

Dysfunctional Voiding: Exploring Disease Transition From Childhood to Adulthood



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OBJECTIVE	To improve our transitional care, we explored how childhood dysfunctional voiding (DV) develops into adulthood. DV is a common condition in both children and adults. However, the long-term course of childhood DV into adulthood is unknown and treatment over the ages differs.
METHODS	A cross-sectional follow-up was performed in a cohort of 123 females treated from 2000 to 2003 for childhood DV with urinary tract infections (UTIs) and/or daytime urinary incontinence (DUI). The main outcome was a staccato or intermittent urinary flow pattern, possibly indicating persistent or recurred DV according to the International Continence Society criteria. Flow patterns of healthy women were used to compare results.
RESULTS	Twenty-five patients participated in this study, with a mean duration of 20.8 years after urotherapy. In 10/25 (40%) cases, a staccato or interrupted urinary flow pattern was found on the current measurement, compared to 5/47 (10.6%) in the control group. Around 50% (5/10) of the patients with a dysfunctional flow pattern reported UTIs and 50% (5/10) experienced DUI. In the group with a normal flow pattern, 2/15 (13%) reported UTIs and 9/15 (60%) DUI. The impact of DUI on quality of life was moderate to high in both groups.
CONCLUSION	Our results show that 40% of females who had extensive urotherapy for DV in childhood, still have DV according to International Continence Society criteria as an adult, 56% still experience DUI, and 28% UTIs. These data should be taken into account in the counseling of patients and for guiding the process of transition into adulthood. UROLOGY 177: 60–64, 2023. © 2023 The Author(s). Published by Elsevier Inc. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).

Dysfunctional voiding (DV) is a bladder outlet problem characterized by an intermittent and/or fluctuating flow rate due to impaired relaxation of the urethral sphincter or pelvic floor musculature during voiding.¹ In both children and adults, it is a common condition that is known to cause urinary tract infections (UTIs) and daytime urinary incontinence (DUI).^{2,3} Although both the International Continence Society (ICS) and the International Children's Continence Society use

equivalent definitions for DV,^{4,5} treatment options for DV differ between children and adults.

For adulthood DV, training with pelvic floor physiotherapy and biofeedback has been proven effective and represents standard therapy.^{6,7} Main goals herein are to normalize micturition patterns and improve lower urinary tract symptoms (LUTS),⁷ as these may have a profound impact on quality of life.⁸ In children, urotherapy is considered to be the first-line treatment.⁵ The aim of urotherapy is the rehabilitation of the lower urinary tract by, that is, demystification of the underlying dysfunction and providing instruction on voiding and bowel habits in order to encourage behavioral change.^{5,9,10}

Disease prognosis in the long term of children with DV is largely unknown due to the scarcity of long-term follow-up data after urotherapy. On the other hand, we do not know whether adult patients with DV also suffered from UTI and DUI as a child. Up to date, no longitudinal studies are available on the transition of

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patients with DV from childhood to adult life. The long-term effect of treatment for childhood DV is therefore also still unknown. Given the different treatment approaches that are provided over the ages, the objective of our study is to explore how DV develops from childhood into adulthood, in order to improve our transitional care for patients with DV.

MATERIAL AND METHODS

The present study was exempt from the Dutch Medical Research Involving Human Subjects Act by the Institutional Review Board of the University Medical Centre Utrecht (subject number 21-601/D).

A cohort study with cross-sectional follow-up was performed at the Wilhelmina Children's Hospital, Utrecht, from December 2021 to January 2022. All 123 girls who completed the follow-up in the randomized controlled trial of Klijn et al. were considered for inclusion.² In that study, conducted from 2000 to 2003, the effect of urotherapy-based treatment strategies for UTIs and DUI was assessed in 143 children with DV, 12 months after randomization.

All patients were sent study information and an informed consent form by mail. After 2 weeks the patients were contacted by phone and asked to participate. Current pregnancy was an exclusion criterion. A total of 25 women participated in our present study (Fig. 1). Participants were invited for uroflowmetry with post-void residual (PVR) assessment. Additionally, a combined version of the International Consultation on Incontinence Modular Questionnaire – Female Lower Urinary Tract Symptoms and International Consultation on Incontinence Modular Questionnaire – Urinary Incontinence questionnaires were completed (Appendix 1; questionnaire). Furthermore, participants were questioned about UTIs over the last year.

A group of 47 healthy, nulligravid female medical students aged 18-30 years was used as control. They were recruited after written informed consent and invited for a single uroflow measurement.¹¹

DV was defined according to the ICS standardization paper as a bladder outlet problem, characterized by contractions of the peri-urethral striated muscles during voiding, which consequently demonstrates a staccato or intermittent/interrupted uroflow pattern on uroflowmetry in neurologically normal individuals.⁴ Flow pattern was rated as bell-shaped (normal) or as interrupted/staccato (dysfunctional). The flow pattern was

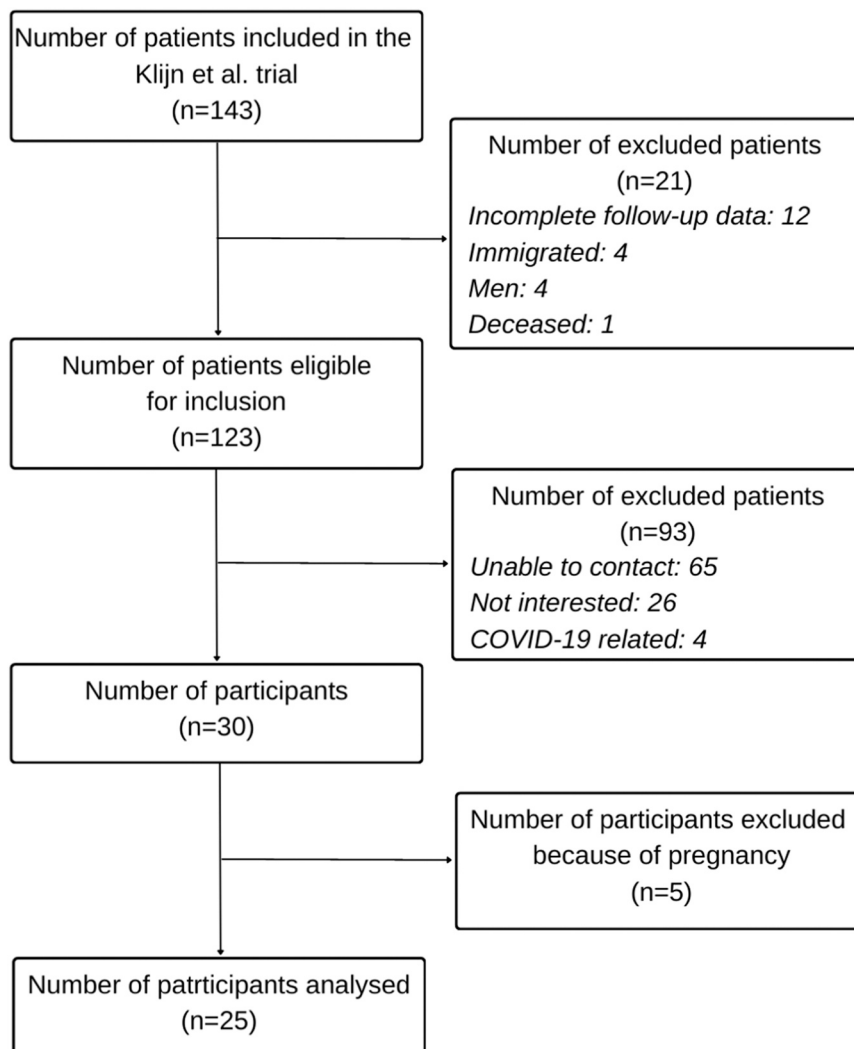


Figure 1. Inclusion flowchart.

considered interrupted if the flow rate reached the zero line in between micturition portions. A staccato flow pattern was defined as an irregular and fluctuated flow curve wherein the fluctuations between peak and trough were larger than the square root of Qmax.⁵

Outcome Measures

The primary outcome was the percentage of females with an interrupted and/or staccato flow pattern as a measure for persistence or recurrence of DV in adulthood.

The following secondary endpoints were defined to assess the long-term success on LUTS after urotherapy in children with DV:

- The percentage of females with DUI, defined as any form of involuntary leakage of urine during the day.
- The percentage of females with subjective complaints suspicious for UTI, assessed by reported dysuria, macroscopic hematuria, pollakisuria, fever and flank pain over the last year.
- PVR, defined as at least 100 mL of residual urine measured by transabdominal ultrasound within 5 minutes after voiding.
- Impact of current DUI on quality of life, rated by use of an 11-point numeric scale; 0 = no impact, 10 = maximal impact.

Statistical Analysis

Descriptive statistics were used to provide an overview of the primary and secondary outcome measures. Additionally, a generalized linear mixed model was performed to predict a statistically significant change in flow patterns, DUI and UTIs over time. In performed tests, the level of statistical significance was predefined at $P < .05$ (two-sided). Statistical analyses were performed using IBM Statistical Package for Social Sciences software (version 27, SPSS).

RESULTS

Data from 25 women were analyzed, with a mean age of 29 years; 72% (18/25) were nulligravid. Baseline characteristics are shown in Table 1.

After a mean duration of 20.8 years after urotherapy, in 40% (10/25) of participants, a dysfunctional flow pattern was found, while in the control group, this was 11% (5/47).

Five of 10 (50%) of the participants with a dysfunctional flow reported UTIs and 50% (5/10) experienced DUI, while 9/

Table 2. Long-term follow-up (stratification on flow pattern).

	Flow Pattern Dysfunctional (n = 10)	Normal (n = 15)
DUI		
No DUI, N (%)	5/10 (50%)	6/15 (40%)
Persisting, N (%)	2/10 (20%)	6/15 (40%)
Recurred, N (%)	1/10 (10%)	3/15 (20%)
New onset, N (%)	2/10 (20%)	0/15 (0%)
UTI		
No UTI, N (%)	5/10 (50%)	13/15 (86.7%)
Persisting, N (%)	2/10 (20%)	1/15 (6.7%)
Recurred, N (%)	3/10 (30%)	1/15 (6.7%)
PVR		
No PVR, N (%)	7/10 (70%)	15/15 (100%)
Persisting, N (%)	2/10 (20%)	0/15 (0%)
Recurred, N (%)	1/10 (10%)	0/15 (0%)

DUI, daytime urinary incontinence; PVR, post-void residual; UTI, urinary tract infection.

15 (60%) patients with a normal flow pattern had DUI and 2/15 (13%) reported UTIs (Table 2). An elevated PVR was only found in patients with a dysfunctional flow (3/3, 100%), as shown in Table 2.

Table 1 also includes an overview of the cohort development from baseline, through treatment, and into adulthood. Independently of the current flow pattern, a total of 14/25 participants (56%) reported DUI and 7/25 (28%) experienced UTIs at long-term follow-up. Around 64% of the women with DUI had delivered one or more children. Women with recurred or new onset DUI were predominantly nulliparous (5/6, 83%). Figure 2 shows the impact of present DUI on quality of life, with a median score of 5 out of 10 (interquartile range 3-8), independently of the present flow pattern. None of the participants were under current treatment for UTIs or DUI.

A generalized linear mixed model showed a slight reduction over time in dysfunctional flow patterns (Exp 1.016, $P < .001$) and reported UTIs (Exp 1.018, $P < .001$) when comparing long-term follow-up to baseline. Regarding DUI no significant reduction was found (Exp 1.002, $P < .298$).

DISCUSSION

After a mean duration of 20.8 years, 40% of women with childhood DV showed a dysfunctional flow pattern on

Table 1. Patient characteristics and development over time.

	Before Urotherapy (n = 25)	After Urotherapy (n = 25)	Long-Term Follow-up (n = 25)
Mean age, y (min-max)	8.3 (6-13)	9.1 (7-14)	29.1 (26-33)
Nulligravid, N (%)			18/25 (72%)
Time to follow-up, y (\pm 1SD)	na	0.88 (0.85-0.9)	20.8 (20.7-21)
Flow pattern			
Dysfunctional, N (%)	25/25 (100%)	18/25 (72%)	10/25 (40%)
Normal, N (%)	0/25 (0%)	7/25 (28%)	15/25 (60%)
DUI, N (%)	20/25 (80%)	12/25 (48%)	14/25 (56%)
UTI, N (%)	25/25 (100%)	10/25 (40%)	7/25 (28%)
PVR, N (%)	11/25 (92%)	9/25 (38%)	3/25 (12%)

DUI, daytime urinary incontinence; PVR, post-void residual; UTI, urinary tract infection.

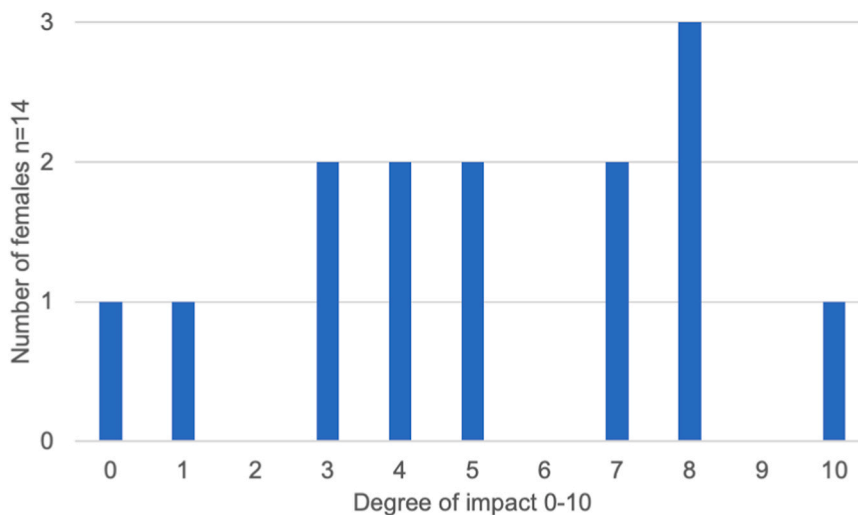


Figure 2. Impact of DUI on quality of life. DUI, daytime urinary incontinence. (Color version available online.)

uroflow measurement, compared to 11% in our control group. Independently of the flow pattern, 56% of participants still reported DUI and 28% experienced UTIs. Although the generalized linear model showed a statistically significant change in dysfunctional flow patterns and UTIs over time, the reduction was minimal making it difficult to draw solid conclusions. To date, there is no literature on the evolution of flow patterns during adolescence and young adulthood in female patients with childhood DV. Nevés et al. described the development of DUI over time.¹² They found incontinence in childhood to be a risk factor for persistent complaints in adulthood.

The prevalence of DUI we found (56%) is much higher than reported in other studies in the same age group. Van Breda et al. assessed the prevalence of LUTS and DUI in young, otherwise healthy nulligravid women.¹¹ She found that 20.1% of the participants reported involuntary leakage of urine during the day. Also, in our population, UTIs were much more prevalent than in other population-based surveys reporting incidences of around 11% for uncomplicated UTIs.^{13,14} Far more participants with a dysfunctional flow pattern and residual urine had UTIs compared with women with a normal flow pattern. Although a causative relation between the abnormal flow pattern and UTIs cannot be proven, abnormal voiding is known to correlate with UTIs in females.¹⁵

The association between abnormal flow patterns and DUI was less clear. We did not find a clear relation between uroflowmetry parameters and (improvement on) incontinence, as previously described by Vesna et al.¹⁵ The fact that 36% of the women with DUI had given birth to a child, possibly leading to de novo stress urinary incontinence, may also have influenced outcomes.

Despite the level of bothersomeness being a known indicator of help-seeking behavior and the reported moderate to high impact of DUI on quality of life,¹⁶ none of the participants was under current treatment of a urologist. The absence of a help-seeking intention might

therefore indicate a certain degree of acceptance that has developed in this group of women after having undergone extensive, third-line treatment in childhood, wherein symptoms do no longer equate complaints with the need for treatment. Moreover, urinary incontinence on its own is also not considered life-threatening, possibly creating an additional barrier to further treatment.

Although our findings strengthen the conviction that DV persists over the ages, the need for treatment decreases over time, and DUI and UTI can also persist after normalization of the flow pattern. We, therefore, believe that our results should be used in the counseling of young patients with DV and their parents, before starting extensive treatment. In the process of transition into adulthood, giving insight is of paramount importance.

LIMITATIONS

The results of this present study should be viewed within the context of its limitations. Firstly, the limited sample size. Due to a long time between treatment and follow-up, were not able to reach a larger part of the original cohort. This might have caused a selection bias. Furthermore, no concomitant EMG recording was performed in order to confirm childhood DV when a dysfunctional flow pattern was found and we only performed a single uroflow measurement in order to lower the burden on participants. For practical reasons, UTI was only reported by the participants, not proven by urinary culture. DUI was not further quantified in amount or frequency of urinary loss, nor was differentiated between stress or urgency type of incontinence because of a small number of participants. Also, data on sexual activity, body mass index, and comorbidity that could have influenced DUI and UTI was incomplete.

Despite these limitations, in our opinion, our findings are valuable, because this is the first real study on the long-term outcomes of childhood DV.

CONCLUSION

Our results show that, after a mean duration of 20.8 years, 40% of females who had extensive urotherapy for DV in childhood, still had DV according to ICS criteria. Furthermore, 56% reported DUI and 28% UTIs. This finding is of relevance in the counseling of young patients with DV, and their parents and for guiding the process of transition into adulthood.

DECLARATION OF COMPETING INTEREST

None Declared.

APPENDIX A. SUPPORTING INFORMATION

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.urology.2023.03.018](https://doi.org/10.1016/j.urology.2023.03.018).

References

1. Tarcan T, von Gontard A, Apostolidis A, Mosiello G, Abrams P. Can we improve our management of dysfunctional voiding in children and adults: International Consultation on Incontinence Research Society; ICI-RS2018? *Neurourol Urodyn*. 2019;38(S5):S82–S89.
2. Klijn AJ, Uiterwaal CSPM, Vijverberg MAW, Winkler PLH, Dik P, de Jong TPVM. Home uroflowmetry biofeedback in behavioral training for dysfunctional voiding in school-age children: a randomized controlled study. *J Urol*. 2006;175(6):2263–2268.
3. Carlson KV, Rome S, Nitti VW. Dysfunctional voiding in women. *J Urol*. 2001;165(1):143–148.
4. Abrams P, Cardozo L, Fall M, et al. The standardisation of terminology in lower urinary tract function: report from the standardisation sub-committee of the International Continence Society. *Urology*. 2003;61:37–49.
5. Austin PF, Bauer SB, Bower W, et al. The standardization of terminology of lower urinary tract function in children and adolescents: update report from the standardization committee of the International Children's Continence Society. *Neurourol Urodyn*. 2016;35(4):471–481.
6. Hickling D, Aponte M, Nitti V. Evaluation and management of outlet obstruction in women without anatomical abnormalities on physical exam or cystoscopy. *Curr Urol Rep*. 2012;13(5):356–362.
7. Minardi D, d'Anzeo G, Parri G, et al. The role of uroflowmetry biofeedback and biofeedback training of the pelvic floor muscles in the treatment of recurrent urinary tract infections in women with dysfunctional voiding: a randomized controlled prospective study. *Urology*. 2010;75(6):1299–1304.
8. Fan YH, Lin ATL, Wu HM, Hong CJ, Chen KK. Psychological profile of female patients with dysfunctional voiding. *Urology*. 2008;71(4):625–629.
9. Chang S-J, Van Laecke E, Bauer SB, et al. Treatment of daytime urinary incontinence: a standardization document from the International Children's Continence Society. *Neurourol Urodyn*. 2017;36(1):43–50. <https://doi.org/10.1002/nau.22911>
10. Nieuwhof-Leppink AJ, Hussong J, Chase J, et al. Definitions, indications and practice of urotherapy in children and adolescents: - A standardization document of the International Children's Continence Society (ICCS). *J Pediatr Urol*. 2021;17(2):172–181.
11. van Breda HM, Bosch JL, de Kort LM. Hidden prevalence of lower urinary tract symptoms in healthy nulligravid young women. *Int Urogynecol J*. 2015;26(11):1637–1643. <https://doi.org/10.1007/s00192-015-2754-1>
12. Nevés T, Sillén U. Lower urinary tract function in childhood; normal development and common functional disturbances. *Acta Physiol*. 2013;207(1):85–92.
13. Butler CC, Hawking MKD, Quigley A, McNulty CAM. Incidence, severity, help seeking, and management of uncomplicated urinary tract infection: a population-based survey. *Br J Gen Pract*. 2015;65(639):e702–e707.
14. Geerlings SE. Clinical presentations and epidemiology of urinary tract infections. *Microbiol Spectr*. 2017;4(5):27–40.
15. Vesna Z, Milica L, Marina V, Andjelka S, Lidija D. Correlation between uroflowmetry parameters and treatment outcome in children with dysfunctional voiding. *J Pediatr Urol*. 2010;6(4):396–402.
16. Howard F, Steggall M. Urinary incontinence in women: quality of life and help-seeking. *Br J Nurs*. 2010;19(12):742–749.