catheterization

In the unsuccessful group, 71 patients (83.5%) experienced UTI, with the average onset of UTI occurring approximately 8 months after being diagnosed with neurologic bladder dysfunction (Table 1).

The multivariate analysis revealed that the ability to perform CIC effectively (OR 5.679; 95%CI 2.423-13.311) is an independent predictor of successful outcomes. However, there were no significant differences between successful and unsuccessful CIC groups in terms of cooperation (94.6% vs. 73.5%, p 0.084), socioeconomic status, caregiver, etiology of disease, medication use (66.5% vs. 71.8%, p 0.254), number of CIC (3.56 vs. 3.75, p 0.252), school environment (20.9% vs. 25.9%, p 0.482), access to healthcare providers (19.6% vs. 24.7%, p 0.454), and gender (54.7% vs. 48.2%, p 0.413) (Table 2).

Discussion

CIC is widely accepted as the cornerstone of conservative management of pediatric NLUTD, with the primary goal of preserving upper urinary tract function and reducing UTI, as emphasized by the EAU/ESPU guidelines.[1]

Previous studies have demonstrated that improper or inconsistent catheterization is strongly associated with increased risk of UTI, highlighting the importance of correct CIC technique rather than catheterization frequency alone.[8]

Therefore, this study focused on the identification of factors that may influence the outcome of CIC, such as age, gender, etiology, medication (anticholinergic drug), number of CICs performed, effectiveness in performing CIC, cooperation, caregiver identity (parent, grandparent, or other relative), caregiver education level (primary, secondary, or bachelor's degree), socioeconomic status, school environment, and access to healthcare providers.

The study revealed that performing CIC effectively and patient cooperation positively influenced the success rate of CIC. This correlation is reflected in the CIC training program, which is individualized by urologists for each patient.

Similar to findings in adult and elderly populations, Hentzen et al. reported that successful catheterization depends primarily on technical ability and physical feasibility rather than age alone, supporting our finding that effective CIC performance is the key of determinant of success.[6]

In the multivariate analysis, only the "accuracy of performing CIC" remained significant, with a confounding effect observed for cooperation. Notably, cooperation with the urologist's schedule of CIC could lead to excellent outcomes, particularly for patients requiring multiple numbers of CIC sessions when complete emptying of residual urine is not achieved. While cooperation initially showed significance, it no longer remained significantly associated with the main outcome when assessed in the multivariate model. A plausible explanation is that effective CIC performance may be considered a subset of cooperation.

No statistically significant differences related to age and gender were found in the univariate analysis, although accessing the perineum in girls appeared to be more challenging. This observation could be attributed to the fact that the majority of CIC procedures were performed by caregivers in patients under twelve years of age.

Environmental factors played a crucial role in the study. For instance, the home environment, including the presence of a sink in the bathroom and accessibility to toilets, can significantly influence the ease of performing CIC. Similarly, the school environment is also noteworthy, as it impacts the availability of space for CIC to

be performed in children or for them to receive help from teachers. Interview data revealed that many caregivers utilize their break time at noon to perform CIC at school.

Although caregiver characteristics and socioeconomic factors have been reported to influence CIC adherence in infants with myelomeningocele, particularly in resource-limited setting, our study did not demonstrate a statistically significant association between these factors and CIC success.[7]

From the background research, access to healthcare providers was identified as a potential factor influencing the success rate of CIC. Concerns arose from the possibility that patients might not have access to appropriate instruments for CIC due to appointment issues, However, interviews revealed that parents often visited local hospitals to obtain the necessary instruments, crucial for successful CIC.

Several limitations hinder the interpretation of our study findings. First, it was a single-center retrospective study without a control group, which may limit the generalizability of the results. Second, the development of CIC skills is challenging within a day-hospital setting, despite these limitations, our study did not find a statistically significant difference in caregiver levels, and some patients had multiple caregivers performing CIC, which could have influenced the outcomes. The final limitation is the inability to comprehensively interpret urodynamic study data due to incomplete records from some patients. These limitations should be considered when interpreting the results of this study.

This study provides data to present to the authorities to facilitate recognition of difficulties in this situation and encourage provision of increased support for our patients by improving knowledge and awareness. The knowledge can be improved through education and guidance from doctors and nurses, while awareness can be raised by informing caregivers about the potential adverse events that may occur if patients or their care givers are unable to perform CIC effectively.

Conclusion

The ability to perform CIC effectively remains a challenge and is the primary factor associated with successful outcomes in children diagnosed with neurogenic lower urinary tract dysfunction. It is also important in reducing the risk of UTIs.

Other factors such as age, gender, etiology of NLUTD, anticholinergic use, number of CIC, cooperation, caregiver, caregiver education level, socioeconomic status, school environment and access to healthcare providers were found to be statistically insignificant in this study. This highlights the importance of focusing on achieving accurate CIC for improved outcomes in this patient population.

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Conflict of Interest

The authors have no conflicts of interest to declare.

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