Research article

Bladder-emptying methods, neurogenic lower urinary tract dysfunction and impact on quality of life in people with long-term spinal cord injury

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Objectives: To describe bladder-emptying methods used by people with long-term spinal cord injury (SCI) and to determine usage differences in relation to time since injury, sex, lesion level and completeness of lesion. Furthermore, to evaluate the relationship between bladder-emptying methods and the impact of neurogenic lower urinary tract dysfunction (NLUTD) on quality of life (QoL).
Design: Cross-sectional multicenter study.
Setting: Dutch community.
Participants: Persons dependent on wheelchairs ($N = 282$) with traumatic or non-traumatic SCI for ≥10 years and age at injury of 18–35 years.
Interventions: Not applicable.
Outcome measures: The International Lower Urinary Tract Function Basic SCI Data Set and the Short-Form Qualiveen (SF-Qualiveen).
Results: Median time since injury was 22.0 years (IQR: 16.8–30.3). Clean intermittent catheterization (CIC) was most commonly used (42.6%). Longer time since injury was associated with fewer continent urinary diversions and more transurethral catheter use. Transurethral catheter use and continent urinary diversions were more prevalent among women. Participants with tetraplegia were more likely to use reflex voiding or a suprapubic catheter, and participants with paraplegia were more likely to use CIC. Transurethral catheter users reported the highest impact of NLUTD on quality of life (SF-Qualiveen score: 1.9; SD = 0.8). Participants with a continent urinary diversion reported the lowest impact (SF-Qualiveen score: 0.9; SD = 0.6). Higher age and indwelling catheter use versus CIC were associated with a higher impact of NLUTD on QoL.
Conclusions: CIC is the most common bladder-emptying method in Dutch people with long-term SCI. Clinicians should be aware of the impact of NLUTD on QoL, especially for those using an indwelling catheter.

Keywords: Spinal cord injuries, Neurogenic bladder, Quality of life, Long-term care

Introduction

A spinal cord injury (SCI) may interrupt the communication between the pontine micturition center and the spinal cord, causing neurogenic lower urinary tract dysfunction (NLUTD) which can include detrusor overactivity, detrusor sphincter dyssynergia, hypocontractile detrusor, sphincter insufficiency and impaired bladder compliance. NLUTD may give rise to incontinence and bladder-emptying difficulties and may result in

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urological complications such as urinary tract infections (UTIs), vesico-ureteral reflux, hydronephrosis, urolithiasis and ultimately renal failure.

Proper bladder management is an important element of SCI rehabilitation. Its goal is to maintain continence, to prevent urological complications, to preserve upper and lower urinary tract function and to make bladder management compatible with the person's lifestyle and environment. Conservative bladder-emptying methods include: bladder reflex triggering, bladder expression, clean intermittent catheterization (CIC), or the use of an indwelling transurethral catheter. A more invasive method is a suprapubic catheter. Surgical bladder-emptying methods include: sacral anterior root stimulation (SARS), incontinent urinary diversions (ileal conduit, colon conduit) and continent urinary diversions (catheterizable pouches like the Indiana pouch or catheterizable channels like the Mitrofanoff procedure).

However, despite all rehabilitation efforts and advances in surgical treatment options, NLUTD remains one of the most frequently reported health issues among people with SCI.[1,2] In a Dutch survey, problems with bladder regulation were reported by 71% of 454 participants with SCI, and 52% rated these as one of their most important health issues.[1] In addition, urological complications such as UTIs have been described as the leading cause of rehospitalizations after traumatic SCI.[3,4]

Previous studies have shown that NLUTD is associated with lower quality of life (QoL) in people with SCI.[5,6] However, conflicting results have been published regarding the relationship between different bladder-emptying methods and QoL. While two studies found that QoL seemed most affected in people using CIC by an attendant[7,8] and in those with an indwelling catheter,[7] another study found no differences in QoL with regard to bladder-emptying method.[9] This discrepancy might be caused by the use of different generic health-related QoL (HRQoL) instruments.[7–9] Furthermore, generic measures may be less sensitive to condition-specific problems such as NLUTD. To date, only two studies are available in which a domain-specific QoL instrument, the Qualiveen,[10] was used to measure the impact of NLUTD in people with SCI.[6,11] However, both studies focused on just one specific bladder-emptying method.

Few studies have described long-term use of bladder-emptying methods in relation to time since injury (TSI).[2,12–16] Conflicting results have been published concerning the use of CIC over time.[2,12,13] One study reported an increase in CIC use from 11% at initial discharge to 36% at a mean TSI of 24 (10–45) years.[13] Another study reported a decrease in CIC use from 46% at discharge to 14% at 30 years after injury.[12] This study also showed an increase in indwelling catheter use from 23% to 45% in the same period and a decrease in the use of condom catheters, with 35% of individuals continuing to use condom catheters at 30 years after injury.[12]

People with SCI may change their bladder-emptying method even long after the onset of SCI. A longitudinal study among people who had had an SCI for at least 20 years found that no less than 29% of the participants had changed their bladder-emptying method during the 6-year follow-up period.[14]

Not enough is known about the distribution of bladder-emptying methods among people with long-term SCI and about the relationship between different bladder-emptying methods and the impact of NLUTD on QoL. This has led to the following research questions:

(1) Which bladder-emptying methods are currently being used by people with long-term SCI living in the Netherlands?
(2) Are there differences in the use of bladder-emptying methods in relation to different TSI periods (10–19 years, 20–29 years and ≥30 years), sex, spinal cord lesion level and completeness of the injury?
(3) Which demographic or injury-related characteristics and types of bladder-emptying methods are associated with a greater impact of NLUTD on QoL?

Methods

This study is part of the Dutch multicenter research program 'Active LifestyLe Rehabilitation Interventions in aging Spinal Cord injury (ALLRISC),'[17] a TSI-stratified cross-sectional study among people with long-term SCI living in the Netherlands. TSI strata were 10–19, 20–29 and 30 years or more after SCI. We aimed to include 100 persons per stratum.

Participants

Inclusion criteria were: (1) traumatic or non-traumatic SCI with a TSI of ≥10 years, (2) age at injury between 18 and 35 years, (3) current age between 28 and 65 years, (4) using a wheelchair (hand-rim propelled or electric wheelchair), at least for longer distances (>500 m). We choose the restriction to persons aged 18–35 years at onset of SCI in order to minimize the confounding effect of age at injury. By restricting our study to persons who suffered from SCI at a relatively young age, and mostly without any co-morbidity at the onset of SCI, we expected to be better able to study long-term consequences of the SCI itself.

The exclusion criterion was insufficient mastery of the Dutch language.

Since the ALLRISC research program aims to analyze associations between secondary health conditions and participation and QoL, accounting for the influence of demographic and injury-related variables, we performed the following power calculation. With alpha = 0.05 and power = 0.80, a prevalence of a particular secondary health condition of 0.2 can be estimated with a margin of error of ±4.6%. A prevalence difference of 0.2 (0.3 versus 0.5) between two TSI strata with 100 participants each would be statistically significant with the same alpha and power. For the exploratory regression analysis, this number of 300 participants allows inclusion of 19 independent variables in the analysis, using the rule of thumb of 15 participants per variable.

Procedure

Eligible persons were identified in databases from all eight Dutch rehabilitation centers specializing in SCI rehabilitation. Since we aimed to include 30–35 persons per center, and expected a response rate of around 50%, 62 persons per center were invited for the study. If the number of eligible persons allowed it, a random sample was drawn at each center. If the response was less than 30–35 persons per center, an additional sample was drawn at that center.

The study consisted of a one-day visit to the rehabilitation center for a check-up, including an extensive medical assessment and physical examination, performed by an SCI rehabilitation physician, and an oral interview and several physical tests, performed by a research assistant.[17] Two weeks before the visit to the rehabilitation center, participants were asked to complete a self-report questionnaire.[17]

The research protocol was approved by the Medical Ethics Committee of the University Medical Center Utrecht. All participants gave written informed consent.

Instruments

Personal characteristics

The self-report questionnaire included questions concerning age, nationality, relationship status, educational level, and employment.

Medication use and urological medical history were addressed in the consultation with the rehabilitation physician, and further data was retrieved from the medical file if applicable.

Lesion characteristics

The International Standards for Neurological Classification of Spinal Cord Injury were used by the rehabilitation physician to assess lesion characteristics.[18] Tetraplegia was defined as a lesion at or above the first thoracic segment, and paraplegia as a lesion below the first thoracic segment. Complete lesion was defined as the absence of motor and sensory function in the sacral segments, i.e. American Spinal Injury Association (ASIA) Impairment Scale (AIS) grade A. AIS grades B, C, and D were classified as an incomplete lesion.

Date of onset of SCI, age at injury and cause of the injury were asked for in the self-report questionnaire.

Bladder-emptying methods

The International Lower Urinary Tract Function Basic SCI Data Set was used by all physicians for the standardized assessment of bladder management.[19] This data set includes items on urinary tract impairment unrelated to spinal cord lesion, awareness of the need to empty the bladder, main and supplementary bladder-emptying methods, frequency of incontinence over the last three months, use of collecting appliances for urinary incontinence, any medication use for the urinary tract, surgical procedures on the urinary tract and any change in urinary symptoms (changes in presentation of UTI, in frequency, urgency, incontinence, hesitancy) during the previous year.[19] The distinction between main and supplementary bladder-emptying methods was made by determining which method was used most frequently (the main method) and which method(s) was used in a supplemental manner with a lesser frequency.

The only adaptation we made was that we recorded the use of a condom catheter separately, instead of classifying it as involuntary bladder reflex triggering.

Incontinence

Incontinence was operationalized as any involuntary leakage of urine. No involuntary urine leakage implied no leakage of urine outside the urinary tract or a closed urinary collection system.[19]

Urinary tract infections

Participants were asked about UTIs within the last three months. UTI was defined as a symptomatic infection of the urinary tract, treated with antibiotics. Symptoms had to include one or more of the following: onset of urinary incontinence, increased spasticity, malaise, autonomic dysreflexia, discomfort or pain during urination, gritty particles or mucus in the urine or cloudy urine with increased odor.

Urinary specific QoL

The self-report questionnaire included the Short-Form Qualiveen (SF-Qualiveen).[20] This is an eight-item instrument developed for people with neurogenic bladder problems. The eight items are distributed over

four domains, including "bother with limitations," "frequency of limitations," "fears" and "feelings." A total SF-Qualiveen score (range 0–4) is calculated as the average of the item scores. The lower the score, the lower the impact of NLUTD on QoL.

Statistics

Descriptive statistics were used to describe participants' demographic and injury-related characteristics, bladder-emptying methods and SF-Qualiveen scores.

There were some missing values for some variables (nationality, relationship status, level of education, employment and SF-Qualiveen score) since not all participants completed the self-report questionnaire. These missing data were not included in the descriptive analyses. There were no missing data on the participants' bladder-emptying method.

The χ^2 test was used to explore associations between TSI groups and categorical variables, such as sex and level of SCI.

Associations between bladder-emptying methods and other variables were assessed one by one using the Chi-square test, each time comparing the subgroup of participants using a particular bladder-emptying method with all other participants. This was done because of the relatively large number and mostly small size of the bladder-emptying subgroups.

Since age and the SF-Qualiveen score were normally distributed, the independent samples *t*-test was used to compare two independent groups regarding these continuous measures. One-way ANOVA was used to test for differences in age for the three TSI groups. Age at injury was not normally distributed, so the Mann Whitney *U* test was used to assess differences between two independent groups regarding this continuous measure. The Kruskal-Wallis Test was used to assess differences in age at injury between the three TSI groups.

Bivariate regression analysis was used to study the relationships between demographic and injury-related characteristics and bladder-emptying methods with the SF-Qualiveen score. We first calculated the predictive value of each independent variable separately, and then used multiple regression analysis to explore how much of the variance of the SF-Qualiveen score was explained by a set of independent variables. Bladder-emptying method was included as a set of six dummy variables with CIC as the reference category, since CIC has been described as the gold standard for bladder-emptying.[21]

We dealt with missing data by using pairwise deletion of cases with missing values.

All analyses were performed using the SPSS statistical software (SPSS 21.0 for Windows; IBM Corp, Armonk, NY, USA).

Results

Participant characteristics

Between November 2011 and February 2014 a total of 566 persons were invited to participate in the study, 292 of whom were ultimately included. The main

Table 1 Participant characteristics, *N* = 282

	Total (*N* = 282)	TSI 10–19 years (*N* = 107)	TSI 20–29 years (*N* = 96)	TSI ≥ 30 years (*N* = 79)	Sig.
Age (years), mean (SD)	48.3 (8.9)	40.8 (5.4)	48.5 (5.7)	58.3 (5.2)	<0.001
Age at injury (years), median (IQR)	23.4 (20.6–27.8)	25.3 (21.6–29.2)	23.5 (20.9–28.5)	21.3 (19.4–24.3)	<0.001
Sex (% male)	74	72	80	70	0.229
Nationality (% Dutch)*	96	94	98	97	0.315
Cause (% traumatic)	91	94	92	87	0.231
Level (% tetraplegia)	41	42	43	39	0.896
Cervical (%)	41	42	43	39	0.398
Thoracal (%)	53	49	54	56	
Lumbal (%)	6	9	3	5	
Relationship (% married/stable relationship)*	61	57	64	62	0.586
Level of education (% college/university)*	44	45	48	40	0.549
Employment (% having paid work ≥ 1 hour/week)*	39	48	39	28	0.023
ASIA Impairment Scale (AIS), (%)					0.170
A	69	74	70	59	
B	14	11	10	20	
C	10	10	10	8	
D	8	5	8	13	
Time since injury (years), median (IQR)	22.0 (16.8–30.3)	—	—	—	—

*Data extracted from the self-report questionnaire: *N* = 268.

reasons for non-participation were a large travel distance, unwillingness, too busy with daily life, and health issues. After the inclusion procedure there were 10 participants who in retrospect did not meet all the inclusion criteria and were therefore excluded from the analyses. A total of 266 participants (94.3%) completed the self-report questionnaire. The characteristics of the participants ($N = 282$) are described in Table 1. We were not able to perform a non-response analysis since not all of the participating rehabilitation centers could provide us with the required information concerning the non-respondents.

Table 2 presents the scores on the items of the International Lower Urinary Tract Function Basic SCI Data Set, including the reported bladder-emptying methods. Twenty-seven percent of the participants reported being incontinent at least once a month, 58.5% used a collecting appliance for urinary incontinence, 22.7% used bladder relaxant drugs and 19.1% used prophylactic antibiotics. In addition, 48.2% of the participants reported to have had at least one surgical procedure on the urinary tract.

Bladder-emptying methods and association with TSI

CIC was most commonly used as the main bladder-emptying method (42.6%, excluding the catheterizable pouches and channels), followed by condom catheter drainage (11.3%), indwelling suprapubic catheterization (11.3%) and voluntary bladder reflex triggering (11.0%).

The continent urinary diversions included the Indiana pouch ($N = 5$), the Mitrofanoff procedure ($N = 2$), and the Monti procedure ($N = 1$). The incontinent urinary diversions included ileal conduit (Bricker procedure; $N = 7$) and an ileo-vesicostomy ($N = 1$).

Table 3 presents the distribution of the main bladder-emptying methods for each of the three TSI groups. There were more participants with a continent urinary diversion in the TSI 10–19 years group compared to the other two TSI groups. More participants in the TSI ≥30 years group had a transurethral catheter than in the other two TSI groups. No further significant associations were found between bladder-emptying methods and TSI.

Bladder-emptying methods and associations with sex, lesion level, and completeness

Table 3 also presents the different bladder-emptying methods by sex, lesion level (tetraplegia versus paraplegia) and completeness of the lesion. Transurethral catheter use and continent urinary diversions were more prevalent among women. While voluntary bladder-reflex triggering and suprapubic catheter use were more often reported by participants with tetraplegia than by participants with paraplegia, more participants with paraplegia used CIC.

Among participants with complete lesions there were more who used CIC than among those with an incomplete lesion. There were no participants with a complete lesion who voided normally, and none of the participants with an incomplete lesion used SARS.

SF-Qualiveen score

The mean SF-Qualiveen score for all participants was 1.33 (SD 0.72) (Table 4). Participants with a transurethral catheter reported the highest impact of NLUTD on QoL, while participants with a continent urinary diversion reported the lowest impact. As regards SF-Qualiveen domain scores, participants who needed an attendant for bladder reflex triggering or CIC and those with SARS reported the highest scores for the "bother with limitations" domain. Participants with a transurethral catheter had the highest scores on the "frequency of limitations," "fears" and "feelings" domains. Participants with an incontinent or continent urinary diversion reported the lowest scores on all four domains.

In order to perform the regression analyses with the lowest possible number of groups using different bladder-emptying methods, we merged the transurethral and suprapubic catheter groups to form one indwelling catheter group, and the continent and incontinent urinary diversions groups to form one urinary diversion group. This was justifiable since no significant differences in mean total SF-Qualiveen scores were observed between these groups (Table 4).

In the series of bivariate regression analyses, complete SCI, incontinence at least once a month, the use of a collecting appliance for urinary incontinence and the need for an attendant to assist with bladder-emptying were all associated with a higher impact of NLUTD on QoL (Table 5). Normal voiding versus CIC and urinary diversion versus CIC were associated with a lower impact of NLUTD on QoL (Table 5).

The multiple regression model revealed that higher age and indwelling catheter use versus CIC were the only independent variables associated with a higher impact of NLUTD on QoL, explaining 18% of the variance. (Table 5).

Discussion

This study on bladder-emptying methods used by Dutch persons with long-term SCI showed that CIC was the most commonly used bladder-emptying method. A decrease in continent urinary diversions and an increase in transurethral catheter use were observed with

Table 2 International lower urinary tract function basic spinal cord injury data set (*N* = 282)

Item	*N* (%)	
Urinary tract impairment unrelated to spinal cord lesion:		
No	274 (97.2)	
Yes	8 (2.8)	
Unknown	0 (0.0)	
Awareness of the need to empty the bladder:		
No	77 (27.3)	
Yes	43 (15.2)	
Indirectly (i.e. by spasms, unpleasant sensations, abdominal cramps, headache, sweating)	158 (56.0)	
Unknown	4 (1.5)	
Bladder-emptying:	Main:	Supplementary:
Normal voiding	21 (7.4)	1 (0.4)
Bladder reflex triggering:		
voluntary (tapping, scratching, anal stretch, etc.)		
Independently	27 (9.6)	16 (5.7)
By attendant	4 (1.4)	3 (1.1)
Bladder expression:		
Straining (abdominal straining, Valsalva's manoeuvre)	6 (2.1)	1 (0.4)
External compression (Credé manoeuvre)	0 (0.0)	2 (0.7)
Intermittent catheterization:		
Self-catheterization *(excluding catheterization of a continent urinary diversion)*	113 (40.1)	14 (5.0)
Catheterization by attendant	7 (2.5)	7 (2.5)
Indwelling catheter:		
Transurethral	9 (3.2)	0 (0.0)
Suprapubic	32 (11.3)	0 (0.0)
Sacral anterior root stimulation	15 (5.3)	0 (0.0)
Incontinent urinary diversion/ostomy	8 (2.8)	0 (0.0)
Other method, specify:		
Collection of urine in condom catheter	32 (11.3)	65 (23.0)
Continent urinary diversion	8 (2.8)	0 (0.0)
Unknown	0 (0.0)	0 (0.0)
Any involuntary urine leakage (incontinence) within the last three months:		
No	164 (58.2)	
Yes, average daily	27 (9.6)	
Yes, average weekly	28 (9.9)	
Yes, average monthly	21 (7.4)	
Yes, less than once per month	40 (14.2)	
Not applicable	0 (0.0)	
Unknown	2 (0.7)	
Collecting appliances for urinary incontinence:		
No	117 (41.5)	
Yes, condom catheter / sheath	104 (36.9)	
Yes, absorbing appliances: diaper / pad / panty liner	64 (22.7)	
Yes, ostomy bag	7 (2.5)	
Any drugs for the urinary tract:		
No	155 (55.4)	
Yes, bladder relaxant drugs (anticholinergics, tricyclic antidepressants, etc.)	64 (22.7)	
Yes, sphincter / bladder neck relaxant drugs (alpha adrenergic blockers etc.)	13 (4.6)	
Yes, antibiotics / antiseptics:		
For treatment of urinary tract infection	1 (0.4)	
For prophylactic reasons	54 (19.1)	
Yes, other, specify:		
Reflux (methenamine)	12 (4.3)	
For prophylactic reasons:		
Cranberry tablets	54 (19.1)	
Cranberry juice	18 (6.4)	
D-mannose	4 (1.4)	
Vitamin C	16 (5.7)	
Surgical procedures on the urinary tract:		
No	146 (51.8)	
Supra-pubic catheter insertion	43 (15.2)	
Bladder stone removal	26 (9.2)	
Upper urinary tract stone removal	17 (6.0)	
Bladder augmentation	7 (2.5)	
Sphincterotomy / urethral stent	20 (7.1)	
Botulinum toxin injection	26 (9.2)	

Continued

Table 2 ***Continued***

Item	*N* (%)
Artificial sphincter	1 (0.4)
Ileovesicostomy	1 (0.4)
Ileoureterostomy (Bricker conduit)	7 (2.5)
Continent catheterizable stoma	8 (2.8)
Sacral anterior root stimulator	21 (7.4)
Yes, other	27 (9.6)
Any change in urinary symptoms within the last year:	
No	214 (75.9)
Yes	62 (22.0)
Not applicable	1 (0.4)
Unknown	5 (1.8)
At least one symptomatic urinary tract infection during the last three months:	94 (33.3)

increasing TSI. Transurethral catheter use and continent urinary diversions were more prevalent among women. Furthermore, participants with tetraplegia were more likely to use reflex voiding or a suprapubic catheter, and participants with paraplegia were more likely to use CIC.

Transurethral catheter users reported the highest impact of NLUTD on QoL, while participants with a continent urinary diversion reported the lowest impact. A higher age and indwelling catheter use were independently associated with a higher impact of NLUTD on QoL, but explained only a small proportion of the variance.

Bladder-emptying methods

Overall, most participants used CIC (43%) as their main bladder-emptying method, and this percentage remained fairly stable over time. A previous study reported CIC use by 44% of the participants with a TSI of 10–20 years and by 29% and 30% of those with a TSI of 20–30 years and 30–45 years, respectively.[13] Other studies also described a decline in CIC use over time, mostly due to a switch to indwelling catheter use.[12,22] The main reasons for this switch were dependence on caregivers and unacceptable incontinence. However, another study found that CIC use remained relatively constant over time, with a prevalence of 30% for the 11–20 years TSI group, 45% for the 21–25 years TSI group and 32% for the 26–30 years TSI group.[16] The stability of CIC use over time in our study is encouraging, since CIC has been established as the safest bladder-emptying method in individuals with SCI, in terms of urological complications.[21]

Regarding sex differences, more women than men used transurethral catheters, which can possibly be explained by the fact that the option of external condom drainage is not available to women. Furthermore, women were more likely to have continent urinary diversions, which can be a valuable alternative, especially for wheelchair-bound women who suffer from bladder-emptying problems and have difficulty performing CIC.[23,24] Continent urinary diversions enable them to self-catheterize without having to make a transfer, thereby avoiding the use of indwelling catheterization.

There were more participants with continent urinary diversions in the 10–19 years TSI group than in the other two TSI groups. This probably illustrates the growing familiarity and greater experience with these procedures during the past years.

SF-Qualiveen score

Relatively low mean SF-Qualiveen scores were reported, indicating a slight to moderate impact of NLUTD on QoL. Participants using a transurethral catheter (1.86) and those treated with SARS (1.64) reported the highest impact of NLUTD on QoL. Since there have been no similar studies using the SF-Qualiveen in people with SCI, we cannot compare our results with other data.

Two studies have used the King's Health Questionnaire to assess the effects of different bladder-emptying methods on QoL in people with SCI.[7,8] Both studies described that participants who voided normally reported the highest QoL and those with CIC performed by an attendant reported the lowest QoL. We found similar results in our sample, although in our study participants using an indwelling catheter also reported a relatively high impact of NLUTD on QoL.

Implications

Overall, our results show a moderate impact of NLUTD on QoL. The lack of an association with TSI is encouraging, since one might expect worsening of NLUTD and thereby of the impact of NLUTD on QoL over time. Almost all participants experienced at least some impact of NLUTD on QoL, with substantial differences

Table 3 The different bladder-emptying methods reported by TSI group, gender, lesion level (tetraplegia versus paraplegia) and completeness of the injury

	TSI 10–19 years (*N* = 107)	TSI 20–29 years (*N* = 96)	TSI ≥ 30 years (*N* = 79)	Sig.	Male (*N* = 209)	Female (*N* = 73)	Sig.	Tetraplegia (*N* = 116)	Paraplegia (*N* = 165)	Sig.	Complete (*N* = 193)	Incomplete (*N* = 89)	Sig.
Normal voiding* (*N* = 21)	7 (6.5%)	8 (8.3%)	6 (7.6%)	0.887	13 (6.2%)	8 (11.0%)	0.199	11 (9.5%)	9 (5.5%)	0.240	0 (0.0%)	21 (23.6%)	**<0.001**
Bladder expression* (*N* = 6)	0 (0.0%)	3 (3.1%)	3 (3.8%)	0.146	3 (1.4%)	3 (4.1%)	0.182	1 (0.9%)	5 (3.0%)	0.406	5 (2.6%)	1 (1.1%)	0.669
Bladder reflex triggering (voluntary)* (*N* = 31)	9 (8.4%)	13 (13.5%)	9 (11.4%)	0.502	26 (12.4%)	5 (6.8%)	0.276	22 (19.0%)	9 (5.5%)	**0.001**	19 (9.8%)	12 (13.5%)	0.482
Condom catheter* (*N* = 32)	11 (10.3%)	15 (15.6%)	6 (7.6%)	0.226	32 (15.3%)	NA	NA	16 (13.8%)	16 (9.7%)	0.382	22 (11.4%)	10 (11.2%)	1.000
CIC* (*N* = 120)	51 (47.7%)	36 (37.5%)	33 (41.8%)	0.339	90 (43.1%)	30 (41.1%)	0.877	21 (18.1%)	99 (60.0%)	**<0.001**	93 (48.2%)	27 (30.3%)	**0.007**
SARS* (*N* = 15)	2 (1.9%)	9 (9.4%)	4 (5.1%)	0.059	11 (5.3%)	4 (5.5%)	1.000	9 (7.8%)	6 (3.6%)	0.177	15 (7.8%)	0 (0.0%)	**0.004**
Indwelling catheter (*N* = 41)	18 (16.8%)	8 (8.3%)	15 (19.0%)	0.096	28 (13.4%)	13 (17.8%)	0.467	29 (25.0%)	12 (7.3%)	**<0.001**	27 (14.0%)	14 (15.7%)	0.839
Transurethral catheter (*N* = 9)	2 (1.9%)	1 (1.0%)	6 (7.6%)	**0.030**	3 (1.4%)	6 (8.2%)	**0.011**	5 (4.3%)	4 (2.4%)	0.495	6 (3.1%)	3 (3.4%)	1.000
Suprapubic catheter (*N* = 32)	16 (15.0%)	7 (7.3%)	9 (11.4%)	0.228	25 (12.0%)	7 (9.6%)	0.673	24 (20.7%)	8 (4.8%)	**<0.001**	21 (10.9%)	11 (12.4%)	0.871
Urinary diversion (*N* = 16)	9 (8.4%)	4 (4.2%)	3 (3.8%)	0.297	6 (2.9%)	10 (13.7%)	**0.002**	7 (6.0%)	9 (5.5%)	1.000	12 (6.2%)	4 (4.5%)	0.783
Continent urinary diversion (*N* = 8)	7 (6.5%)	1 (1.0%)	0 (0.0%)	**0.013**	0 (0.0%)	8 (11.0%)	**<0.001**	3 (2.6%)	5 (3.0%)	1.000	7 (3.6%)	1 (1.1%)	0.442
Incontinent urinary diversion (*N* = 8)	2 (1.9%)	3 (3.1%)	3 (3.8%)	0.720	6 (2.9%)	2 (2.7%)	1.000	4 (3.4%)	4 (2.4%)	0.721	5 (2.6%)	3 (3.4%)	0.710

*Only the use of main bladder-emptying methods is reported.
NB: associations are displayed in bold. CIC = clean intermittent catheterization; NA = Not Applicable; SARS = sacral anterior root stimulation; TSI = time since injury.

Table 4 Mean SF-Qualiveen score for the different main bladder-emptying methods

	SF-Qualiveen score Mean (SD)
Total ($N = 266$)	1.33 (0.72)
Normal voiding ($N = 18$)	0.93 (0.71)
Bladder expression ($N = 6$)	1.27 (0.45)
Bladder reflex triggering (voluntary) ($N = 29$)	1.50 (0.75)
Independently ($N = 26$)	1.51 (0.72)
By attendant ($N = 3$)	1.42 (1.21)
Condom catheter ($N = 30$)	1.32 (0.67)
CIC ($N = 113$)	1.30 (0.67)
Independently ($N = 106$)	1.29 (0.65)
By attendant ($N = 7$)	1.48 (0.91)
SARS ($N = 15$)	1.64 (0.88)
Indwelling catheter ($N = 39$)*	1.54 (0.79)
Transurethral catheter ($N = 9$)	1.86 (0.82)
Suprapubic catheter ($N = 30$)	1.44 (0.76)
Urinary diversion ($N = 16$)†	0.90 (0.65)
Continent urinary diversion ($N = 8$)	0.89 (0.58)
Incontinent urinary diversion ($N = 8$)	0.91 (0.75)

NB: CIC = clean intermittent catheterization; SARS = sacral anterior root stimulation.
*No significant difference in total SF-Qualiveen score between transurethral catheter use and suprapubic catheter use ($P = 0.159$).
†No significant difference in total SF-Qualiveen score between continent and incontinent urinary diversions ($P = 0.963$).

in impact scores within and between bladder-emptying methods. This underlines the need to optimize bladder management across the life span of people with SCI. Our findings suggest underuse of continent urinary diversions in individuals with long-term SCI, which is unfortunate since these procedures can be a valuable alternative, especially for a selected group of people with paraplegia and women needing CIC. We found the highest impact of NLUTD on QoL among participants using transurethral catheters and those needing an attendant. Clinicians can use this information when discussing treatment options with people with SCI.

However, the choice for a specific bladder-emptying method needs to be tailored to the individual patient, since it depends on a number of different factors, including spinal cord lesion level (suprasacral versus sacral), manual abilities, convenience, and risk of complications. The most disabled individuals living with SCI, who are likely to experience the highest impact of their disabilities on QoL, are also most likely to be assigned to indwelling catheter use or to bladder-emptying by an attendant.

Our multiple regression model only explained 18% of the variance of the total SF-Qualiveen score. NLUTD-related QoL is probably influenced by many more factors than we have included, such as psychological factors (i.e. self-efficacy, coping, self-esteem), social support, and financial circumstances.[25] This implies that future studies on the association between bladder-emptying methods and QoL should also focus on these other psychosocial and environmental factors.

Table 5 Bivariate and multiple regression analysis for the association between potential predictors and the overall quality of life score of the SF-Qualiveen

	Bivariate regression			Standard multiple regression		
Variables entered	B (S.E)	beta	Sig.	B (S.E)	beta	Sig.
Age	0.009 (0.005)	0.105	0.089	0.021 (0.010)	0.253	**0.036**
TSI	0.005 (0.005)	0.062	0.314	−0.013 (0.009)	−0.164	0.170
Sex (male = 1)	0.092 (0.101)	0.056	0.364	0.048 (0.112)	0.029	0.664
Completeness of SCI (motor and sensory complete = 1)	0.237 (0.095)	0.152	**0.013**	0.148 (0.112)	0.095	0.188
Level of SCI (paraplegia = 1)	0.067 (0.091)	0.046	0.457	0.088 (0.111)	0.060	0.428
Cause of injury (traumatic=1)	–0.209 (0.154)	–0.083	0.178	-0.142 (0.160)	–0.056	0.375
Education (college/university = 1)	–0.020 (0.089)	–0.014	0.826	0.006 (0.089)	0.004	0.944
Main bladder-emptying method						
Constant*	1.299 (0.067)					
Dum_M1 (normal voiding vs. CIC)	–0.368 (0.181)	–0.128	0.043	–0.252 (0.193)	–0.092	0.192
Dum_M2 (voluntary bladder reflex triggering vs. CIC)	0.201 (0.148)	0.087	0.175	0.128 (0.158)	0.056	0.417
Dum_M3 (condom catheter vs. CIC)	0.018 (0.146)	0.008	0.902	-0.035 (0.153)	–0.016	0.818
Dum_M4 (SARS vs. CIC)	0.343 (0.196)	0.110	0.081	0.344 (0.203)	0.108	0.092
Dum_M5 (Indwelling catheter vs. CIC)	0.237 (0.132)	0.116	0.075	0.353 (0.143)	0.174	**0.014**
Dum_M6 (Urinary diversion vs. CIC)	–0.400 (0.190)	–0.132	**0.036**	–0.358 (0.197)	–0.116	0.070
Incontinence of at least once a month	0.265 (0.099)	0.162	**0.008**	0.161 (0.107)	0.099	0.134
Use of collecting appliances for urinary incontinence	0.243 (0.089)	0.165	**0.007**	0.181 (0.101)	0.123	0.076
Bladder-emptying by attendant	0.382 (0.163)	0.142	**0.020**	0.355 (0.171)	0.124	0.052
At least one symptomatic UTI during the last 3 months	0.224 (0.093)	0.146	**0.017**	0.161 (0.092)	0.105	0.082
				R	R square	
				0.420	0.176	

*The reference category was clean intermittent catheterization.
NB: CIC = clean intermittent catheterization; SARS = sacral anterior root stimulation; TSI = time since injury; UTI = urinary tract infection.

Limitations

Due to the cross-sectional design of the study, our analyses of associations with TSI are limited and possibly biased. In addition, it was not possible to reliably reconstruct the use of bladder-emptying methods over periods of sometimes more than 30 years from the available medical records. Hence we were not able to provide information regarding previous use of bladder-emptying methods, nor did we know for how many years participants had been using their current method(s). Finally, the inclusion criteria we used resulted in a study sample that predominantly consisted of participants with a traumatic and complete SCI who had acquired their SCI at a relatively young age. This does not correspond to the general profile of the SCI population in the Netherlands.[26] The advantage, however, is that the impact of normal ageing of our sample will be limited, so that NLUTD can be ascribed to the SCI.

Conclusions

This study shows that CIC is the most common main bladder-emptying method among people with long-term SCI living in the Netherlands. People with long-term SCI who use a transurethral catheter as their main bladder-emptying method experience the highest impact of NLUTD on QoL, while people with a continent urinary diversion experience the lowest impact. Increasing age and the use of an indwelling catheter are both independently associated with a higher impact of NLUTD on QoL. This indicates that clinicians should be aware of the impact of bladder-emptying methods on the QoL of people with long-term SCI, especially for those using indwelling catheters.

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