MOTOR DISORDERS

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Introduction

Motor disorders begin early in the developmental years and involve problems with movement. Children with motor disorders may be substantially delayed in reaching motor milestones (such as navigating stairs or tying shoes); they may make repetitive and driven movements (such as rocking); or they may have physical or verbal tics. As with other disorders, these behaviors cause impairment and result in negative physical and/or social consequences.

Recent Changes from the DSM-IV to the DSM-5

The American Psychiatric Association released the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM-5*) in 2013 to replace the fourth text revision *DSM-IV-TR*. The *DSM-5* created a new subcategory called "Motor Disorders" under a new grouping called "Neurodevelopmental Disorders." In the *DSM IV-TR*, developmental coordination disorder, stereotypic movement disorder, and tic disorders were included under the cluster "Disorders Usually First Diagnosed in Infancy, Childhood, and Adolescence." Furthermore, *DSM-IV-TR* only specified that developmental coordination disorder was a motor skills disorder. In the *DSM-5*, these disorders are now reclassified under the motor disorders subcategory. Tic disorders include Tourette disorder (also called Tourette syndrome), persistent (chronic) motor or vocal tic disorder, provisional tic disorder, other specified tic disorder, and unspecified tic disorder (APA, 2013).

A significant change was made to the tic disorders category. In the *DSM IV-TR*, a tic disorder diagnosis required that the youth did not have a period of more than three months in which he or she was tic-free. The *DSM-5* does not have this requirement in the criteria. This is because tics may "wax and wane" in their occurrence and frequency (APA, 2013).

In the future, more evidence supporting treatments of disorders with *DSM-5* classifications will be available as clinical studies utilizing *DSM-5* criteria are conducted. As a result, this *Collection* will reference studies that utilize *DSM-IV* diagnostic criteria to explain symptoms and treatments.

Categories

Unless otherwise cited, information in the section "Categories" is taken from the DSM-5 (APA, 2013). Categories of motor disorders as defined in the DSM-5 are outlined in Table 1.

Table 1
Motor Disorders Affecting Children & Adolescents

Disorder		Description
Developmental coordination disorder		Coordinated motor skills, both developing and executing, is substantially below expectations based on age and education. Symptoms include clumsiness and slow and inaccurate motor skills. Onset is early in development.
Stereotypic movement disorder		Includes repetitive, driven, and purposeless motor behavior like shaking, rocking and hitting oneself. Onset is early in development.
Tic disorders	Tourette disorder	Both vocal and motor tics for a period of more than one year, but not necessarily concurrently. The tics may wax and wane in frequency. Onset is prior to age 18.
	Persistent (chronic) vocal or motor tic disorder	Single or multiple motor tics or verbal tics occurring multiple times daily or almost daily for more than one year. Onset before age 18. Both motor and verbal tics cannot be present for this diagnosis
	Provisional tic disorder	Single or multiple vocal and/or motor tics present for less than one year. Onset before age 18.
	Other specified tic disorder	Applies to symptoms characteristic, but not meeting the diagnostic criteria, of a tic disorder or any disorder in the neurodevelopmental disorder categories. The clinician will specify why the tic disorder presented.
	Unspecified tic disorder	Applies to symptoms characteristic, but not meeting the diagnostic criteria, of a tic disorder or any disorder in the neurodevelopmental disorder categories. The clinician will not specify the reason for the tic disorder.

Source: APA, 2013.

Developmental Coordination Disorder

Developmental coordination disorder presents early in development. A child with developmental coordination disorder develops and executes coordinated motor skills substantially below expectations based on the child's age and education. A child may be clumsy or his or her motor skills may be slow, inaccurate, or both.

Young children with developmental coordination disorder may be delayed in reaching motor milestones such as climbing stairs and buttoning shirts. They may reach these milestones, but do so with awkward, slow, or imprecise movements when compared with their peers. Alternatively, older children may show slow speed or inaccurate movements with skills like handwriting, puzzles, model building, ball games, or self-care. Only when these slow, awkward movements interfere with performing or participating in daily activities can a developmental coordination disorder diagnosis be given. Also, the child must be assessed for any visual impairments and neurological disorders before they are diagnosed with developmental coordination disorder. Although onset must be early, most diagnoses normally do not occur prior to age

five, when a child enters school. Problems remain in about 50 to 70 percent of children diagnosed even after coordination improves.

Stereotypic Movement Disorder

Stereotypic movement disorder, like developmental coordination disorder, presents early in a child's development. Symptoms include repetitive and driven motor behaviors like shaking, rocking, and hitting oneself. For a confirmed case of stereotypic movement disorder, these behaviors cannot be attributed to a substance or other neurological disorder. Typically developing children can stop repetitive motions when distracted or given attention, but children with motor disorders cannot stop the motions or will restrict their movements through other means such as sitting on their hands or wrapping their arms in their clothing.

There are two types of classifications for stereotypic movement disorder: "with self-injurious behavior" and "without self-injurious behavior." Children with the classification "with self-injurious behavior" engage in movements that could be harmful to their bodies (e.g. lip biting, head banging, or eye poking). Conversely, children with the classification "without self-injurious behavior" engage in movements that are not physically harmful to themselves (e.g. body rocking, arm flapping, or head nodding).

In terms of body location, stereotypies frequently involve arms, hands, or the entire body, rather than the more common tic locations of the eyes, face, head, and shoulders. Stereotypies are more fixed, rhythmic, and prolonged in duration than tics, which (except for the occasional dystonic tic) are brief, rapid, random, and fluctuating. Also in contrast to tics, stereotypies are not associated with premonitory urges, preceding sensations, or an internal desire to perform. Both occur during periods of anxiety, excitement, or fatigue, but stereotypic movements are also common when the child is engrossed in an activity. Tics and stereotypic movements are both reduced by distraction, but the effect on stereotypic movements is more instantaneous and dramatic (D. Oswald, personal communication, September 18, 2017; Singer, 2009).

More males than females present with stereotypic movement disorder in childhood (Gluck, 2016). In children who develop complex motor stereotypies, approximately 80 percent exhibit symptoms before 24 months of age, 12 percent between 24 and 35 months, and 8 percent at 36 months or older. Simple stereotypic movements are often present in typically developing children under the age of three. Only when these movements persist or become a hindrance to development are they considered a disorder.

Stereotyped or repetitive motor movements are also a distinguishing feature of autism spectrum disorder (ASD). Differential diagnosis of stereotypic movement disorder and ASD involves consideration of the individual's social communication and reciprocity. Deficits of social communication and reciprocity are generally absent in stereotypic movement disorder. When ASD is present, stereotypic movement disorder is diagnosed only when there is self-injury or when the stereotypic behaviors are sufficiently severe to become a focus of treatment.

Tic Disorders

Tics are involuntary movements, sounds, or words that are sudden, rapid, recurrent, and nonrhythmic. *DSM-5* uses the following terminology to describe tics:

- Vocal tics (e.g., repeated throat clearing or spoken words)
- Motor tics (e.g., repeated blinking or arm movements)
- Simple tics (a short, brief noise or movement)
- Complex tics (a vocalization, noise, or movement that appears to take effort, like a spoken word, a complex sound, or raising one's arm up over one's head)

Tics vary from other childhood movement disorders in a few ways. They have varied severity, their movement characteristics change over time, the movements are temporarily suppressible, and they are associated with sensory phenomena (Cohen, Leckman, & Bloch, 2013).

There are five distinct tic disorders in the *DSM-5*: Tourette disorder, persistent (chronic) motor or vocal tic disorder, provisional tic disorder, other specified tic disorder, and unspecified tic disorder. Diagnosis varies, depending upon the particular kind of tic-related motor disorder.

Tourette disorder is the most well-known tic disorder, largely because of its depictions in movies and television shows, but it is relatively uncommon. Symptoms for Tourette disorder must be present before age 18, and both vocal and motor tics must be present. The tics may vary over time, but must persist for over one year since the onset of the original symptoms. Age of onset can be anywhere between the ages of two and 21, with the most severe tics occurring between the ages of 10 and 12.

Persistent (chronic) motor or vocal tic disorder involves one or more motor or vocal tics, but cannot include both. If both motor and vocal tics occur, the child should be screened for Tourette disorder. The tics may vary in frequency, but must persist for more than one year after onset. Tics must begin before age 18 and cannot be attributable to another disorder or substance.

Provisional tic disorder is diagnosed when tics are present for less than one year. There can be one or more tics, which can include motor and/or vocal tics. Tics cannot be attributable to another disorder or substance. Additionally, the child cannot have been diagnosed with Tourette disorder or persistent (chronic) motor or vocal tic disorder in the past.

Other specified tic disorder applies to cases in which there are symptoms characteristic of a tic disorder that cause significant distress or impairment but do not meet the full criteria for a tic disorder or for any of the disorders in the neurodevelopmental disorders diagnostic class. This diagnosis is used in situations in which the clinician chooses to specify the reason that the criteria are not met for a tic disorder or for a specific neurodevelopmental disorder. Diagnosis is followed by the specific reason (e.g., "with onset after age 18 years"). Because this subcategory is not common, the *Collection* will focus on more prevalent motor disorders.

Unspecified tic disorder also applies to cases in which there are symptoms characteristic of a tic disorder that cause significant distress or impairment but do not meet the full criteria for a tic disorder or for any of the disorders in the neurodevelopmental disorders diagnostic class. However, this diagnosis is used in situations in which the clinician chooses not to specify the reason that the criteria are not met for a tic disorder or for a specific neurodevelopmental disorder. It includes presentations in which there is insufficient information to make a more specific diagnosis. Because this subcategory is not common, the *Collection* will focus on more prevalent motor disorders.

Prevalence

Table 2 discusses the prevalence of motor disorders.

Table 2
Prevalence of Motor Disorders

Disorder	Prevalence
Developmental coordination disorder	• In children ages 5 to 11: 5% – 6% • In children age 7: 1.8% are diagnosed with severe developmental coordination disorder, and 3% with probable developmental coordination disorder • Males are affected more than females, with a ratio of between 2:1 and 7:1
Stereotypic movement disorder	• Simple movements (e.g., rocking) are common in young, developing children • Complex stereotypic movements are much less common and exhibited in 3% – 4% of children • Among individuals with intellectual disability, 4% – 16% engage in stereotypy and self-injury • Among individuals with intellectual disability living in residential facilities, 10% – 15% may have stereotypic movement disorder with self-injury
Tourette disorder	• 0.3% – 0.8% of school-age children • Estimated that there are 3 per 1,000 of clinically identified cases in the U.S. • Males are affected more than females, with a ratio of between 2:1 and 4:1
There is insufficient data available about the prevalence of persistent (chronic) motor or vocal tic disorder, provisional tic disorder, other specified tic disorder, or unspecified tic disorder.	

Source: APA, 2013.

Causes and Risk Factors

Underlying causes for the development of motor disorders are not well understood (United States National Library of Medicine, 2015). However, as with many psychological disorders, the evidence suggests that numerous factors, such as genetic vulnerability, learning, and environment, may contribute to the development of these disorders. Studies of families suggest the presence of genetic underpinnings in the development of tic disorders. For example, relatives of individuals with Tourette disorder are 10 to 15 percent more likely to develop the disorder, and 15 to 20 percent more likely to have another tic disorder. These risk levels are significantly higher than in the general population. Studies of the human genome have identified specific genes thought to be related to Tourette disorder (Woods, Flessner, & Conelea, 2008). Studies have also shown that 25 percent of youth with stereotypic motor disorder have an affected relative (Mills & Hedderly, 2014). There is also likely to be a family history of obsessive tendencies often in the form of counting rituals.

There is also reason to believe that learning factors are significant in the development and maintenance of motor disorders. In stressful situations, for example, youth can develop the urge to trigger their tics or to self-injure. After the tic or self-injury becomes habitual, all similar situations may elicit the same response. These situations may, in turn, elicit an urge to perform the habit. Youth with motor disorders report an uncomfortable urge that is satisfied by the tic or self-injury. The satisfaction or reduction of the urge may reinforce the habit and thus increase the likelihood that the youth will repeat the behavior.

Environmental factors have also been implicated in the development of motor disorders. Developmental coordination disorder may be caused by prenatal exposure to alcohol, and it is often associated with preterm and children with a low birth weight (APA, 2013). Stereotypic movement disorder is frequently seen in socially isolated children who tend to self-stimulate, which may progress to stereotypic movements and even repetitive self-injury (APA). There have also been cases in which individuals who

suffered from a traumatic head injury (e.g. concussion) had symptoms that mimic those seen in of stereotypic motor disorder (United States National Library of Medicine, 2015).

Assessment

Assessments of motor disorders vary slightly by the type of motor disorder. Typically, physicians obtain information about a motor disorder from a developmental and medical history, physical examination, school report, and individual assessment (APA, 2013). Assessment of tic disorders should include a medical examination to rule out conditions that can mimic tic disorders, such as behaviors related to allergies, eye problems that mimic tics, and stereotypic movement disorders (Woods, Piacentini, & Himle, 2007). Other medical conditions that may cause tics, such as Huntington's disease or post-viral encephalitis, must also be considered prior to diagnosing a motor disorder (APA).

Screening, followed by more in-depth assessment, is critical to accurate diagnosis due to the comorbidity that occurs frequently in youth with motor disorders. The Schedule for Affective Disorders and Schizophrenia-Children's Version (K-SADS) and the Anxiety Disorders Interview for *DSM-IV* Child Version (ADIS-C) are semi-structured diagnostic interviews that have demonstrated strong psychometric characteristics (Chorpita & Southam-Gerow, 2006). Suggested assessment tools for motor disorders are listed in Table 3.

Developmental Coordination Disorder

For developmental coordination disorder, it is important to recognize that symptoms may be confused with those of other conditions. There are four criteria that must be met for a diagnosis of developmental coordination disorder:

- The child shows delays in reaching motor milestones;
- The condition significantly interferes with activities of daily living and/or academic performance;
- The symptoms begin early in the child's life; and
- Difficulties with motor skills are not better explained by intellectual disability, visual impairment, or brain disorders (Harris, Mickelson, & Zwicker, 2015).

Stereotypic Movement Disorder

It can be difficult to distinguish stereotypic movement disorder from symptoms of other disorders such as autistic spectrum disorder, intellectual disabilities, genetic syndromes, and sensory impairment. A tailored assessment is critical in order to define a precise developmental profile and to avoid misdiagnosis (Cardona et al., 2016). While there are no assessments that are specific for the diagnosis of this particular disorder, the Motor Severity Stereotypy Scale (MSSS) and the Repetitive Behavior Scale-Revised (RBS-R) can be used to assess the stereotypies (Cardona et al.). The MSSS is a five-item caregiver questionnaire in which the parent rates the child's motor stereotypies with regard to the motor severity by rating the number, frequency, intensity, and interference of stereotypies and the global impairment during the past few days (Harris et al., 2016). The RBS-R is a caregiver questionnaire that captures the breadth of repetitive behaviors in children with autism spectrum disorders. It consists of 43 items, rated on a four-point Likert scale ranging from "behavior does not occur" to "behavior occurs and is a severe problem," where higher scores indicate frequent dysfunctional behaviors (Di Renzo et al., 2017).

Tic Disorders

In conjunction with a thorough medical examination, a structured or semi-structured interview can be particularly helpful in gathering information about the expression of tics, including frequency, location and nature of the tic, complexity, controllability, intensity, level of distress, and temporal stability (Woods, Piacentini, & Himle, 2007). One such clinical interview is the Yale Global Tic Severity Scale

(YGTSS), which can be administered in 15 to 30 minutes. This assessment helps to gather information about tic topography, symptom severity, and impairment (Woods et al.). Another assessment is the Premonitory Urge for Tics Scale (PUTS), a brief self-report measure for use with children age ten and older to measure awareness of tic-related premonitory urges (Woods, Flessner, & Conelea, 2008). Two assessment tools for Tourette disorder are Tourette Syndrome Severity Scale (TSSS), which weighs Tourette disorder social impairment, and Tourette Syndrome Global Scale (TSGS), which measures tics and comorbid problems (Murphy et al., 2013).

Table 3
Suggested Assessment Tools

Name of Measure	Measure Type	Who Completes	Data Generated
Schedule for Affective Disorders and Schizophrenia – Children's Version (K-SADS)	Clinical interview	Clinician w/ youth/parent	Diagnosis
Anxiety Disorders Interview Schedule for *DSM-IV* – Child Version (ADIS-C)	Clinical interview	Clinician w/ youth/parent	Diagnosis
Yale Global Tic Severity Scale (YGTSS)	Clinician rating scale	Clinician	Symptom rating
Motor tic, Obsessions and compulsions, Vocal tic Evaluation Survey (MOVES)	Self-report rating scale	Parent or youth	Symptom rating
Repetitive Behavior Scale – Revised (RBS-R)	Caregiver rating scale	Parent or caregiver	Symptom rating
Motor Severity Stereotypy Scale (MSSS)	Caregiver rating scale	Parent or caregiver	Symptom rating
Tic Self-Report Scale	Self-report rating scale	Parent or youth	Symptom rating
Tourette Disorder Scale	Self-report rating scale	Parent or youth	Symptom rating
Parent Tic Questionnaire (PTQ)	Self-report rating scale	Parent or youth	Symptom rating
Child Tourette Disorder Impairment Scale – Parent Version	Self-report rating scale	Parent or youth	Symptom rating
Tourette Syndrome Severity Scale (TSSS)	Clinician rating scale	Clinician	Social impairment
Tourette Syndrome Global Scale (TSGS)	Clinician rating scale	Clinician	Symptoms and comorbidity

Sources: Chorpita & Southam-Gerow, 2006; Woods et al., 2006; Woods, Piacentini, & Himle, 2007; Woods, Flessner, & Conelea, 2008; Murphy et al., 2013; Harris et al., 2016; & Di Renzo et al., 2017.

Comorbidity

Youth with motor disorders frequently experience other kinds of problems (Scahill, Sukhodolsky, & King, 2007; Woods et al., 2006; Woods, Piacentini & Himle, 2007).

ADHD is the most frequent coexisting condition in youth with developmental coordination disorder, with about 50 percent co-occurrence. Other disorders that commonly co-occur with developmental coordination disorder are autism spectrum disorder (ASD), disruptive and emotional behavior problems, speech and language disorder, and specific learning disorder, especially with reading and writing (APA, 2013).

Stereotypic movement disorder has been associated with children who have intellectual disabilities, including those with ASD (Oakley et al., 2015). As noted previously, stereotypic motor disorder may be a presenting symptom of ASD, which should be considered in the assessment and evaluation of repetitive movements and behaviors (APA, 2013). Several other disorders may co-occur with stereotypic disorder. A recent study that extended the period of follow-up through adolescence assessed the course of movement abnormalities with stereotypic movement disorder as well as documented comorbidities. This study found that stereotypic movement disorder was associated with high rates of comorbid ADHD (63 percent), obsessive-compulsive symptoms (35 percent), tics/Tourette syndrome (22 percent), and anxiety (71 percent) (Oakley et al.). Moreover, stereotypic movement disorder may occur as a primary diagnosis or a secondary diagnosis to another disorder. For example, stereotypies are a common manifestation of a variety of neurogenetic disorders, such as Lesch-Nyhan syndrome, Rett syndrome, fragile X syndrome, Cornelia de Lange syndrome, and Smith-Magenis syndrome (APA, 2013).

Youth with tic disorders frequently experience co-occurring obsessive-compulsive disorder and ADHD (APA, 2013). One study of 3,500 participants from a worldwide sample revealed that 88 percent of all individuals with Tourette disorder have at least one other co-occurring disorder. Of that 88 percent, 60 percent reported having comorbid ADHD and 59 percent reported having obsessive-compulsive behaviors. Males were significantly more likely to report comorbid symptoms than females (Robertson, Eapen, & Cavanna, 2009). Individuals with tic disorders can also have other movement disorders, as well as depressive, bipolar, or substance-use disorders (APA).

The vulnerability toward developing co-occurring disorders changes as individuals pass through the age of risk for various co-occurring conditions. Pre-pubertal children with tic disorders are more likely to experience ADHD, obsessive-compulsive disorder, and separation anxiety disorder than are teenagers and adults, who are more likely to experience the new onset of major depressive disorder, substance use disorder, or bipolar disorder (APA, 2013).

Any assessment of a child or adolescent that reveals the presence of tics should prompt assessment for co-occurring mental health disorders. Given the frequent comorbidity of tic disorders with other psychiatric conditions, incorporating measures for comorbid conditions into the assessment of youth is frequently warranted (Murphy et al., 2013).

Treatments

The treatments for tic disorders are those with the most evidence at this time. Comprehensive behavioral intervention for tics and habit reversal therapy (HRT) are the only treatments for tic disorders researched sufficiently to warrant the designation of evidence-based treatment. Pharmacotherapy may also be appropriate for youth with tic disorders when the disorder causes impairment in the youth's quality of life and when there are co-occurring psychiatric conditions that will respond to medication. Table 4 outlines the treatments available for motor disorders.

Habit Reversal Therapy (HRT)

Habit reversal therapy (HRT) is the most well-studied and most effective treatment for youth with motor disorders (Tucker, Conelea, & Woods, 2012; Cook & Blacher, 2007; Himle et al., 2006). Though treatments may vary slightly, HRT includes three main components, as cited by Woods, Flessner, & Conelea, 2008:

1. Awareness training;
2. Competing response training; and
3. Social support.

Table 4
Summary of Treatments for Motor Disorders

What Works	
Habit reversal therapy (HRT) for tic disorder	Treatment increases awareness to the feelings and context associated with the urge to tic and implements a competing and inconspicuous habit in place of the tic.
Comprehensive behavioral intervention for tics (C-BIT)	Combines habit reversal and other approaches like education, awareness via self-monitoring, relaxation techniques, and sometimes situational changes.
What Seems to Work	
Exposure with response prevention (ERP)	Consists of repeated, prolonged exposures to stimuli that elicit discomfort and instructions to refrain from any behavior that serves to reduce discomfort.
Pharmacotherapy	Medications may be considered for moderate to severe tics causing severe impairment in quality of life or when medication responsive psychiatric comorbidities are present that target both tic symptoms and comorbid condition.
Massed negative practice	Treatment involves children's over-rehearsal of target tic in high-risk situations.
What Does Not Work	
Deep brain stimulation	Surgical intervention; not recommended.
Repetitive transcranial magnetic stimulation (rTMS)	Safety in youth has not been established; not recommended.
Plasma exchange; Intravenous immunoglobulin (IVIG) treatment	Blood transfusions alter levels of plasma or immunoglobulin. While several of these treatments have been shown to be promising, they are not empirically supported and not recommended.
Dietary supplements (magnesium and vitamin B6); Special diets	Supplements may have the potential to negatively interact with other pharmacological agents. Not recommended until safety in children is established.

Awareness training involves first teaching youth to become aware of instances of the habit, then teaching awareness of the associated environment and internal sensations, such as muscle tension and urges (van de Griendta et al., 2013). Once the youth is able to identify feelings and situations likely to elicit the habit, competing response training begins. A competing response is a behavior that is incompatible with the habit that is performed in the presence of the feelings or situations that elicit the habit or in the presence of the habit itself. Competing responses must meet the following criteria:

- Must be physically incompatible with the habit (e.g., holding the arm close to the body to compete with an arm movement tic);
- Must be socially inconspicuous; and
- Must be held for one minute or until the urge to engage in the habit dissipates.

Supportive individuals are recruited to provide gentle reminders when the youth is engaging in the habit and praise when the competing response is implemented correctly (Woods, Flessner, & Conelea, 2008). The social support component runs concurrently with other phases of treatment.

Follow-up studies of HRT in youth with tic disorders show success at six months to two years, and secondary symptoms (including anxiety, disruptive behavior, family strain and social functioning) improved (van de Griendta et al., 2013).

Other treatments for stereotypic motor disorder have shown promise. One study assessed the effectiveness of a behavioral treatment that combines modified HRT and a treatment called "differential reinforcement of other behavior" in reducing the occurrence of stereotypic movement disorder in non-autistic children (Miller et al., 2006). The study found that this combination provides a potentially valuable treatment option, but success requires a motivated patient, multiple training sessions, and an experienced therapist (Miller et al.). Further study with a larger number of patients with longer follow-up is needed. Another study was conducted to evaluate the efficacy of an instructional DVD as a home-based, parent-administered behavioral therapy for reducing stereotypies in children with primary complex motor stereotypes (Specht et al., 2017). While the study has limitations, results suggest that parent-administered therapy effectively reduces primary motor stereotypy severity.

Comprehensive Behavioral Intervention for Tics (C-BIT)

Comprehensive behavioral intervention for tics (C-BIT) combines habit reversal and awareness of tics through techniques like self-monitoring, along with education about tics and relaxation techniques (Centers for Disease Control [CDC], 2012; Piacentini et al., 2010). A therapist works with the child and his or her family to understand the types of tics and situations in which the tics occur (CDC). Where HRT combines tic awareness and competing-response training, C-BIT includes relaxation training and functional intervention. C-BIT helps the patient identify situations in which tics occur and develop strategies to overcome the tic (Piacentini et al.).

In one C-BIT trial, 126 youth with Tourette disorder were randomized to an 8-session, 10-week HRT-based intervention. For those youth, over 52 percent responded compared to 18 percent in the control group. Moreover, the reduction in tic symptom severity was 51 percent. The C-BIT intervention included sessions with focus on the functional assessment of tics. These sessions aimed to help parents to identify factors that sustained or exacerbated tics (Murphy et al., 2013).

Exposure with Response Prevention (ERP)

Exposure with response prevention (ERP) is a treatment in which a youth is asked to suppress his or her tics for prolonged periods of time. The theory behind ERP is that the youth is exposed to the premonitory sensations (premonitory urges or "sensory tics") associated with tic expression and begins to adjust to them, thus causing the urge to produce a tic to diminish. Two single-case studies found the treatment to be

effective, although booster sessions were recommended to maintain treatment effects. Two studies were carried out that tested for the rebound effect post-ERP treatment, whereby tic frequency increases after an ERP session. Neither study demonstrated a rebound effect, thus supporting the theory that youth learn through ERP that the premonitory sensation can be tolerated to some extent, and that there is no need to release tension afterwards. ERP is currently considered to be effective; however, long-term effects need to be determined (Frank & Cavanna, 2013).

Pharmacotherapy

According to the American Academy of Child and Adolescent Psychiatry, medications for chronic tic disorders should be considered for moderate to severe tics that cause severe impairment in quality of life, or when comorbid conditions are present and the medication targets both tic symptoms and comorbid conditions (Murphy et al., 2013). A meta-analysis to determine the efficacy of antipsychotics and alpha-2 agonists (a class of drug that selectively stimulates alpha adrenergic receptors) demonstrated that both were effective in treating tics. However, the study's findings suggest that alpha-2 agonists may have minimal benefit in tic patients who do not have co-occurring ADHD (*Clinical Trials Week,* 2014).

Treatment of ADHD in the context of tic disorders can, at times, be challenging because of concerns of worsening tic severity. Recent studies have demonstrated that tics are not universally increased by stimulant medication in children with ADHD (Murphy et al., 2013). For example, several investigators have shown that the potential impact of stimulants on the development of tics is minimal or of short duration and that a definite causal effect is present in very few children. For youth with co-occurring tic disorders and ADHD, results showed that the stimulants studied were associated with significant improvement in ADHD symptoms (Robertson, 2017). However, it should be noted that the FDA package insert for stimulants does list tics as a contraindication (Murphy et al). For youth with disabling obsessive-compulsive symptoms, pharmacologic treatments, along with behavioral treatments, may be helpful. Selective serotonin reuptake inhibitors (SSRIs) and clomipramine has been demonstrated to be beneficial in several studies (Murphy et al.).

Massed Negative Practice

Massed negative practice is based on the premise that over-rehearsal of the tic by youth can lead to its disappearance. One study assessing the effectiveness of massed negative practice with HRT showed that the youth receiving massed negative practice showed a 33 percent tic reduction following the first day, and an average tic reduction of 25 percent at four-week follow-up (Tucker, Conelea, & Woods, 2012). In comparison, HRT was associated with an 84 percent tic reduction following the first day of treatment, and gains appeared to be maintained through an 18-month follow-up. However, this study did not include an inactive control group, suggesting that this treatment may be a minimally effective treatment for tics, albeit much less effective (Tucker, Conelea, & Woods).

Treatments with Inadequate Support

Deep brain stimulation, repetitive transcranial magnetic stimulation (rTMS), and special diets lack empirical support for the treatment of tic disorders and are not recommended (Murphy et al., 2013). Deep brain stimulation is a surgical treatment approach that may hold benefit for adults; however, few cases have been reported of youth receiving it and guidelines have advised that this procedure should not be conducted in individuals less than 25 years of age outside of a research setting. A study examining repetitive transcranial magnetic stimulation (rTMS) in youth with Tourette disorder has been conducted with no reported adverse outcomes. However, very few youth have received rTMS and this treatment option should be considered preliminary until larger blinded studies have resolved issues regarding its safety (Murphy et al.). Research has also shown a lack of evidence to support treatment using either plasma exchange or intravenous immunoglobulin (IVIG).

One study found that approximately 60 percent of patients with Tourette disorder use complementary and alternative medicines, and about 80 percent initiate such therapies without informing their doctor (Lyon et al., 2010). Although many patients with tic disorders do use complementary and alternative medical therapies, support for this practice is not currently at the evidence-based level. Both the NIMH and the Tourette Syndrome Association (TSA) had previously advised that some therapies, such as high-dose vitamin B6 or St. John's wort, have the potential for interactions with medications and are not recommended until studied appropriately in children (NIMH, 2000). A clinical trial was undertaken to study the effectiveness and safety of magnesium and vitamin B6. The results of a clinical trial published in 2009 shows that treatment with vitamin B6 and magnesium could be helpful in controlling Tourette syndrome and side effects associated with it. However, the researchers state that more studies are required before conclusively establishing the benefits of magnesium for Tourette syndrome (Garcia-Lopez et al., 2009).

Cultural Considerations

Research suggests that motor disorders are prevalent across cultures (Woods, Flessner, & Conelea, 2008). The understanding of the disorder varies significantly from culture to culture. For example, in Costa Rica, tic symptoms are not considered a problem and are not usually mentioned to physicians (Mathews, 2001). Many families consider the tics to be a voluntary bad habit and health care professionals, when consulted, may concur (Mathews).

Tourette disorder is less prevalent in African Americans and Hispanic Americans (APA, 2013; CDC, 2012; Robertson et al., 2009). However, Tourette disorder is very rare in sub-Saharan African people, which may explain its rarity in African Americans (Cohen, Leckman, & Bloch, 2013; Robertson et al.).

A Tourette disorder study in the United Kingdom (U.K.) and United Arab Emirates showed similar core symptoms, yet there were more behavioral symptoms in the U.K. sample (Eapen & Robertson, 2008). These results strengthen the case for a biological and genetic basis for Tourette disorder, but they imply that Tourette disorder may have phenotypes or additional treatment paths (Eapen & Robertson).

Tourette disorder is less prevalent in China than in the rest of the world, but the discrepancy may be due to a stricter diagnostic system (Robertson et al., 2009). Some studies suggest that slightly different symptoms present in different nations, but that is unproven. Whether this variation truly exists is debated (Robertson et al.).

Overview for Families

Unless otherwise cited, information in this section is taken from the DSM-5 (APA, 2013).

Motor disorders encompass a variety of disorders, many of which have symptoms of seemingly involuntary, repetitive motion. Developmental coordination disorder, stereotypic movement disorder, and the tic disorders, including Tourette syndrome, are all classified as motor disorders. The main features of these motor disorders are listed below:

Developmental Coordination Disorder

- Onset in early development
- Motor skills are developed and carried out substantially below expectations based on age and education
- Signs include clumsiness and slow/inaccurate motor skills

Stereotypic Movement Disorder

- Onset in early development
- Repetitive, driven, and purposeless motor behavior
- Signs include shaking, rocking, and hitting self

Tic Disorders

Tourette Disorder

- Onset before age 18
- Multiple motor tics and one or more vocal tics, all of which have been present for at least one year since the first tic onset
- Frequency may change over time; tics do not necessarily have to happen concurrently

Persistent (Chronic) Motor or Vocal Tic Disorder

- Onset before age 18
- Single or multiple motor or vocal tics, but not both, that have been present for at least one year since the first tic onset
- Frequency of tics may change over time

Provisional Tic Disorder

- Onset before age 18
- Single or multiple motor and/or vocal tics
- Present multiple times daily or almost daily
- Tics present for more than four weeks and less than one year

Males are more likely than females to develop motor disorders. Onset of tics typically occurs between the ages of four and six, with severity peaking between the ages of 10 and 12. Families should seek a comprehensive evaluation with a qualified service provider when symptoms of a motor disorder become prevalent (American Academy of Child & Adolescent Psychiatry [AACAP], 2012). Families may need to work with clinicians and the child's teachers to change situations in the child's day to help reduce the urge to tic (Piacentini, 2010).

Resources and Organizations

American Academy of Child, & Adolescent Psychiatry (AACAP)

http://www.aacap.org/

American Academy of Family Physicians

Understanding Tics and Tourette's Syndrome

https://www.aafp.org/afp/1999/0415/p2274.html

American Psychiatric Association (APA)

https://www.psychiatry.org/

American Psychological Association (APA)

http://www.apa.org/

Association for Neurologically Impaired Children (AFNIC)

http://www.afniconline.org

Jim Eisenreich Foundation (for children with Tourette Syndrome)

http://www.tourettes.org

National Alliance for the Mentally Ill (NAMI)

https://www.nami.org/

Tourette Syndrome Association, Inc.

https://www.tourette.org/

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