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Introduction

Nocturnal enuresis is often considered one of the most embarrassing problems a child can face in childhood. Because it occurs at night and at home, however, it is possible often to limit the social effect, albeit at times by making social sacrifices. Families can keep their children out of overnight school field trips or sleepovers. They may turn down camp-out invitations. They work out discreet solutions with chaperones and camp counselors. Daytime incontinence on the other hand can be quite vexing to both the child and family. If it seems to occur particularly in a sporadic fashion or with little warning, it can be very frustrating. The child and family may feel “caught” by the wetting and have a sense of being powerless to prevent future occurrences. This chapter is a survey of the primary causes of daytime incontinence in children. It will review the general concepts underlying the basic approach to evaluating and treating a child who has daytime wetting. Specific conditions that cause daytime incontinence will be discussed and guidance offered on targeted therapies.

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Natural History of Continence Control

Normal bladder control in a child requires several basic parts of the anatomy to be complete and normal. There must be an intact neural system. The coordination of voiding is mediated in the pontine micturition center of the brain stem. External sphincter relaxation is synchronized to occur just prior to detrusor contraction. There must be a normal and intact urinary system. These two components are sufficient to have a physiologically safe system. Healthy babies and pre-toilet-trained children, for example, store and void using just these two components without any consequences [1]. In addition to these two components, continence requires that there is a conscious perception of what are occurring during storage and voiding and an understanding of the social norms associated with continence. In a sense, every normal child already has the mechanism of continence but has to learn when and where it is appropriate to void.

Babies and pre-toilet-trained children store urine under low pressure until the volume reaches the bladder functional capacity at which point the external sphincter relaxes, the bladder neck opens, and the detrusor contracts. These actions occur in a synchronized sequence that is essentially reflexic. It is involuntary, and there is little social awareness as anyone who has ever been

voided upon while changing a baby's diaper can attest. Adults in contrast perceive when their bladders are becoming full and have awareness typically *long before* the functional capacity is reached. They can then choose to voluntarily initiate the voiding process. Likewise they can inhibit or delay the voiding reflex for often extended periods of time until it is socially convenient to void.

The transition from the pattern of babies and incontinent children to the adult pattern passes through several phases. First, the child must be able to sense bladder fullness and link the sensation to a mental perception of fullness. This usually occurs around age 1–2 years. Next, the child must have awareness and perception of the external sphincter. The earliest means of continence control is squeezing the external sphincter in response to a detrusor contraction. This may be an extension of voluntary control over the guarding reflex [2]. It may be also at this period of time, around age 2–4 years, that avoidance maneuvers such as the Vincent's curtsy can occur [3]. This is the maneuver wherein a child tucks the heel under the perineum and sits on it. This action presses up against the perineum thereby tightening the pelvic muscles. By age 3–5 years, most children have developed an adult pattern of voiding. They are aware of bladder fullness and perceive what that sensation means. They can inhibit the micturition reflex temporarily until it is socially appropriate and can initiate voiding even when bladder volume is less than the functional capacity. By age 6 years, the vast majority of children (>75 %) have achieved daytime continence, and the majority are dry at night [4].

Children before they can be expected to void like adults, therefore, must be able to do the following. They must have awareness of bladder fullness and understand what that sensation means. They must be able to void before they are compelled to void at their functional capacity. They must understand or want to understand the social norms of continence. Many of the problems we encounter in children struggling to achieve daytime relate to a failure to fully achieve these capabilities.

Structure of this Chapter

This chapter focuses on daytime continence issues. Often daytime continence problems occur simultaneously with nighttime wetting or other issues. Separate chapters elsewhere cover topics that are often associated with daytime wetting, including classic or monosymptomatic nocturnal enuresis; neurogenic bladder; incontinence in patients with renal failure; wetting after failed prior continence procedures; wetting associated with bowel problems; wetting after chemotherapy, radiation therapy, and trauma; adult and recalcitrant nocturnal enuretics; and wetting due to congenital or anatomical anomalies.

General concepts related to the evaluation of any child with daytime wetting problems will first be discussed. Specific causes of daytime wetting will then be covered. Finally treatment techniques will be discussed, particularly those which related to changing toilet habits and voiding patterns.

A Practical Approach Toward Evaluation

General Concepts

Most children achieve some degree of daytime continence by age 5 years old. If they do not achieve any significant period of continence (6 months or more), they are defined as having primary daytime incontinence. Children who have achieved at least 6 months or more of continence before becoming incontinent are defined as having secondary incontinence. About 70 % of affected children have primary incontinence [5]. This differentiation is important. Secondary incontinence is usually the result of a change in a previously normal function and supports the assumption that the internal anatomy and function is inherently normal in the past. It implies that something new has occurred that has altered the normal state. When searching for a cause, it should logically therefore be aimed at discerning

what has changed recently in the child's life. Has there been some social upheaval such as a death, birth, divorce, job loss, or other major events? Did they move? Has the child been enrolled into a new school? Is there a new member in the household?

Children who have never been continent for a sustained period of time may have a variety of causes. Some may have congenital anomalies which were previously unrecognized until the child failed when attempting to achieve continence [6]. Occasionally there are children who have only just gained control of their bladders and may have done very well for 6–12 months before relapsing and having wetting episodes. Up to 10 % of children fall into this category [6]. The vast majority of these children later do regain control and typically do not have any underlying conditions. It is not known why this relapse occurs. It has been speculated that it may simply represent that the achievement of control is not a fixed event but can have a spectrum wherein some children gain stable persistent control a bit earlier, and others don't achieve this until 6–12 months later. Another point to remember is our adult perceptions are unlike that of a child. We view the achievement of toilet control as a developmental building block leading to other accomplishments. Some inexperienced parents mistakenly expect that each child will automatically hit their developmental landmarks and proceed as if on an agenda. Their child may be very interested in the toilet, the whole toileting process, or the kiddie potty, but in much the same way as they can be very interested in a particular toy. They can be fascinated for a short intense period of time, but that does not necessarily mean they are achieving continence; 6 months later they are no longer as interested much as they can lose interest in a toy.

Other studies suggest that intermittent periods of urgency, frequency, and incontinence may be normal in otherwise healthy children up to age 7 [5, 7, 8]. Some experts therefore advocate taking a less aggressive and more patient approach until the child is in primary school. Girls are more commonly affected than boys in general across age groups [9]. Several risk factors have been associated with daytime wetting although definite

causative links have not been established. They include a strong family history in parents and siblings, social upheaval or disturbance (social trauma such as a death of parent, sibling, loss of home, divorce, and refugee status), neuropsychiatric pathology, mild and minor neuropsychiatric dysfunction (attention-deficit disorder, hyperactivity disorder), general developmental delay, and physical and sexual abuse.

Families with children now live more complex and busier lives than they did in the past. There are more social pressures to have better and earlier toilet control. Many day care centers, for example, will not accept a child until daytime continence is achieved. As physicians we must try to be sure the expectations of the families are reasonable and that our evaluation is appropriate and measured. A general strategy when addressing wetting is to divide the patients into three categories depending on when the wetting occurs. This separates the patients into these groups: wetting only at night, wetting in the day and night, and daytime-only wetting. Though there are always exceptions, one can use these observations to help organize an evaluation and treatment process. For patients who are wet only at night, it suggests that when the children are awake and conscious, they are able to understand what is occurring in their bladders and act accordingly. It is when they are unconscious that there are problems, and so one could argue teleologically that the underlying anatomy is probably intact and functional. For patients who are wet day and night, one has to consider nearly all of the possible causes of wetting. The occurrence of wetting regardless of the state of consciousness suggests that whatever is probably occurring does so below the level of the child's mind or volition. Finally in cases of daytime-only wetting, one is left with the interesting situation that wetting occurs only when the children are conscious. When they are asleep, they are dry, and so one must conclude that their unconscious selves do a better job at maintaining continence than when they are awake. The old saying reminds us that, "one should never say never." These basic observations are not foolproof but help to provide a framework for the subsequent approach.

The initial evaluation of any child with daytime incontinence is no different than those with any sort of voiding disorder. It should begin with a detailed voiding and bowel history, a physical exam, and a urinalysis. In some cases other non-invasive testings such as uroflow, postvoid residual (PVR) using ultrasound, or pad or diaper weighing have value. In a few specific diagnoses, more invasive testing with x-ray imaging, urodynamics, and cystoscopy may be warranted. In the vast majority of cases, however, daytime wetting can be effectively evaluated and treated without resorting to testing beyond the history, physical, and urinalysis.

Directed History

Whenever possible the history must be obtained from both the child and the parents or guardians. The history should start from the beginning and include birth history, noting prematurity, time, if any, spent in the neonatal care unit, and if the child was sent home with auxiliary care such as home oxygen. If positive these findings suggest that there may be a risk of developmental delay. One should also inquire if the prenatal ultrasound noted any abnormalities in the urinary system. Occasionally a duplicated system or even a posterior urethral valve can be overlooked particularly if the child had some other concomitant illnesses which preoccupied the family and treating physicians [10]. The rest of the general history should inquire as to any known neurological and congenital abnormalities. Is the child achieving the expected development milestones? Is the child otherwise voiding and defecating in a normal manner? Young and inexperienced parents may not always be sure what is normal and have only their own habits and behavior to use. Be sure when conducting the history that the interviewer's understanding of what is "normal" is similar to what the parents report as "normal." For parents who do not have much experience and who do not have grandparents or more experienced parents to consult with, their understanding can be naïve and primitive. Any urine coming out may be misconstrued as being "normal" voiding.

Be sure to inquire specifically about wetting outside of daytime wetting. Patients with both day- and nighttime wetting encompass a wider possibility of causes than those who only have daytime wetting. Families and patients (particularly older children and adolescents) sometimes focus more on what is most socially annoying to them and so downplay or ignore wetting at other times, inadvertently making the evaluation less clear.

The past medical and surgical history should include any surgical procedures especially those involving the back, central nervous system (CNS), bowel, genitalia, bladder, kidney, or urethra. Significant illnesses such as meningitis should be noted along with any documented urinary tract infections. For older children and adolescents, sexual development and menarche should be noted. The family history should note any familial disorders and history of familial voiding issues. The current family structure and living situation should be recorded in the social history, noting any recent sudden changes. A general review of systems should be done looking for any other issues. Children who have other major health issues early in life can be delayed developmentally simply because they have spent a large amount of their life sick, in the hospital, or recuperating from treatment.

There should be a detailed voiding and bowel history. The age of toilet training (if achieved) should be noted and the course of the daytime wetting described. A toileting diary can be helpful in gathering accurate data. Elaborate surveys are not needed, and a simple grid noting the date and time of toilet use is more than sufficient. Specific data should include the frequency and pattern of voiding and defecation and when wetting occurs. These tools are needed because the recall of toilet habits is not always reliable despite well-meaning patients and guardians. When asked about basic information such as how often the child voids, these parents often do not know because they are unaware of the actual pattern of toilet use once the child has some semblance of control and independence. Be especially wary when the parents give the nondescript answer of "normal." What is normal of an adult is not normal for a child. The normal adult frequency of

voiding is only 3 or 4 times from the time they arise in the morning to the time they turn in to bed at night. For primary school-age children, such a frequency is very low. In a survey of normal children in the primary school-age range, only 10 % voided as infrequently as 4 times per day [11]. Seek out details about the nature of voiding. Does the child use avoidance maneuvers (also called holding maneuvers)? These are repetitive actions which are often observed by the family such as squatting down on a toy or heel of the foot (Vincent's curtsy), crossing the legs, or dancing about (doing the "potty dance"). Does the child have to run to the bathroom at the last moment? When does the wetting occur? Is it the same time of day each time? Are there activities which are associated with wetting? Is the wetting associated with giggling and laughing? Finally when the child does void, is the stream strong and straight? Does it deflect or angle off? Is there hesitation or straining?

In addition to voiding frequency and pattern, one needs to know about bowel habits. Is the child constipated? Does he/she strain at stool? How often does the child have a bowel movement? Has the child needed help in the past with bowel movements? The typical child has a bowel movement every day or every other day. If the time between bowel movements is greater than that be suspicious of constipation. Ask about the size and consistency of the stool. Very large bowel movements (e.g., the parents report that the child can clog the toilet or have to break up the bowel movement prior to flushing) are also suspicious of constipation. Is the child also suffering from fecal soiling? If so, how often is this happening and for how long?

Pertinent Physical Examination

The physical examination should begin with a global sense of development. If the child is in primary school, is the child at an age-appropriate grade? Does the child strike you as being appropriate in terms of affect and behavior? Can the child perform basic tasks and follow and understand the questions directed toward him/her

during the exam? The physical examination should include testing of perineal sensation and reflexes (can the child plantar and dorsiflex?). Is the anal sphincter tone normal? Particular attention should be paid to the back, genitals, and urethra. Funny tufts of hair along the back and irregular clefts or grooves especially those who run deep and whose base cannot be visually inspected are noteworthy and suggest an occult spinal dysraphism. Asymmetry of the buttock, anal verge, legs, and feet is an additional sign. When examining the abdomen, note if the bladder or colon is palpable. Note the underwear; sometimes the history is grossly underestimated, and the underwear bearing signs of past episodes of wetting and soiling is a far more accurate record.

Urinalysis

A basic urinalysis is needed during the initial evaluation of every child for daytime wetting. The usual parameters should be examined (specific gravity, pH, dipstick testing for glucose, protein, nitrites, leukocytes, and hemoglobin). If the urine is suspicious, microscopy is recommended along with culture and antibiotic sensitivities. An inconclusive or ambiguous dipstick does not rule out a UTI—only a true culture can do that.

Ancillary Diagnostic Tools

Toilet Diary

The toilet diary is probably the most useful ancillary tool. Once the child has a modicum of control and independence, the parents often have only a very rudimentary sense of the actual daily habit and routine. It is typically a social disruption (i.e., extra laundry, difficulty enrolling in day care or after-school care) which triggers the initial consultation. The toilet diary is a useful tool in two ways. First, it is a diagnostic tool in helping to determine the actual pattern and frequency of voids. Second, once a treatment plan has been created, the toilet diary can serve as a way of tracking progress and ensuring that there

is good compliance with the treatment regimen. For younger children up to early primary school age, the parents should help the children to fill in the data. Remember to be considerate of the child; don't make the child take the diary to school where inadvertent discovery by classmates could be devastating. Have the child track the habits on a separate slip of paper or notebook. Once at home the data could be transferred onto the main diary.

Pad Testing

Some authors advocate the use of pad weighing to help to quantify wetting [12]. Pad weighing is clearly less subjective, but in most cases, their use is not necessary. Unlike in adult urology where chronically wet women and men have used pads historically as a primary means of management, the use among children with daytime-only wetting is limited. Other researchers have not found much utility with pad weighing with children; frankly the long-term goal of the patients and parents is usually no wetting, so quantification is usually not an issue [13].

Uroflow and Postvoid Residual

Uroflow is a noninvasive means of measuring how rapidly the child is voiding. The child is asked to void with a full bladder into a special toilet or container which is equipped with a sensor so that the rate of urine flow can be tracked. The typical normal child will have a bell-shaped curve. The test is an excellent screening test but lacks specificity. In patients who have reports of hesitancy or slow stream, it may help identify anatomical issues such as a stricture or posterior urethral valves. Unfortunately it is not very specific, and so patients with poor flow due to poor bladder activity may not be differentiated. When ordering this test, be sure the child's bladder is full and there is an adequate volume. Ideally the voided volume should be at least 50 % of the estimated capacity by age [14]. For example, if the patient is 8 years old, one would like at least a voided volume of 150 mL ($8+2$ =volume estimate by age +2 in ounces \approx 300 mL). Uroflow may be of practical value in patients being treated with biofeedback. It is an effective noninvasive

way of judging relaxation of the sphincter and pelvic muscles. The availability of inexpensive ultrasound devices dedicated to measuring bladder volume makes it possible to measure PVR noninvasively. The usual PVR is close to zero; although some normal children will have small PVRs of 5–7 mL. If the PVR is elevated it must be interpreted in terms of the estimated bladder capacity. Volumes which are over 30 mL and which are more than 10–15 % of the estimated bladder capacity may be significant [15–17].

These tests are simple to perform and noninvasive and do not use ionizing radiation. These advantages, however, should not lead to widespread indiscriminate use. They are most useful when applied to a patient with report of a poor or hesitant stream. The finding of a poor uroflow with a concomitant elevated PVR with daytime wetting would justify further more invasive testing. Likewise if the diagnostic picture assembled from the history, physical exam, and toilet diary is unclear or contradictory, it may be helpful to do these tests. For example, if the toilet diary suggests that the child is voiding regularly and frequently and, yet, there is still wetting between voids, one has to wonder about the efficacy and completeness of each void.

Invasive Testing

Invasive testing is usually not required to evaluate and treat the vast majority of patients. Their use is most effective when the noninvasive methods have not been able to clarify the situation or if there is a specific question which cannot be resolved by any other less invasive method. Symptoms which indicate a need for further invasive evaluation include recurrent or febrile UTI, continuous incontinence, prior urological surgery, or known GU anomaly. Findings of occult spinal dysraphism at physical exam and abnormal uroflow and marked elevated PVR (suggesting some bladder dysfunction or significant obstruction) all need further evaluation. These tests include voiding cystourethrogram (VCUG), urodynamics, and more complex imaging such as magnetic resonance imaging (MRI).

Voiding Cystourethrogram and Nuclear Medicine Renal Scans

The VCUG is usually indicated in children who have recurrent culture-proven UTI and can detect vesicoureteral reflux, abnormal bladder necks, and outlet obstructions (valves and strictures). It may also show nonneurogenic detrusor-sphincter dyssynergia, a situation where in the bladder and sphincter muscle act out of synch and work against each other. There is currently much discussion in the pediatric urology world as to the best approach to evaluating a child with recurrent UTI. Some advocate working up the bladder (so-called “bottom-up” approach) first with a VCUG. Others recommend working up only those who are susceptible to renal scarring (so-called “top-down” approach) by ordering a nuclear medicine renal scan [18, 19]. In this particular situation because wetting is the primary issue, at this time, it would be the author’s opinion that until further evidence becomes available, the “bottom-up” approach starting with a VCUG should be considered when faced with both wetting and UTIs. The advantage is that not only would VUR be detected, but other issues of interest such as strictures, posterior valves, and completeness of emptying could be assessed.

Urodynamics

Formal urodynamic studies (UDS) like other invasive studies are usually not necessary in the vast majority of children [20]. For neurologically normal children and those who have not had prior urological reconstructive surgery, urodynamics are rarely necessary. These studies attempt to recreate or simulate what happens to the child during urine storage, emptying, and ideally at time of wetting. The behavior of the bladder and urethra is tracked during this recreation. This monitoring is achieved by placing special catheters which have pressure sensors into the urethra and bladder or rarely suprapubically. These tests include the cystometrogram, urethral pressure profile, pelvic floor electromyography, and bladder and Valsalva leak point pressures. They can be done individually or in concert; fluoroscopy can also be added to visualize the behavior of the bladder and urethra. These tests can be done

individually but usually are combined in concert to obtain the most information. The nuances of these tests and how they are carried out are beyond the scope of this chapter, but typically they can be carried out as an outpatient and do not last more than an hour or two. For children who are sensate and who may be anxious about being catheterized, it is sometimes necessary to put the child under general anesthesia very briefly and place and secure the urodynamic catheters before waking up the child for testing. The child must be fully awake for the test to be of value.

There are four main indications for urodynamics in children with daytime wetting. The first indication is to help diagnose neurogenic bladder disorders. If there are symptoms and signs (known prior history, back abnormalities, neurologic deficits) which raise the suspicion of neurogenic dysfunction, then urodynamics should be carried out. The primary study is the cystometrogram; additional tests are added depending on the nature of the voiding dysfunction. For children with daytime-only wetting, the principal concerns are with the parameters of bladder compliance, bladder activity, and bladder sphincter coordination. Bladder compliance refers to the ability of the bladder to accommodate increases in urine storage with minimal or no increase in pressure. The normal bladder will fill and expand over time with only a small increase in storage pressure. Patients with neurogenic bladders can have poor bladder compliance resulting in sporadic wetting when the bladder pressure is sufficiently high. Patients with neurogenic bladders can be overactive with contractions which occur at volumes less than the functional capacity and outside of volitional control. The other extreme, underactivity or hypoactivity, can also occur; these patients will fill well beyond their expected capacity but cannot generate a normal voiding contraction. Finally, normal emptying and storage occurs in synchronization with the urinary sphincter mechanism. During normal filling, the sphincter mechanism is active to help preserve continence. When normal capacity is reached, the normal sequence is to have the sphincter mechanism relax and open prior to the contraction of the bladder. In some cases of

neuropathic bladder and all cases of nonneurogenic neurogenic bladder, this coordination is lost, and the bladder and sphincter mechanism contracts and relaxes out of sequence. At times they contract simultaneously and end up working against each other. This lack of coordination is termed detrusor-sphincter dyssynergia and is commonly seen when there is some neuropathology between the sacral spine and pontine micturition center.

The second use of urodynamics is when there is some specific anatomical condition suspected to be associated with wetting. For example, if daytime wetting is only associated with straining, coughing, or heavy lifting, urodynamics can help both not only to quantify the degree of exertion needed to cause wetting but also to offer insight into a possible cause. True stress incontinences are very rare among children, but if the history and findings suggest this possibility, then urodynamics would be worthwhile.

The third application of urodynamics is in the diagnosis of patients with nonneurogenic neurogenic bladder (see later discussion) [21, 22]. This is a condition which by definition is a diagnosis of exclusion. Afflicted children present with physical findings on imaging studies consistent with severe obstruction or neuropathology, yet all workup fails to find any such issues. The etiology is believed to be a severe bladder sphincter dyssynergia.

Finally urodynamics are needed to help puzzle out patients with daytime wetting who have failed all prior conventional treatments. They may serve to help confirm the absence of more severe concerns thereby giving resolve and reassurance to carry on with other therapies. When all conventional treatments have been unsuccessful and more invasive and irreversible therapies are being contemplated, urodynamics should definitely be carried out.

Other Studies

When history, physical findings, symptoms, and signs justify, a MRI scan of the lumbosacral spine should be carried out looking for a tethered cord or other occult neuropathology. Kidney and bladder ultrasound (USN) is commonly done to rule out any occult anatomical issue such as a duplex system with an ectopic insertion.

Unless there is compelling evidence on imaging studies, history, or physical exam of urethral pathology or bladder obstruction, cystoscopy has no role in the evaluation of daytime wetting.

Differential Diagnosis

The International Children's Continence Society Standardization Committee document recognizes eight conditions as possible causes of nonneurogenic daytime wetting [23]. They can usually be diagnosed, and treatment can be begun with only a good history, physical exam, and some basic noninvasive methods. If there is no clinical improvement, more invasive methods can then be carried out (See Table 16.1).

Pseudo-Daytime-Only Wetting

Before discussing the differential diagnosis in detail, one should be aware of conditions which can mimic daytime-only wetting. These conditions can be grouped under the heading of pseudo-daytime-only wetting. They should be distinguishable by a thorough history and physical exam. Occasionally they may present mislabeled as a case of daytime-only wetting.

Table 16.1 Differential diagnosis of daytime-only wetting

Pseudo-daytime-only wetting
Duplicate ureter with ectopic insertion
Obstruction of urethra or bladder neck
Extraordinary urinary frequency syndrome
Urinary retention
Physical and sexual abuse
Urethral prolapse
Hypospadias and epispadias in girls
Overactive bladder
Infrequent voiding
Dysfunctional voiding
Underactive (hypoactive) bladder
Nonneurogenic neurogenic bladder
Dysfunctional elimination syndrome
Giggle incontinence
Vaginal voiding

Duplicate Ureter with Ectopic Insertion

During fetal development complete ureteral duplication can occur. Rather than a single ureter, there are two distinct ureters from the kidney carrying urine down toward the pelvis. The upper pole ureter can insert outside of the bladder. It can end up draining into the urethra, bladder neck, uterus, or vagina. These upper pole moieties can be quite small and poorly developed yet be sufficient enough to create wetting. The result of this ectopic insertion is a continuous slow drip by drip leakage. The patient paradoxically will report normal voiding and emptying yet will have continuous wetting. This condition can only occur in girls. Embryologically, the ureter cannot insert below the bladder neck and pelvic diaphragm in boys. The diagnosis can be suspected on ultrasound (USN) which can show an elongated kidney with two distinct renal pelves. Confirmatory testing includes intravenous urography (IVP), computed tomography (CT), or MRI. Nuclear medicine renal scans (dimercaptosuccinic acid [DMSA] or mercaptoacetyl-glycerine [MAG3]) can also be used. The definite treatment is surgical. The upper pole moiety can be removed (heminephrectomy), or the upper pole ureter can be connected to the lower pole pelvis (ureteropyelostomy). Occasionally, it may be preferable to reimplant the ectopic ureter into the bladder.

Obstruction of the Urethra or Bladder Neck

Patients with true obstruction of the urethra or bladder neck (stricture, posterior urethral valve, or rhabdomyosarcoma of the bladder neck or prostatic urethra) can present with dribbling incontinence after voiding in the daytime. Typically there will be a weak force of stream or in severe cases near-complete retention. The diagnosis is confirmed by VCUG. Treatment is dependent on the diagnosis; posterior valves and strictures are usually initially treated by endoscopic incision, and masses are typically staged by biopsy. Final therapy with the tumors is usually dependent on the clinical stage and pathological grade.

Extraordinary Urinary Frequency Syndrome

Occasionally children up to about age 10 years will present with only markedly increased urinary frequency but with no pathological cause. This condition is termed extraordinary urinary frequency syndrome. The number of voids can be as high as 10–12 times when awake, sometimes several times in an hour, and often the children will even wake up and void at night. There is no history of UTI, and the force of stream is otherwise normal. There are no other associated issues. Usually the condition is self-limiting and resolves within 6 months. There is no known etiology, but some type of social change (new school, new sibling, etc.) has been found in many cases [24, 25].

Urinary Retention

Complete retention with overflow wetting can occur in children and is often due to a combination of constipation, infrequent voiding, and urinary infection. Extrinsic or intrinsic masses while rare should be remembered as possible diagnoses. For young preschool-age children, bladder neck or prostatic rhabdomyosarcoma can obstruct normal urinary flow. For girls, external compression due to hydrometrocolpos can present with retention. Finally very large ovarian cyst can cause a marked sense of urgency and be confused with a distended bladder; USN will usually help to differentiate these conditions.

Physical and Sexual Abuse

Physical and sexual abuse can manifest as urinary problems; occasionally only as daytime wetting. Some studies have suggested that up to one in five children prior to puberty experience some form of abuse [26]. Remember that many cases of abuse will not always have obvious physical signs. A lack of physical signs does not rule out abuse. Usually there is dramatic change in behavior. There may be regression of milestones and fearful behavior. In older school-age children, phobias, acting out, sleep disturbances, and overtly sexual behavior have all been reported. In addition to voiding issues, the most common symptoms are generalized vague complaints, such

as headaches or stomachaches. A good history and keeping an open mind to this possibility are critical. When evaluating patients with voiding disorders, one must always consider the possibility of sexual abuse as an underlying cause of secondary voiding dysfunction, particularly in older children. Inquiring about the possibility of abuse should be included in the history. Many jurisdictions in the United States mandate reporting of suspicion by all physicians. Typically parents are aware of why you have to ask about this possibility. If the history leads to a suspicion of abuse, many facilities will have an established protocol. Often there are specific teams of physicians, nurses, and social workers who will carry forward the investigation.

Urethral Prolapse, Hypospadias, and Epispadias in Girls

Young girls, particularly African-American girls, can prolapse their urethras [27]. No specific cause has been identified. There is laxity in the lining of the urethra and it rolls out. Ischemia and edema develop, and the girl may present with dysuria, poor emptying, and a dribbling incontinence. It is hard to miss this diagnosis because there is a characteristic edematous “doughnut”-shaped urethral opening on visual inspection. The treatment can be conservative with sitz baths to help reduce the swelling, hoping for natural reduction. When that fails, surgical resection is necessary.

Finally, epispadias and hypospadias are rare malformation anomalies of the female urethra and bladder neck. Usually this results in an incompetent continence mechanism and nearly continuous leakage of urine. A good physical exam should be sufficient with confirmatory testing on VCUG and MRI. Treatment usually requires surgery to reconstruct the bladder neck or to close it off and building a catheterizable channel.

Overactive Bladder

The constellation of symptoms comprising urgency and frequency with or without incontinence is defined as being overactive bladder (OAB). The frequency must be greater than seven times per day. Overactive detrusor contraction

during filling is the causative factor. In the history, avoidance maneuvers such as squatting, heel sitting, pressing on the perineum or genitalia, or walking on tiptoes are commonly reported. They occur as the child tries to suppress the urgency and thereby prevent wetting. For some children with recurrent wetting, the problem can worsen through the day owing to loss of concentration and fatigue. It may occur during the night leading to nocturia but not always nocturnal enuresis. Children with this problem often diminish their fluid intake to minimize wetting. Another form termed “dry OAB” manifests as a strong urge but is associated with little or no actual voided urine. There is only a tremendous sense of urgency. It can be equally disruptive causing the child to hurry to the bathroom but with no relief from voiding. This form usually occurs more commonly in older patients and the elderly. No specific single cause is known. The current theories suggest that overactivity maybe a manifestation of more generalized issues in the body which can affect also the bowel, mood, and behavior [28, 29].

A thorough history and a toilet diary will quantify the urinary frequency, small voided volumes, and urgency incontinence. Fluid intake in older children will often be low, and the urine specific gravity will be high. With normal voiding and emptying of the bladder, no further investigations are necessary before empiric therapy has begun. The only critical exception is if the child has had recurrent UTIs together with bladder problems. In these cases, assessment with renal and bladder ultrasound should be performed and, depending on the age of the child, a VCUG to look for VUR.

It is imperative to obtain a good bowel history. Constipation can both be a contributing factor and a side effect. Forceful contractions of the pelvic floor during avoidance maneuvers may lead to postponement of defecation. A constipated child will often be also an infrequent voider. Constipation and fecal soiling are often found in children with OAB, and this condition has to be treated simultaneously.

Treatment in children should always start with the standard approach addressing each of these concerns. From the toilet diary look to see if there

is a pattern which could be accommodated by adjusting the child's daily activity. If a scheduled voiding pattern and normalizing habits do not correct the symptoms after 3–4 weeks or if there are tremendous social pressures on the child, anticholinergic drugs should also be started. Establishing a normal voiding pattern by promoting good habits and eliminating avoidance maneuvers along with judicious use of anticholinergic drugs are the foundations of any treatment of OAB. If the initial treatment is unsuccessful particularly if the results seem to call into question the original diagnosis, further UDS are indicated. The main concern is to exclude any other pathology, particularly occult neuropathy.

Should the condition prove to be recalcitrant to conventional therapy, other options such as neuromodulation and biofeedback can be offered. Sacral nerve neuromodulation has been used effectively in adults and older children [30, 31]. Biofeedback can also be used to help retrain the pelvic muscles; the aim being to teach the child how to fully relax the sphincter and pelvis. Many of these methods are invasive (with rectal or vaginal sensors) and require a lot of cooperation from the child and family. In some cases a less invasive approach using electromyography patches can be used. The child is taught to relax the pelvic muscles and to learn what contraction and relaxation feels like. Recently there have been successes reported with adapting computer video games to this use. The child's ability to control the pelvic muscles is tracked and used to manipulate game play [32]. For the most difficult cases, those who are unresponsive to any treatment, endoscopic suburothelial botulinum toxin type A injections to the detrusor muscle have been used, but this approach is not yet a standard therapy and is an off-label use (see below for further discussion).

The treatment of children with OAB is nearly always done as an outpatient. There have been reports of inpatient treatment or group treatments, but usually these methods have been only done in Europe and are not translatable at this time to a North American practice environment [33]. There are few studies of any rigor on the efficacy of any therapy only in OAB. Of the

results available, signs and symptoms seems to disappear in about 50 % of the children. If pharmacotherapy is added, the cure rate seems to increase to 70 %, but the long-term stability without recidivism remains in question [33].

Infrequent Voiding

Some children will wait until there is an overwhelming sense of urgency before attempting to void. They are not reacting to the earlier sense of mere fullness. This infrequent voiding pattern causes them to rush to the bathroom. Usually they are too late, and urge incontinence occurs. It has been theorized that the strong sphincter activity in infrequent voiding is a behavioral maladjustment of the guarding reflex and not a primary bladder/sphincter dysfunction [2, 34]. Usually this syndrome is considered an acquired disorder due to a combination of detrusor overactivity and voluntary overcompensation with the sphincter mechanism. The history will include urgency and incontinence with avoidance maneuvers, delay of voiding, and few voids per day. In the most cases, flow is often normal, and emptying is complete; testing with uroflow and bladder scan is usually not needed. In some extreme cases where there has been long-term distention, the PVR may be elevated. No invasive investigations are recommended in the initial phase. Treatment should start with standard the institution of a scheduled voiding program with 6–7 voiding efforts during the time the child is awake. The parents or guardians are asked to pick events which naturally punctuate the day into small chunks. These chunks do not have to be perfectly equidistant in time, but should be regular events. By choosing to schedule voiding attempts at these moments, there is no excuse that the child was too busy; it is easier to enforce and remember, and there are built-in reminders due to the regularity of these events. Mealtimes, coming and going to school, favorite morning or afternoon activity, bath time, and bedtime are all excellent choices to pick from. Children are encouraged to go to the toilet even if they do not feel any need; parents and guardians are instructed in front of the child not to negotiate, bargain, or otherwise alter this schedule. They are told never to ask the child if

he or she “feels like going to the bathroom.” If the patient had an accurate sense of this feeling, they would not be in the office seeking consultation. This treatment is usually the only one needed for improvement.

Dysfunctional Voiding

Dysfunctional voiding refers to overactivity in the external sphincter or the pelvic floor during voiding, often with incomplete emptying as a result. The overactivity can be seen as a *staccato* flow pattern caused by intermittent contractions of pelvic floor activity during the voiding. This action results in dips in flow rate and coincides with high bladder pressure. It can also be seen as fractionated voiding with complete interruption of the stream. This pattern occurs if the detrusor contraction is weak, and so the urine flow comes to a complete halt when the pelvic floor contracts. To speed up micturition, these children often start to strain.

Because of incomplete emptying, UTIs are common. In addition to incontinence and straining at voiding, constipation is a common symptom. The number of daily voids can be normal or infrequent. There can also be urgency owing to the fact that most of the affected children also show signs of overactivity. Dysfunctional voiding can be suspected from the history and bladder diary alone. The uroflow is an easy noninvasive method to confirm the diagnosis. The PVR is often increased. In patients with dysfunctional voiding and a history of UTI, ultrasound of the kidneys and bladder is needed, and a VCUG to determine if VUR and renal damage are present. Urodynamic investigation is often indicated, especially if there is poor emptying. It is important to determine if the bladder problems are secondary to some form of neuropathology or if the bladder is hypocontractile.

Like other functional concerns, treatment should start with the standard advice on normalizing toilet habits, treatment of constipation, and antibiotic prophylaxis if there are recurrent UTIs. In children with decreased daytime voiding frequency (four or fewer), the number of micturitions should be increased to by a scheduled voiding program. Basic relaxed voiding training

is often not enough to help these children keep their pelvic floor relaxed during voiding. Treatment is aimed at inducing full relaxation of the sphincter during voiding, with no residual urine. Strategies to achieve these goals include pelvic floor muscle awareness and timing training, repeated sessions of biofeedback visualization of pelvic floor activity, and relaxation. When large PVRs are present, especially in combination with recurrent UTIs, VUR, or renal scarring, clean intermittent self-catheterization (ISC) may be indicated. In these cases, α -blockers can also be an appropriate alternative before clean ISC is introduced.

Treatment efficacy can be measured by tracking improvement of bladder emptying and resolution of associated symptoms. Although some studies have evaluated the effects of the above-discussed treatment options in patients with dysfunctional voiding, only one was randomized [35]. From the studies available, it seems that standard therapy alone has a cure rate of approximately 50 % of patients with dysfunctional voiding. With addition of biofeedback, the cure rate would probably increase to 60–70 %.

Underactive (Hypoactive) Bladder

The term underactive bladder (also known as a hypoactive or lazy bladder) is the counterpart to the OAB. This diagnosis is given only after confirmatory urodynamics show that detrusor activity is absent or diminished during voiding. The child empties the bladder in an abnormal fashion by abdominal straining. The bladder capacity is typically higher than normal, and the PVR can be markedly elevated; values of 50 % or more are not uncommon. The symptoms are usually infrequent voiding, straining and intermittent flow, recurrent UTI, incontinence, and often constipation. Treatment is aimed at improving bladder emptying. Clean ISC is the procedure of choice. Intravesical electrostimulation has been described, but it is not yet recommended as a routine procedure for children [36]. Intermittent catheterization achieves two goals: effective emptying and prevention of further detrusor muscle distention.

Nonneurogenic Neurogenic Bladder

The nonneurogenic neurogenic bladder was first discussed by Hinman and colleagues in 1973. These patients present with the symptoms, signs, and findings on imaging studies consistent with a neuropathic bladder or a severely obstructed one. Paradoxically, there is no detectable neuropathology or obstruction. It is currently believed to be an extreme form of dysfunctional voiding; the patient is literally fighting against himself or herself. The history usually includes daytime and nighttime wetting, recurrent UTIs, and encopresis or constipation. Imaging of the upper and lower urinary tracts typically shows hydroureteronephrosis. In most cases, a thorough evaluation with renal scintigraphy, VUCG, and urodynamics is recommended. The VUCG typically shows a grossly trabeculated bladder (so-called Christmas tree bladder), and VUR is seen in half of patients [21, 22, 37]. Half of the patients have renal damage. A long futile past medical history with multiple failed surgeries aimed at correcting VUR can occur before the correct diagnosis is finally made. Urodynamics will show findings consistent with a neurogenic bladder; hyperreflexia with detrusor-sphincter dyssynergia is the classic finding. Due to the nature and rarity of the condition, it is a diagnosis of exclusion. A careful neurological exam and an MRI of the spinal cord must be done to rule out a neurogenic cause.

The management of nonneurogenic neurogenic bladder depends on the severity of the findings. It is similar to the approach used to treat neurogenic bladder dysfunction. Clean ISC and anticholinergic drugs are the mainstays of treatment. If the patient is noncompliant with clean ISC because of urethral discomfort, a catheterizable stoma (Mitrofanoff continent stoma) can be created. Temporary urinary diversion or augmentation cystoplasty may be necessary, if bladder compliance is poor. These can be quite challenging cases, and often the key is early recognition before unnecessary and ineffectual surgeries have been performed.

Dysfunctional Elimination Syndrome

When bowel dysfunction is found simultaneously with nonneurogenic voiding problems, it is termed dysfunctional elimination syndrome. The common neural pathways to the brainstem that control and relax the pelvic floor musculature may provide a theoretical basis for both systems being affected. Typically constipation and infrequent voiding are present. It is more often seen in girls and is associated with recurrent UTI and VUR [38]. The workup follows the same pattern as for other types of bladder dysfunction, with the additional attention paid to bowel habits. Treatment of voiding habits is conducted simultaneously with treatment of the bowel problems. Correcting the constipation will often improve the bladder symptoms, and biofeedback therapy often is an important part of treatment.

Giggle Incontinence

In some children, giggling can trigger partial or complete bladder emptying [39]. This can occur in childhood, adolescence, and adulthood. Termed *enuresis risoria*, it is well known enough to generate the saying, "I laughed so hard, I peed my pants." Usually the patient does not have any other lower urinary tract symptoms. The cause is unknown, but it has been suggested that laughter via central mechanisms allows the micturition reflex to "escape" central inhibition.

There is no simple treatment. Most children as they grow older simply outgrow it. The standard approach is to have the child empty the bladder prior to situations where laughter or giggling is expected, but this is simpler said than done. Biofeedback and pelvic floor muscle exercises to strengthen awareness of the muscles have been also advocated [40]. CNS stimulatory drugs, such as methylphenidate (Ritalin™), have been reported to be effective [41].

Vaginal Voiding

Some girls who otherwise are continent will experience mild wetting soon after normal voiding, due to trapping of urine in the vagina. Termed

vaginal reflux, usually there is no other issue except vaginal entrapment of urine. The condition is not associated with other lower urinary tract symptoms. It may be due to labial adhesions or an inappropriate position on the toilet. The classic presentation is that of a girl who does not spread her legs enough during voiding and who is sitting on the front edge of the toilet seat. Small girls who may be afraid of falling backward into the toilet seem particularly prone. The treatment is usually simple: change how the girl sits on the toilet. If there are labial adhesions, these need to be treated. Initial therapy can be with topical estrogen ointment; recalcitrant cases should be divided surgically.

General Treatment Recommendations

Constipation Therapy

Constipation needs to be treated whenever it occurs in conjunction with daytime wetting. The parents and child should plan on a regular time each day to try to defecate. Sometimes a cycle exists that must be undone before regularity can be restored. Hard stools can lead to painful defecation; the pain in turn makes the child reluctant to defecate which only worsens the constipation. Treatment is aimed at both an acute solution and a long-term solution. In the long term, a diet rich in fiber is recommended. We suggest a plan of commonly available fiber-rich foods which can be rotated in order to provide variety. Increased fluid intake with water is also recommended. Laxatives are usually necessary until the situation can be managed by diet alone. In some cases they have to be used indefinitely. Usually we prefer to use osmotic laxatives such as polyethylene glycol (MiraLAX™) because they can both be used acutely to empty out the colon and at smaller doses for long-term management. We usually recommend 1.5 g/kg/day up to 34 g. Other options include mineral oil (15–30 mL/kg/day up to 200 mL in 12 h) or hypertonic enemas.

Normalize Bladder Habits

Any plan of treatment for daytime wetting in general requires good bladder habits. These plans must necessarily take into account the particular nuances of each patient's situation. As noted above any such plans must correct any bowel issues. In addition there are several other general requirements. First, the patient and parents or guardians must fully understand the plan and be able and willing to cooperate. It does little good to work up a plan if the child and adults involved are not interested in participating. In cases where the child is not developmentally able to play a part (that is, it is not a psychological or psychiatric issue which can be treated simultaneously), treatment might have to be deferred or delayed until the point the child is able to participate. Any treatment plan will not work instantly nor will it yield results in just a few days. Both the patients and the adults must have a realistic understanding of how long it might take and how much effort it will require. Second, the patient should be asked to cease any and all avoidance maneuvers. Dancing about, doing the "potty dance," Vincent's curtsy, and crossing one's legs habitually should be stopped, and they should be regarded as a reminder that the child should go to the bathroom and try to void [3]. Third, the child should have good toilet mechanics. For girls, this means sitting in a comfortable situation which allows them to spread their legs and to fully relax their pelvic muscles. Many girls especially those who are small often "perch" on the edge of the toilet and sit in a manner which presses their legs together because of a lack of stability. Potty chairs can be useful in small children but for older girls, having them sit facing the tank may be a solution. The tank will give the girls something to hold onto for stability, and the wider sitting stance will open the legs apart and help facilitate relaxation of the pelvic muscles. For boys, be sure that they actually take the time to unzip their pants and take their time voiding. Fashion comes in and out of favor, and so one has to be aware of habits which can affect voiding. Some boys rather than opening the fly will instead push their pants downward

and guide the penis up and over the edge of the pants to void. Fourth, voiding should become regular in frequency. The patient should try to void regularly throughout the day and not wait until there is a strong urgency. A regular pattern should be established. The majority of children and most adults do not easily follow a schedule based on the clock. Children's lives are typically dictated by adults, and their day is more similar to cultures based on event time. Their day is punctuated by events such as waking, breakfast, start of school, gym or recess, lunch, end of school, and favorite afternoon activity such as sports/music practice, dinner, and bedtime. These events usually occur regularly throughout the day even if they are not perfectly spaced. The gap time between the end of one event and the start of the next event is the ideal time for the child to go to the bathroom. There is no excuse of interrupting a favorite event, and it is an unobtrusive opportunity to void. Fifth, the child and adults are asked to help track the habits and behavior by maintaining a voiding diary. This serves to not only track progress or the lack thereof in a reliable fashion but also as a gentle reminder to stick to the plan. Collectively, these general recommendations are termed urotherapy (see Table 16.2) [36].

Additional Therapies

Biofeedback

Biofeedback is often used in conjunction with a comprehensive rehabilitation program. It is a broad general term applied to techniques by which physiologic activity is conveyed to the patient as

visual or acoustic signals, providing the patient with information about physiologic processes. In brief, a series of repetitive exercise or activities are done by the child with the goal of improving better control of the pelvic floor muscles and sphincter. The aims are to improve both the resting tone of the pelvic muscles and the ability to fully relax. Biofeedback may be used for the management of filling (detrusor overactivity) and voiding (dysfunctional voiding owing to pelvic floor muscle overactivity) phase abnormalities. In relation to the filling phase, it can help the child to recognize involuntary detrusor contractions, and in relation to the voiding phase, it can help the child to identify how to relax the pelvic floor muscles.

Typically this training is done by having the child repetitively contract and relax the pelvic floor and sphincter muscles. This activity can be tracked invasively using an anorectal or vaginal probe or less invasively by surface patch electromyography electrodes. Biofeedback may be performed using a cystometrogram for children with involuntary detrusor contractions. In this situation, the child is taught how to recognize early and inhibit involuntary detrusor contractions, by watching the pressure curve during cystometry. When an involuntary contraction occurs, the child is encouraged to try consciously to suppress the contraction. This form of biofeedback is very invasive and time consuming and has limited use as routine treatment. If there is an indication for a cystometric investigation (e.g., in a patient with therapy-resistant urge syndrome), it can be used to teach the patient at the same time.

Biofeedback in the treatment of dysfunctional voiding is widely used and has been reported to be effective [42]. It is performed either by using uroflow only or in combination with pelvic floor electromyography. The technique teaches the child how to relax the pelvic floor muscles during micturition: the child sits on a toilet with a flow transducer, watching the flow curve and the electromyogram online on a computer monitor, trying to empty completely in one relaxed continuous portion. As noted earlier, efforts to make the process more interesting and tolerable to the child have included linking the training to a video game. Other such approaches of linking an interactive interface with the biofeedback training may help

Table 16.2 Urotherapy options

General treatment recommendations
Correct constipation
Normalize bladder habits
Stop avoidance maneuvers
Additional options
Biofeedback
Neuromodulation
Clean intermittent catheterization
Anticholinergic drugs
Alpha-adrenergic blocking drugs
Botulinum toxin type A

improve patient compliance and cooperation [32]. Estimation of PVR should always be checked after each voiding to see whether or not progress with the emptying ability is made.

Neuromodulation

Neuromodulation has been used in adults for various lower urinary tract symptoms. The invasive nature of the procedure (anal, genital, or urethral probe) makes it less applicable for children. In OAB, stimulation of inhibitory pathways via an anal probe has been used, and in the underactive bladder, the detrusor has been activated through intravesical stimulation [43, 44]. Another technique is transcutaneous electrical nerve stimulation with surface electrodes. The inhibitory nerves to the bladder are stimulated via cutaneous receptors to the sacral root (S3). Some benefits have been shown, but no controlled studies are available. These techniques are applicable only to children in whom other treatment modalities have failed [30, 31].

Clean Intermittent Self-Catheterization

In children with an underactive detrusor, bladder emptying can often be achieved with timed and double voiding. If this does not provide adequate results, clean ISC, which long has been used to manage neurogenic bladders, may be tried [45]. Fortunately outside of situations with retention or when the bladder has to be blocked down using anticholinergics to prevent high storage pressures, ISC does not play a major role in most children with daytime wetting. The key limitation with clean ISC is the invasiveness of the procedure. The problem in the long run is not just the discomfort but coping with the situation. The acceptance and training period is often worse than for children with neuropathic bladder dysfunction. Long-term compliance in these otherwise healthy children is also often lower.

Pharmacotherapy

Anticholinergic Drugs

Anticholinergic drugs aimed at the muscarinic receptors remain one of the mainstays of therapy for OAB. The blockade of parasympathetic

muscarinic receptors inhibits activity of the bladder detrusor and limits or completely blocks overactivity. Treatment has been shown to increase bladder capacity, increase bladder compliance, and decrease detrusor contractions in neurogenic detrusor overactivity.

In functional overactivity, pharmacotherapy is instituted when modification of habits and behavior does not work. The use of medications as the primary treatment in children with daytime incontinence with bladder overactivity can be carried out empirically. Medication alone is rarely successful and almost always has to be part of a coordinated effort along with behavioral modification. We do not support pharmacotherapy alone, but emphasize the importance of standard urotherapy together with the use of drugs.

When anticholinergic drugs are used, there is always a risk of increase in PVR. The development of a UTI or poor urinary stream should cause the PVR to be rechecked. Other common side effects include sun sensitivity, dry mouth, blurring of vision, constipation, and flushing. Occasionally, overheating (hyperpyrexia) may occur, particularly when the child is exposed to hot weather. CNS side effects (hallucination, irritation) have also been described. They are usually rare and warn of overdose.

Currently the most widely used anticholinergic drug is oxybutynin hydrochloride. In addition to the anticholinergic effects, the agent has musclopotropic relaxant effects and local anesthetic properties [46]. In the treatment of OAB, oxybutynin can be used in oral doses of 0.1–0.15 mg/kg twice daily. Efficacy of oxybutynin in OAB has been described in only a few open studies. While there have been comparative studies with other medications, there are no large-scale placebo-controlled studies that are available in children [47].

Tolterodine is another anticholinergic drug used mainly for the treatment of OAB in adults. Several studies have been performed in children and showed a satisfactory safety profile [48]. Its chemical structure reduces penetration of the blood–brain barrier, thereby limiting some side effects. Trospium chloride and propiverine are other commercially available anticholinergics, but there are no large studies in children about their efficacy and tolerability.

α -Adrenergic Blocking Agents

Alpha-adrenergic blockers (e.g., doxazosin, prazosin) have been prescribed to treat dysfunctional voiding and incomplete bladder emptying. It is hoped that they would help relax the overactive pelvic floor and sphincter. Theoretically it should work much as it has been applied to treat benign prostatic hypertrophy in adult men. No large-scale controlled prospective study using these drugs in children has been conducted, but the evidence of their efficacy from case series is promising and optimistic [49].

Botulinum Toxin

Botulinum toxin type A is currently used in children mainly with neurogenic detrusor overactivity but has also been used for nonneurogenic OAB [50]. The initial results are interesting. One study of 20 patients who underwent injection of botulinum toxin A resulted in 12 months of suppression of overactivity. Injection into the external sphincter is also possible in cases with pelvic floor overactivity. Results from a study with botulinum toxin type A in nonneurogenic conditions in children have been published more recently, with some positive results [51]. The use of botulinum toxin in the nonneurogenic bladder regarding OAB and dysfunctional voiding shows promise but remains an off-label use which needs further study before being incorporated into the usual treatment options. In particular further understanding of its mechanism of action and its durability are needed.

Antibiotics

All children with symptomatic UTI should be treated with appropriate antibiotic therapy. If a child has an underlying voiding disorder associated with recurrent UTIs, prophylactic antibiotic therapy is recommended during the treatment period. Trimethoprim-sulfamethoxazole, nitrofurantoin, and trimethoprim alone have proven to be successful in this role. If the patient is prone to infection, it can confuse matters; one is not sure if the symptoms are due to the infection or the ongoing voiding issues. We usually suggest that the patient be kept on a course of prophylactic antibiotics until the treatment plan is well in place, then it could be tapered off.

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