Infants and children are frequently brought to the emergency department in the setting of profound weakness. It is imperative to determine the etiology of this type of presentation to treat the child effectively. Neuromuscular disorders must be considered. This article explores 4 such diseases, including the Guillain-Barré syndrome, tick paralysis, botulism, and myasthenia gravis. Distinguishing features of each specific disorder, as well as diagnostic criteria, recommended treatment, and prognosis, are discussed.

KEYWORDS Guillain-Barré syndrome, tick paralysis, botulism, myasthenia gravis, pediatric neuromuscular disorders

Neuromuscular disorders are often encountered in the emergency department (ED) typically presenting with weakness as the primary concern. Key pieces of the history and examination will help to localize the disease process and aid in the diagnosis. Table 1 illustrates affected locations, symptoms, electrodiagnostic studies, and examples of common neuromuscular diseases encountered in the pediatric population. Attention to the details listed in Table 1 should facilitate neurological localization of the cause for weakness to the spinal cord, peripheral nerve, neuromuscular junction, or muscle. Four diseases that one must be sure to recognize in the pediatric ED are Guillain-Barré syndrome (GBS), tick paralysis, botulism, and myasthenia gravis (MG).

Guillain-Barré Syndrome

Background

GBS is the most common etiology of acute paralysis in children, with an annual incidence of approximately 1 to 3 in 100 000 [1]. The classic form is known as acute inflammatory demyelinating polyradiculoneuropathy (AIDP) and is caused by the autoimmune-mediated destruction of the peripheral myelin sheath and inflammation of the nerve roots. In other forms, the axon itself is damaged. The pathogenesis of such destruction is thought to be caused by a preceding infection activating T cells, disruption of the blood-brain barrier, and attack of endoneurial antigens and the release of cytokines. It is the cytokines that lead to macrophage action resulting in demyelination and, ultimately, axonal damage [2].

History

Most children will be brought to medical attention because of the acute onset of progressive weakness, typically more so in the legs than in the arms. Maximal weakness is typical within 2 to 3 weeks after onset, and two thirds of patients are unable to walk unaided at their nadir. The child may also describe tingling dysesthesias. Unlike adults, children experience pain to a significant degree, and approximately one half of patients will report pain in the shoulder, back, or posterior thigh. A positive straight leg raise test is common, with the child reporting severe pain on elevation of the leg while supine. Two thirds of children will have had an antecedent gastrointestinal (GI) or upper respiratory illness 1 to 3 weeks before the onset of symptoms. Common culprits are Campylobacter jejuni, cytomegalovirus, Epstein-Barr virus, mycoplasma pneumonia, and influenza. It is also important to consider HIV and varicella.
Physical Examination Findings
Weakness is typically symmetric, but mild differences between each side are not uncommon. There may be ataxia or an apparent dysmetria due to weakness. The diaphragm is eventually involved in many patients, presenting as respiratory distress or altered mental status if hypercarbia or hypoxia has ensued. Reflexes tend to diminish in an ascending fashion. The seventh cranial nerve is usually involved, resulting in a mild to moderate facial diplegia, or Bell palsy. Bulbar symptoms such as dysphagia and difficulty handling secretions are present in 25% of patients at the initial presentation [3]. Dysautonomia may be noted and is a potentially life-threatening complication because of arrhythmias and hypotension or hypertension.

Diagnosis
Besides the history and physical examination, the key diagnostic measures include the lumbar puncture and nerve conduction studies (NCSs). After 2 to 3 days of symptoms, the cerebrospinal fluid (CSF) should reveal an albuminocytologic dissociation with less than 10 to 50 white blood cells (WBC) and increased protein. The opening pressure might be increased if the protein is significantly raised. In AIDP, NCSs typically show decreased velocities, prolonged or absent F waves and latencies, and conduction block. These findings usually evolve over the first 2 weeks and are often sought out if there is a question in the diagnosis. The diagnosis of GBS can often be made on a clinical basis alone. It is not necessary to image the spine when the history and examination are consistent with GBS. Occasionally, the rapid onset of leg weakness, which may or may not be accompanied by bowel or bladder dysfunction, will require spinal magnetic resonance imaging (MRI) to exclude transverse myelitis or other spinal cord pathology. In GBS, anterior nerve root enhancement would be observed with MRI of the spine.

Variants
There are several different variations of GBS in addition to AIDP. It is not uncommon to have axonal nerve loss as well in this subtype. Others that are predominately axonal include acute motor axonal neuropathy, which can be associated with the GM1 antibody, and acute motor sensory axonal neuropathy. Acute motor sensory axonal neuropathy is commonly associated with C jejuni and is more often found in children. Acute motor sensory axonal neuropathy affects sensory nerves and roots in addition to the motor fibers and is usually diagnosed in the adult population. The Miller-Fisher (MF) syndrome is a triad of ataxia, areflexia, and ophthalmplopia. There is also a common association with C jejuni and GQ1b antibodies in this variant [4]. Less commonly diagnosed is the...
pharyngeal-cervical-brachial type of GBS, associated with anti GT1 antibodies.

Morbidity
Respiratory failure is more likely to occur in those with rapid progression of weakness to involve the proximal upper extremities, signs of bulbar dysfunction, facial weakness, or dysautonomia. It is important to get baseline forced vital capacities or negative inspiratory forces. The pulse oximeter alone is not a reliable indicator of respiratory function. Factors associated with progression to diminished respiratory function include a vital capacity of less than 20 mL/kg, maximum inspiratory pressure of less than 30 cm H₂O, or maximum expiratory pressure less than 40 cm H₂O. Roughly one third of those with GBS will warrant intubation. In a study by Lawn et al [5], 15 of 32 patients with GBS requiring intubation had a rapid decline in their vital capacity in less than 24 hours from their admission. They also showed that nearly half of the intubations occurred between 6 PM and 8 AM.

Dysautonomia is an important feature in up to 65% of those with GBS. This can be manifested by hypotension or hypertension, arrhythmias, ileus, urinary retention, altered sweating, or acral cyanosis [2]. Given the potential for respiratory failure and dysautonomia, patients with GBS are typically admitted to the pediatric intensive care unit (PICU) for closer monitoring.

Treatment
Supportive care for GBS is critical and includes respiratory care with intubation if needed, the prevention of aspiration and atelectasis, deep vein thrombosis prophylaxis, cardior-espiratory monitoring, and frequent turning if not mobile to prevent pressure neuropathies or decubitus ulcers. Treatment to quicken recovery includes either intravenous immunoglobulin (IVIG), which aims to decrease the proinflammatory cytokines, or plasma exchange (PE), with the goal of removing auto-antibodies.

Recommendations from the American Academy of Neurology include PE for nonambulatory patients within 4 weeks of symptom onset and considering it for ambulatory patients within 2 weeks of symptoms and IVIG for nonambulatory adults within 2 to 4 weeks of symptom onset, and either as an option for children. Steroids, combining IVIG and PE, and repeated courses were not found to be helpful [6]. Typically, IVIG is given as 2 g/kg total divided over 2 vs 5 days. Early relapses were more common if given over 2 days. Adverse effects include allergic reactions, transient liver and renal dysfunction, increased serum viscosity leading to stroke and congestive heart failure, and aseptic meningitis [7]. Plasma exchange is typically given as 1 plasma volume exchange every other day for 5 to 7 courses. Complications of PE consist of sepsis, acquisition of infections from the blood product, hypotension, thrombosis, and cardiac arrhythmias. Some prefer to use PE first because it is rational to follow it with IVIG. The reverse is not true.

Prognosis
Overall, children with GBS fare better than adults. Predictors of a worse outcome include a preceding GI illness, rapid progression of severe weakness, and respiratory failure at the onset of disease. Mortality is roughly 5% in adults, and causes include respiratory failure, pulmonary embolus, cardiac arrhythmias, and sepsis [8]. A study of the long-term outcome in children revealed that 23% had residual weakness in at least 1 muscle group. This outcome was often correlated with age less than 9 years and a rapid (<10 days) progression to the nadir in muscle strength [9]. Approximately 3% to 6% of those affected by GBS will ultimately be diagnosed with chronic AIDP, which requires symptoms lasting greater than 2 months [2].

Tick Paralysis
Background
For any child presenting with progressive weakness, it is imperative to perform a thorough history and examination looking for ticks. Although uncommon, the presentation of tick paralysis can mimic GBS, but the treatment is quite different. If one does not consider this diagnosis, it is easily missed. Ticks are found worldwide. During the attachment and feeding by the female tick, a neurotoxin is released. Mechanisms suggested for its pathogenesis include decreasing acetylcholine at presynaptic nerve terminals or failure of the distal nerve fibers to conduct action potentials [10].

History
North American ticks are more commonly found in the Rocky Mountains, Northwestern United States, and Western Canada. The common history is that of a child younger than 10 years who was in an endemic area during April through June who may or may not give the history of a known tick bite, now brought to medical attention for weakness. Most symptoms begin several days after the tick has fed. There is typically a prodrome initially, leading to weakness.

Physical Examination
The weakness, like in GBS, is symmetric and ascending. Also observed may be ataxia and cranial nerve weakness, such as bulbar symptoms or facial nerve involvement. Ophthalmoplegia can be internal, with minimally reactive pupils, or external, with limited extraocular movement.

Diagnosis
The way to diagnose tick paralysis is simply to visualize the tick. Most are found in the scalp, usually behind the ear. Ticks can be difficult to find in those with dark hair but
should always be sought after. It is also important to look in body crevices and be aware of the fact that there could be multiple ticks attached. In cases where NCs have been done, there will be low-amplitude action potentials with normal velocities and normal sensation [11].

**Variants**

There are 6 common types of ticks in the United States. All of the North American varieties show rapid improvement after removal of the tick. The Australian tick species have a much slower recovery in comparison.

**Morbidity**

Because of the potential for diaphragm and bulbar involvement, most morbidity is secondary to respiratory failure and the need for intubation. If there is any concern for respiratory compromise, the child should be admitted to the intensive care unit. It is possible for patients to require respiratory support even after tick removal. Other complications reported include myocarditis and myositis [11].

**Treatment**

As mentioned, locating and removing the tick are the medical evaluation primary treatment. The suggested means to do so includes using forceps or tweezers. The goal is to get a hold of the tick at the point of attachment without leaving the head under the skin. Some propose first killing the tick with an antitoxin, but this is not routinely done.

**Prognosis**

With North American species of ticks, most children start to improve within 1 hour of removal and reach their baseline within 1 day. For the Australian varieties, children might initially worsen for 24 to 48 hours after tick removal before improvement. If the cause of the weakness goes unrecognized, there have been deaths related to respiratory failure. The mortality in these cases is roughly 10% [12].

**Botulism**

**Background**

There are several types of *Clostridium botulinum* that harbor the neurotoxin producing the disease known as botulism. *C botulinum* is found in the soil and is embedded in spores resistant to temperatures up to 120°C. It thrives in anaerobic and alkaline conditions. The toxin itself is heat labile. There are 8 unique toxins known (A, B, C1, C2, D, E, F, and G). Most important in pediatrics includes the infant and food-borne entities. The food-borne form consists of a preformed toxin and is commonly associated with types A, B, or E, with A producing the most severe course. The infantile form is attributed to the ingestion of organisms that colonize the digestive tract and consists mainly of types A and B. In both cases, as the toxin travels throughout the bloodstream, it has an affinity for peripheral and cranial nerve cholinergic nerve endings and it binds irreversibly. There is then a presynaptic block of acetylcholine release via the cleavage of essential proteins, leading to autonomic dysfunction and skeletal muscle paralysis. [13] On average, in the United States, there are 24 cases of food-borne botulism and 71 cases of infantile botulism annually [14].

**Infantile History**

Most infants affected by botulism are younger than 6 months, although it has been reported in patients from a few days of age through 12 months. There may or may not be a history of ingestion of honey, in which spores are present in up to 25% of products [13]. This route is suspected in about 15% of cases [14]. Simply living in a dusty environment, such as during home renovation, puts the infant at risk. The spores are ingested and later germinate in the baby’s intestinal tract. Children younger than 1 year lack the protective bacterial flora and bile acids that counteract clostridium. Most children are brought to medical evaluation because of general weakness, constipation, or poor suck and decreased feeding. A weak cry may also be noted by caregivers.

**Infantile Physical Examination**

When an infant is brought to the ED for poor feeding and weakness, there are many etiologies in the differential diagnosis, most commonly sepsis, ingestions, and meningitis. One key distinguishing feature of botulism is that these children should maintain their normal level of alertness unless they are significantly dehydrated or hypoglycemic due to poor feeding. In addition to generalized hypotonia and head lag, the cranial nerves are often affected. This will manifest as facial weakness, ptosis, diminished extraocular muscle movement and pupillary reactions, and a poor suck and cry [15]. Reflexes could be diminished, and decreased sphincter tone is often noted. It is important to elicit these, especially in the very young infant in whom the course is so gradual that one must rule out spinal muscular atrophy. Spinal muscular atrophy should spare the extraocular muscles and sphincters.

**Diagnosis**

It is vital that laboratory studies are sent as soon as possible if this disease is suspected. Stool samples should be sent for *C botulinum* spores (although these have been isolated from some healthy infants) and serum sent for botulinum toxin. If the food-borne variety is suspected, the food could be examined as well. If there is a delay greater than 2 days after infection in sending the serum, or greater than 3 days in sending the stool, the sensitivity for a positive test drops to 30% to 36% [13]. Neuromuscular transmission studies are occasionally done to differentiate weakness from the neuromuscular junction (as found in botulism) from peripheral nerve
disease (as in GBS). With rapid rates of nerve stimulation, the evoked responses increase in amplitude, indicating a presynaptic defect. Sensation should be normal. Small amplitudes of evoked action potentials are often seen on electromyogram (EMG) [14]. Another disease that affects the neuromuscular junction is Lambert-Eaton, which is typically suspected in adults with a risk of such a paraneoplastic process.

**Variants**

For the food-borne illness, the associated culprits are home canned foods with fish, vegetables, potatoes, garlic, onions, and salsa. Most patients present within 2 to 36 hours of ingestion with oculobulbar muscle weakness and complaining of blurry vision, diplopia, and trouble speaking. The patient might report constipation that followed a diarrheal illness, dry mouth, and urinary retention. On examination, one should check for orthostatic hypotension. Patients will have ptosis, ophthalmoplegia, dysarthria, and tongue weakness. Pupils show dilatation in less than half of affected children. There is typically a descending pattern of weakness, beginning in the upper extremities [13]. Reflexes should be present, distinguishing this disease from GBS and its MF variant. If MF is greatly suspected, CSF should be sent to check for an increased protein. In addition to sending antibodies to help distinguish botulism from the types of GBS and pharyngeal-cervical-brachial disease, it is important to rule out diphtheria. Although most children in the United States are fully immunized, diphtheria still exists in other areas of the world. Affected patients would have a sore throat and a grayish tonsillar exudate. Again, tick paralysis, should be in the differential, and the scalp, in particular, should be examined.

**Morbidity**

Morbidity is primarily due to respiratory failure, aspiration, and autonomic instability. The same preventive and monitoring measures as previously discussed for GBS should be undertaken.

**Treatment**

The treatment of the infantile and the food-borne forms of botulism are quite different. In both cases, if the disease is highly suspected, one should not wait for laboratory confirmation before initiating treatment. Similarly, in all cases, supportive care is of the utmost importance. Patients with any signs of respiratory compromise should be electively intubated. Monitoring for autonomic and respiratory dysfunction should take place in an intensive care unit.

In those with the food-borne illness, gastric lavage could be attempted if the implicated ingestion was recent. Botulism antitoxin has antibodies to types A, B, and E. These particles neutralize the toxin that is not yet bound to nerve endings. If it is given early, it can be quite effective in halting the disease progression and has been shown to shorten the duration of ventilatory support. Because it is an equine toxin, there have been hypersensitivity reactions in up to 9% of recipients. The half-life of this product is 5 to 8 days. When this product is needed, the Centers for Disease Control and Prevention should be contacted directly at 800-CDC-INFO (800-232-4636).

For infants with suspected botulism, the treatment is human botulism immunoglobulin (Baby BIG or BIG-IV). This product, which was licensed in 2003, is obtained from the plasma of donors immunized with a botulinum toxoid against A, B, C, D, and E types. Although the half-life of Baby BIG is 28 days, it has the ability to neutralize the toxin for 6 months or longer. This is key because many antibiotics used to treat common infant maladies such as otitis can continue to lyse spores and release toxin in the gut. There are many reasons why the equine antitoxin is not used in infants. The high risk of serum sickness and anaphylaxis, short half-life, and potential for lifelong sensitivities to equine products make this treatment unacceptable for infants [16]. Early treatment with Baby BIG decreased the hospital stay in one 2004 study by more than 3 weeks and decreased ICU stay and ventilation by nearly 3 weeks. Other benefits were a shortened time of total parenteral nutrition or nasogastric feeds by more than 6 weeks and a savings in hospital charges by more than $88,000 per patient.[16] Potential complications are anaphylaxis and hypotension. BIG-IV can be obtained from the California Department of Health Services, Infant Botulism Treatment and Prevention Program, at 510-231-7300 [6].

**Prognosis**

In both types of botulism, the outcome is largely related to the degree of respiratory compromise. In a study of infants in New York City hospitalized for botulism, the fatality rate was less than 1% [17]. In adults with the food-borne disease, the fatality rate was up to 9%, and this was likely because of prolonged ventilation and its complications. Typically, recovery is complete, although it can take weeks to months to regenerate new end plates. Dysautonomic symptoms may last longer [13].

**Myasthenia Gravis**

**Background**

A disease that often brings those to the ED with exacerbations is MG. Less commonly, those who are not yet diagnosed will present acutely with weakness or bulbar symptoms. In those younger than 18 years, the incidence is 1 per 1 000 000 in North America. There is an increased prevalence in females, with a female-to-male ratio of 3:1 [18]. The pathophysiology of MG is related to the presence of autoantibodies against the acetylcholine

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receptor on the postsynaptic area of the neuromuscular junction. This results in loss of function of the receptor because of destruction and inflammatory changes in the postsynaptic membranes. Roughly 60% of those diagnosed with MG have thymic hyperplasia [19]. Thymomas are more common in adults and are exceedingly rare in children.

History
Up to 65% of patients with MG will report initial symptoms of ptosis and diplopia. Less than 25% will have bulbar symptoms at presentation, such as dysphagia or difficulty swallowing secretions. Children may present with aspiration pneumonia at the initial hospital visit. Limb weakness is reported in 14% to 27% at disease onset [20]. Symptoms of all areas affected are noted to be worse later in the day and when fatigued. Strength is typically improved after rest. In contrast to GBS, there is no pain. There may be a preceding viral illness. The patient might report recurring symptoms given that only one half to two thirds of those with MG are diagnosed within the first year of disease onset [20]. Those with known disease will present with similar symptoms, which may be noted after a medication taper or during hot weather. With the known myasthenic, it is important to distinguish between a myasthenic crisis and a cholinergic crisis because both may present with weakness and increased secretions. Cramps and diarrhea are also a key historical component of a cholinergic crisis.

Physical Examination
All patients eventually will have ocular findings on examination. Ptosis usually develops within 2 minutes of sustained upgaze. A unique finding in MG is that there is usually an asymmetry to the ptosis. There may be notable hyperretraction of the other lid. One sign that supports the diagnosis of MG is that upon elevation of the weak eyelid, the other one will droop [18]. To assess for facial weakness, one can have patients puff out their cheeks. Bulbar symptoms, such as difficulty swallowing secretions and hypophonia, may also be observed. If these symptoms or those of respiratory compromise are present, it is a good idea to have the patient take a breath and count or recite the ABCs to get a baseline. In young children, a proposed mechanism to monitor bulbar function is to give them a 4-oz cup of liquid with a straw and encourage them to drink the fluid in one attempt and see how long they can make the “slurp” noise when the liquid is gone. The same muscles are used in this exercise as those required for airway protection [21].

In the known myasthenic, when trying to differentiate myasthenic vs cholinergic crises, it is imperative to check vital signs and pupils. Bradycardia can be found in cholinergic toxicity, as can miosis. Mydriasis is more suggestive of a myasthenic exacerbation. If miosis is noted, it is typically bilateral in cases of excessive medication. It is always important to consider a Horner syndrome in a new case of asymmetric ptosis and miosis. In extreme cases of cholinergic crisis, fasciculations may also be observed. When examining for weakness, the neck flexors can be most strikingly affected. As another means to distinguish MG from GBS, the deep tendon reflexes should be normal.

Diagnosis
In those patients with a known diagnosis, it is most important to differentiate between a myasthenic crisis and cholinergic toxicity as has been previously discussed. In those without an established diagnosis in whom the disease is suspected, there are both bedside tests, which should be carried out with careful monitoring, and laboratory testing. A noninvasive way to check for MG is to do the ice-pack test. One can take crushed ice and fill a latex glove and place it over the ptotic eyes. This should be left in place for 2 to 5 minutes. A decreased temperature, like cholinesterase inhibition, produces an increased end-plate potential, which is often adequate to achieve the necessary threshold. Ptosis is often improved. Most children, however, do not tolerate an ice pack placed upon their eyes for several minutes. Sleep or simply eyelid closure and rest will also improve symptoms. This can be objectively measured by at least a 2-mm increase in the width of the palpebral fissure. It is prudent to remember that in true ptosis, the iris should not be visible because of the Bell phenomenon. The iris may be observed in factitious disorders or if there is severe ophthalmoplegia.

Another bedside test that can be carried out in the ED or PICU where there is cardiorespiratory monitoring and resuscitation equipment available is the edrophonium (tensilon) test. Because of the risk of bradycardia, there should be atropine available at the bedside, the dose for this being 0.01 to 0.04 mg/kg IV or IM. This test should be done with great caution in patients with asthma. One should select a specific weak muscle to watch for a response. It may be helpful to videotape the pretest and posttest findings in the patient. The IV formulation of tensilon is 10 mg/mL, and a dose of 0.1 to 0.2 mg/kg with a maximum dose of 5 mg for those under 34 kg and 10 mg for those more than 34 kg should be drawn up. In neonates, the IV dose is 0.1 mg total. Over the first minute, a test dose of 0.01 mg/kg is given. If the patient is stable, the remainder is given until a response is noted over 9 minutes. The test should end if there is a response or if muscarinic signs such as bradycardia, salivation, sweating, or miosis are noted. [10] A positive response is typically seen within 30 seconds and lasts less than 5 minutes. Edrophonium should be administered blindly by the person evaluating the child to minimize subjective analysis.

Antibodies (AchR) are noted in 50% of those with ocular disease only and in 80% to 90% of children with generalized MG [10]. There are also reported cases of
children with anti–muscle-specific kinase antibodies. Antibodies are more likely to be found in those who have already reached puberty. Computed tomography or an MRI of the chest should be obtained to look for a thymoma. Thyroid function tests and antibodies should also be sent given the increased frequency of coexisting disease [22]. Electrodiagnostic testing is very helpful and usually reveals a decremental response of the action potentials of weak muscles. Preceding isometric exercises may increase the likelihood of a positive result [10].

Variants
This discussion is focused on autoimmune MG. There are neonatal and congenital forms as well. In pregnant women with myasthenia, up to one third of their babies will be born with transient weakness because of the passive transmission of antibodies through the placenta. There may be arthrogryposis due to decreased fetal movements. Supportive care is typically all that is needed, and symptoms resolve over weeks. Being a symptomatic neonate does not increase the chances of having autoimmune MG later in life. Children with congenital MG have negative antibodies. The presentation and treatment for these children are different and will not be further discussed in this review [10].

Morbidity
The main cause of morbidity is respiratory failure. Again, prudent care of secretions, suctioning, and elective intubation should be a priority in these patients. Adverse effects of the anticholinergic medications, as well as the initiation of steroids, may also worsen weakness. Acute management with IVIG or PE also carries risks. Anyone with limited mobility should be given deep vein thrombosis prophylaxis and have position changes to prevent decubitus ulcers. A key concern for patients with MG is certain drugs that can lead to an exacerbation of their illness. These patients are sensitive to nondepolarizing neuromuscular blockers and have shown a hypersensitivity to vecuronium [23]. They are also known to have a resistance to succinylcholine, which is depolarizing. Long-acting muscle relaxants, as well as aminoglycosides, polymyxins, β-blockers, procainamide, and phenytoin, should be avoided. Inhaled agents and short-acting agents are typically used for elective intubation [24].

Treatment
Maintenance therapy includes pyridostigmine (Mestinon; Valeant Pharmaceuticals International, Costa Mesa, CA) in a dose of 4 to 7 mg/kg/d divided into 4 to 6 doses while awake. Sustained release form and liquid form are also available. Patients may report a difference in symptoms between the tablet and the liquid forms. The total daily dose of Mestinon should rarely exceed 450 mg [22]. Mestinon’s mechanism of action is inhibition of acetylcholinesterase, thereby making more acetylcholine available. Steroids are often added as treatment. These should be either started at a low dose and very gradually titrated up or initiated while in the hospital because of an anticipated worsening of muscle strength over the first days to weeks of treatment. The target dose is 1 mg/kg/d, with a maximum of 60 mg of prednisone. Also, G1 prophylaxis should be given. Other immunomodulating drugs such as cytoxan, cyclosporine, cellcept, azathioprine, and rituximab are often eventually added to the regimen. Thymectomy is an important surgical intervention, usually done within the first few years of diagnosis. A maximal response is often noted between 2 and 5 years postoperation. It has been suggested that the initial sensitization of the antibody to the AchR occurs in the thymus gland itself.

The acute management is usually carried out in a PICU setting. If cholinergic toxicity is suspected, the medication should be held as the patient is closely observed. Supportive care includes cardiorespiratory monitoring with close pulmonary observation. There should be regular suctioning after pre-oxygenating the patient. If the patient is able, incentive spirometry should be pursued to prevent atelectasis. Signs of impending respiratory failure include drooling, grunting, tachypnea, change in voice quality, and air hunger [10]. Intubation might be stayed off by bilevel positive airway pressure, but there should no hesitation to intubate the patient if indicated. Other key elements of care include treatment of concurrent infections; avoidance of sleep deprivation; physical, occupational, and speech therapies; and nutritional support. If the patient cannot take oral medications, Mestinon is converted to the IV form at an equivalent of 1/30th of the oral dose.

Typically, IVIG and PE are used during acute crises. The dose of IVIG is 2 g/kg given over 1 to 5 days, depending on the severity of weakness. It is important to check for immunoglobulin A deficiency first. Plasma exchange is typically given as 1 volume exchange every other day for 5 treatments. Most patients improve within 48 hours of their first or second exchange. The effects of both treatments may last up to 2 months [19].

Prognosis
Mortality for myasthenic crises is 5% and is mainly related to respiratory failure [19]. There has been some evidence that patients who receive PE vs IVIG have a better ventilatory status and outcome at 1 month, but complication rates were increased [25]. Others report a similar but slower response with IVIG [19], which acts by modulating the pathways of antibody production.

Summary
Many infants and children will be brought to the ED for weakness. With so many etiologies to consider, the differential may initially seem endless. Obtaining a good
history, along with localizing the deficits on the physical examination, will help to narrow the possible disorders. It is always important to remember which entities are typical at which ages. Once the most likely causes of weakness are suspected, given the history and physical examination, one can begin a systematic approach to the rest of the evaluation and management of the weak child.

References