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Daytime and nighttime incontinence in children: use of a digital bladder diary

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Urinary incontinence remains a common condition with a significant impact on children's health-related quality of life. Epidemiological studies report an overall prevalence of up to 22 % in children aged 8 to 17 years, with urge incontinence affecting 6 % of the population studied (1). Enuresis, as incontinence while asleep, reaches a maximum 10 % prevalence in 7-year-olds and accounts for an average of 5 % of the population studied (2). Incontinence is often associated with psychosocial problems, stigmatization, and reduced self-esteem. In addition, untreated overactive bladder (OAB), the leading cause of urge incontinence, can contribute to secondary vesicoureteral reflux, recurrent pyelonephritis, and potential kidney damage. Given the low spontaneous recovery rate (15.4 % per year), early diagnosis and structured management are crucial (3).

An accurate medical history is essential to assess the extent of symptoms (4). Classification and differentiation between storage and voiding symptoms as defined by the International Children's Continence Society (ICCS) is necessary for targeted intervention (Table 1). The most accurate and practical approach to assess the severity of symptoms is to use validated and published questionnaires, such as OABSS (5) or parental reports on enuresis (6). In terms of diagnostics, the ICCS highlights the bladder diary as a first-line non-invasive tool of choice in the assessment of the etiology of urinary incontinence and rational pharmacotherapy. Traditional paper-based diaries present challenges in terms of compliance, accuracy, and interpretation. The introduction of digital bladder diaries significantly improves the user experience by enabling real-time data entry, automated calculations, and standardized output formats, ensuring greater compliance and accuracy. However, moving these tools from research to clinical use requires regulatory approval and compliance with medical device regulations. Certification by the relevant health authorities will ensure safety, reliability, and integration into standard clinical practice, facilitating widespread use in pediatric incontinence management. The BeDry Bladder Diary is an innovative mobile and web-based application designed to improve the accuracy and feasibility of using a digital bladder diary in clinical practice (7). This platform enables comprehensive data collection, including voiding patterns, fluid intake, incontinence episodes, and stool tracking, providing an objective assessment of lower urinary tract function. Using the bladder diary, clinicians can objectively determine bladder capacity (with maximum voiding volume), number of urinations per day, nighttime diuresis, and drinking habits. The Overactivity Index (OI) is a novel, non-invasive marker derived from bladder diary data that calculates the median voided volume normalized to the expected bladder capacity for age (EBC). This index provides a quantifiable measure of bladder overactivity, independent of

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Table 1. Classification of storage and voiding signs and symptoms based on ICCS terminology

Symptom type	Description	Related conditions and treatment
Storage dysfunction		
Increased voiding frequency	Urinating 8 times per day and more	*Small bladder capacity and overactive bladder* (urgency, increased frequency, with or without incontinence) *Extraordinary daytime frequency* (increased frequency without incontinence and nighttime symptoms) *Nighttime polyuria* (enuresis, nocturia) *Urinary tract infections* (increased frequency, urgency, nocturia, incontinence) *Vaginal reflux* (postvoid dribble in females) *Syringocoele* in males and *significant postvoid residual* (postvoid dribble in males)
Urgency	Sudden and unexpected need to urinate.	
Urinary incontinence Intermittent Daytime Urge Postvoid dribble Stress Giggle Enuresis Continuous	Intermittent daytime incontinence is involuntary urine loss while awake. Enuresis is intermittent incontinence while asleep. It is subdivided into monosymptomatic and nonmonosymptomatic (when daytime symptoms coexist), primary and secondary (incontinence recurs after a sustained dry period of six months or more).	
Nocturia	Waking up at night to urinate.	
Voiding dysfunction		
Hesitancy	Difficulty in initiating urination when the child is ready to urinate.	*Dysfunctional voiding* when a child contracts pelvic floor muscles instead of relaxing them during the voiding. *Anatomical bladder neck or urethral obstruction.* *Underactive bladder or spastic urethral sphincter*
Straining	Intense effort with increased abdominal pressure is needed to start or maintain urination.	
Week and intermittent flow	Either observed at home or during investigations such as uroflow.	
Decreased voiding frequency	Urinating 3 or less times a day.	

outliers in voiding volume (e.g. first morning or bedtime voiding). A prospective study of 92 pediatric patients with urgency showed that an OI >= 23 was a significant predictor of OAB symptoms (OR 7.97, 95 % CI 1.97–32.22, p = 0.004), which correlated strongly with urgency episodes and maximum cystometric capacity (MCC)/EBC ratio. Importantly, the OI may distinguish patients who require pharmacotherapy (OI >= 23) from those who may benefit from urotherapy alone (8). The integration of the digital bladder diary into the OI calculation offers several clinical advantages: 1) objective assessment by eliminating recall bias and increasing reliability, 2) non-invasive nature reducing the need for urodynamic testing while maintaining diagnostic accuracy, 3) predictive value aids treatment decisions by identifying children who are likely to respond to urotherapy as opposed to children who require pharmacologic treatment, 4) Improved patient engagement with digital interfaces that promotes treatment adherence and enable real-time feedback.

First-line therapy for incontinence starts with standard urotherapy, a non-pharmacological and non-surgical approach to managing lower urinary tract symptoms. This includes patient education on the causes of incontinence, along with behavioral modifications such as timed urination, proper voiding posture, adequate fluid intake, and avoiding bladder-irritating drinks. For successful treatment, addressing constipation is essential when present. Studies suggest that up to 10 % of children with lower urinary tract symptoms have underlying, untreated constipation (8). This can be assessed using the Rome IV criteria, identifying stool types 1 and 2 on the Bristol Stool Chart, or measuring a transverse rectal diameter >3 cm on ultrasound.

The use of a digital bladder diary in combination with the OI represents a fundamental change in pediatric incontinence management. By providing a standardized, objective, and user-friendly assessment tool, this approach may improve diagnostic accuracy, promote patient compliance, and facilitate personalized treatment decisions. Further multicenter validation studies are needed to confirm the broad applicability of this model in routine pediatric nephrology and urology practice.

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