Voiding dysfunction in children

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The two most common presentations of voiding dysfunction in children, urinary incontinence and urinary tract infections (UTIs), constitute a significant proportion of visits to the practicing urologist. UTIs occur in 7.8% of girls and 1.6% of boys in Sweden by 7 years of age [1], and are associated with uncomfortable symptoms and expensive antibiotics. Vesicoureteral reflux is associated with bladder dysfunction (15%–50%) [2] and an increased treatment cost compared to patients with reflux who void normally [3]. Reflux may be resolved faster after management of voiding dysfunction [4].

Wetting causes considerable anxiety in children and parents. By 7 years of age, 6% of girls and 3.8% of boys continue to have problems with daytime wetting [5]. Children with a history of UTI have a higher prevalence of daytime wetting than those without [6]. Older children consider wetting in school the third-worst stress, following the death of a parent and going blind [7]. Women who recall a history of daytime urinary symptoms are more likely to have urge incontinence [8]. Despite the frequency and vexing nature of voiding dysfunction, physicians may not always obtain a careful history to identify and properly treat children with this condition. This article addresses the diagnostic and therapeutic approach to such children.

Definitions

The International Continence in Children Society has provided standard definitions of lower-tract dysfunction in children [9]. Incontinence implies urinary leakage, rather than soaking, and can occur during the day or night. Enuresis is complete expulsion of urinary contents after a period where urinary control is anticipated. Generally, children are expected to be dry during the day by 4 years of age and at night by 5 years of age. Nocturnal enuresis is wetting during the night and diurnal enuresis is wetting during the day. A condition is primary if there has been no dry period longer than 6 consecutive months and secondary if a dry period has lasted 6 months. Monosymptomatic nocturnal enuresis describes bedwetting exclusively, with no daytime concerns; in polysymptomatic nocturnal enuresis, complaints such as UTI, urinary urgency, frequency, or wetting may coexist. The latter condition is usually more difficult to treat.

Dysfunctional voiding as a broad term to describe functional incontinence or UTI is a misnomer because it describes inappropriate relaxation with micturition, a subset in a broader category of lower–urinary tract dysfunction. Some have labeled children with these symptoms as having dysfunctional elimination syndrome to include the important relationship between bowel and bladder [10,11], because although the systems are thought to be independent, conditions affecting one system significantly affect the other.

Developmental aspects of bladder control

Children usually follow a predictable course of continence for bowel and bladder, although the mechanisms to achieve continence are not understood completely. First, bowel control is established at night, followed by bowel control during the day. Soon after, bladder control is achieved during the day, usually between 24 months and 4 years of age. Finally, children remain dry at night.
Voiding in infancy traditionally has been thought to be reflexive, with the brain having a passive role in coordinating the flow. The child less than 1 year of age voids about once an hour with contractions under the control of the pontine mesencephalic micturition center in the brainstem [12]. Recent studies have shown that the cortex is stimulated in infants and that infants awaken when they void at night. Furthermore, bladder instability is not the rule; infants do not always void in a coordinated fashion, which suggests they contract their pelvic floor musculature [13]. As children get older, bladder capacity increases and the ability to empty improves. By 3 years of age voiding is uninterrupted and voiding frequency decreases to approximately two times over a 4-hour observation period [14].

Three important accomplishments occur during toilet training. First, the toddler develops the ability to sense bladder fullness and inhibit bladder contractions. Second, the ability to void volitionally develops as the toddler relaxes the pelvic floor and the bladder contracts. Finally children are able to contract their sphincter during voiding, if they choose, and stop voiding.

The frequency of voiding decreases with age such that 6-year-old children void approximately five to six times per day, with most voiding between three to eight times per day [6]. This decrease occurs because bladder capacity increases with age, and because fluid intake is decreased as the child relies on table food for nutrition. Although a nonlinear model is most accurate for determining expected bladder capacity for age, two practical linear equations have been determined [15]:

\[
(2 \times \text{years of age}) + 2 = \text{bladder capacity (ounces) for children less than 2 years of age}
\]

\[
\text{years of age}/2 + 6 = \text{bladder capacity (ounces) for children 2 or more years of age}
\]

Some approximate the normal bladder capacity in ounces by adding 2 to the child’s age in years.

Etiologies of incontinence and infections

Before assuming that a patient has a functional disorder, one must exclude organic pathology. Therefore, a comprehensive classification scheme to assist the clinician in directing the history, physical examination, and appropriate laboratory and radiographic studies is useful. Box 1 lists causes associated with wetting and infection [16].

<table>
<thead>
<tr>
<th>Box 1. The ABCs of incontinence and infection</th>
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<tbody>
<tr>
<td><strong>Anatomic</strong></td>
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<tr>
<td>Ectopic ureters</td>
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<tr>
<td>Posterior urethral valves</td>
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<tr>
<td>Vesicoureteral reflux</td>
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<tr>
<td><strong>Acquired</strong></td>
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<tr>
<td>Labial adhesions</td>
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<tr>
<td>Tumor</td>
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<tr>
<td>Traumatic</td>
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<tr>
<td>Toilet avoidance</td>
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<tr>
<td>Cerebral palsy</td>
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<tr>
<td>Multiple sclerosis</td>
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<td>Syringomyelia</td>
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<tr>
<td>Tumor</td>
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<tr>
<td>Giggle micturition</td>
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<tr>
<td>Primary nocturnal enuresis</td>
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<td>Urge syndrome</td>
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<td><strong>Functional</strong></td>
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<td>Dysfunctional voiding</td>
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<td>Encopresis/constipation</td>
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<tr>
<td>Hinman syndrome</td>
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<td>Infrequent voiding</td>
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Because toilet training is a developmental milestone, it is not surprising that children with developmental delays will take longer to accomplish this task. Additionally, perturbations that arise during toileting may explain why some children develop functional voiding difficulties during the day. Irritative voiding symptoms caused by chemical irritation, recurrent UTIs, and constipation can cause children to contract their external sphincter inappropriately because they fear pain, as well as increase the bladder’s likelihood to contract without central inhibition. McKenna and colleagues [17] postulate that neuroplasticity caused by the stimulation of trophic factors may cause changes in bowel and bladder innervation. These changes may decrease the functional bladder capacity and increase chances of wetting and, in some cases, UTI. Infections perpetuate this cycle by reinforcing the child’s fear of urinating, just as constipation inhibits effective defecation.

Types of voiding dysfunction

The urge syndrome is characterized by frequent attacks of the need to void countered by hold maneuvers such as squatting [18]. The urine loss is usually mild, with dampening of the undergarments. A nocturnal component also may be present with dampness but not saturation. These children void frequently. Some children experience suprapubic or perineal pain during contractions [19]. The signs and symptoms are caused by uninhibited detrusor contractions countered by voluntary contraction of the pelvic floor to minimize wetting, creating enormous intravesical pressures. The functional capacity of the child’s bladder is small for age.

Staccato voiding is characterized by periodic bursts of pelvic floor activity causing increased detrusor pressure coinciding with dips in the urine flow rate. The flow time is prolonged and emptying may not be complete, increasing the child’s risk for developing UTIs. Staccato voiding may be seen in conjunction with urge syndrome.

Fractionated voiding is characterized by incomplete, infrequent voiding with micturition in small fractions. The bladder capacity is large for age and urge is inhibited easily. Abdominal pressure (Valsalva) is necessary to shorten the flow time. The flow rate is irregular because of the reflex activity of the pelvic-floor muscles. Wetting in these patients is usually secondary to overflow incontinence. UTIs are common because emptying is incomplete.

Lazy bladder syndrome is the result of long-standing fractionated voiding. These children void infrequently and strain to empty because detrusor contractions are virtually absent. Large postvoid residuals and UTIs are common.

Hinman syndrome, first described by Hinman [20] in 1973, may be the most severe form of voiding dysfunction. This condition is characterized by detrusor overactivity, followed by bladder-sphincter dyssynergy, followed by detrusor decompensation. Radiographs show thick trabeculated bladder walls, vesicoureteral reflux, and reflux nephropathy. Psychologic “failure personalities” were described as a possible etiology [20]. Surgical treatment before correcting this imbalance may lead to significant complications and is discouraged [21].

Diurnal enuresis is associated with normal but infrequent voiding. These children, usually boys, delay emptying until it is too late. Therapy aimed at increasing voiding frequency is usually successful. An association with behavioral problems in these children has been suggested [22].

Children with benign urinary frequency (pollakiuria) suddenly need to void frequently, as often as 30 times per day [23]. They do not complain of dysuria and rarely wet during the day. Once asleep, these children do not awaken and do not wet their bed. UTI should be excluded. This condition is self-limited, is believed to be related to stress, and responds to reassurance. A recent study suggests a relationship between this behavior and pediatric autoimmune neuropsychiatric disorders associated with streptococcal infections in some children [24].

Girls with vaginal reflux complain of leaking after standing or of incomplete emptying and the
need to void again. They often wipe themselves excessively, irritating the perineum. Vaginal reflux is likely to occur if girls void with their legs together. Advising these girls to void with their legs straddling the toilet may be helpful. Labial fusion should be excluded on examination.

Almost exclusively seen in girls, giggle micturition is associated with the complete expulsion of bladder contents on laughing. This embarrassing condition is often confused with stress incontinence, which is uncommon in children. In many cases, a detailed history will suggest these patients have symptoms such as urge, with improvement after the use of anticholinergic agents [25]. In its pure form, however, affected girls have no symptomatology between episodes. Giggle micturition may be related functionally to cataplexy and has responded to stimulants such as methylphenidate in uncontrolled studies [26].

**Vesicoureteral reflux and voiding dysfunction**

Increased intravesical pressure can promote reflux through a marginally competent vesicoureteral junction. Investigators have identified detrusor instability and a history of voiding dysfunction in a large proportion of children with reflux [27,28]. Reflux may be identified before the knowledge of voiding dysfunction as part of the evaluation for UTI. It is important, therefore, to obtain a history that includes questions focusing on voiding behavior. In many cases, reflux resolves after treatment of voiding dysfunction without the need for surgery [4,29,30], although breakthrough infections may develop that prompt the need for surgical correction [31]. Theoretically, surgical treatment alone does nothing to help children with their voiding problems. Although open surgery is effective in such children, treatment specifically aimed at reducing elevated detrusor pressures should be undertaken before and after surgery because postsurgical infections develop [32]. Early reports on endoscopic antireflux surgery with dextranomer/hyaluronic acid copolymer on similar patients have not been as favorable [33].

**Evaluation**

A complete history and physical examination are essential to identify children with a neuropathic etiology for their incontinence, to identify obstructive lesions, and to distinguish between the different forms of functional incontinence. Daytime wetting or recurrent UTIs are the hallmark complaints associated with dysfunctional voiding. Wetting is usually prevalent in the afternoon because most children are anxious about wetting in school and work hard to stay dry.

A voiding diary is useful to determine a child’s voiding frequency and volumes. Children with urge syndrome void at least seven times per day. Children with advanced stages of dysfunctional voiding may void infrequently and strain or use manual pressure to empty.

Suddenly and imperative sensations of urge, several times a day, are characteristic of the urge syndrome. Despite the use of hold maneuvers such as Vincent’s curtsy [34] to prevent leakage, these children will dampen their pants. Children with lazy bladder syndrome rarely demonstrate urge. Children with diurnal enuresis deny urge and ignore uncontrolled wetting.

One should inquire about a history of recurrent UTIs, which may be secondary to dysfunctional voiding with incomplete emptying as the inciting factor [35,36]. Incontinence in conjunction with stress may be seen in children with urge syndrome when increased abdominal pressure evokes a detrusor contraction. Constipation and fecal soiling are seen commonly in children with dysfunctional voiding because children with sphincter dyssnergy also may postpone defecation [37]. Conversely, constipation causes postvoid residuals and hydronephrosis, with significant improvement seen after treatment [38,39]. These studies underscore the importance of obtaining information regarding bowel function.

Unfortunately most parents do not know the bowel habits of their children. Specific questions must be asked about fecal staining; the frequency, caliber, and volume of bowel movements; the presence of abdominal pain; and the child’s relationship to defecation.

A family history of day and night wetting should be obtained. A strong genetic predisposition has been identified in primary nocturnal enuresis and recent data show a correlation between children with moderate to severe daytime wetting and their parents [40].

A social history that includes how wetting affects the child is essential to assess motivation, a key element of success in any behaviorally oriented program. School performance, attention deficit disorder (with or without hyperactivity), and a history of problems with sensory
integration, such as avoiding loud noises and certain tactile stimuli, may play a role in voiding abnormalities [41].

The physical examination is usually unrevealing, but the back should be examined for sacral malformations, lipomas, hemangiomas, hairy patches, and asymmetry of the gluteal crease. The presence of spina bifida occulta alone, however, does not portend a poorer prognosis compared with similar children without spine anomalies [42]. Abnormal tone on rectal examination, absent perineal sensation, and an absent bulbocavernous reflex can be confirmatory of a neurogenic etiology for wetting. Inspection of the genitalia for meatal stenosis in boys and labial fusion in girls should be performed. The neurologic examination should include careful attention to the lower extremities, including tone, strength, sensation, and reflexes.

In children with daytime symptoms, a urinalysis and urine culture should be obtained. A renal and bladder ultrasound performed before and after voiding can be useful to identify obstructive uropathy, ureteroceles, and functional bladder capacity. Children with recurrent afebrile UTIs or one episode of a febrile UTI, as well as boys with thick-walled bladder and poor stream, should have a voiding cystourethrogram to identify vesicoureteral reflux and posterior urethral valves. Some patients demonstrate a peculiar anomaly on the voiding cystourethrogram: the spinning-top configuration of the posterior urethra (Fig. 1). This anomaly seems to be secondary to the force of the detrusor on the closed external sphincter, causing dilatation of the posterior urethra [43]. A scout film of the abdomen can determine if there are bony abnormalities of the spine or severe constipation. In some cases an MRI of the lumbosacral spine is necessary to exclude spinal-cord anomalies.

Urodynamic testing is reserved for children who do not respond to conservative treatment. This study can be done in children of any age, although it is easier to interpret results when the patient is cooperative. Uroflowmetry determines the voiding profile, including the velocity and flowtime. A normal flow should be continuous and uninterrupted [44]. Coupled with ultrasonography to establish the presence or absence of a postvoid residual, this tool can assess pelvic floor relaxation indirectly. The composite data derived from the history, physical examination, radiographic studies, uroflow, and urodynamic study (if performed) assign patients into the broad classifications of voiding abnormalities.

**Therapy**

After determining that there is no anatomic or neuropathic etiology for incontinence and infections, the author recommends a stepwise treatment regimen that increases in complexity pending each patient’s response. This interdisciplinary approach uses various team members with individual strengths to assist the patient and his or her family. The author’s approach includes:

- **Step I:** Bowel program
- **Step II:** Regular voiding while avoiding irritation
- **Step III:** Relaxing the pelvic floor—biofeedback
- **Step IV:** Increasing functional bladder capacity—anticholinergic medication
- **Step V:** Difficult cases: psychology, clean intermittent catheterization, other therapies

Fig. 1. Spinning top urethra in a girl with left vesicoureteral reflux.
Bowel program

For several years, investigators have reported that proper management of constipation or large, infrequently passed bowel movements with little attention to the bladder reduces wetting and UTIs [37,39]. In many cases it is difficult to convince parents that their child has large fecal boluses. Koff has suggested weighing children before and after the effective administration of laxatives. A weight loss greater than 0.9 kg suggests significant fecal retention.

The author advocates a series of enemas followed by the administration of laxatives, such as polyethylene glycol (Miralax) without electrolytes, or lactulose. Children are advised to sit in a comfortable position with their resting their legs on a stool twice a day after meals to take advantage of the gastrocolic reflex. High fiber intake and water also are encouraged strongly to maintain good bowel health. The American Academy of Pediatrics recommends that children and adolescents consume 0.5 g of dietary fiber per kg of body weight, up to a maximum of 35 g/d [45]. The American Health Foundation recently recommended that children and adolescents consume grams of dietary fiber equivalent to their age in years plus 5 g/d [46]. Physicians can review sources with recommendation to increase a child’s fiber intake [10,47].

Patients are encouraged to keep elimination diaries and have bowel movements that are neither small, hard pellets, nor voluminous boluses. Over time, stool softeners can be removed while the child remains on high fiber intake indefinitely.

Eliminating inflammation

Generally, individuals feel relief after voiding. If a child experiences discomfort with voiding, however, it becomes an unpleasant task that is likely to be averted or performed improperly. Therefore, anything that causes irritation should be suppressed. The author recommends increasing water to dilute urine and eliminating caffeine, carbonation, citrus juices, and chocolate, which the author believes are bladder irritants. The perineum of young girls who wet is often inflamed. Emollient creams may be applied, if tolerated, whereas soap is avoided. Soaks in baking soda and water also may be beneficial.

Children with recurrent UTIs enter a cycle of pain, causing poor relaxation that increases the risk of subsequent infections. In some cases a short course of antibiotic prophylaxis (trimethoprim-sulfamethoxazole, 2 mg/kg, or nitrofurantoin, 1–1.5 mg/kg) is used to attempt to break the cycle [16].

A voiding schedule is used to teach children to have their “brain be the boss of their bladder.” Diaries are used to help children void about every 2 hours, or six times per day. It is important to ask teachers to remind patients discreetly to void during breaks rather than allow them free access to the restroom. Watches that quietly beep or vibrate can be used to remind them to void.

Biofeedback

A program aimed at retraining the child to remain continent and empty effectively would be the best approach to manage these patients, assuming the child has sufficient cognitive ability to understand what they are being taught and provided that feedback can be incorporated into the training. Biofeedback is the use of modern instrumentation to give a person better immediate information about a specific physiologic process controlled by the central nervous system, but not perceived clearly or accurately [48]. Urodynamic signals such as urine flow rate, pelvic floor electromyogram, or detrusor pressure are suited perfectly for biofeedback [49–52].

Different methods of biofeedback have been used. Initially, the author used real-time uroflow to teach children directly how to relax the pelvic floor as they void. The author and others also have used Kegel (contraction/relaxation) exercises to teach children how to isolate and control their pelvic floor musculature [53,54]. McKenna and colleagues [17] have used interactive games in a series of biofeedback sessions to optimize success. Ultimately, the author found little difference in the methodology with regard to reducing incontinence and UTIs, but children must be encouraged to practice their exercises at home and listen to their flow to verify their ability to relax [55].

Anticholinergic treatment

Anticholinergic medications are helpful for children with urge syndrome and reduce the degree of vesicoureteral reflux by decreasing the number of uninhibited detrusor contractions and increasing functional capacity [56–58]. Short-acting
preparations used in the past largely have been replaced by long-acting preparations (Table 1), although the US Food and Drug Administration (FDA) has approved only one of these medications for use in children. Recent uncontrolled studies have shown promising results in children using the long-acting forms of tolterodine and oxybutynin [59,60]. Regardless of the medication selected, emphasis should remain on proper bowel habits and frequent urination. The author assesses the child’s flow and bladder emptying regularly while they are taking anticholinergic medication.

**Table 1**

<table>
<thead>
<tr>
<th>Medication</th>
<th>Dose</th>
<th>Adverse events</th>
<th>Comments</th>
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<tbody>
<tr>
<td>Oxybutynin HCl</td>
<td>2.5–5 mg bid to qid (0.2 mg/kg/dose)</td>
<td>Dry mouth, flushing, blurry vision, constipation, heat intolerance</td>
<td>Short-acting preparation</td>
</tr>
<tr>
<td>Long-acting oxybutynin (Ditropan XL)</td>
<td>5–15 mg/d</td>
<td>Same as above</td>
<td>FDA-approved in children Must be taken without chewing</td>
</tr>
<tr>
<td>Tolterodine tartrate</td>
<td>1–2 mg bid</td>
<td>Same as above; may be less intense than oxybutynin</td>
<td>Use lower dose with CYP3A4 inhibitors</td>
</tr>
<tr>
<td>Long-acting tolterodine (Detrol LA)</td>
<td>2–4 mg/d</td>
<td>Same as above</td>
<td>May be sprinkled on food Available as 1- or 2-mg tablets Same as above</td>
</tr>
<tr>
<td>Long-acting hyoscyamine (Levbid)</td>
<td>0.375–0.75 mg bid</td>
<td>Same as above; more problems with visual accommodation</td>
<td>May not be chewed; may be halved Available as 0.375-mg tablets FDA-approved in children (short-acting)</td>
</tr>
<tr>
<td>Doxazosin</td>
<td>0.5–1 mg/d</td>
<td>Hypotension, dizziness</td>
<td>Alpha-blocker may help relax internal sphincter</td>
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![Fig. 2. Probability of remaining dry during the day after being seen in the author’s program. (From Saedi N, Schulman SL. Natural history of voiding dysfunction. Pediatr Nephrol 2003;18:994–7, with permission.)](image-url)
The overall results using medication may be temporary, with more success seen when medications are used in conjunction with a well-organized treatment program.

Other treatments

When children do not respond to these measures, the clinician should reevaluate the etiology for the treatment failure. In many cases there may be problems with treatment adherence because of comorbid factors such as attention deficit/hyperactivity disorder, learning disabilities, or sensory integration issues, or because of problems in the family [41]. In such cases, psychologic counseling can be invaluable [61].

Clean intermittent catheterization (CIC) has been a useful tool in children with persistently elevated postvoid residuals, such as those with lazy bladder syndrome. Pohl and colleagues [62] instituted CIC in 23 such children. Sixteen children tolerated the treatment and improved clinically.

Alpha adrenergic blockade (doxazosin, 0.5–1 mg/d) is beneficial in some children with inadequate bladder emptying [63]. Neuromodulation has been reported to help children with recalcitrant urge syndrome [64,65]. Randomized, controlled studies are needed to verify these initial reports.

Prognosis

Only isolated reports have documented the long-term outcome of children with voiding dysfunction. Kuh and colleagues [8] reported that women who at 6 years of age had wet in the day or several nights per week were more likely to have severe incontinence and report urge symptoms. Curran and colleagues [66] reported that most children with idiopathic detrusor overactivity improved from a conservative method of treatment, including the use of anticholinergic treatment. With an average resolution time of 2.7 years, 87% had complete or significant symptom resolution. The author has shown that after over 6.5 years of follow-up in 99 children, 91% no longer wet during the day (Fig. 2), 84% no longer wet at night and, among those with a history of infection, 82% no longer have infections (Fig. 3) [67]. It remains difficult to assess the direct effect of the author’s treatment versus the natural history of this condition.

Summary

Children presenting with daytime wetting and recurrent infections require thorough histories and physical examinations to exclude organic pathology. Careful attention to bowel habits is mandatory. The evaluation and treatment of these children should be stepwise and comprehensive. The prognosis of most of these children is favorable.

References


