



Original Research

Real-world treatment adherence and dropout across pediatric enuresis subtypes: A retrospective cohort study

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Keywords

Enuresis; Bowel–bladder dysfunction; Treatment adherence; Dropout; Pediatric urology

Received 15 December 2025
Revised 29 January 2026
Accepted 19 February 2026
Available online xxx

Summary**Background**

Pediatric enuresis is a heterogeneous condition in which treatment adherence and family engagement vary widely across clinical subtypes. While the efficacy of individual therapies is well described, real-world data on adherence and dropout patterns remain limited.

Objective

To evaluate subtype-specific differences in treatment adherence, dropout, and early response in a large real-world pediatric enuresis cohort.

Methods

We conducted a retrospective cohort study of children aged 5–18 years diagnosed with enuresis at a tertiary pediatric urology center between 2019 and 2024. Patients were classified according to International Children's Continence Society criteria into monosymptomatic nocturnal enuresis (MNE), non-monosymptomatic enuresis (NMNE), secondary enuresis (SE), and bowel-bladder dysfunction (BBD). Primary outcomes were treatment adherence and dropout at initial follow-up (8–12 weeks). Secondary outcomes included early treatment response, defined as complete resolution or $\geq 50\%$ reduction in wet nights. Multivariate logistic regression identified independent predictors of dropout.

Results

The cohort included 961 patients (mean age 8.6 ± 2.8 years; 53.2 % male). BBD represented 48.0 % of cases, reflecting referral complexity in a tertiary setting. Overall treatment success was 43.8 %, while dropout occurred in 51.4 % of patients. Dropout rates were highest in BBD (58.0 %) and lowest in MNE (45.0 %, $p = 0.003$). In multivariate analysis, BBD was independently associated with increased dropout compared with MNE (OR 1.42; 95 % CI 1.10–1.84; $p = 0.007$), while lower initial treatment response was the strongest predictor of dropout (OR 3.24; 95 % CI 2.51–4.18; $p < 0.001$). MNE demonstrated the highest early response rate (53.1 %), whereas NMNE and BBD showed lower and comparable response rates.

Conclusions

In real-world pediatric practice, treatment adherence and dropout vary substantially by enuresis subtype. Complex phenotypes, particularly BBD, are associated with higher dropout independent of early response. These findings highlight the importance of accurate subtype classification, realistic family counseling, and early structured follow-up to improve engagement and outcomes in pediatric enuresis management.

<https://doi.org/10.1016/j.jpurol.2026.105835>

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Introduction

Pediatric enuresis is a common lower urinary tract disorder affecting approximately 5–10% of school-aged children and represents a frequent reason for referral to pediatric urology clinics [1,2]. Beyond nocturnal wetting, enuresis is associated with impaired quality of life, psychosocial distress, and significant family burden, affecting self-esteem, school performance, and family dynamics [3,4]. Although prevalence decreases with age, persistence into later childhood often reflects underlying clinical complexity rather than delayed maturation alone [5].

The International Children's Continence Society (ICCS) recognizes enuresis as a heterogeneous condition encompassing distinct clinical subtypes, including monosymptomatic nocturnal enuresis (MNE), non-monosymptomatic enuresis (NMNE), secondary enuresis (SE), and bowel–bladder dysfunction (BBD) [6,7]. This classification has important diagnostic and therapeutic implications, as treatment response and required interventions vary substantially across phenotypes. While first-line therapies such as desmopressin and enuresis alarms demonstrate acceptable efficacy in MNE, more complex subtypes—including NMNE and BBD—often require prolonged, multimodal management strategies [8–10].

Existing literature has largely focused on treatment efficacy under controlled or protocol-driven conditions [11,12]. However, in routine clinical practice, treatment success is strongly influenced by family engagement, adherence to recommendations, and sustained follow-up. Dropout from care represents a major yet underreported challenge in pediatric enuresis management, particularly among families facing complex treatment regimens, delayed symptom improvement, or competing psychosocial stressors [13,14]. Real-world data quantifying adherence and dropout patterns across enuresis subtypes remain limited, especially in large North American pediatric cohorts.

The present study aimed to evaluate subtype-specific differences in treatment adherence, dropout, and early treatment response in a large retrospective cohort of children managed at a tertiary pediatric urology center. By focusing on real-world practice patterns rather than protocolized efficacy, we sought to provide clinically relevant data to inform counseling, expectation-setting, and follow-up strategies in pediatric enuresis care.

Materials and methods

Study design and setting

We conducted a retrospective cohort study of pediatric patients evaluated for enuresis at a tertiary pediatric urology center between January 2019 and January 2024. The study was approved by the institutional review board with a waiver of informed consent due to its retrospective nature. All data were de-identified in accordance with HIPAA regulations.

Patient selection

Children aged 5–18 years with a documented diagnosis of enuresis and at least one follow-up encounter were eligible

for inclusion. Exclusion criteria included neurogenic bladder, known anatomic urinary tract abnormalities, active urinary tract infection at presentation, and severe developmental delay precluding participation in standard behavioral or pharmacologic therapies. Children aged 5 years were included to reflect real-world referral patterns to tertiary pediatric urology care. In accordance with ICCS recommendations, management in children younger than 6 years focused on counseling, reassurance, and basic urotherapy rather than pharmacologic treatment. Age was included as a covariate in multivariate analyses to account for potential differences in maturity and treatment response.

Diagnostic evaluation and subtype classification

All patients underwent an initial clinical evaluation by a pediatric urologist or continence specialist. Enuresis subtypes were classified according to ICCS criteria based on clinical history and documented lower urinary tract symptoms. Diagnostic evaluations, including voiding diaries, functional bladder capacity estimates, and screening for contributing conditions such as sleep-disordered breathing, diabetes, or polyuria, were performed selectively based on clinical judgment rather than systematically. This approach reflects routine real-world practice in a tertiary care setting but may have contributed to variability in treatment response and family expectations.

- **Monosymptomatic nocturnal enuresis (MNE)** was defined as nocturnal enuresis in the absence of daytime lower urinary tract symptoms.
- **Non-monosymptomatic enuresis (NMNE)** was defined as nocturnal enuresis accompanied by at least one daytime symptom, including urgency, frequency, daytime incontinence, or voiding postponement behaviors.
- **Secondary enuresis (SE)** was defined as recurrence of enuresis after a minimum of six consecutive months of dryness. Secondary enuresis was analyzed as a descriptive subgroup rather than a distinct ICCS-defined subtype. This approach was used to explore adherence and dropout patterns in children with recurrent enuresis after a period of dryness, acknowledging that secondary enuresis may coexist with other phenotypes such as MNE or NMNE.
- **Bowel–bladder dysfunction (BBD)** was defined as the presence of daytime lower urinary tract symptoms consistent with BBD in combination with constipation or fecal incontinence. Constipation was identified using Rome IV–based clinical criteria documented in the medical record. Constipation alone, without daytime urinary symptoms, was not classified as BBD.

Formal voiding diaries, functional bladder capacity estimates, and urodynamic studies were obtained selectively based on clinical judgment and were not uniformly available for all patients, reflecting real-world practice. Urodynamic testing was reserved for selected cases, such as refractory symptoms, secondary enuresis with concerning features, or suspicion of neurologic dysfunction, consistent with guideline recommendations.

Treatment approach

Initial management reflected routine clinical practice and was tailored to enuresis subtype, symptom severity, and family preference rather than a rigid institutional protocol.

All families received standardized counseling regarding basic urotherapy principles, including regular daytime voiding, appropriate fluid intake, and avoidance of excessive evening fluids. Adherence to these recommendations was not objectively monitored and ultimately depended on family engagement and feasibility.

- **MNE** patients were most commonly treated with desmopressin as first-line therapy. Desmopressin was prescribed as oral tablet or melt formulation, typically initiated at 0.2 mg and titrated up to 0.4 mg based on response and tolerance.
- **NMNE** patients received a combination of urotherapy and, when indicated, pharmacologic therapy such as anticholinergic agents for urgency or reduced functional bladder capacity.
- **BBD** patients were managed with multimodal therapy emphasizing aggressive constipation treatment (polyethylene glycol-based regimens \pm enemas), bladder retraining, and behavioral modification prior to or in conjunction with urologic pharmacotherapy.
- Enuresis alarm therapy was offered selectively, depending on family readiness and anticipated adherence.

Referral for psychological evaluation was reserved for selected patients with suspected psychosocial contributors, secondary enuresis with concerning history, or significant behavioral comorbidities.

Outcome measures

The primary outcomes were treatment adherence and dropout at initial follow-up, typically occurring 8–12 weeks after initiation of therapy. Dropout was defined as failure to attend scheduled follow-up or discontinuation of therapy prior to completion of the initial treatment trial.

Secondary outcomes included early treatment response, defined as complete resolution of enuresis or a ≥ 50 % reduction in wet nights as documented in the medical record.

Statistical analysis

Descriptive statistics were used to summarize baseline characteristics and outcomes across enuresis subtypes. Continuous variables were compared using analysis of variance, and categorical variables were analyzed using chi-square or Fisher's exact tests, as appropriate. Multivariate logistic regression was performed to identify independent predictors of dropout, adjusting for age, sex, enuresis subtype, and early treatment response. Odds ratios (ORs) with 95 % confidence intervals (CIs) are reported. A two-sided p value < 0.05 was considered statistically significant. Missing data were handled by complete case analysis.

Results

Patient characteristics and enuresis subtypes

A total of 961 children met inclusion criteria. Mean age was 8.6 ± 2.8 years, and 53.2 % were male. Baseline characteristics stratified by enuresis subtype are summarized in [Table 1](#). Nearly half of the cohort (48.0 %) met criteria for bowel–bladder dysfunction (BBD), followed by non-monosymptomatic enuresis (NMNE, 27.8 %), monosymptomatic nocturnal enuresis (MNE, 22.5 %), and secondary enuresis (SE, 1.8 %).

Patients with MNE were significantly older than those with NMNE and BBD ($p < 0.001$). Constipation prevalence differed markedly across subtypes, affecting almost all BBD patients (99.6 %) but only 6.9 % of MNE patients ($p < 0.001$). No significant differences were observed between subtypes with respect to sex distribution, family history of enuresis, sleep disorders, or ADHD/behavioral diagnoses.

Treatment outcomes and dropout

Overall early treatment success, defined as complete resolution or ≥ 50 % reduction in wet nights, was achieved in 43.8 % of patients. Success rates varied significantly by subtype ([Table 2](#)). MNE demonstrated the highest success rate (53.1 %), followed by SE (54.5 %), BBD (40.3 %), and NMNE (36.2 %) ($p = 0.025$). Post-hoc analysis confirmed that MNE achieved significantly higher success than NMNE ($p = 0.018$) and BBD ($p = 0.025$), with no significant difference between NMNE and BBD.

Table 1 Baseline patient characteristics by enuresis subtype.

Characteristic	Overall (n = 961)	MNE (n = 216)	NMNE (n = 267)	SE (n = 17)	BBD (n = 461)	p-value
Age, mean \pm SD (years)	8.6 \pm 2.8	9.7 \pm 2.6	8.4 \pm 2.7	9.3 \pm 2.9	8.1 \pm 2.8	<0.001
Male sex, n (%)	511 (53.2)	118 (54.6)	145 (54.3)	8 (47.1)	240 (52.1)	0.832
Constipation, n (%)	678 (70.6)	15 (6.9)	193 (72.3)	11 (64.7)	459 (99.6)	<0.001
Family history, n (%)	345 (35.9)	89 (41.2)	98 (36.7)	7 (41.2)	151 (32.8)	0.095
Sleep disorders, n (%)	119 (12.4)	31 (14.4)	36 (13.5)	2 (11.8)	50 (10.8)	0.563
ADHD/behavioral, n (%)	84 (8.7)	16 (7.4)	28 (10.5)	1 (5.9)	39 (8.5)	0.567

MNE, monosymptomatic nocturnal enuresis; NMNE, non-monosymptomatic enuresis; SE, secondary enuresis; BBD, bowel-bladder dysfunction; SD, standard deviation; ADHD, attention-deficit/hyperactivity disorder.

Table 2 Treatment outcomes and multivariate predictors of dropout.

Variable	Overall (n = 961)	MNE (n = 216)	NMNE (n = 267)	SE (n = 17)	BBD (n = 461)	p-value
Treatment success, n (%)	421 (43.8)	115 (53.1)	97 (36.2)	6 (54.5) ^a	186 (40.3)	0.025
Complete resolution, n (%)	198 (20.6)	62 (28.7)	41 (15.4)	3 (27.3) ^a	84 (18.2)	0.001
Dropout, n (%)	494 (51.4)	97 (45.0)	135 (50.5)	8 (47.1)	267 (58.0)	0.003

Multivariate Predictors of Dropout:

- BBD vs. MNE: OR 1.42 (95 % CI 1.10–1.84), $p = 0.007$.

- Lower initial response: OR 3.24 (95 % CI 2.51–4.18), $p < 0.001$.

^a Based on 11 SE patients with follow-up. Post-hoc: MNE > NMNE ($p = 0.018$), MNE > BBD ($p = 0.025$).

Complete resolution occurred in 20.6 % of the overall cohort and was most frequent in MNE patients (28.7 %), compared with NMNE (15.4 %) and BBD (18.2 %) ($p = 0.001$).

Overall dropout occurred in 51.4 % of patients and differed significantly across subtypes ($p = 0.003$). Dropout rates were highest among patients with BBD (58.0 %) and lowest among those with MNE (45.0 %) (Table 2). Dropout was inversely associated with early treatment response ($p < 0.001$).

Predictors of dropout

On multivariate logistic regression analysis adjusting for age, sex, enuresis subtype, and early treatment response, BBD was independently associated with increased odds of dropout compared with MNE (OR 1.42; 95 % CI 1.10–1.84; $p = 0.007$). Lower initial treatment response was the strongest independent predictor of dropout (OR 3.24; 95 % CI 2.51–4.18; $p < 0.001$). Age and sex were not independently associated with dropout.

First-line treatment modalities

First-line treatment approaches varied by subtype and reflected routine clinical practice (Table 3). Desmopressin monotherapy was predominantly used in MNE patients (87.5 %), achieving a success rate of 55.0 %. NMNE and BBD patients were more commonly treated with multimodal therapy combining urotherapy, behavioral interventions, and constipation management, with success rates of 35.1 % and 41.2 %, respectively. Enuresis alarm therapy was used selectively across subtypes and demonstrated lower

Table 3 First-line treatment modalities and success rates by subtype.

Treatment	MNE	NMNE	BBD
Desmopressin monotherapy			
Patients, n (%)	189 (87.5)	45 (16.9)	18 (3.9)
Success rate, %	55.0	42.2	33.3
Enuresis alarm			
Patients, n (%)	22 (10.2)	31 (11.6)	12 (2.6)
Success rate, %	45.5	35.5	25.0
Multimodal therapy			
Patients, n (%)	5 (2.3)	191 (71.5)	431 (93.5)
Success rate, %	60.0	35.1	41.2

Multimodal therapy includes urotherapy, behavioral modification, and constipation management (laxatives ± enemas).

success rates compared with pharmacologic or multimodal approaches.

Discussion

This large real-world cohort highlights substantial subtype-specific differences in treatment adherence, dropout, and early response among children with enuresis managed in a tertiary pediatric urology setting. While early treatment success varied by phenotype, the most clinically relevant finding was the high overall dropout rate, particularly among children with complex subtypes such as BBD and NMNE.

Subtype-specific response and clinical complexity

Consistent with prior ICCS-based literature, children with MNE demonstrated the most favorable early response to therapy, particularly with desmopressin monotherapy, achieving success rates exceeding 50 % [1–3]. In contrast, NMNE and BBD exhibited significantly lower response rates and comparable outcomes, underscoring the shared complexity of these phenotypes and the need for multimodal management strategies [4,5]. The relatively low success rate observed with enuresis alarm therapy in this cohort should be interpreted cautiously. Alarm use was selective and often reserved for families perceived as ready for behavioral interventions or after prior treatment failure, introducing significant selection and adherence bias. Therefore, these findings likely reflect real-world challenges with alarm implementation rather than true therapeutic inefficacy.

The near-universal presence of constipation in the BBD subgroup highlights the central role of bowel dysfunction in treatment resistance. Previous studies have emphasized that bladder symptoms often fail to improve until constipation is adequately addressed, a pattern reflected in our real-world cohort [6–8].

Adherence and dropout as key outcomes

Dropout represents a heterogeneous outcome and may reflect diverse scenarios, including symptom improvement without follow-up, transfer of care to another provider, dissatisfaction with treatment, or logistical barriers. As reasons for discontinuation were not systematically captured, associations between clinical phenotype,

treatment response, and dropout should not be interpreted as causal.

More than half of the cohort discontinued follow-up during the initial treatment phase. Importantly, BBD emerged as an independent predictor of dropout even after adjusting for early response, suggesting that factors beyond symptom improvement—such as treatment burden, delayed gratification, and family fatigue—play a significant role in disengagement. Early treatment response was the strongest predictor of adherence, reinforcing the importance of early wins in maintaining family motivation.

Despite being widely recognized by clinicians, dropout in pediatric enuresis has been insufficiently quantified in large cohorts. Our findings add to limited existing data suggesting that attrition rates of 40–60 % are common in real-world pediatric continence care [9–11,15,16].

Implications for counseling and follow-up

These results have direct implications for clinical practice. Accurate early subtype classification enables realistic counseling regarding expected timelines and success rates. Families of children with MNE may expect relatively rapid improvement, whereas those managing BBD should be counseled regarding the prolonged and staged nature of therapy. Early, structured follow-up—potentially within 2–4 weeks—may help mitigate dropout by reinforcing progress, addressing barriers, and recalibrating expectations.

Multidisciplinary collaboration, particularly with gastroenterology and continence nursing, is essential for managing BBD effectively. Pediatric urologists are uniquely positioned to coordinate care and provide longitudinal support to families navigating complex treatment regimens.

Limitations

Several limitations must be acknowledged. The retrospective, single-center design limits causal inference and generalizability. Diagnostic evaluations and screening for contributing conditions were not systematically performed, and treatment approaches were not standardized. Dropout may have been overestimated, as some families may have continued care elsewhere or experienced symptom improvement without returning for follow-up. Additionally, reasons for discontinuation were not systematically captured, limiting interpretation of adherence patterns.

Treatment approaches were not standardized and reflected real-world clinical practice rather than a protocol-driven algorithm. Selection bias is likely, given the tertiary referral setting and the high proportion of BBD cases. Finally, long-term outcomes and relapse rates could not be assessed.

Despite these limitations, the large sample size, standardized subtype classification, and multivariate analysis strengthen the relevance of our findings for pediatric urology practice.

Conclusions

In real-world pediatric practice, treatment adherence and dropout vary substantially across enuresis phenotypes. Children with more complex presentations, particularly bowel–bladder dysfunction, demonstrate higher rates of discontinuation. These findings suggest that early phenotype recognition, careful expectation-setting, and structured follow-up may support engagement and help mitigate attrition. However, causal relationships cannot be established from this study. Future prospective, multicenter studies are needed to better characterize reasons for discontinuation and to identify targeted strategies to improve long-term adherence and outcomes.

Ethics approval

This study was approved by the Institutional Review Board (IRB #00001244) with waiver of informed consent due to its retrospective design.

Author contributions

Conceptualization: S.T.-G., J.P.C.
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Writing – original draft: S.T.-G.
Writing – review & editing: All authors.
Supervision: M.B., J.P.C.

Declaration of generative AI and AI-assisted technologies in the writing process

The authors did not use generative AI or AI-assisted technologies in the development of this manuscript.

Funding

No external funding was received for this study.

Conflict of interest

The authors declare no conflicts of interest.

Acknowledgments

We thank the Pediatric Urology team at Driscoll Children's Hospital for their collaboration and clinical support.

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