PediatricsinReview®

Nocturnal Enuresis: Current Concepts

Michael R. Lawless and Darby H. McElderry

Pediatr. Rev. 2001;22;399-407
DOI: 10.1542/pir.22-12-399

Nocturnal Enuresis: Current Concepts

Michael R. Lawless, MD,* and Darby H. McElderry, MD†

Objectives

After completing this article, readers should be able to:

1. Delineate the age-related prevalence of nocturnal enuresis in the United States.
2. Describe the etiologic factors of nocturnal enuresis.
3. Characterize appropriate counseling principles for families whose children have nocturnal enuresis.
4. Describe nonpharmacologic and pharmacologic treatments for nocturnal enuresis.
5. Identify appropriate age-related strategies for management of nocturnal enuresis.

Introduction and Definition

Nocturnal enuresis affects approximately 5 to 7 million children in the United States, making it the most common pediatric urologic complaint encountered by primary care physicians. Despite its prevalence, nocturnal enuresis remains incompletely understood, which can frustrate patients, family members, and physicians. Appropriate intervention is justified for the affected child because of the potential consequences of family stress, social withdrawal, and poor self-esteem.

Enuresis refers to the persistence of inappropriate voiding of urine beyond the age of anticipated bladder control (age 4 to 5 y at the latest). The development of bladder control is a multidimensional process that requires sensory awareness of bladder fullness by the child, capacity for storage of urine, voluntary control of the bladder sphincter, psychological desire for control, and a positive training experience. Diurnal enuresis is involuntary leaking of urine during waking hours. Nocturnal enuresis refers to involuntary passage of urine during sleep and is classified as primary (no prior period of sustained dryness) or secondary (recurrence of nighttime wetting after 6 mo or longer of dryness). Recent urology literature describes another classification of nocturnal enuresis based on the presence or absence of other bladder symptoms. Monosymptomatic nocturnal enuresis (MNE) is defined as a normal void occurring at night in bed in the absence of any other symptoms referable to the urogenital tract, and it precludes any daytime symptomatology. It is the focus of this article. Polysymptomatic nocturnal enuresis (PNE) is bed-wetting associated with other bladder symptoms such as urgency, frequency, instability, or voiding dysfunction. Investigations of patients who have MNE reveal that they are clearly different from patients who have PNE.

Epidemiology/Prevalence

The spontaneous resolution rate of nocturnal enuresis is approximately 15% per year, with 1% of teenagers at 15 years of age still wetting the bed (Fig. 1). Parents may become concerned about nocturnal enuresis when their child reaches 5 to 6 years of age and is preparing to enter school. Most children are not concerned until 7 to 8 years of age. Approximately 80% to 85% of children who have nocturnal enuresis have MNE. Another 5% to 10% of cases meet the definition of PNE, with daytime wetting or other bladder symptoms. Organic causes are responsible for nocturnal enuresis in fewer than 5% of cases. Such organic causes must be searched for and ruled out if the history suggests their presence. There is a slight male predominance (about 60% overall) for nocturnal enuresis. Etiologic factors contributing to MNE include genetics, sleep arousal dysfunction, uro-

*Editorial Board. Professor of Pediatrics, Wake Forest University School of Medicine, Winston-Salem, NC.
†Assistant Professor of Pediatrics, University of Kentucky, Chandler Medical Center, Lexington, KY.

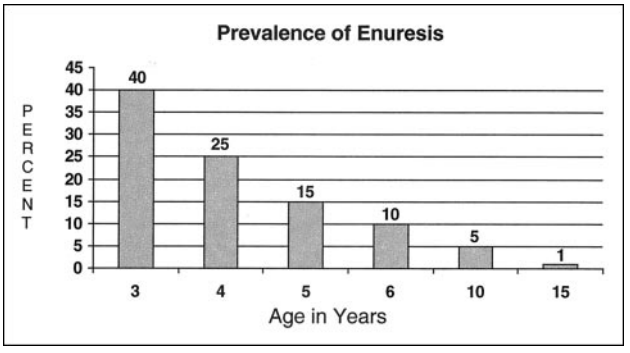

Figure 1. Prevalence of enuresis by age.

dynamics, nocturnal polyuria, psychological components, and maturational delay. That the condition probably is multifactorial, with various contributing factors in any one patient, confounds attempts to base therapeutic approaches on etiology.

Genetics

A hereditary basis for nocturnal enuresis has been suspected for years. Studies of twins show a concordance rate of 43% to 68% for monozygotic and 19% to 36% for dizygotic twins. Seventy percent of children who have enuresis have a parent who has a history of the disorder. Studies indicate that if one parent had enuresis, the probability of a child having it is approximately 40% to 45%. If both parents were affected, the probability of a child having the condition increases to 70% to 77%. If neither parent had enuresis, only 15% of offspring will have enuresis. Chromosomes 12q, 13q, and 22 all have been named as possible locations of a gene(s) resulting in enuresis, but a specific mechanism for enuresis related to a gene locus is not known.

Sleep Arousal Dysfunction

The association between the presence of a full bladder and the sensation in the brain of a full bladder occurs in most children by the age of 5 years, which correlates with the normative standard in the United States for nocturnal dryness in 85% of 5-year-olds. Concurrently, by this age the child's pattern of several sleep/wake cycles daily, known as multiphasic sleep, has changed to a single period of sleep daily, known as monophasic sleep. Daytime urination control usually occurs first, followed by learning to arouse during sleep to the sensation of a full bladder. Many parents report that a child who has enuresis is more difficult to arouse from sleep than are other children in the home, but sleep studies have not documented a convincing association between a child's sound sleep and a nocturnal wetting episode.

The relationship of sleep patterns with enuresis is an area of active research. In some studies, the enuretic event seemed to occur during nonREM sleep and could occur during any part of the night. In others, enuresis reportedly was caused by a mild disturbance in arousal, based on the finding that activation of the arousal center proceeded correctly, but the transition from light sleep to complete awakening was not achieved properly. In a subset of patients, the arousal center in the brain failed to activate, despite proper full bladder sensation. There is conflicting evidence that children who have enuresis may exhibit other parasomnias, such as sleepwalking and night terrors. A recurrent theme in sleep research is the child's inability to recognize the sensation of a full bladder during sleep and failure to awaken from sleep to urinate in an appropriate place. There appears to be a maturational pattern of progressive central nervous system "recognition" of bladder fullness and control over the micturition reflex.

Urodynamics

Some children who have enuresis may have a small bladder capacity. Functional bladder capacity in children may be estimated by the formula: age in years plus 2, which gives bladder capacity in ounces. By adolescence, this no longer applies; adult bladder capacity is approximately 10 to 15 oz. Children who have small bladder capacities probably represent a subgroup of patients who have MNE and presumably cannot hold the normal amount of urine produced at night. They are more likely to report frequent daytime voiding, some nights with multiple episodes of enuresis per night, and no history of attaining dryness.

In some children who have normal bladder capacities, urgency may play a role in nocturnal enuresis. These children exhibit daytime urgency, but they can maintain bladder control during the day. They have a pattern of partial emptying of the bladder that results in frequent daytime urination to maintain continence and enuresis occurring at night when they cannot void as often. No evidence supports abnormal urodynamics in children who have MNE. Involuntary nighttime voiding in those who have MNE occurs with a urodynamically normal bladder at functional capacity. Because most patients who have abnormal urodynamics as an underlying cause for their nighttime enuresis also have daytime symptoms, asking patients about daytime voiding patterns in the initial history is important.

Nocturnal Polyuria

Polyuria is defined as excessive urine production. It may be associated with chronic illnesses such as diabetes mel-

litus and diabetes insipidus. Caffeine, alcohol, and medications also may cause it. Factors such as irregular food and drink intake and staying up late also may contribute. It seems reasonable to limit fluid intake several hours prior to bedtime because the most common cause of polyuria is habit polydipsia.

Since first described in 1985, the theory that MNE is due to nocturnal polyuria with relative nocturnal deficiency of pituitary-produced antidiuretic hormone (ADH) has been controversial. Early studies reported that the plasma level of ADH did not increase during sleep in those who had enuresis compared with a rise in ADH among unaffected children, resulting in relative nocturnal polyuria as a factor in enuresis. Studies documenting the percentage of children who have enuresis and lack a nocturnal surge in ADH ranges from 25% to 100%, suggesting the presence of other factors. New research about polyuria and enuresis theorizes that a full bladder might communicate with the kidneys to reduce urine production. Some recent investigations also suggest abnormal osmoregulatory function in the kidney, with higher solute excretion among those who have enuresis.

A history of small, frequent voids suggests bladder instability or a small bladder capacity.

Psychological Factors

Most children who have enuresis have no psychological disorder. The dated concept that enuresis frequently is due to anxiety or stress is unproven. On the contrary, enuresis creates psychosocial problems for the bed-wetting child, including poor self-esteem, family stress, and social isolation. Secondary enuresis commonly has been attributed to psychological factors. Recent studies show no major psychological differences between children who have secondary enuresis and children who have no enuresis. If a child reverts to bed-wetting during treatment for enuresis or has increased episodes of bed-wetting during times of stress, it is more likely due to poor compliance with treatment. Children who have enuresis not only have lower self-esteem than unaffected children, but they have lower self-esteem than children who have chronic, debilitating illnesses. These study results both emphasize the profound impact that enuresis may have and justify a careful evaluation of psychosocial symptoms in the family and the patient.

Maturational Delay

The fact that most children who have enuresis become dry in time with or without intervention supports maturational delay as a factor in MNE. At age 5 years, 15% of children occasionally wet the bed compared with only 10% at 6 years of age. Perhaps development of central nervous system recognition of and response to the sensation of a full bladder is delayed, a concept that correlates strongly with the arousal dysfunction theory. Proposed abnormal urodynamic factors also may normalize as the child becomes older. A similar process of maturation over time is seen in other milestones of normal development, such as the age range of 9 to 15 months at which a child begins to walk. Maturational delay may be the most plausible and unifying concept among proposed etiologic factors in MNE.

Evaluation

History

In addition to a detailed toilet training history, a family history of enuresis should be sought because it rarely is volunteered, even when known by a parent. Other pertinent details of a history include the onset and pattern of wetting, voiding behavior, sleep pattern, parasomnias, medical conditions, daytime urinary symptoms, bowel habits, and psychosocial factors. It also is important to assess both the family's and the patient's attitude toward the bed-wetting and their readiness to initiate and continue treatment. Questions about voiding patterns may reveal urgency or a history of small, frequent voids that suggests bladder instability or small bladder capacity. Organic causes of enuresis may be apparent by a history of dysuria (urinary tract infection), polyuria and polydipsia (diabetes insipidus or mellitus), encopresis (constipation), abnormal urine stream (lower obstructive lesions), gait disturbances (spinal cord pathology), or nighttime snoring (adenoidal hypertrophy). A thorough and thoughtful history is the means by which the infrequent organic causes of enuresis are separated from the majority of cases that have no organic etiology (Table).

Physical Examination

Most children who have nocturnal enuresis will have normal findings on physical examination. In addition to

Table. Important Points of a History

Urinary history
Behavioral history
• Drinking habits
• Parasomnias
• Psychiatric symptoms
• Environment
Voiding history
• Nighttime wetting and toilet practices
• Daytime symptoms
• Longevity and frequency of enuresis
• Abnormalities of urine stream
History suggesting medical etiology
• Anatomic problems (posterior urethral valves, spina bifida, ectopic ureter)
• Diabetes insipidus
• Diabetes mellitus
• Encopresis or constipation
• Endocrine dysfunction
• Allergies or asthma
• Sleep apnea (heavy snoring or mouth breathing)
• Urinary tract infection
• Child abuse
• Urethral, genital, or midline skin abnormalities

Adapted from Faber SH, Goblin AZ, Jacobs TH, et al. Enuresis control in primary care. *Proceedings from a Symposium on the Control of Uncomplicated Primary Nocturnal Enuresis.* 1996.

assessing the child's height, weight, and blood pressure, perform a complete examination, paying careful attention to the urogenital, neurologic, and gastrointestinal systems. A palpable bladder or palpable stool may be present on abdominal examination, ectopic ureter or signs of sexual abuse on urogenital examination, or abnormal gait apparent during neurologic examination. Cremasteric, anal, abdominal, and deep tendon reflexes that reflect spinal cord function all should be tested. The skin of the lower back should be inspected for the presence of a sacral dimple, hair patches, or vascular birthmarks, which can be clues to spinal dysraphism. Mouth breathing may suggest sleep apnea with associated enuresis due to adenoidal hypertrophy. Direct observation of the urinary stream in the office is important, especially if findings on the history suggest an abnormality. The family can measure bladder capacity at home prior to the initial evaluation or it can be measured in the office by having the child drink 12 oz of fluid on arrival, then voiding into a calibrated cup.

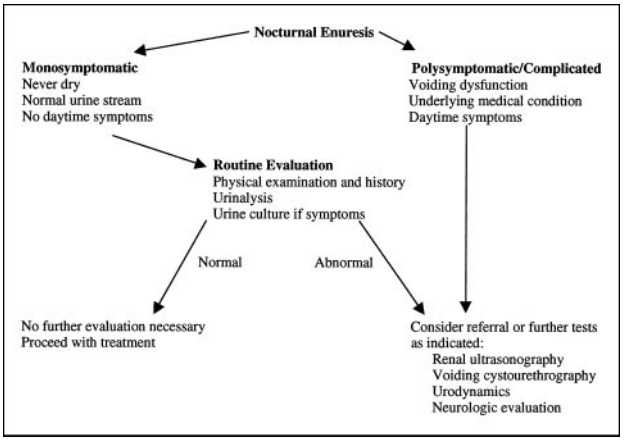

Figure 2. Algorithm for evaluation and treatment of nocturnal enuresis. Adapted from Faber SH, Goblin AZ, Jacobs TH, et al. Enuresis control in primary care. *Proceedings from a Symposium on the Control of Uncomplicated Primary Nocturnal Enuresis.* 1966.

Laboratory/Imaging Studies

All children who have enuresis should have urinalysis of a clean-catch midstream urine specimen (Fig 2). The ability to concentrate urine to 1.015 or greater rules out diabetes insipidus and the absence of glucose rules out diabetes mellitus as causes of nocturnal enuresis. Further laboratory testing is unnecessary for MNE. A urine culture should be obtained for symptoms suggestive of urinary tract infection on history or findings on urinalysis. Routine radiologic or ultrasonographic imaging studies of the urinary tract or cystoscopy are not recommended for children who have MNE. PNE may require further evaluation with voiding cystourethrography (VCUG), renal and bladder ultrasonography, or urodynamic testing. When enuresis is resistant to treatment and the history suggests a sleep disorder, a sleep study may be useful to look for sleep apnea or parasomnias.

Treatment

An important factor in any pediatric treatment is the child's motivation and acceptance. Parents also must support the child and the treatment program for maximal effectiveness. The child's age is a critical factor when formulating a treatment plan. Consideration of treatment is guided by the clinician's understanding of the changing prevalence of enuresis in school-age children and the effect of enuresis on the child's self-esteem and family function. Timing of the intervention should be tailored to the individual child and family.

Although a child's self-esteem can be harmed by MNE, even at early school age, the effects are variable.

Some school-age children and their parents are not bothered by the child's enuresis; others experience anxiety and stress. It is reasonable to discuss MNE during a health supervision visit and provide facts for families of patients at 6 or 7 years of age. The maturational aspects of nighttime awakening to void should be explained to parents and likened to other familiar developmental milestones that occur over a range of time rather than at a specific age. Providing plausible medical explanations, identifying a family history of enuresis, and defining its age-specific prevalence may lessen the burden on the child. Parents should understand that punishment or negative reinforcement is counterproductive, both in resolving the enuresis and in protecting the child's self-esteem. For children and families who are bothered by the child's enuresis, targeted intervention is recommended by age 8 years at the latest. In general, MNE should be thoroughly explained, selectively treated, and never ignored.

Enuresis alarms have the highest overall cure rate of any available treatment.

Nonpharmacologic Therapy

MOTIVATIONAL THERAPY. This approach begins with educating parents and the child about enuresis, a process that usually allays guilt. Handouts with printed instructions can teach the parents and the child to manage the condition. Positive reinforcement can be initiated by setting up a diary or chart to monitor progress and establishing a system to reward the child for each night that he or she is dry. The child should be taken out of diapers or training pants and encouraged to empty the bladder completely prior to going to bed. The child should participate in morning cleanup as a natural, nonpunitive consequence of wetting. The risk of secondary psychological injury to the child's self-esteem is minimized by discouraging ridicule from siblings and by avoiding a critical, demoralizing approach.

Because excessive fluid intake before bedtime can cause increased nocturnal urine production, as can caffeinated beverages and certain foods (eg, dairy products, citrus juices, chocolate), restricting fluids for 2 hours prior to bedtime is reasonable. The child should agree to fluid restriction, however, rather than having it imposed. The rate of complete resolution of enuresis with motivational therapy alone is estimated to be only 25%, but up to 70% of children who have MNE have some reduction in the number of wet nights. Once consistently dry nights are achieved, the reported relapse rate is low. Motivational therapy is a reasonable first-line approach, especially with the younger child. If unsuccessful after a trial of 3 to 6 months, a different treatment program should be considered.

BEHAVIORAL THERAPY. This approach includes dry-bed training and classic conditioning therapy using an enuresis alarm system. Hypnotherapy also may be part of a comprehensive program to treat enuresis. This therapy involves an age-appropriate explanation of how the brain and bladder communicate, taking the mystery out of enuresis by educating the patient and family, teaching relaxation techniques, and having the child practice imagery of awakening to urinate in the toilet or staying dry all night. It can be combined with an alarm system. Frequent office visits are required initially until the physician is certain that the child can practice imagery at home; then, visits may be monthly. Referral to a behavioral pediatrician or clinic may be necessary if the primary care physician does not have the necessary training or time for this approach.

Dry-bed training (as described by Azrin and Thienes in 1978) involves waking the child on a progressive schedule at decreasing intervals over several nights, having the child change pajamas and bedding if wet or walk to the toilet when voiding is needed. As in the use of alarm therapy, the eventual goal is to have the child self-awaken to void. Although a high cure rate is reported with this technique by the authors, it is a more time- and labor-intensive process than most families are willing to undertake.

Enuresis alarms have the highest overall cure rate of any available treatment. They also represent the best-researched behavioral intervention. Alarm systems can be used in combination with motivational and other behavioral therapy techniques or in combination with pharmacotherapy. Several different alarm devices range in cost from $50 to $75. Insurance companies may cover an enuresis alarm with a prescription from the physician describing it as a medical device. In contrast to the older bell-and-pad type of alarms, the new devices are portable, small, and worn directly on the child's clothing. They emit a transistorized audio or vibratory alarm when urine is sensed in the underpants.

Alarms are most effective when combined with other behavioral or pharmacologic therapy. The alarm wakes

the child or parent from sleep, who then implements the appropriate component of the behavioral program. The alarm allows the parent and child to intervene and monitors bed-wetting as the program proceeds. Parents and child should be told that this treatment requires a long-term commitment and may take several months to achieve a cure. The device can be discontinued when the child has had three consecutive weeks of dry nights. The cure rate may be as high as 70% long-term. Among the 10% to 15% of children who relapse, most can be treated successfully with a repeat of the original alarm program.

Methods to reduce alarm failure include pretesting the child for his or her ability to awaken to the alarm and encouraging parents and child to continue using the alarm. Failure also can be reduced by enabling the child who is afraid of the dark to walk to the toilet using a flashlight or night light in the room or by offering other options to the child who is reluctant to try an enuresis alarm. If a child does not awaken to the alarm during pretesting, dry-bed training or parent awakening should precede the use of the alarm. One study showed that an ordinary alarm clock used with dry-bed training was as effective as an enuresis alarm. This may be an attractive alternative to families who cannot afford an alarm or whose insurance will not cover it. (See the 1997 *Pediatrics in Review* article by Schmitt for practical tips on successful use of the enuresis alarm.)

Pharmacotherapy

Medication is an attractive treatment modality for parents who hope for relatively effortless success. However, medication alone for initial treatment of nocturnal enuresis is never preferred and seldom should be considered before 8 years of age, even in combination therapy. Three drugs are used most commonly for the treatment of enuresis: imipramine, desmopressin (DDAVP), and oxybutynin. Imipramine and DDAVP have been evaluated in the treatment of MNE; oxybutynin is used primarily in polysymptomatic enuresis.

IMIPRAMINE. Imipramine is a tricyclic antidepressant that has been used for more than 3 decades to treat nocturnal enuresis. It appears to increase bladder capacity through a weak anticholinergic effect and also may decrease detrusor muscle contractions via noradrenergic effects. The starting dose is 25 mg taken 1 hour before bedtime for children ages 6 to 8 years and 50 to 75 mg for older children and adolescents. The duration of action is 8 to 12 hours. The dose may be increased in 25-mg increments weekly up to 75 mg. Therapy may continue from 3 to 9 months, with a slow tapering of medication recommended over 3 to 4 weeks in 25-mg decrements. Imipramine is relatively inexpensive, and the clinical response is usually apparent during the first week of treatment. The initial success rate (dry at 6 months posttreatment) is reported to be 15% to 50%, but the relapse rate is high following drug discontinuation.

When used at the recommended dosage, mild side effects include irritability, dry mouth, decreased appetite, headaches, and sleep disturbances. An accidental or intentional overdose, however, can have serious and potentially lethal effects, including ventricular dysrhythmias, seizures, and coma. Because of its narrow toxic/therapeutic ratio, some clinicians are understandably reluctant to use imipramine to treat a relatively benign, self-limiting condition such as nocturnal enuresis. If imipramine therapy is selected, the physician must counsel the family carefully about the dangerous potential of its accidental ingestion, safe storage of the drug, and supervision of the child taking the medication.

DDAVP. DDAVP is a synthetic analog of arginine vasopressin (ADH). Acting on the distal tubules of the kidney, it increases water reabsorption in the collecting ducts, producing a more concentrated, lower volume of urine. The use of DDAVP to treat nocturnal enuresis is based on the observation that some children who have enuresis do not have the normal nocturnal rise in ADH production, potentially leading to polyuria. DDAVP theoretically reduces urine volume at night in such children, who thereby can avoid a full bladder at night.

DDAVP is available in an oral form and a nasal spray. The bioavailability is only 1% for the tablet and 10% for the nasal spray. Its duration of action is extended (approximately 10 to 12 h), and it is rapidly absorbed from the nasal mucosa. The initial dose of DDAVP is 20 mcg or one 10-mcg puff in each nostril within 2 hours of bedtime, regardless of the patient's age. The dose may be increased in increments of 10 mcg every 1 or 2 weeks up to a maximum dose of 40 mcg. The response to DDAVP usually can be evaluated within a few days of starting therapy. Patients may remain on medication for 3 to 6 months, then should begin a slow decrease of the dose by 10 mcg/mo. If a child remains enuretic after 6 months of therapy, combination therapy may be considered. If oral medication is preferred, the starting dose is 0.2 mg (one tablet) administered 1 hour before bedtime. If there is no response within 1 week, the dose can be titrated by 0.2 mg up to a maximum of 0.6 mg nightly.

Side effects of DDAVP are rare and include abdominal discomfort, nausea, headache, and epistaxis. Symptomatic hyponatremia with seizures has been reported

very rarely, usually in the context of exceeding the recommended dosage. Nonetheless, nighttime fluid restriction is a reasonable recommendation for those receiving DDAVP. Contraindications include habit polydipsia, hypertension, and heart disease. There are few data on long-term use of DDAVP. In a Swedish study that monitored children who had MNE, 22% became dry with DDAVP, a response not significantly different from the spontaneous cure rate of 15% per year. All patients, however, had a marked reduction in the number of enuretic events per month. More patients remained dry after slow tapering of the DDAVP dose than following abrupt discontinuation of the medicine. Various studies show immediate response rates as high as 70% and relapse rates as high as 95%. Moffat et al reviewed 18 controlled studies of DDAVP and found overall that only 25% of children were completely dry on the medicine, with a relapse rate similar to that noted previously.

DDAVP reduces urine volume at night and is available in an oral form and nasal spray. Used episodically (for summer camp, sleepovers, or to bridge the gap during other treatments) reduces its significant costs.

DDAVP's high initial response rate is attractive for episodic use to treat enuresis, alone or in combination with other treatments. It can be very useful for summer camp and sleepovers to prevent enuresis. DDAVP also may be useful to bridge the gap between enuresis and dryness during other treatments. Using DDAVP episodically also reduces its rather significant cost, which may be $150 to $250 for 1 month of nightly use.

OXYBUTYNIN. Oxybutynin chloride is an anticholinergic and antispasmodic drug that has a role in reducing uninhibited bladder contractions. It is used primarily to treat children who have symptoms of daytime urgency or frequency in addition to nighttime enuresis. It appears to be no better than placebo in treating children who have MNE. Side effects are related to the anticholinergic action of the drug and include flushing, blurred vision, constipation, tremor, and decreased ability to sweat. The recommended starting dose is 5 to 10 mg/d (or 0.1 mg/kg) for most children. This drug is not approved by the United States Food and Drug Administration to treat enuresis in children younger than 5 years of age. Hyoscyamine is another anticholinergic agent used to treat bladder instability that recently has received attention in clinical studies on enuresis. These medications may play a role in the treatment of PNE.

Age-related Treatments

As a condition that has no single etiology and various causal factors in any one patient, it is not surprising that a single method of treating nocturnal enuresis is often of limited success. Age-related strategies that combine more than one treatment may improve response rates.

Younger Than Age 8 Years

For young children and their parents, reassurance and education about enuresis are of utmost importance. They must understand that nocturnal wetting is not the child's fault. There is no place for ridicule or a punitive approach to the problem by parents, siblings, or peers. Previously described motivational and behavioral methods that assist the child in waking to void and that praise successful dryness suit this age group best.

Ages 8 Through 11 Years

For children who still have nocturnal enuresis at this age and for whom the child and family request an intervention, the enuresis alarm gives the best results in terms of response rate and low relapse rate. This also is the age at which intermittent use of medication such as DDAVP can be useful for special events such as an overnight at a friend's home or a camping trip.

Ages 12 Years and Older

Because of the emotional impact of persistent bedwetting in adolescence, aggressive intervention is indicated. If use of an enuresis alarm does not stop or greatly reduce the wetting episodes, continuous use of medication is justified as additional treatment. When 2 months of dryness using the combination of alarm and medication are achieved, the medication should be tapered gradually while continuing to use the enuresis alarm.

Comparative Evaluation of Therapies

Assessments of treatment results of enuresis must consider the rate of initial response, the duration of response, and the relapse rate. In general, studies comparing an alarm system with placebo or drug therapy show the alarm system to have the most favorable combination of initial response rate (60% to 70%) and relapse rate (10% to 30%), especially when dryness is assessed at 12 months after initiating treatment. The success rate with alarms, of course, depends on continued use of the alarm. A significant number of families (30% to 50%) discontinue use of the alarm within only 2 to 3 weeks. Studies evaluating medication alone compared with placebo show favorable initial response (10% to 60%), but a significant relapse rate (80% to 90%) when the child is off medication. Two studies documented identical rates of 56% of children maintaining dryness after 12 months' use of an alarm system. In both studies, the rate of dryness after 12 months when using medication alone, either imipramine or DDAVP, was no better than the expected improvement rate of about 15% with no treatment.

Summary

Nocturnal enuresis is a common problem seen by the primary care physician. It remains a source of considerable anxiety for the child, parents, and sometimes the pediatrician. In spite of several decades of research, no single explanation or classification of enuresis is sufficient. The nocturnal wetting episode occurs when the child does not awaken during sleep at a time when urine volume exceeds functional bladder capacity, due either to excess urine production, small bladder capacity, or both. This perspective requires the practitioner to take a careful history for polyuria, sleep dysfunction, and daytime bladder symptoms to devise the best treatment for each child. Once organic causes are ruled out by careful history and physical examination, no laboratory or radiographic evaluation is necessary beyond a simple urinalysis. Although a spontaneous cure rate of 15% per year can be expected, intervention may benefit some children through earlier attained dryness and improved self-esteem. Behavior therapies, including alarm systems, have the best long-term results, but they require strong family commitment and do not offer immediate results. Medication has a better short-term cure rate than motivational/behavioral therapy, but relapse rates are high when drugs are discontinued. A combination of behavioral therapy and pharmacotherapy is reasonable if monotherapy fails. The ultimate goal is for the child to maintain nighttime dryness or to self-awaken to void at night.

Suggested Reading

Azrin NH, Thienes PM. Rapid elimination of enuresis by intensive learning without a conditioning apparatus. *Behav Ther*. 1978;9:342–354

Chandra M. Nocturnal enuresis in children. *Curr Opin Pediatr*. 1998;10:167–173

Djurhuus JC, Rittig S. Current trends, diagnosis, and treatment of enuresis. *Eur Urol*. 1998;33(supplement 3):30–33

Faber SH, Goblin AZ, Jacobs TH, et al. Enuresis control in primary care. *Proceedings from a Symposium on the Control of Uncomplicated Primary Nocturnal Enuresis*. 1996

Hjalmas K. Nocturnal enuresis: basic facts and new horizons. *Eur Urol*. 1998;33(supplement):53–57

Mellon MW, McGrath ML. Empirically supported treatments in pediatric psychology: nocturnal enuresis. *J Pediatr Psychol*. 2000;25:193–214

Moffatt ME. Nocturnal enuresis: a review of the efficacy of treatments and practical advice for clinicians. *J Dev Behav Pediatr*. 1997;18:49

Moffatt ME, Kato C, Pless IB. Improvement in self-concept after treatment of nocturnal enuresis: a randomized clinical trial. *J Pediatr*. 1987;110:647

Monda JM, Husmann DA. Primary nocturnal enuresis: a comparison among observation, imipramine, desmopressin acetate and bed-wetting alarm systems. *J Urol*. 1995;154:745–748

Neveus T, Stenberg A, Lackgren G, et al. Sleep of children with enuresis: a polysomnographic study. *Pediatrics*. 1999;103:1193–1197

Olness K. The use of self-hypnosis in the treatment of childhood nocturnal enuresis: a report of forty patients. *Clin Pediatr*. 1975;14:273–279

Robson WLM. Diurnal enuresis. *Pediatr Rev*. 1997;18:407–412

Schmitt BD. Nocturnal enuresis. *Pediatr Rev*. 1997;18:183–191

Scmitt BD. Nocturnal enuresis: finding the treatment that fits the child. *Contemp Pediatr*. 1990;7:70

Schulman SL, Colish Y, vonZuben FC, et al. Effectiveness of treatment for nocturnal enuresis in a heterogeneous population. *Clin Pediatr*. 2000;39:359–364

Tietjen DN, Husmann DA. Nocturnal enuresis: a guide to evaluation and treatment. *Mayo Clin Proc*. 1996;71:857–862

PIR Quiz

Quiz also available online at *www.pedsinreview.org.*

1. The likelihood of enuresis occurring in a child whose parents both had enuresis is *closest* to:

   A. 75%.
   B. 50%.
   C. 25%.
   D. 10%.
   E. 5%.

2. Of the following statements about the impact of anxiety or stress on regressive bed-wetting, the *most* accurate is that:

   A. Children who have chronic, debilitating illnesses are more prone to enuresis than those who do not have such illnesses.
   B. Children whose families are in stressful situations, such as with family finances, are more prone to enuresis than other children.
   C. Enuresis is more common among ethnic minorities.
   D. Poor self-esteem has been shown to correlate with enuresis.
   E. The causative association between enuresis and anxiety or stress is not proven.

3. Of the following, the etiologic factor that may be the *most* plausible explanation for enuresis beyond the age at which it usually ceases is:

   A. Maturational delay.
   B. Nocturnal polyuria due to chronic illness.
   C. Psychological factors.
   D. Sleep arousal dysfunction.
   E. Small bladder capacity.

4. Motivational therapy results in complete regression of enuresis in approximately what percentage of patients for whom it is used?

   A. 5%.
   B. 25%.
   C. 50%.
   D. 75%.
   E. Almost 100%.

5. The cure rate for enuresis using alarms is up to:

   A. 10%.
   B. 30%.
   C. 50%.
   D. 70%.
   E. 90%.

6. Pharmacotherapy generally should not be employed as sole treatment for enuresis in patients younger than age:

   A. 3 years.
   B. 4 years.
   C. 5 years.
   D. 8 years.
   E. 15 years.

Nocturnal Enuresis: Current Concepts
Michael R. Lawless and Darby H. McElderry
Pediatr. Rev. 2001;22;399-407
DOI: 10.1542/pir.22-12-399