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Practice Standards for Initial ADHD Assessment: A Review

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PRACTICE STANDARDS FOR INITIAL ADHD ASSESSMENT: A REVIEW

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There are many challenges that come with diagnosing attention-deficit/hyperactivity disorder (ADHD), including shared symptoms with many similar disorders, high comorbidity of other mental disorders, and subjective bias from informant reports. Three clinical guidelines for diagnosing ADHD currently exist, published by the American Academy of Pediatrics (AAP), the National Institute for Health and Care Excellence (NICE), and the American Academy of Child and Adolescent Psychiatry (AACAP). However, these guidelines are outdated as they are based on the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (DSM-IV) and do not include more recent research. This project was intended to update these guidelines by incorporating the *Diagnostic and Statistical Manual of Mental Disorders, 5th Edition* (DSM-5) as well as a selection of research on ADHD diagnosis published in the last ten years. This updated set of guidelines can be found in Appendix A of this document. Emphasis is on the evidence-based assessment model of using only psychometrically strong assessment measures and basing diagnostic decisions on posterior probabilities. Review of the literature also indicated a need to assess for differential and comorbid diagnoses in ADHD evaluations. Recommendations for doing so are discussed. Lastly, results of the review provided a strong argument against the use of continuous performance tests (CPTs) and other executive functioning measures in diagnosing ADHD, as their diagnostic accuracy is generally not acceptable.

Introduction

Roughly 10% of children ages 4 through 17 were diagnosed with attention-deficit/hyperactivity disorder (ADHD) in 2011 and through 2013, making ADHD the most common childhood neurodevelopmental disorder in the United States (Pastor, Reuben, Duran, & Hawkins, 2015). Pooled estimates across 172 studies suggest that the prevalence of ADHD in children under 18 is 7.2%, meaning that approximately 129 million children worldwide have ADHD (Thomas, Sanders, Doust, Beller, & Glasziou, 2015). Adding to its detriment, ADHD tends to have lifelong implications (Barbaresi et al., 2013; Ingram, Hechtman, & Morgenstem, 1999; Shaw et al., 2012). However, evidence shows that early intervention can reduce negative outcomes; therefore, it is essential that children with ADHD begin treatment as early as possible (Delavarian, Towhidkhah, Dibajnia, & Gharibzadeh, 2012; Shaw et al., 2012).

Negative Impacts of ADHD on the Child

Living with ADHD poses many challenges. Children with ADHD often face functional impairment in a wide range of areas, including academics, social life, motor control, and emotional regulation (Mash & Barkley, 2003). Children with ADHD score significantly lower than non-ADHD peers on academic achievement tests as early as preschool (Mash & Barkley, 2003). Having ADHD is associated with increased conflict with parents, teachers, and peers. It is also associated with social rejection and having very few friends (Mash & Barkley, 2003). In addition to functional impairments, parents of children with ADHD consistently rate their children as having lower quality of life than the average child (Danckaerts et al., 2010).

ADHD symptoms persist into adolescence and adulthood in the majority of cases, and around one third of children with ADHD still meet full criteria at age 27 (Barbaresi et al., 2013; Ingram et al., 1999). Long-term observation of children with ADHD has revealed that childhood symptoms can lead to more severe problems in adulthood, especially if the disorder is left untreated (Shaw et al., 2012). Children with ADHD are more likely than others to later drop out of school; in fact, 32.2% of children with ADHD combined type will drop out of high school (Kuriyan et al., 2013). Children with ADHD are more likely to be involved in crime, be unemployed, and abuse substances (Kovshoff et al., 2012). They are likely to develop other mental disorders, particularly depressive and conduct disorders (Ingram et al., 1999). Adolescents and adults with ADHD are more immature than others, have lower self-esteem, and oftentimes exhibit antisocial behavior (Ingram et al., 1999). ADHD has also been linked to obesity and higher incidence of car accidents (Shaw et al., 2012).

Prevalence and Etiology

The American Psychiatric Association (APA) reports that ADHD is present in about five percent of children across most cultures (APA, 2013). A 2013 article reported that this number is 9.5% in American children (Pastor et al., 2015). Due to large differences in methodology and sampling, prevalence studies in the past have reported numbers ranging from less than one percent to above twenty percent (Polanczyk, Willcutt, Salum, Kieling, & Rohde, 2014). While these ranging numbers have led some to believe the prevalence of ADHD is increasing over time, multiple meta-analyses of these studies have shown that the average reported prevalence has remained relatively stable over the years (Polanczyk et al., 2014; Thomas et al., 2015).

It is believed that ADHD is a highly heritable disorder; many of the risk factors appear to be genetic (Nigg, 2012). Researchers have identified six specific genes believed to contribute to ADHD, and the disorder is more likely to occur in relatives of others who have it (APA, 2013; Nigg, 2012). These genetic factors help to explain why ADHD is present across all (or most) cultures, despite differing environments. Outside of genetics, many prenatal and birth factors play a role as well—low birth weight, maternal consumption of alcohol or tobacco during pregnancy, premature delivery, early exposure to lead, and brain injury during birth have all been shown to correlate with ADHD (Children and Adults with Attention Deficit/Hyperactivity Disorder, 2017). Despite popular belief, factors such as excessive media exposure, poor parenting, and eating too much sugar are not believed by researchers to cause ADHD (Centers for Disease Control and Prevention, 2017a). It appears that the causes of ADHD must occur in the very early developmental stages, and that children may be predisposed to ADHD from shortly after birth.

Many of the symptoms of ADHD can be explained by deficits in executive functions (Mash & Barkley, 2003). Executive functions are overarching brain functions which control lower cognitive processes. Mash and Barkley (2003) defined four categories of executive functions affected by ADHD: nonverbal working memory, verbal working memory, self-regulation of affect/motivation/arousal, and reconstitution (analysis and synthesis of new behaviors). Children with ADHD tend to have impairments in some or all of these areas, which become evident in the early stages of development. It is Barkley's (2003) belief that impairments in these areas are the result of a general deficit in behavioral inhibition, and that impairments in these four areas then

lead to reduced motor control and fluency. It should be noted that the severity of these deficits is far lesser if the child presents with primarily inattentive symptoms.

Diagnostic Criteria

In order to get the appropriate treatment, children with ADHD must first be properly diagnosed (Bruchmüller, Margraf, & Schneider, 2012). There currently exist many factors affecting proper ADHD diagnosis, which will be discussed in following sections. These factors can cause both over-diagnosis (i.e., false positives) and under-diagnosis (i.e., false negatives). Under-diagnosis is a problem because the child will likely not receive treatment appropriate for ADHD, creating a possible waste of time and money spent on ineffective treatment, while the child's academic, social, and emotional functioning continues to suffer (Delavarian et al., 2012). On the other hand, over-diagnosing ADHD causes similar problems—the child receives wasteful, inappropriate treatment, while likely continuing to have the same symptoms if another disorder is present. In addition, wrongly diagnosing ADHD introduces the problem of prescribing ADHD-aimed stimulant medications for children to whom they may be inappropriate and even harmful (Bruchmüller et al., 2012). Proper diagnosis of ADHD means strictly abiding by diagnostic criteria. The two most accepted sources of ADHD diagnostic criteria are currently the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) (American Psychiatric Association [APA], 2013) and the ICD-10 (World Health Organization [WHO], 2004).

DSM-5. According to the DSM-5, an ADHD diagnosis must specify one of three subtypes: combined type, predominantly inattentive type, or predominantly hyperactive/impulsive type (APA, 2013). The DSM-5 divides ADHD symptoms into an

inattentive category—which includes items such as difficulty sustaining attention, being easily distracted, and often losing or forgetting things—and a hyperactive/impulsive category—which lists frequent fidgeting, inappropriate running or climbing, and appearing to be "driven by a motor," among similar symptoms. A child should be diagnosed with ADHD-combined type if he or she has exhibited six or more of the symptoms in each category, to a degree that impairs functioning, for at least six months. A child is diagnosed with ADHD-inattentive type if he or she displays six or more inattentive symptoms and fewer than six hyperactive/impulsive symptoms. The opposite presentation of symptoms qualifies a child for a diagnosis of ADHD-hyperactive/impulsive type. While ADHD may be diagnosed in adolescence and into adulthood, there must be evidence that symptoms were present before the age of 12. Lastly, for ADHD to be diagnosed, symptoms must be present in two or more settings—(e.g., at home and at school; APA, 2013).

ICD-10. The ICD-10 is published by the World Health Organization, and lists criteria for diseases both medical and psychological (WHO, 2004). What we consider ADHD is referred to in the ICD-10 as hyperkinetic disorder. However, the ICD-10 requires a more severe presentation, with inattention, hyperactivity, and impulsivity symptoms all having to be present to qualify for diagnosis. In other words, the ICD-10 only recognizes ADHD-combined type. The ICD-10 specifies that, for a diagnosis of hyperkinetic disorder, symptoms must be present at home and at school (rather than any two or more settings), and lists separate symptoms for each setting. However, many of the symptoms are overlapping. In the home setting, the ICD-10 requires three attentional symptoms, three hyperactivity symptoms, and one impulsivity symptom to be present, for

a total of seven symptoms in the home setting. In the school setting, there must be two attentional symptoms and three hyperactivity symptoms, for a total of five symptoms in the school setting. In addition, it is required that these symptoms either be directly observed by the clinician or be indicated by the results of a psychological test of attention—parent and/or teacher reports may not be used as the only source of symptom observation. Unlike the DSM-5, the ICD-10 states that symptoms must be present before age seven, as in the previous version of the DSM (APA, 2000). Also unlike the DSM-5, the ICD-10 states that an individual cannot receive a hyperkinetic disorder diagnosis if he or she meets criteria for pervasive developmental disorder (PDD), or a manic, depressive, or anxiety disorder. Further information and comparison of DSM-5 and ICD-10 diagnostic criteria can be found in Table 1.

The ICD-10 is updated yearly, and a new version is set to be put into use October 1, 2017 (Centers for Disease Control and Prevention, 2017b). The 2018 version will include the significant name change from hyperkinetic disorder to attention deficit/hyperactivity disorder (ADHD), as in the DSM-5. Whereas the current version of the ICD-10 requires that inattentive and hyperactive/impulsive symptoms both be present for diagnosis, the 2018 version will include the subtypes listed in the DSM-5: inattentive type, hyperactive type, and combined type. There will also be the additional options of other type and unspecified type. With the 2018 updates, the ICD-10 and DSM-5 criteria for ADHD will begin to look much more similar.

A comparative review of the DSM-5 (APA, 2013) and ICD-10 (WHO, 2004) reveals substantial similarities across the two organizations primarily tasked with nosology and the operational definition of mental disorders. However, despite

similarities, key differences exist, including the term used in diagnosis, number and variety of symptoms required, and required age of onset.

Table 1

Comparison of DSM-5 and ICD-10 (2017) criteria

	DSM-5	ICD-10
Publisher	American Psychiatric Association (APA)	World Health Organization (WHO)
Term	Attention deficit/hyperactivity disorder (ADHD)	Hyperkinetic disorder (HKD)
Subtypes	Combined, inattentive, and hyperactive	None
# Symptoms required	6 inattentive and/or 6 hyperactive/impulsive	At home: 3 inattentive, 3 hyperactive, and 1 impulsive; At school: 2 inattentive and 3 hyperactive
Settings required	Any 2 or more	Home and school
Age of onset	< 12	< 7
Duration	At least 6 months	At least 6 months
Direct observation required	Not specified	Yes
Exclusions	Symptom occurrence only in the course of a psychotic disorder	Presence of a manic, depressive, or anxiety disorder, or pervasive developmental disorder

Note. DSM-5= Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition; ICD-10= International Classification of Diseases, 10th Revision.

Challenges to Correct Diagnosis

Differential diagnosis. Despite criteria outlined by the DSM-5 (APA, 2013) and ICD-10 (WHO, 2004), there are many challenges to correctly diagnosing ADHD in children. One primary challenge to this task is the fact that ADHD often presents similarly to many other childhood disorders, such as oppositional defiant disorder (ODD), autism spectrum disorder (ASD), and specific learning disorder (SLD), to name a select few (APA, 2013). While the DSM-5 offers substantial guidance regarding differential diagnosis of ADHD, many of these disorders present with similar symptoms, creating a challenge for clinicians (Delavarian et al., 2012). It is important to note that for ADHD to be diagnosed along with another disorder, full criteria must be met for both disorders. Often, dual diagnoses are incorrectly made when the child's symptoms can be explained by one disorder (Milberger, Biederman, Faraone, Murphy, & Tsuang, 1995).

Other neurodevelopmental disorders. ADHD can often be confused with other neurodevelopmental disorders. For example, children with ASD and ADHD often share the symptoms of inattention, social impairment, and behavior problems (APA, 2013). In addition, the fidgeting and inability to sit still that is characteristic of ADHD may be mistaken for the repetitive self-stimulating behaviors seen in ASD. A child with ADHD displaying these symptoms may be wrongly diagnosed with ASD for this reason. To differentiate these two disorders, it is important to closely observe and assess the features and causes of the child's social impairment—peer rejection due to overactivity or difficulty maintaining attention points to ADHD while social isolation and inappropriateness due to lack of interest or understanding in social interactions points to ASD.

With SLDs, children show notable academic impairment and often have a lack of focus in the classroom due to their frustration with their performance (APA, 2013). These symptoms can be mistaken for ADHD when the teacher perceives the child's low performance as being the result of his or her lack of focus, rather than the opposite. Ascertaining the cause of this low performance can distinguish between the disorders. Dual diagnosis may be made if the child continues to exhibit academic deficiencies even when substantial efforts are made to focus his or her attention.

ADHD also presents similarly to intellectual disabilities (IDs) at times. Low academic performance, inattention, immaturity, poor emotional regulation, and poor social skills are some of the symptoms these disorders may share (APA, 2013). Dual diagnoses are not often made here as a diagnosis of ADHD is not appropriate if the hyperactive and inattentive behaviors seen are appropriate to the *mental age* of the child (APA, 2013).

ADHD may also be misdiagnosed or missed in children with motor disorders such as developmental coordination disorder. Children with this disorder are known to be generally clumsy and uncoordinated, causing confusion between the two. To distinguish between ADHD and motor disorders, attention should be paid to the features of the atypical motor behavior, and whether it should be considered general hyperactivity or a more specific deficit (APA, 2013).

Mood and anxiety disorders. ADHD can be misconstrued as a depressive or bipolar disorder. Children who have depression are often restless and unable to concentrate, emulating the symptoms of ADHD (Delavarian et al., 2012). If these behaviors occur solely during the course of a depressive episode, ADHD should not be

diagnosed (APA, 2013). The same symptoms may be seen in children with anxiety disorders (APA, 2013). However, with anxiety disorders, inattention and restlessness are associated with persistent worry, while inattention and restlessness in ADHD is due to distraction by external stimuli and hyperactive tendencies (APA, 2013). With bipolar disorder, behavior that occurs during a manic or hypomanic episode can look very similar to ADHD (APA, 2013). Given that hyperactivity, impulsivity, and inattention are typical to manic episodes, it is easy to imagine how a child observed only in a manic state may be presumed to have ADHD. In order to differentially diagnose these disorders, information on the full course of the child's disorder should be assessed, with close attention to whether episodic moods are present. ADHD should only be diagnosed if symptoms outside those of a manic episode exist. ADHD is also sometimes confused with disruptive mood dysregulation disorder (DMDD), which features frequent temper outbursts (APA, 2013). Inattention and impulsive behaviors are not characteristic of DMDD and may warrant an additional diagnosis of ADHD if present.

Disruptive behavior disorders. Disruptive behavior disorders (DBDs), particularly oppositional defiant disorder (ODD), can be incredibly difficult to differentially diagnose from ADHD (National Collaborating Centre for Mental Health (UK) [NCCMH], 2009). Teachers and parents who observe acting out behavior in a child may be inclined to believe that child has ADHD, when a diagnosis such as conduct disorder or intermittent explosive disorder may be more appropriate. Similar features between DBDs and ADHD include impulsive behavior and aversion to schoolwork and other tasks, resulting in alternative "acting out" behaviors (APA, 2013). However, aggressive and hostile behavior is an important feature of DBDs that is not characteristic

of ADHD. Children with DBDs also do not typically have problems with attention. While these differences between the disorders exist, it is also very common for a child to meet full criteria for ADHD and a DBD, warranting a dual diagnosis (NCCMH, 2009).

Comorbid disorders. Though differentiating ADHD from other mental disorders is important, at times it is appropriate to diagnose co-occurring disorders. Comorbidity of other mental disorders also poses a challenge in ADHD diagnosis. While the DSM-5 (APA, 2013) states that ADHD should not be diagnosed if symptoms can be better explained by another disorder, it is important to note that the ICD-10 (WHO, 2004) specifies that hyperkinetic disorder cannot be diagnosed alongside a mood disorder, anxiety disorder, or pervasive developmental disorder.

The most common disorder to co-occur with ADHD is ODD (APA, 2013). These two disorders co-occur so often that researchers have questioned whether their symptoms can really be differentiated (NCCMH, 2009). Resulting research has suggested that these two disorders do constitute separate diagnoses; however, they are clearly not mutually exclusive (Martel, Nikolas, Jernigan, Friderici, & Nigg, 2012; NCCMH, 2009). Other disorders that commonly co-occur with ADHD include conduct disorder, specific learning disorder, depressive disorders, and anxiety disorders (Delavarian et al., 2012). Occurrence of symptoms meeting criteria for another mental disorder may distract from ADHD symptoms, causing the child's ADHD to be left undiagnosed and potentially untreated. It is useful to remember that more than one diagnosis may be present in any given child, and to attempt to account for all symptoms in diagnosis.

Construct irrelevant influences. While comorbid disorders and shared symptoms commonly cause misdiagnosis of ADHD, there are also factors outside of the child's symptoms that can play a role in diagnostic decisions.

Client and clinician bias. There is evidence of frequent misdiagnosis of ADHD due to the subjective perception of the rater (Bruchmüller et al., 2012; Chilcoat & Breslau, 1997; Merten, Cwik, Margraf, & Schneider, 2017). This is to be expected, as symptom and impairment ratings are heavily influenced by the parents' or teachers' opinions of the child. Parents and teachers are also generally not trained to recognize these symptoms and impairments, and they may not truly know how the child compares to the average child. In addition, several specific biases have been discovered. For example, if a male and a female client present with the same symptom profile, the male is more likely to be diagnosed with ADHD than the female due to the representativeness heuristic; clinicians know that ADHD is more common in boys and thus expect this diagnosis in boys while leaning away from it in girls (Bruchmüller et al., 2012). The same study also revealed that ADHD is more likely to be diagnosed if the clinician himself is male (Bruchmüller et al., 2012). Another study revealed that ADHD is more likely to be diagnosed when the child's mother is suffering from a depressive disorder; these mothers are more likely to perceive their children negatively and unwittingly exaggerate their symptoms on parent report forms (Chilcoat & Breslau, 1997). Research has also shown that children born just before school cut-off dates, who are therefore the youngest in their class, are much more likely to be diagnosed with ADHD due to their relative immaturity (Merten et al., 2017). These examples give light to the idea that biases surrounding the client may determine whether a diagnosis is made.

Malingering and forced diagnoses. There are also cases where ADHD is misdiagnosed for secondary gain—malingering often occurs in ADHD evaluations (Frye & Feldman, 2012). One reason this may occur is in the case of a parent suffering from factitious disorder by proxy, a mental disorder that causes one to lie about or exaggerate a child's symptoms in order to gain special attention (Frye & Feldman, 2012). However, this type of lying by parents or others may also occur in the absence of a disorder. In receiving an ADHD diagnosis for their child, parents may receive secondary gain in the form of academic accommodations, medication, and/or disability benefits (Pettapiece, 2005). Medication may be particularly alluring to parents, who may perceive it as a quick fix to their child's out of control behavior. On occasion, these benefits may entice parents to lie about or exaggerate their child's symptoms. Another form of purposeful over-diagnosis of ADHD occurs due to insurance companies' requirement of an official diagnosis before reimbursing for treatment (Merten et al., 2017). Children who do not meet criteria for any mental disorder but who show some symptoms of ADHD may be diagnosed simply to appease insurance companies into covering treatment.

Culture and language. ADHD has been found to exist in cultures worldwide. However, clinicians in some cultures may be more or less likely to diagnose the disorder, based on cultural norms (Mash & Barkley, 2003). In cultures where high expectations are placed on children to be quiet, attentive, and compliant, ADHD is much more likely to be diagnosed in an unruly child. It has also been reported that children from higher income families are more likely to get an ADHD diagnosis simply due to increased access to resources (Davis, 2011). Differences in prevalence across races have been reported; one study indicated that African American and Hispanic children were generally being

diagnosed with ADHD less frequently than White children (Morgan, Hillemeier, Farkas, & Maczuga, 2014). It is unclear whether these differences truly exist or are due to clinician biases. It is also hypothesized that the differences may arise from different attitudes towards seeking help across races, with White parents being more likely to have their child assessed for a mental health disorder such as ADHD (Morgan et al., 2014).

Construct irrelevant influences can unfortunately have great impact on whether a child receives a diagnosis of ADHD. It is important for clinicians to stay focused on the diagnostic criteria for ADHD, whether DSM-5 or ICD-10, and ignore extraneous factors that may influence them. For instance, in the case of malingering, care should be taken to ensure that symptoms reported are sincere and truly meet the criteria for ADHD. To address the issue of access to resources, efforts should be made to provide appropriate screening and testing to all children in schools (Bradshaw, Buckley, & Ialongo, 2008).

Evidence-Based Assessment of ADHD

In addition to best practice guidelines, the evidence-based assessment (EBA) movement (see Hunsley & Mash, 2007; Mash & Hunsley, 2005) in psychology has delineated procedures for the diagnosis of childhood and adolescent disorders. EBA is the use of research-supported and psychometrically sound measures and procedures for the purpose of making diagnostic and treatment development decisions (Hunsley & Mash, 2007). As a foundational element for EBA, Hunsley and Mash (2008) set forth criteria related to the internal consistency reliability, test-retest reliability, and inter-rater reliability. Specifically, good internal consistency reliability was defined as α values between .80 and .89, while excellent internal consistency reliability was defined as α values above .90. Inter-rater reliability values above .75 (*k*) or above .80 (*r*) were deemed

good. Finally, test-retest correlations were deemed good when they were at least .70 over a period of several months (Hunsley & Mash, 2008).

Youngstrom and Van Meter (2016) defined a functional model of EBA for children consisting, broadly, of three phases that tie together empirically supported assessment and treatment practices. In the *prediction phase*, clinicians are first encouraged to develop an understanding of national and local base rates of common clinical hypotheses. Given this data, clinicians can better prepare for their clientele and have ready the information necessary to make evidence-informed decisions about the probability of each clinical hypothesis. Following this initial step in the prediction phase, individual client details are first considered, including risk factors and appropriate test results. Subsequently, cross-informant information is collected, considered, and integrated with other data. These data are combined to determine the posterior probability of a specific hypothesis, and to quickly and accurately inform diagnostic decision making. In the following phase, *prescription,* Youngstrom and Van Meter suggest that the clinician is charged with driving the assessment forward, based on the probability data obtained during the initial stage, by obtaining data from narrow band measures and structured diagnostic interviews to make a binary decision about the presence or absence of a specific diagnosis. The last step of the prescription phase is to develop a contextually appropriate treatment plan in collaboration with the client and/or parents. In Youngstrom and Van Meter's final phase, *Process and Progress,* the clinician fully merges assessment with treatment by tracking outcome data associated with treatment, ensuring treatment efficacy, and making treatment changes as appropriate (Youngstrom & Van Meter, 2016).

Pelham, Fabiano, and Massetti (2005) completed a comprehensive review of evidence-based practices for the assessment of ADHD wherein they reviewed best practices related to diagnosis and measurement issues. While the authors conclude that the focus of ADHD assessment should be on the selection of target behaviors for therapy, they emphasize the necessity of efficient, evidence-based approaches to the diagnosis of ADHD. The authors review a number of different measurement methods (e.g., omnibus and narrow band rating scales) and offer recommendations related to their utility.

Established Practice Guidelines

In addition to Pelham and colleagues' (2005) review, three sets of comprehensive ADHD diagnostic guidelines have been published in the past ten years. These guidelines, published by the American Academy of Pediatrics (AAP) (American Academy of Pediatrics, 2011); the National Institute for Health and Care Excellence (NICE) (NCCMH, 2009); and the American Academy of Child and Adolescent Psychiatry (AACAP) (Pliszka, 2007) have aimed to combat the diagnostic challenges outlined above. However, there is much room for improvement in providing clinicians with a step-by-step guide to diagnosing ADHD. In addition, having been published in 2011 (AAP), 2009 (NICE), and 2007 (AACAP), these guidelines are based on outdated criteria for ADHD and should be updated to be consistent with DSM-5. While the guidelines tend to cover both assessment and treatment, this review will only address sections dedicated to assessment and diagnosis.

AAP guidelines. The AAP guidelines (AAP, 2011) are intended for primary care physicians (PCPs) seeing children. The AAP (2011) provides, as a summary of their guidelines, three key action statements pertaining to diagnosis.

The first action statement says that PCPs should complete an ADHD evaluation for any child age 4 to 18 struggling with academic or behavioral issues along with any signs of inattention or hyperactivity. The second action statement says that (a) ADHD criteria from the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision (DSM-IV TR) (American Psychiatric Association [APA], 2000) must be met prior to diagnosis; (b) symptoms must be present in at least two settings; and (c) reports should be taken from parents, teachers, and any mental health professionals who have treated the child. The final action statement regarding diagnosis states that diagnosing physicians should be sure to evaluate for co-occurring disorders, including any psychological, developmental, or physical disorders.

The AAP notes within their guidelines that a referral to a mental health specialist should be made if the PCP feels uncertain in his or her ability to diagnose ADHD in a child. However, it is implied throughout the document that PCPs are generally capable of this task.

NICE guidelines. The NICE is a branch of the British Department of Health which publishes assessment and treatment guidelines for disorders both psychological and physical. Its ADHD guidelines appear similar to those of the AAP, but are more extensive (NCCMH, 2009). They also appear to be aimed more towards psychologists than PCPs, as they were developed by the National Collaborating Centre for Mental Health and published by the British Psychological Society. The topics of assessment and diagnosis span two sections of the guidelines—one covering pre-diagnostic evaluation and referrals to mental health professionals, and one covering the diagnostic process itself.

Pre-diagnosis & screening. In the pre-diagnosis section, the NICE suggests that it is the responsibility of the primary care doctor, when seeing children with ADHD symptoms, to assess for severity of symptoms, level of functional impairment, and whether symptoms exist across multiple settings. When symptoms and impairment are seen by the physician as mild or moderate, an observational waiting period may be established before further steps are taken. However, if the physician deems the child's impairment to be severe, the NICE recommends immediate referral to secondary care for assessment.

Diagnostic process. The NICE is clear in stating that PCPs should not make initial ADHD diagnoses. They recommend that diagnoses be made only by healthcare professionals with specific training and experience diagnosing ADHD, such as psychiatrists and specialized pediatricians. According to the NICE, an ADHD evaluation should include the following: full psychosocial assessment, discussion of presentation of symptoms across settings, full psychological and developmental history, informant reports, and mental status exam. They also emphasize that diagnosis should not be made using only behavior rating scales and observer reports. The guidelines state that symptoms must meet DSM-IV-TR (APA, 2000) criteria for ADHD *or* ICD-10 (WHO, 2004) criteria for hyperkinetic disorder, and again stress the importance of impairment existing across settings. In their final notes on diagnosis, the NICE recommends that ADHD not be ruled out by a child or individual's age, and suggests that children should be able to give their perspective when appropriate.

AACAP guidelines. The AACAP provides a thorough review developed for practicing psychiatrists (Pliszka, 2007). The guidelines give key recommendations,

similar to the AAP, and break the process into pre-diagnostic screening and the diagnostic process, similar to the NICE.

Pre-diagnosis and screening. For screening, they recommend that all mental health evaluations include assessment for ADHD symptoms, regardless of the referral question. They indicate that this can be done simply by inquiring the parent about the child's attention and activity level, or by using a symptom rating scale.

Diagnostic process. Next, the organization recommends evaluation begin with an in-depth parent interview covering the age of onset, frequency, severity, and context of symptoms. The child should then be assessed for any co-occurring disorders, beginning with ODD as it is the most likely. It is suggested that a behavior rating scale is used to assess for ADHD symptoms and provide information about possible co-occurring conditions; the document provides a list of common standardized scales used for this purpose. The AACAP then recommends that the child's medical and mental health history be assessed, with a focus on early developmental milestones; family medical and mental health history should also be discussed. Lastly, it is recommended that the child him or herself be interviewed; whether this interview is conducted with the child alone or together with the parent should be decided by the clinician and depend on the child's age and the parent-child relationship. The following recommendations regard necessary testing. The AACAP states that neurological testing is not necessary in ADHD evaluation unless deemed necessary by the presence of symptoms outside of those expected in ADHD. They also state that ability and achievement (i.e., IQ and academic performance) testing are not necessary unless it is believed that the child may have a learning disorder or intellectual disability. These guidelines are in contrast with the NICE guidelines,

which state that informant reports and behavior rating scales are insufficient for ADHD diagnosis. The AACAP do not require direct observation of symptoms by the clinician.

Comparative review and use of clinical guidelines. Because the most recent clinical guideline was published in 2011, these guidelines need updates. Currently, the published guidelines do not provide clear enough instructions as to how to assess for and diagnose ADHD, nor do they suggest appropriate instruments to be used. The AAP took a purely medical approach, while the AACAP took more of a psychosocial approach. The NICE, together with the NCCMH, took a biopsychosocial approach, which psychologists may benefit from most. While these organizations have provided a model for thorough, descriptive diagnostic guidelines, updates and improvements are still needed. The most recent of these guidelines was published six years ago, and all are based on DSM-IV criteria. Thus, the guidelines need to be updated to comply with DSM-5 and ICD-10. In addition, a list of procedures and instruments to be used in ADHD assessment should be established, and a biopsychosocial approach should be taken.

Despite the proliferation of diagnostic guidelines by three respectable organizations across two countries, reports show that current guidelines are not being used in practice. Kovshoff and colleagues (2011) administered a semi-structured interview to clinicians regarding their perspective of the diagnostic process for ADHD, asking them to provide information on how they go about assessing, diagnosing, and treating ADHD, and what goes into their decision-making process. A main conclusion reached by the article is that existing guidelines are not practical when it comes to real-world decision making. The diagnostic process is more complex than the guidelines allow. Clinicians noted that much clinical judgement and subjectivity goes into their

diagnoses of ADHD. Examples of factors affecting their decisions included the family's or their own opinion on diagnostic labels, the clinician's perception of the child's impairment, differing accounts from informants, informant biases, clinician inclination to believe one informant over another, and reliance on past experience and schemas. The clinicians participating in the study listed subjectivity of informant reports and lack of universal guidelines as key factors contributing to the difficulty of diagnosing ADHD. This article highlights the need for updated clinical guidelines for ADHD; efforts should be made to take the above-mentioned factors into consideration when developing new guidelines.

Measurement

A large portion of this review will focus on specific instruments used in ADHD assessment. These instruments may fall into the categories of ADHD symptom rating scales, broadband rating scales, structured interviews, and continuous performance tests, among others (Hall et al., 2016; Pelham et. al., 2005). Thorough review will be completed on the psychometric properties of current tests as well as their appropriateness for diagnosing ADHD.

Purpose of this Review

ADHD has the highest prevalence rate of any neurodevelopmental disorder recognized by the extant literature (Pastor et al., 2015; Thomas et al., 2015), and has been shown to have lifelong impact on clients and families (Barbaresi et al., 2013; Ingram et al., 1999; Shaw et al., 2012). While early intervention strategies have been shown to be effective (Shaw et al., 2012), the first step to accessing treatment for clients is an accurate and efficient diagnosis (Delavarian et al., 2012). Multiple organizations have published

clinical guidelines regarding screening and assessing for ADHD (AAP, 2011; NCCMH, 2009; Pliska, 2007), but those guidelines are not always used by practitioners, who describe them as simplistic and impractical (Kovshoff et al., 2012). In addition to these issues, no current guidelines include specific measures appropriate for use in diagnosing ADHD. Most importantly, all current guidelines are based on DSM-IV-TR (APA, 2000) criteria, and need to be updated to correspond with DSM-5 and ICD-10 criteria. Lastly, existing guidelines have been based largely on the medical model, while a biopsychosocial model is more appropriate.

This paper serves to update existing guidelines to comply with more recent diagnostic criteria and updated assessments, as well as to provide a psychologist's rather than physician's perspective. Updates will be made based on research published in the last ten years. In addition, a step-by-step guide to the diagnostic process of ADHD will be provided, including suggested instruments and any other necessary considerations.

Method

A literature search was conducted for peer-reviewed journal articles, published in English in 2007 and through 2017, using the Psycinfo database. Articles for which the full text is not available were excluded from the review. The aim of the search was to gather articles regarding diagnosis or assessment of ADHD in children and adolescents. To capture these criteria, the following search criteria were used: (1) ADHD, attention deficit hyperactivity disorder, attention deficit disorder, ADD, HKD, OR hyperkinetic disorder AND (2) evaluation, assessment, diagnos*, screen*, test, OR measure. Search terms were required to be present in the title of the article. The focus of the articles chosen was on initial diagnosis in children and adolescents, excluding articles focusing on treatment and/or adult ADHD. The following search criteria were added to exclude such articles: NOT adult, treatment, OR intervention.

Articles were selected by the author based on title, with all articles focused on diagnostic assessments or general diagnostic practices for ADHD in children and adolescents initially included. Further narrowing of selected articles was then done by review of abstracts, with the author eliminating remaining irrelevant articles. Finally, the full text of remaining articles was reviewed by the author, to ensure that all articles met the criteria as defined for this review.

Search criteria were intentionally made broad as this review was intended to cover all aspects of initial ADHD diagnosis. Subsequent searches were included as needed to evaluate screening and assessment measures for psychometric adequacy. Selected studies included a wide array of topics ranging from the psychometric properties of various diagnostic assessments, to differential diagnosis and biomarkers. Articles were selected

from various countries and geographical regions. However, articles focusing on measures exclusive to a single foreign country or language were excluded.

Results

Initial search of PsycInfo database using selected criteria revealed 881 articles. After selection based on title and abstract, 89 articles remained. The author then read the full text of each article and carefully selected only the articles most relevant to the study. Twenty-four articles were thrown out due to irrelevance. Nine articles on specific assessment measures were added to ensure coverage of common measures. A total of 74 articles were included in analysis (see Figure 1 for further details). Articles were then sorted by the author into the following categories: Measures, Differential Diagnosis, Construct Irrelevant Influences, and Best Practice and Decision-Making Models. Some articles were assigned to more than one topic due to covering a wide range of information.

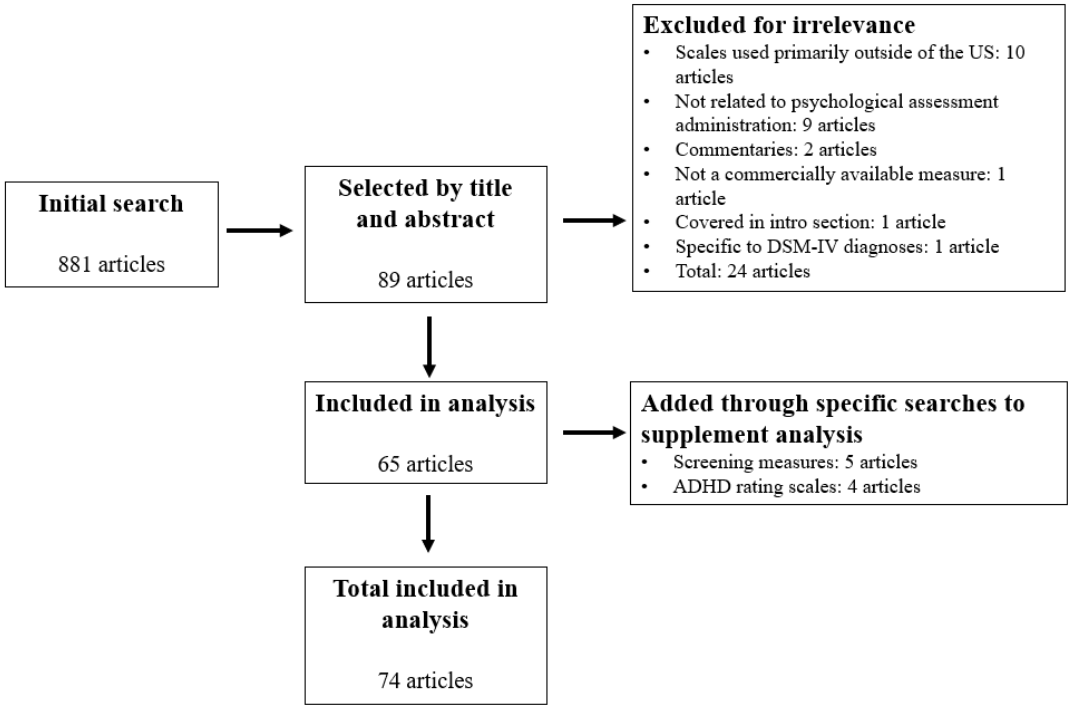

Figure 1. Inclusion and exclusion criteria

Measures

Forty-one articles covering evaluations of specific measures and/or more general procedures used in diagnosing ADHD were selected from the database search. Subsequent specific searches were done to include psychometric data for all commonly used ADHD assessment measures; nine articles were added through this process (see Figure 1). Articles covering assessment measures were further divided into the following categories: Screening measures and broadband rating scales, ADHD symptom rating scales, Executive functioning measures, CPTs, Structured interviews and observation schedules, and Biological tests.

Screening measures. Ten articles from the database search covered screening measures. Five articles were added through specific searches. Screening measures are commonly carried out in schools and doctor's offices to assess for any risk of ADHD before conducting a full evaluation. The purpose of using screening measures is twofold: 1) to identify children at risk for ADHD diagnosis whose caregivers may have otherwise not been alerted to the need for assessment, and 2) to maximize efficient use of time and resources by conducting full ADHD evaluations only on those at moderate to high risk.

Sayal and colleagues (2008) highlighted the benefit of using screening measures prior to conducting full evaluations. They observed a clinic in the United Kingdom as they introduced the procedure of supplying the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997) and short form Conners' Rating Scales (Conners, 1997) to all children referred for ADHD assessment. These measures are quick to complete and relatively cheap for clinicians to purchase. Secondly, they can be sent to the child's parents and teacher without needing to come into the office. Using a predetermined cutoff

score required for both the parent and teacher (greater than or equal to 6 on the SDQ hyperactivity scale *or* a T score of at least 70 on the hyperactivity scale, inattention scale, or ADHD index of the Conners' rating Scale), the clinicians only conducted full ADHD evaluations on children who appeared to have pervasive ADHD symptoms across school and home. Across a 28-month period of using this screening procedure, the percentage of children diagnosed with ADHD after a full ADHD evaluation rose to 48%, compared to the 16% diagnosed in the year prior to introducing the screening procedure. The authors concluded that the introduction of the screening procedure contributed to a decrease in the use of time and resources spent on ADHD evaluations for children at low risk for diagnosis. The screening procedure also helped to guide evaluation for children at low risk for ADHD, but at high risk for other disorders such as ODD or SLDs (Sayal, Letch, & El Abd, 2008).

Other studies of screening procedures have shown less promising results. Barry and colleagues (2016) analyzed the effectiveness of school-wide screening for ADHD across 40 schools. Numerous steps had to be completed before any at-risk children were able to be identified. First, the researchers were required to obtain consent from the children's parents to assess them—47.0% of parents returned the form giving consent. Next, the teacher of each child with consent was given a screener to complete—70.4% of these screeners were completed. From the returned screeners, 18.1% of the children were identified as at-risk for ADHD. Of the at-risk children, 60.9% of parents were able to be contacted by phone. Finally, of the parents contacted, 53.1% verbally agreed to contact the child's PCP for assessment. Overall, around one third of the school children were able to be screened. Additionally, only one third of the parents of at-risk children verbally

agreed to seek further assessment; with no follow-up or written agreement, this verbal agreement from parents was a relatively weak promise to seek evaluation. In the end, assuming that 100% of the parents who gave verbal agreement did indeed bring their children in for assessment, 1.9% of the total school children were evaluated for ADHD. Given this small percentage, compared with the 18.1% of the screened children who were identified as at-risk, and recalling the two thirds of the children who were not screened at all, it is apparent that only a small fraction of the at-risk school children was aided by this screening procedure. However, it is important to note that this procedure was carried out in schools rather than in a clinic setting where parents were already seeking treatment for their children as in the study by Sayal and colleagues (2008). Compliance from parents—and, in smaller part, teachers—was the largest barrier to success in this school-wide screening procedure (Barry et al., 2016).

Hale and colleagues (2009) tested the effectiveness of a 15-minute screening battery for ADHD. Their battery included a behavioral rating scale completed by teachers—the Child Attention Profile (CAP)—as well as two direct measures of neuropsychological functions including sustained attention, working memory, and response inhibition—the Trail Making Test-Part B and the Hale-Denckla Cancellation Test (HDCT). The test battery required a total of five to ten minutes with the child and around five minutes for the teacher to complete the rating scale. Using results of the battery to predict children with ADHD versus healthy controls, 87% of the children were correctly classified. The researchers found that the highest predictors by far were the two indices of the teacher rating scale, followed by the number of errors made on the Trail-Making Test and the number of correct items on the HDCT. Sensitivity of the battery

(i.e., percentage of true positives detected) in diagnosing ADHD versus normal control was 64%, and specificity (percentage of true negatives identified as such) was 92%. This shows that a very small amount of false positive diagnoses was made while a larger portion of the children (36% of those with ADHD) was given a false negative diagnosis. Because the purpose of screening measures is to identify all those at moderate to high risk, this percentage of false negatives is concerning, and begs the question of whether this particular screening battery really serves its purpose (Hale et al., 2009).

Holmberg and colleagues (2012) conducted a study in Sweden of the predictive power of identifying at-risk children in first grade for receiving a diagnosis of ADHD later on in fourth grade. Using the Abbreviated Conners Rating Scales (Conners, 1990) for parents and teachers, first grade children were identified as at risk for ADHD if they reached a cutoff score of 10 or above. The researchers followed up with the same children in fourth grade, again giving the Abbreviated Conners Rating Scales to parents and teachers and adding the executive functions screening scale (EFSS) for parents and teachers. Fourth graders were identified as "screen-positive" if they met designated cutoff scores on at least two of the four rating scales completed. Screen-positive children underwent a comprehensive evaluation by a child neurologist. Screening results in first grade were then compared to diagnoses (or lack thereof) made in fourth grade. Based only on teacher ratings, 63% of the children diagnosed with ADHD in fourth grade were identified as at-risk in first grade (thus giving us a sensitivity of 63%). The specificity of first grade screening by teachers was 91%. However, sensitivity of first grade screening by parents was far lower at 29%. The researchers argue that the results of this study show that screening in first grade is effective for identifying children at risk for ADHD so that

early intervention can be implemented. On the other hand, the study also shows that children with minimal to no ADHD symptoms in the early school years may develop symptoms later on. This finding highlights the importance of repeated screenings throughout the school years to account for symptoms developed after entering school (Holmberg, Sundelin, & Hjern, 2013).

Other studies have examined the psychometric properties of specific screening measures. Reddy and colleagues (2010) sought to determine the concurrent validity of the Pediatric Attention Disorders Diagnostic Screener (PADDS; Pedigo, Pedigo, & Scott, 2006). This computer-administered test battery includes parent and teacher rating scales—namely, the Swanson, Nolan, and Pelham Questionnaire (SNAP-IV; Swanson et al., 2012)—a yes/no format diagnostic interview (CADI), and three tests of executive functioning (TTEFs). The PADDS provides clinicians with likelihood ratios upon completion of the test. The researchers compared results of a clinical sample of children with ADHD on the PADDS, Test of Variables of Attention (TOVA; Leark, Greenberg, Kindschi, Dupuy, & Hughes, 2007), Conners' Continuous Performance Test (CCPT-II); Conners, 2000), and the Behavior Rating Inventory of Executive Function (BRIEF; Gioia, Isquith, Guy, & Kenworthy, 2000). The researchers found that scores on the TTEFs correlated significantly with those of the TOVA and CCPT-II. However, PADDS scores did not correlate significantly with scores on the BRIEF. The TTEFs were reported by Huang (2009) to have a Cronbach's alpha of 0.86, and sensitivity, specificity, positive predictive power, and negative predictive power all above 0.85 (Huang, 2009). The SNAP-IV was previously reported to have good psychometric properties when evaluating

children with ADHD (Bussing et al., 2008). No psychometric data could be found for the CADI (Reddy, Newman, Pedigo, & Scott, 2010).

Two articles from the database search evaluated screening of ADHD using the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997). In one study, by Ullebø and colleagues (2011), parents completed the SDQ as well as the ADHD portion of the SNAP-IV. Children were classified as having the ADHD phenotype if they were rated as having at least six hyperactive/impulsive and/or six inattentive symptoms by *both* the parent and teacher. These classifications were then compared to results of the SDQ. Using an SDQ cutoff score of greater than or equal to four, sensitivity of parent and teacher ratings for identifying ADHD was 95% and 88%, respectively, and specificity was 82% and 76%, respectively. While these results seem promising, the authors noted that the SDQ had very low sensitivity for children with ADHD inattentive or hyperactive types, and that the algorithm mainly identified children with the combined subtype (Ullebø, Posserud, Heiervang, Gillberg, & Obel, 2011).

Algorta and colleagues (2016) also looked at the SDQ for identifying ADHD. Unlike Ullebø and colleagues (2011), Algorta looked at the Total Difficulties (TD) and Conduct Problems (CP) indices in addition to the Hyperactivity/Inattention (H/I) index. The researchers found that the TD and H/I scales were equally good at predicting ADHD, and that both scales were better predictors of ADHD than the CP scale. Using a high cutoff score of greater than or equal to ten on the H/I scale, the researchers found a diagnostic likelihood ratio (DLR) of 21.32, meaning that children with this score were 21.32 times more likely than a given child to have ADHD. Using a lower cutoff score of

five, as suggested by Ullebø, gave a DLR of 2.34 (Algorta, Dodd, Stringaris, & Youngstrom, 2016).

Another article found in the database search reported that when using a cutoff score of "above the 90th percentile," the SDQ had a sensitivity of 68% and a specificity of 88% for identifying ADHD (Posserud et al., 2014). However, sensitivities and specificities reported for the SDQ vary greatly. It has been reported that the H/I scale of the SDQ is the most reliable of the five subscales, with a Cronbach's alpha of 0.78 and 0.85 for parents and teachers, respectively (Mieloo et al., 2012). The same researchers also reported a Pearson correlation of 0.75 between the SDQ H/I scale and the attention problems scale of the Child Behavior Checklist (CBCL; Achenbach & Rescorla, 2001).

Based on the evidence presented, the SDQ appears to be an adequate screening measure for ADHD relative to its cost (free) and brevity. However, it is also evident that low cutoff scores around four or five need to be applied in order to meet the goals of the screening process; that is, to identify children whose behavioral presentation warrants a comprehensive evaluation for ADHD. As reported by Ullebø et al (2011), the SDQ does well at detecting combined type ADHD; however, it does appear to fail in the area of detecting ADHD inattentive type and thus, the goals of screening must be considered.

The Behavior Assessment System for Children, Third Edition (BASC-3; Reynolds & Kamphaus, 2015) is a set of broadband rating scales including parent, teacher, and self-report scales commonly used to screen children for emotional and behavioral disorders such as ADHD. Zhou and colleagues (2017) applied an evidence-based medicine (EBM) model to the BASC-3 for diagnosing ADHD. The EBM model consists of making diagnoses based on DLRs and posterior probabilities. Posterior

probabilities were obtained by combining the DLRs from an average of three (for teachers) or four (for parents) scales. In this study, children were classified as having a positive diagnosis if posterior probability reached 80%. The scales found to contribute the highest DLRs for ADHD on both parent and teacher rating scales included Attention Problems, Executive Functioning, Functional Communication, and Hyperactivity. The authors showed that using the EBM model rather than relying solely on the Attention Problems and Hyperactivity scales increased the accuracy of diagnosis significantly. The sensitivity and specificity for ADHD using the EBM model were 0.70 and 0.73, respectively, for teachers, and 0.94 and 0.51, respectively, for parents. This study showed that the inclusion of impairment measures can increase accuracy of the diagnosis of ADHD, and that the BASC-3 is a good measure for diagnosing ADHD. For screening purposes, the BASC-3 is a quick and easy measure that provides accurate information about the risk of ADHD as well as several other emotional and behavioral disorders (Zhou, Reynolds, Zhu, Kamphaus, & Zhang, 2017).

The Child Behavior Checklist (CBCL) and its corresponding Teacher Report Form (TRF; Achenbach & Rescorla, 2001) are broadband rating scales assessing children in the following areas: aggressive behavior, anxiety, attention problems, rule-breaking behavior, somatic complaints, social problems, thoughts problems, and depression. The Attention Problems (AP) scale has been found to be useful at detecting children with ADHD. A 2008 dissertation reported the fixed effects reliability of the AP scale to be 0.77, compared with the reliability of 0.84 originally published by the authors of the measure (Nassen, 2008). This falls below necessary levels for clinical decision-making

(Hunsley & Mash, 2005), and should evoke concern from clinicians due to the potential for unreliable results.

Edwards and Sigel (2015) conducted a study in which they looked at the diagnostic utility of the CBCL and TRF for ADHD. The researchers compared results of the CBCL and TRF to diagnostic decisions made based on the Computer-Diagnostic Interview Schedule for Children (C-DISC; Columbia University DISC Development Group, 2000) and Conners' ADHD/DSM-IV Scales (Conners, 1997). The criterion for ADHD in the study was a t-score of at least 65 on the Conners parent and teacher scales and a positive classification from the C-DISC. Using a cutoff t-score of at least 65 on the CBCL and TRF, they found a sensitivity of 87% and specificity of 53% for the CBCL, and sensitivity of 78% and specificity of 75% for the TRF. These results show that the CBCL and TRF are adequate screening measures for ADHD but are not sufficient for diagnosis. They also show that the TRF tends to be more helpful than the CBCL in identifying ADHD (Edwards & Sigel, 2015).

As we have seen, mass screening procedures, such as those across schools, are difficult to carry out due to noncompliance from parents and teachers. However, adding a screening step to clinical evaluations reduces the amount of time and resources needed for comprehensive evaluations, while increasing diagnostic accuracy and assessing for comorbid difficulties. The PADDS is promising, but it is relatively new and warrants further research to determine psychometric properties of the battery as a whole. The SDQ is a quick and free screening measure; however, it does not do well in detecting ADHD inattentive type, and there are better options available. The BASC-3 is widely used and shows screening and diagnostic utility for ADHD as well as many other emotional and

behavioral disorders. Lastly, the CBCL and TRF are adequate screening measures, but should not be heavily relied on for diagnosis; if one is to be favored over the other, the TRF tends to show higher accuracy than the CBCL in identifying ADHD.

ADHD symptom rating scales. Initial database search revealed five articles on ADHD symptom rating scales, also referred to as narrow rating scales. Four articles were added through specific searches. Narrow rating scales are defined as those that focus on ADHD symptoms and associated difficulties; they may also include assessment of closely related disorders such as ODD. The benefits of narrow rating scales include briefer and more focused assessment of ADHD symptoms; this may also be considered a drawback as comorbid or differential diagnoses may be missed. Three articles on functional impairment measures intended to supplement symptom rating scales were also included in this section.

ADHD rating scales may be completed by parents, teachers, and/or the child being assessed. Granero and colleagues (2008) provided a comparison of the diagnostic utility of ratings from these different raters. They based their study on previous research that parent and child ratings of ADHD are inferior to teacher ratings in the preadolescent and adolescent years. Granero and colleagues then state that parent ratings are generally considered next after teacher ratings; however, they designed their study to show that child ratings in later years have some value as well. The researchers looked at the assessment of children ages 9 to 15 by parents and the children themselves, and which symptoms required parent and/or child detection. For example, at age 14, children frequently reported the symptoms of "loses things" and "acts as if driven by a motor," whereas parents reported these symptoms at a lower frequency. This example represents

a case where child (self) report rating scales may be necessary to identify ADHD symptoms that parents may miss. At age 13, the researchers reported the same phenomenon for the symptom of "runs and climbs;" the children reported it more often than the parents. For these two symptoms at age 14 and one symptom at age 13, the researchers determined that the child ratings should be considered rather than parent ratings when making diagnostic decisions. The researchers showed that, as children age, including child ratings becomes more essential; in addition to the symptoms just mentioned, the researchers determined that 11 and 14 of the 18 ADHD symptoms required both parent and child ratings to make accurate diagnostic decisions for ages 13 and 14, respectively. On the other hand, younger children contribute less to their own diagnoses; only three and four of the 18 symptoms required both parent and child ratings for ages nine and ten, respectively. No symptoms for this age range were identified more often by the children than the parents. The authors conclude that including child ratings in diagnostic evaluations is increasingly important when children reach the early teen years, though it may not be useful in preadolescence (Granero, Ezpeleta, Domenech, & de la Osa, 2008).

Numerous ADHD rating scales currently exist. One very popular set of rating scales is the Conners Rating Scales-Revised (CRS-R; Conners, 1997), which includes the Conners Parent Rating Scale-Revised (CPRS-R) and the Conners Teacher Rating Scale-Revised (CTRS-R). Conners also developed the Abbreviated Symptom Questionnaire (ASQ) (Conners, 1990). Chang and colleagues (2016) conducted a meta-analysis to determine the diagnostic utility of the CRS-R and ASQ, as well as the Attention Problems scale of the CBCL (discussed in previous section). The researchers averaged

sensitivities and specificities reported for each of the three CRS-R rating scales, giving them the following pooled statistics: sensitivities of 0.75, 0.72, and 0.83 for the CPRS-R, CTRS-R, and ASQ, respectively; and specificities of 0.75, 0.84, and 0.84, respectively. These numbers should be interpreted with caution as a large amount of heterogeneity was found between data reported by different studies. The authors noted that the ASQ had the highest sensitivity and specificity of the three rating scales, despite its brevity and classification as a broadband rating scale. Based on data reported in this study, the CPRS-R and CTRS-R can be considered adequate diagnostic tools for ADHD, while the ASQ may be considered a good tool (Chang, Wang, & Tsai, 2016).

More recently, Conners developed the Conners, 3rd Edition (Conners 3; Conners, 2008). The Conners 3 is a very common rating scale used to assess for ADHD, ODD, and Conduct Disorder (CD). The system includes parent, teacher, and self-report forms, and both long- and short-form versions are available. The Conners 3 provides separate scores for ADHD-HI and ADHD-IN. Cronbach's alpha for these two scale scores were 0.92 and 0.93 on the parent version, 0.95 and 0.94 on the teacher version, and 0.86 and 0.89 on the self-report version (Gallant et al., 2007). Comparisons between clinical and non-clinical groups revealed that the Conners 3 was able to discriminate between populations in 77.6% (parent), 75.6% (teacher), and 72.9% (self) of cases (Kao & Thomas, 2010). Statistics for discrimination between clinical populations have not been reported. Overall, the Conners 3 is a very reliable and valid measure for identifying ADHD. It is quick and easy to administer and to score, and it has the added benefit of assessing for closely related disruptive behavior disorders.

Burns and colleagues (2013) largely aimed to test the effectiveness of exploratory structural equation modeling (SEM) versus confirmatory factor analysis (CFA) to determine construct validity. However, they did so by looking at the Child and Adolescent Disruptive Behavior Inventory (CADBI) (Burns, Taylor, & Rusby, 2001)—thus, we can extract relevant data from their study on the validity and reliability of this measure. The authors analyzed separately the psychometric properties of the inattentive and hyperactive symptom groups (as well as an ODD group, not included in this review). The CADBI revealed excellent reliability coefficients, ranging from 0.95 to 0.98, with teacher ratings showing the highest reliability. Correlations between mother and father ratings were moderate, averaging 0.72. Correlations between teacher and either parent were not meaningful for the CADBI. Discriminant correlations between and within raters for all factors were significantly lower than their respective convergent correlations, indicating that each factor contributed unique variance. Based on Burns' (2013) research, it appears that the CADBI is a very reliable and acceptably valid measure. While parent and teacher ratings were found to not correlate highly, this is to be expected based on previous research (Burns et al., 2013).

Breuer and colleagues (2011) looked at the effectiveness of the Day Profile for ADHD Symptoms (DAYAS) for diagnosing and monitoring ADHD. The DAYAS is an English translation of a German scale (Dopfner, Lehmkuhl, & Steinhausen, 2006) that allows raters to rate children's symptoms at different times of the day, on different days, and in different settings. The researchers compared parent and teacher scores on the DAYAS to their corresponding scores on another German scale, the FBB-ADHD to determine convergent validity. Correlations between the two scales were moderate, with

parent score correlations ranging from 0.32 to 0.68 (mean = 0.49). Internal consistency reliability ranged between 0.71 to 0.95 for the parent rating, 0.74 to 0.94 for the teacher rating, and 0.89 to 0.95 for the parent and teacher rating. Based on their findings, the authors concluded that, on average, children's scores were fairly homogenous throughout the day; in other words, randomized data collection during the day rather than continuous data collection was equally informative. The authors also noted that averaging total daily scores to get a total weekly score was just as useful as rating children on the different time periods for each day. Perhaps more importantly, the authors conducted regression analyses and found that DAYAS ADHD ratings accounted for between 53% and 70% of a criterion ADHD rating, that the instrument had adequate reliability, divergent validity, and convergent validity, and that it is sensitive to change. Given the information found about the utility of weekly scores, the instrument has adequate psychometric utility for diagnostic purposes, but also for progress monitoring purposes (Breuer, Görtz-Dorten, Rothenberger, & Döpfner, 2011).

Brites and colleagues (2015) conducted a literature review on the Strengths and Weaknesses of Attention-Deficit/Hyperactivity-symptoms and Normal-behaviors (SWAN: Swanson et al., 2012) rating scale for diagnosing ADHD. The SWAN scale is unique in that, while it assesses for problem areas, it also identifies areas of strength. The SWAN scale has raters classify children on a scale from performing far below to performing far above the average child on a list of ADHD-related symptoms. Findings of the articles reviewed supported the validity of the SWAN scale and its use for ADHD evaluations. The SWAN scale was found to produce a normal curve when administered to a general population; Brites notes that the curve produced by the SWAN scale appears

more normal than that of the SNAP-IV or CBCL. In addition, one study revealed that the scale identified ADHD in 4% of the population assessed, comparable to the 5% prevalence listed in the DSM-5. Analysis also indicated that the SWAN scale is useful in discriminating between ADHD subtypes. Lastly, the review stated that the SWAN scale has good reliability, though specific coefficients were not given. The SWAN has the benefit of providing a profile of both strengths and weaknesses for children with ADHD; it can also discriminate between subtypes. However, more research is needed regarding diagnostic application and psychometric properties (Brites, Salgado-Azoni, Ferreira, Lima, & Ciasca, 2015).

The Vanderbilt ADHD Parent and Teacher Rating Scales (VAPRS and VATRS; Wolraich, Feurer, Hannah, Pinnock, & Baumgaertel, 1998) are commonly used to screen for ADHD. The rating scales include the 18 DSM-V criteria for ADHD as well as criteria for ODD and CD, and a few items to screen for anxiety and depression. Lastly, the scales include a performance section to screen for learning problems. The scales are easy to obtain and quick to administer. Cronbach's alphas for the 18 ADHD symptoms on the VAPRS and VATRS were 0.94 and 0.95, respectively, for a clinical sample. Tests for convergent validity revealed that the VAPRS does correlate highly with the ADHD portion of the Computerized Diagnostic Interview for Children, Fourth Edition (C-DISC-IV). The Vanderbilt scales appear to be valid and reliable measures for ADHD, and include screening items for comorbid disorders (Wolraich et al., 2003).

DuPaul's ADHD Rating Scale—5 is a very quick (five minutes), up-to-date rating scale for diagnosing ADHD (DuPaul, Power, Anastopoulos, & Reid, 2016). The scale provides scores for inattentive and hyperactive symptoms, as well as impairment scores

for both domains. Cronbach's alphas for scores on this test range from 0.89 to 0.96. Convergent validity was demonstrated by high correlations between corresponding scores on the Rating Scale—5 and the Conners 3. As this scale is rather new, little research has been done on its clinical utility. However, it appears to be a very reliable measure and is based entirely on DSM-5 criteria, making it a desirable measure for diagnosing ADHD.

In addition to meeting criteria for symptom severity, the DSM-5 requires a child to have functional impairment in social or academic domains in order to be diagnosed with ADHD (APA, 2013). While some rating scales such as the ADHD RS-5 (DuPaul et al., 2016) include ratings of functional impairment, other times it may be necessary to administer an additional measure to determine the child's level of functional impairment associated with his or her symptoms. While a given child may meet the symptom criteria for ADHD, it is also possible that that child is not significantly impaired by his or her symptoms, and thus should not be diagnosed with ADHD.

Measuring impairment is especially important in younger populations, as evidenced by Healey and colleagues (2008), who looked at the effect of introducing an impairment measure in ADHD evaluations with preschoolers. The study was based on previous research indicating that ADHD is often overdiagnosed in young children due to the reliance on symptom rating scales and the commonality of these symptoms in children in this age group. The researchers developed their own impairment scale, the Children's Problems Checklist, and found that when using modest cutoff criteria (at least 90^{th} percentile for one rater and at least 75^{th} percentile for the other) for impairment, the number of preschool children that met criteria for diagnosis of ADHD was reduced by more than half. After the impairment measure was implemented, the percentage of

children diagnosed was reduced to a prevalence much more similar to that expected (around 5%), implying a reduced number of false positives (Healey, Miller, Castelli, Marks, & Halperin, 2008).

Another common measure for this purpose is the Weiss Functional Impairment Rating Scale (WFIRS; Weiss, 2010). The WFIRS is a 50-item scale that assesses problems in the following domains: Home, Self-Concept, Learning & School, Activities of Daily Living, Social Activities, and Risky Activities. Thompson and colleagues (2017) reported that the parent version of WFIRS was able to discriminate between ADHD and controls with relatively high accuracy; sensitivity was 83% and specificity was 85%. The WFIRS appears to be an accurate and beneficial measure to include in ADHD evaluation to assess level of impairment (Thompson, Lloyd, Joseph, & Weiss, 2017).

Symptom rating scales are often the first step in ADHD diagnosis. Current research shows that teachers are the most accurate and reliable raters of ADHD symptoms, and that parent ratings also contribute helpful information; however, self-report measures do not appear to become useful until around age 13. The Conners' Rating Scales-Revised consists of a set of three rating scales, of which the shortest of the three, the ASQ, appears to be the best for diagnosing ADHD. The Conners 3 assesses for ADHD, ODD, and CD, and is widely used across clinical and school settings; reliability statistics are excellent, and rates of correct classification are adequate. The CADBI can assess for ADHD as well as ODD, and is a reliable measure. Research on the DAYAS has revealed that assessing ADHD symptoms at different times of the day is not more useful than overall ratings; however, the scale's reliability and validity are high, and weekly ratings can be substituted for daily ratings. The SWAN scale has the unique

capability of identifying both strengths and limitations of children with ADHD; it is a reliable measure and is able to discriminate between subtypes. The Vanderbilt scales include a quick assessment of DSM-5 (APA, 2013) ADHD symptoms, as well as screening items for common comorbid disorders; reliability statistics are excellent and it has been found to correlate highly with other ADHD measures. The ADHD RS-5 includes symptom severity ratings as well as impairment measures; it has been found to be very reliable and correlate highly with the Conners 3. In addition to symptom severity, it is important to assess level of impairment in children being evaluated for ADHD. Impairment measures are especially important in young children, who tend to exhibit higher rates of ADHD symptoms but may not be impaired by them. When symptom rating scales do not include measures of impairment, one option is the WFIRS, which assesses for functional impairment in several areas.

Executive functioning measures. Initial database search revealed four articles covering the use of executive function (EF) impairment measures in the diagnosis of ADHD. The four aspects of EF—nonverbal working memory, verbal working memory, self-regulation, and planning—are believed to be deficient in children with ADHD (Barkley, 2006). The four executive functions are largely controlled by the overarching function of behavioral inhibition, a key factor in ADHD. This model implies that ADHD is neurobiological in nature, and thus neuropsychological testing is appropriate. EF measures largely entail performance-based tasks such as the Stroop Word-Color Test or cancellation tasks, but can also include rating scales which list various symptoms of deficits in the executive functions, such as the BRIEF2 (Gioia, Isquith, Guy, & Kenworthy, 2015).

Holmes and colleagues (2010) looked at the clinical utility of various EF measures for diagnosing ADHD. Specifically, they used four subtests of the Delis-Kaplan Executive Function System (D-KEFS; Delis, Kaplan, & Kramer, 2001), the Walk-Don't Walk subtest from the Test of Everyday Attention for Children (TEA-Ch; Manly, Robertson, Anderson, & Nimmo-Smith, 1999), and the full Automated Working Memory Assessment (AWMA; Alloway, 2007). In general, results of the study found that the clinical ADHD population performed more poorly than the control population on all measures; this supports the theory that deficient EF is strongly related to ADHD, and in turn supports the use of EF measures in diagnosis of the disorder. The study found that the Walk-Don't Walk test was the best single predictor of ADHD, with a sensitivity of 83% and specificity of 70% (Holmes et al., 2010).

Miranda and colleagues (2010) compared the results of performance-based EF measures and EF rating scales in a normative sample of preschoolers. They also aimed to determine the predictive quality of these measures for ADHD. Researchers used the BRIEF (Gioia et al., 2000); two measures of behavioral inhibition, including a picture-based Stroop task; and four measures of working memory, including a backward digit span test. Internal consistency for the BRIEF was reported to be 0.86 for the parent version and 0.99 for the teacher version. Test-retest reliabilities of the performance-based tasks ranged from adequate (0.62) to excellent (0.97). Correlations between the BRIEF indices and performance-based tests were found to be low, with most correlations ranging from -0.1 to -0.3. The authors concluded that this difference implies that EF rating scales and EF performance tests measure different constructs; they suggested that EF rating scales such as the BRIEF measure the behavioral manifestation of EF, while

performance-based tasks such as the Stroop task used in this study measure the cognitive component of EF. When looking at ADHD symptoms, the authors found that EF seemed to be more closely related to inattention symptoms than hyperactive/impulsive symptoms. They found that the BRIEF was the best predictor of ADHD of the tests used, with teacher ratings explaining 76.1% of variance in inattention symptoms and 53.3% of variance in hyperactive/impulsive symptoms. The authors suggested that the combination of an EF rating scale and performance-based EF measures would give the best picture of EF deficits, and likewise the best prediction of ADHD (Miranda, Colomer, Mercader, Fernández, & Presentación, 2015).

Dovis and colleagues (2015) highlighted the risks of relying solely on EF impairment measures for diagnosis. Their study tested a clinical ADHD-C, clinical ADHD-IN, and non-clinical control group to identify group-level impairments in working memory (WM) and short-term memory (STM). They also tested for motivational impairments. However, results of the study showed that, while the two ADHD groups were more likely to be impaired than the control group, 24.4% of the ADHD-C group and 44.4% of the ADHD-IN group did not show impairment on any of the three factors. Measures of motivational impairment were particularly unhelpful for diagnosis, with only 22% of children in either ADHD group showing impairment in this area. WM and STM measures showed acceptable diagnostic validity for ADHD-C, but not for ADHD-IN. An ADHD-HI group was not included in the study. This article indicates that memory measures should be used cautiously in ADHD diagnosis, or if ADHD-IN is suspected, perhaps should not be used at all. The authors emphasize that, while EF measures may contribute useful information, ADHD symptom measures should

always be considered above EF measures when making diagnostic decisions. Motivational impairment measures should generally not be used to diagnose ADHD (Dovis, Van der Oord, Huizenga, Wiers, & Prins, 2015).

Like motivational impairments, some measures of EF are not acceptable for use in diagnosing ADHD. For example, Allen and Decker (2008) discovered that the Bender Visual Motor Gestalt Test, Second Edition (BVMGT-II; Brannigan & Decker, 2003) was not sufficiently accurate at identifying children with ADHD. While some argue that the Wechsler Intelligence Scale for Children (WISC; Wechsler, 2014) can help identify children with ADHD using the Working Memory and Processing Speed Indices (WMI and PSI), studies have shown that, while children with ADHD do tend to score lower in these areas, these scores do not significantly differ between subtypes, and are not sufficient for diagnosis (Zieman, 2010). EF measures may be used as a supplement to ratings of symptom severity and functional impairment, but should not be relied upon for diagnosis.

Continuous performance tests. The database search revealed seven articles on continuous performance tests (CPTs). CPTs are computerized tests of attention involving selective attention to certain stimuli while ignoring extraneous stimuli. They generally measure sustained attention and response inhibition, and are a specific type of EF measure. The four most commonly used CPTs are the Conners CPT—Second Edition (CCPT-II; Conners, 2000), the Test of Variables of Attention (TOVA; Leark et al., 2007), the Quantified Behavior Test (QbTest; Knagenhjelm & Ulberstad, 2010), and the Gordon Diagnostic System (GDS; Gordon, 1982); each of these will be reviewed here.

The CCPT-II (Conners, 2000) is perhaps the most commonly used of the CPTs. It consists of a black screen which flashes letters to participants at a variable rate. Participants are asked to click after every letter except for "X." The CCPT-II claims to measure inattention primarily through response time and omission errors, and impulsivity through commission errors. As previous research has revealed, Munkvold and colleagues (2014) found that the CCPT-II is useful in discriminating between ADHD and normal controls, particularly through errors of omission and variability in reaction time; however, the same study found that the CCPT-II was not able to discriminate between children with ADHD and children with ODD. The same findings have been reported in previous studies (Munkvold, Manger, & Lundervold, 2014). A review by Hall and colleagues (2016) reported that accuracy statistics are low and vary by study, with one study reporting sensitivity of 67% and another reporting sensitivity of only 41% (Hall et al., 2016). Hall's (2016) review cited another study which reported no difference in CCPT-II scores between ADHD and Bipolar Disorder groups. Hall also noted that the CCPT-II's use of letters may make the test more difficult for children with reading disorders. Despite its popularity, the CCPT-II does not appear to be a very useful diagnostic tool for ADHD, as it has low sensitivity and is unable to discriminate between ADHD and other clinical populations.

The TOVA CPT (Leark et al., 2007) consists of a screen which flashes images of a small square with a hole either at the top or bottom of the square; participants are asked to respond when the hole is at the top of the square and ignore when it is at the bottom. The TOVA was also reviewed by Hall and colleagues (2016); one study reported a sensitivity of 86% and specificity of 70% for ADHD. While one study reported that the

TOVA was useful in determining ADHD subtype, another study reported no score differences between subtypes, and another study found that the TOVA could not discriminate between a clinical ADHD group and a subclinical group with some ADHD symptoms (Hall et al., 2016; Porumb, 2007). Llorente and colleagues (2008) reported internal consistencies of the TOVA scales ranging from 0.53 to 0.94 when used solely with children with ADHD. Wu and colleagues (2007) also calculated internal consistencies, reporting a mean internal consistency of 0.81; however, some estimates were as low as 0.31. Wu also reported that the ADHD population scored lower on every scale of the TOVA; however, differences were only significant for three of the scales. While there is some evidence that the TOVA may be helpful in ADHD diagnosis, substandard reliability suggests clinicians should avoid its use.

The QbTest (Knagenhjelm & Ulberstad, 2010), in addition to measuring inattention and impulsivity like most CPTs, measures hyperactivity through the use of an infrared camera recording the participant's movements. On the QbTest, participants are asked to respond to the solid grey circle and ignore the grey circle with a cross through it. The QbTest is approved by the US Food and Drug Administration (FDA) for clinical assessment and treatment monitoring of ADHD (Hall et al., 2016). One study reviewed by Hall revealed that, of two groups assessed for ADHD with and without the QbTest, diagnoses of the group assessed with the QbTest remained stable, while 37% of the diagnoses of the no-QbTest group changed after one year (Hall et al., 2016). Hall and colleagues (2017) later conducted a qualitative study on user experience with the QbTest—they reported that, while clinicians generally felt that the test contributed useful information for diagnosis, families had more varied responses, with less than half

reporting that QbTest results helped them to understand their child's symptoms and diagnosis (Hall et al., 2017). Reh and colleagues reported that scores on the QbTest did not correlate significantly with corresponding parent ratings on the Conners 3; QbTest hyperactivity scores correlated with teacher ratings of hyperactivity only slightly ($r = 0.27$), while no other scores were correlated (Reh et al., 2015). With FDA-approval and some evidence of its clinical utility, the QbTest is a promising CPT; however, more research needs to be done regarding its psychometric properties and accuracy in diagnosis of ADHD.

Lastly, the GDS (Gordon, 1982) involves three subtasks to assess for various difficulties associated with ADHD: The Vigilance Task, the Delay Task, and the Distractibility Task. Hall's (2016) review cited a study which found that 28.7% of children with ADHD-IN scored within the normal range on the GDS, while 66.6% of healthy controls scored in the abnormal range, appearing to meet criteria for ADHD (Hall et al., 2016). One study reviewed by Hall (2016) reported that the Delay Task was able to classify children into ADHD subtypes with 69.7% accuracy. Another study reported sensitivity of GDS variables for ADHD ranged from 49% to 59%, while specificities ranged from 81% to 87%. One study reported high positive predictive power (83-87%) and low negative predictive power (59-61%), while another reported low positive predictive power (20-37%) and high negative predictive power (72-88%). As is evident from Hall's review, data on the GDS varies greatly; at this time, it may be used to help understand a child's abilities in the particular areas measured, but its poor stability warrants that clinicians use the test with hesitancy.

Overall, research on CPTs does not widely support their use in the diagnosis of ADHD. Psychometric statistics vary greatly from study to study, making conclusions difficult. CPTs generally show poor ability to discriminate between ADHD groups and controls, and poorer ability to discriminate between ADHD and other clinical populations. In general, CPTs may be used as a supplement in ADHD evaluations to better understand the abilities of participants, but the administration and interpretation of these measures should be completed with caution.

Structured interviews and observation schedules. Five articles from the database search covered structured interviews or observations for ADHD evaluations. The clinical interview is often the most important part of an ADHD evaluation, as it gives the clinician the opportunity to gain a full picture of the child's symptoms as well as their context (Barkley, 2006). This can include clarifying what symptoms look like, when and where symptoms are occurring, and how they affect the child, as well as assessing for comorbid or differential diagnoses. Structured interviews add standardization to psychological evaluations, and ensure that all of the right questions are being asked. While there is no doubt that clinical interviewing in ADHD evaluations is essential, commercially made structured interviews for ADHD are not popular, so research in this area in limited. Behavioral observations can contribute significantly to ADHD evaluations as ADHD is a behavioral disorder by definition. Structured forms of observation, called observation schedules, can be helpful in evaluations for ADHD. Observation schedules provide rules for coding certain behaviors and give a score to help reach diagnostic decisions.

Green and colleagues (2010) reported on the Composite International Diagnostic Interview Version 3.0 (CIDI; Kessler & Ustun, 2004) in adolescents. The researchers reported very low sensitivities (16-35%) of the CIDI to ADHD when compared to the number of ADHD cases identified by the Kaufman Schedule for Affective Disorders and Schizophrenia (K-SADS; Kaufman et al., 1997). This low sensitivity suggests that the CIDI does not have sufficient questions to screen for ADHD, and that more detailed interviews may be necessary (Green et al., 2010).

Bunte and colleagues (2013) looked at the use of the Disruptive Behavior Diagnostic Observation Schedule (DB-DOS; Wakschlag et al., 2008) for ADHD evaluations in preschool children. They reported that the mean Cronbach's alpha of the three score domains was 0.82. Inter-rater reliability was excellent at 0.92. Scores on the ADHD domain correlated significantly with parent and teacher ratings on ADHD questionnaires. Using a predetermined cutoff on the ADHD domain, the DB-DOS had a sensitivity of 87% and specificity of 79% for ADHD. The DB-DOS appears to be a clinically useful and reliable measure to add support to or rule out ADHD diagnoses (Bunte, Laschen, et al., 2013).

In the same study, Bunte and colleagues (2013) tested a semi-structured interview—the Kiddie-Disruptive Behavior Disorder Schedule (K-DBDS; Keenan et al., 2007)—in the same population. Internal consistency was reported to be "good," though specific numbers were not reported. Inter-rater reliability was between 99% and 100%. Like the DB-DOS, the K-DBDS showed significant correlations with parent and teacher symptom ratings. The K-DBDS gives the option of a qualitative or specific coding method. The qualitative coding method is quicker and adds efficiency to the evaluation;

its sensitivity for ADHD-HI was 83% and specificity was 98%. The authors noted that the K-DBDS could not identify ADHD-IN, and could not discriminate between ADHD-HI and ADHD-C, making it a less clinically useful measure (Bunte, Schoemaker, Hessen, van der Heijden, & Matthys, 2013).

McConaughy and colleagues (2010) looked at the incremental validity of the Test Observation Form (TOF; McConaughy & Achenbach, 2004) and Direct Observation Form (DOF; McConaughy & Achenbach, 2009) from the Achenbach System of Empirically Based Assessment (ASEBA) for ADHD diagnosis. The purpose of their study was to see whether behavioral observations made using the TOF and DOF could predict parent and teacher ratings on a rating scale—namely, the CBCL and ADHD Rating Scale-IV (ADHD RS-IV; DuPaul, Power, Anastopolous, & Reid, 1998). The TOF was completed by a psychologist in a clinic setting, and the DOF was completed in a classroom by the child's teacher. Internal consistency of the TOF ranged from 0.74 to 0.94, while inter-rater and test-retest reliabilities were low to moderate. On the DOF, internal consistency ranged from 0.49 to 0.87; inter-rater reliabilities were moderate, and test-retest reliability was low to moderate. Overall results of the study indicated that the scores on the observational measures did not contribute significant unique variance to predictions of parent and teacher ratings, and thus did not add useful information to the evaluation (McConaughy et al., 2010).

Miyahara and colleagues (2014) aimed to find out whether ADHD could be diagnosed using a quantitative measure of hyperactivity. For their study, they used actigraph measures attached to the child's waist and nondominant ankle. The children wore the actigraph measures for two hours on each of two days of neuropsychological

testing. The researchers tested the children on two days one week apart to determine whether activity levels remained stable. On the first day, children with ADHD and normal controls were equally active. On the second day, children with ADHD were significantly more active. Researchers were able to discriminate between ADHD and control 70% of the time using scores from the second-day waist measure only. Measurements from the first day and measurements on the ankle were not useful. This study revealed that this type of activity measure was not very reliable and had low accuracy in classifying ADHD versus controls (Miyahara, Healey, & Halperin, 2014).

Based on current research, neither structured interviews nor structured observation methods, potentially with the exception of the DAYAS observation component, offer incremental validity beyond rating scales. While there is no doubt that interviews and behavioral observations are essential in ADHD evaluations, informal and unstructured versions of these methods may well be more practical and efficient, and may contribute significantly to treatment development and monitoring.

Biological tests. Numerous claims have been made stating that ADHD can be diagnosed by looking at biological measures such as blood oxygenation levels, prefrontal brain activation, and electroencephalograms (EEGs). However, these claims have largely been proven false by the research. Liechti and colleagues (2013) attempted to use resting EEGs to discriminate between children with ADHD and controls; however, they found that they were only able to make this distinction 53% of the time, deeming this measure useless for diagnosis (Liechti et al., 2013). González-Castro and colleagues (2013) had slightly more success using measures of blood oxygenation and electrical activation in the brain (González-Castro, Rodríguez, López, Cueli, & Álvarez, 2013). They reported

that the amount of variance explained by blood oxygenation measures varied from 38% to 54%, and variance explained by differences in EEGs ranged from 57% to 62%. The same authors collaborated on a similar study which found that brain activation measures such as EEG correlated with EF measures, and could help to identify ADHD (Rodríguez, González-Castro, Cueli, Areces, & González-Pienda, 2016). Sato and colleagues (2012) looked at measures of amplitude of low frequency fluctuation (ALFF) and regional homogeneity (ReHo), but found that they only discriminated between ADHD and control just over 50% of the time (Sato, Hoexter, Fujita, & Rohde, 2012). Ferrin and Vance (2012) reported that high levels of minor neurological dysfunction measured by the Scored Developmental Neurological Examination (SDNE; Taylor, Sandberg, Thorley, & Giles, 1991) were a good predictor of ADHD (positive predictive power of 98%); however, many children with ADHD did not show high levels of dysfunction on the test, and thus negative predictive power was only 25% (Ferrin & Vance, 2012). Caudal (2011) reported on the most promising biological measure for ADHD yet—electro interstitial scans (EIS), which work by attaching electrodes to the child's forehead and measuring conductivity of neural pathways. Significantly higher conductivity in children with ADHD allowed the researcher to discriminate between ADHD and control with rather high accuracy—sensitivity was 98% and specificity was 80% (Caudal, 2011).

Based on research reviewed, biological measures do not appear particularly helpful for diagnosing ADHD at this time. With the possible exception of Caudal's (2011) EIS system, biological measures are generally not able to classify ADHD versus control with adequate accuracy. In addition, biological measures such as these tend to be expensive, unavailable in outpatient clinic settings, and overall impractical. Their clinical

utility has not been proven high enough to begin incorporating biological measures in routine ADHD evaluations.

Conclusion on measures. There are currently a multitude of measures available claiming to be useful in diagnosing ADHD; however, some are certainly more qualified than others. Broadband screening measures are useful when referral questions are vague, or when there are concerns about comorbid disorders; the BASC-3 (Reynolds & Kamphaus, 2015), CBCL and TRF (Achenbach & Rescorla, 2001) appear to be the most clinically useful of the screening measures available. When ADHD is determined to be likely, ADHD-specific (narrow) rating scales should be used; our review found that the most reliable and clinically useful narrow rating scales include the CADBI (Burns et al., 2001), the ASQ (Conners, 1990), the SWAN scale (Swanson et al., 2012), the Conners 3 (Conners, 2008), the Vanderbilt rating scales (Wolraich et al., 1998), and the ADHD RS-5 (DuPaul, 2016). Measures of functional impairment are necessary to include in evaluation; when rating scales do not include impairment scales, an additional functional impairment measure, such as the Weiss (Weiss, 2010), may need to be administered. When it comes to rating scales, teachers are generally the best raters, followed by parents, and, starting in adolescence, the children themselves.

EF measures can help contribute useful information to ADHD evaluations; while EF tends to be impaired in children with ADHD, and thus impairment in these areas can help to confirm diagnosis, there are also many cases of children with ADHD who are not significantly impaired on EF measures. As such, reliance on these data sources may result in false negatives (i.e., inaccurately ruling out ADHD due to average EF scores). The same is true for CPTs—while poor performance on CPTs can indicate ADHD, it can also

indicate other clinical disorders such as ODD or SLD, and some children with ADHD may perform at a comparable level to controls. CPT data may result in an increase in false positives given that children with related conditions such as ODD may also be flagged as having ADHD due to CPTs' low accuracy in discriminating between clinical populations. Interviews and behavioral observations are a necessary part of ADHD diagnosis; however, they can generally be done informally and do not require a structured format to be useful. Lastly, biological measures have been proposed for ADHD diagnosis; however, these measures are generally impractical and not available where ADHD evaluations are conducted.

Differential Diagnosis

Five articles from the database search covered differential diagnosis of ADHD. As discussed previously, differential diagnosis of ADHD in children can be difficult as the symptoms often present similarly to other disorders. Common disorders presenting similar to ADHD include ASD, ODD, SLD, Bipolar Disorder, and anxiety disorders. In addition to articles produced by the database search, we review Barkley's (2006) tips to differentiating these disorders from ADHD. We also review one article about differentiating between children with ADHD and children with EF deficits not associated with ADHD.

Buhler and colleagues (2011) attempted to differentiate ASD from ADHD using measures of inhibitory control and theory of mind. Theory of mind measures included a facial emotion recognition task and a social attribution task. The authors found that children under ten with ADHD performed significantly better than same-age children with ASD on the emotion recognition task, whereas children ten years or older with

ADHD performed at the same level as same-age children with ASD. Children with ADHD in both age groups showed lower levels of inhibitory control than children with ASD. Buhler's research suggests that ADHD can be differentiated from ASD in children below ten with low scores on inhibitory control and average scores on emotional recognition tasks, versus children with ASD who tend to have average scores on inhibitory control and low scores on emotional recognition (Buhler, Bachmann, Goyert, Heinzel-Gutenbrunner, & Kamp-Becker, 2011).

Gupta and Kar (2010) proposed and tested a system of cognitive EF measures to differentiate ADHD from similar disorders, particularly ODD (Gupta & Kar, 2010). Their system included the stop-signal task, attentional disengagement task, attentional network task, and delay aversion task; these four tasks measured behavioral inhibition, ability to switch tasks, executive control of attention, and negative emotional reactions to delay, respectively. The tasks provided a total of seven parameter scores; the authors reported that using scores on all seven parameters allowed them to correctly classify children as ADHD, ODD, or normal control in 97% of cases. Using a more reasonable combination of four parameters still gave a high overall classification accuracy of 89% to 95%, depending on parameters used. This study reveals that ADHD and ODD can be reliably differentiated using the combination of particular measures of EF. Children with ADHD tend to perform more poorly than children with ODD on all abilities measured. Barkley (2006) noted that children with ODD without ADHD lack impulsive behaviors, problems with sustained attention, and restlessness associated with ADHD. Barkley also indicated that, regarding task completion, children with ODD will resist beginning tasks, whereas children with ADHD may readily begin a task but have difficulty completing it. Lastly,

Barkley stated that children with ODD have the ability to cooperate and complete tasks when motivated, whereas children with ADHD may not (Barkley, 2006).

Yochman and colleagues (2013) looked at differentiation of ADHD and Sensory Modulation Disorder (SMD). They found that these disorders could be easily discriminated using sensory measures such as those of perceived pain intensity, tactile processing, vestibular processing, taste processing, and olfactory processing, with children with SMD having significantly more difficulties in these areas than children with ADHD. The researchers found that the two groups did not differ on measures of attention or level of participation in social activities (Yochman, Alon-Beery, Sribman, & Parush, 2013).

Kernberg and Yeomans (2013) briefly discussed differential diagnosis of ADHD and Bipolar Disorder. While hyperactivity associated with ADHD can appear similar to manic behaviors associated with Bipolar Disorder, the authors stated that the two disorders can be differentiated by the cyclic nature of Bipolar Disorder and presence of depressive episodes (Kernberg & Yeomans, 2013). According to Barkley (2006), Bipolar Disorder in children is often characterized by persistent irritability and unpredictable explosive outbursts not seen with ADHD (Barkley, 2006). Barkley also noted that onset of Bipolar Disorder symptoms tends to be later than ADHD symptoms, and that children with Bipolar Disorder are more likely than children with ADHD to have pressured speech, psychotic symptoms, suicidal ideation, and family history of Bipolar Disorder.

Alloway and colleagues (2009) compared a group of children with ADHD-C with a group of children with working memory (WM) impairments with no ADHD, to determine their differences. They found that children in both groups performed

comparably on the CCPT-II (Conners, 2000) and Working Memory Rating Scale (WMRS; Alloway, Gathercole, & Kirkwood, 2008). The researchers were able to differentiate between groups using the Conners' Teacher Rating Scale (CTRS; Conners, 1997), on which children with ADHD were elevated on all subscales while children with WM impairment were elevated only on the cognitive problems/inattention scale. The groups also differed on the BRIEF (Gioia et al., 2000); the ADHD group showed elevated impairment on all eight subscales, and the WM-impaired group showed impairment on only three subscales. Using the subscales with the highest differences between groups, the CTRS correctly classified 63% of the ADHD and 80% of the WM-impaired group, while the BRIEF correctly identified 67% of the ADHD group and 76% of the WM-impaired group. This study highlighted the difficulty of differentiating between children with ADHD-C and children with WM impairment without ADHD; the researchers revealed that using a behavioral or EF rating scale only differentiated the groups with moderate accuracy. As the study used only children with ADHD-C, it is expected that differentiating WM-impaired children from children with ADHD-IN would be even more difficult; more research is needed on the differentiation between these groups (Alloway et al., 2009).

Barkley (2006) also provided tips on how to differentiate ADHD from SLD and anxiety disorders. For a diagnosis of SLD, children must meet the criteria of having a significant discrepancy between IQ and achievement in at least one area or experience failure in response to primary and secondary interventions (APA, 2013). Barkley (2006) indicated that attention problems in children with SLD arise only when completing certain tasks or working on specific subjects, versus children with ADHD, who have

attention deficits across contexts. Children with SLD without ADHD are not impulsive, do not display disruptive behaviors, and do not have a history of hyperactivity. To differentiate ADHD from anxiety disorders, Barkley suggested that children with anxiety disorders tend to have difficulty focusing attention, but not as much difficulty sustaining it. Like with SLD, children with anxiety disorders without ADHD are not impulsive, and do not have a history of disruptive or hyperactive behaviors. Lastly, Barkley noted that restlessness associated with anxiety disorders can be described as worrisome and panicky behavior, unlike restlessness associated with ADHD, which tends to be due to overstimulation (Barkley, 2006).

Construct Irrelevant Influences

Seven articles covering construct irrelevant influences for ADHD diagnosis were found by the database search. Topics included influence of assessment measure, malingering, relative immaturity, ADHD in gifted children, ADHD in children involved in child protective services (CPS), and ADHD in children with ID.

Posserud and colleagues (2014) pointed out the simple fact that ADHD diagnosis can depend on which assessment measures are given. In their study using an adapted version of the SDQ (Goodman, 1997) and SNAP-IV (Swanson et al., 2012), the Development and Well-Being Assessment (DAWBA; Goodman, Ford, Richards, Gatward, & Meltzer, 2000), and the K-SADS (Kaufman et al., 1997), they found that the number of diagnoses made based on each measure differed significantly. The DAWBA diagnosed the fewest children, indicating that it was the least sensitive to ADHD. However, the DAWBA was also the most specific, with a specificity of 97%. As has been made clear in this review, some measures have more diagnostic accuracy than others. In

order to contribute to accurate diagnostic decisions, measures must be both sensitive and specific. Measures with low accuracy for ADHD diagnosis should not be given consideration in diagnostic decisions (Posserud et al., 2014).

Malingering is an issue in ADHD diagnosis, as parents often want the best for their children, and may exaggerate their symptoms so that they may receive certain services. Norfolk and Floyd (2015) designed a study in which they had participants respond to the Conners 3 (Conners, 2008) with the goal of having their hypothetical child diagnosed (group 1) or not diagnosed (group 2) with ADHD. The researchers then looked at the validity scales of the measure to see if they could detect parents either "faking bad" or "faking good," by comparing them positive controls (parents of children with ADHD) and negative controls (parents of children without ADHD), respectively. They found that parents faking bad scored significantly higher than positive controls on the Negative Impressions (NI) scale; a score of 3.3 on the NI scale had a sensitivity of 54% for malingerers, with a specificity of 83%. However, the authors found that the Positive Impressions (PI) scale was not able to differentiate those faking good from negative controls better than chance. This study revealed that it is relatively easy to fake a diagnosis of ADHD, with only 54% chance of being detected; on the other hand, it is even easier to fake the absence of an ADHD diagnosis with very little chance of being caught. These results highlight the importance of detailed interviewing, behavioral observations, and multiple informants to confirm the validity of symptoms, as rating scale validity measures are not always sufficient (Norfolk & Floyd, 2016).

As discussed in the introduction of this paper, the relative immaturity hypothesis says that children born just before school entry cut-off dates, who are therefore the

youngest in their class, are more likely to be diagnosed with ADHD due to appearing more immature than their classmates. However, a study by Biederman and colleagues (2014) reported findings contrary to this hypothesis. Using two groups of children born just one month apart but who began school one year apart due to cut-off dates, the researchers found that the two groups were comparable on prevalence of ADHD diagnosis, number of ADHD symptoms and level of impairment, and prevalence of comorbid disorders. Due to ambiguousness of data related to this hypothesis, more research is needed to be able to confirm or deny its validity (Biederman, Petty, Fried, Woodworth, & Faraone, 2014).

Two articles from the database search covered diagnosing ADHD in gifted children. Wood (2012) looked at Conners 3 parent and teacher ratings of gifted children suspected of having ADHD due to performing at a low level relative to IQ. Findings of the study revealed that, on average, parents and teachers did not rate the children as elevated on ADHD subscales or deficient on EF measures; however, high variability and skewed distribution were found. Wood found that correlations between parent and teacher ratings were lower than those in the normative sample. The author suggested that the development of specialized norms for gifted children may be necessary to accurately measure ADHD in this population using rating scales such as the Conners 3 (Wood, 2012). Mullet and Rinn (2015) conducted a review of the literature on ADHD in gifted children. Their findings revealed how, when the two conditions occur together, they can interact to create a unique presentation of symptoms, making both conditions difficult to detect. They also noted that the two conditions often cannot be differentiated using behavior rating scales, as the presentation of symptoms can be very similar. CPTs and

other EF are often not sensitive to ADHD in gifted children, as being gifted can mask EF deficits. The authors concluded that the best way to differentiate and/or dually diagnose the two conditions is through detailed interviewing and comprehensive psychological evaluations (Mullet & Rinn, 2015).

Klein and colleagues (2014) conducted a review of the literature on ADHD in children involved with CPS. The authors noted that children involved in CPS have generally been victims of some type of trauma or abuse, and that trauma-related disorders such as Posttraumatic Stress Disorder (PTSD) can appear similar to ADHD in children. They indicated that rates of ADHD diagnosis are higher in these children than in the general population, and that children involved with CPS are routinely treated for ADHD with psychotropic medications while underlying trauma is ignored. The authors concluded that comprehensive evaluations by a multidisciplinary team are necessary for children with trauma histories suspected of having ADHD; special care must be taken to ensure differentiation between trauma-related behaviors and true ADHD in this population (Klein, Damiani-Taraba, Koster, Campbell, & Scholz, 2015).

Deb and colleagues (2008) looked at the ability of typical ADHD rating scales to detect ADHD in children with ID. Using the CPRS-R and CTRS-R (Conners, 1997), they found that parent ratings identified ADHD with good sensitivity (90%) and adequate specificity (67%). However, they found that teacher ratings had much lower sensitivity to ADHD (69%) and equal specificity (67%). The authors noted that many of the items on the rating scales were not applicable to children with more severe forms of ID. In conclusion, the authors indicated a need for development of ADHD measures made

specifically for children with ID, as typical rating scales were not able to identify ADHD with high accuracy in this population (Deb, Dhaliwal, & Roy, 2008).

There is a need to make adjustments when assessing for ADHD in certain populations. In most cases, detailed interviewing and behavioral observations can help to identify ADHD when behavioral and EF rating scales cannot. These processes are also helpful in identifying those malingering for secondary gain. For some populations, it may be necessary to develop rating scales and/or group-specific norms in order to help accurately identify ADHD. Overall, comprehensive and multidisciplinary evaluations can help resolve issues that come up when assessing for ADHD in special populations.

Best Practice and Decision-Making Models

Recent research on ADHD has attempted to establish best practice methods for diagnosis, and add efficiency and accuracy to clinical decision-making. Ten articles from the database search discussed best practice and/or decision-making strategies for ADHD diagnosis.

Schmiedeler and Schneider (2014) looked at the diagnosis of ADHD in preschool children, a controversial topic due to the high rates of hyperactive and inattentive behaviors seen even in typically developing children at this age. The authors of this study found that when using a categorical diagnosis of ADHD (i.e., a predetermined cutoff score and yes/no decision), diagnostic decisions fluctuated within-participant based on when ratings were made. On the other hand, they found that using a dimensional approach (i.e., classifying severity of ADHD as if on a spectrum) showed that the children's symptoms remained relatively stable across time. The authors also argued that using the dimensional approach to diagnosis in preschoolers allowed for more children to

receive early treatment for ADHD, and would help to prevent later cognitive and academic deficits (Schmiedeler & Schneider, 2014).

As stated in the DSM-5, ADHD must be characterized by symptoms across settings, and thus it is necessary to collect information from the child's primary caregiver(s) as well as his or her teacher. However, the question of how to combine this information accurately when making diagnostic decisions is less clear. Valo and Tannock (2010) researched the effect of different methods of combining this information. As the authors described, there are two basic ways to combine informant reports: the OR rule, in which the child is counted as having a symptom if either the teacher OR the parent endorses it; and the AND rule, in which a symptom only counts towards the six required for diagnosis if both informants endorse it. Valo and Tannock applied these rules to subtype classification, and they observed the effect that changing these rules had on rates of diagnosis. The researchers generally found that going from OR to AND rules for subtype classification caused a significant decrease in diagnosis of ADHD-C and of ADHD overall. They concluded that ADHD diagnosis and particularly subtype classification are highly dependent on the way clinicians choose to combine informant ratings (Valo & Tannock, 2010).

Martel and colleagues (2015) proposed a third way to combine informant ratings—by averaging the raters' scores. The researchers averaged mother, father, and teacher scores on the ADHD RS-IV (DuPaul et al., 1998) per item—for instance, if a mother, father, and teacher rated a child with a 1, 2, and 3, respectively, on a given symptom, that child would be assigned an overall rating of 2 for that symptom. Comparison of this average with a predetermined cutoff score would determine whether

that symptom was included in the child's symptom count. The researchers reported that using the averaging algorithm rather than the OR or AND rules increased both positive and negative predictive power of the assessment (Martel, Schimmack, Nikolas, & Nigg, 2015). Based on these findings, it seems that averaging raters' scores may be the best model for combining informant reports at this time.

In a 2013 article, Lindhiem and colleagues developed a decision-making model for clinical diagnosis called the Posterior Probability of Diagnosis (PPOD) index (Lindhiem, Kolko, & Yu, 2013). The PPOD index provides clinicians with a number to quantify the amount of certainty or uncertainty in a diagnosis; it is, in simplest terms, the probability that a child meets criteria for a given diagnosis given the scores on his or her evaluation. The PPOD index uses item response theory (IRT) to calculate an individual's level of the trait—in this case ADHD—which is referred to as that individual's theta level. In this way, clinicians are able to provide a diagnosis (or no diagnosis) as well as a quantitative measure of the certainty of this decision. This method helps to resolve problems that come from categorical diagnosis, which arise particularly when children fall near the threshold for diagnosis. While the study in which the PPOD was developed tested the index for ODD, it is intended to be used for any DSM disorder. In fact, in 2014, Lindhiem and his colleagues produced another article in which they adapted the PPOD for use in screening, and tested the model for use in ADHD evaluations (Lindhiem, Yu, Grasso, Kolko, & Youngstrom, 2015). The PPOD index is intended to be used as a supplement to DSM diagnoses such as ADHD; its benefit is in providing clinicians and parents with an idea of the severity of the child's symptoms rather than a simple yes/no classification, in order to improve understanding and help guide treatment.

Zhou and colleagues (2017) discussed a similar method of making diagnostic decisions. This evidence-based assessment (EBA) model begins with the local base rate of the disorder; that is, if there is a 5% prevalence of ADHD in Kentucky, then there is logically a 5% chance that a given child has ADHD. When using the EBA model, scores on each assessment given would provide the clinician with a diagnostic likelihood ratio (DLR) based on the discrepancy from the cutoff point. DLRs of each score are combined with the base rate to produce a posterior probability (while this number serves the same purpose as the PPOD index, they are calculated differently). In this model, the more above-threshold scores that are combined, the higher the probability that the child has the disorder. The author of this study suggested using a cutoff of at least 80% posterior probability to make a diagnosis. This model increases accuracy and certainty in ADHD diagnoses, and is becoming more commonplace in clinical assessments (Zhou et al., 2017).

Many have suggested that the best way to diagnosis ADHD is through an interdisciplinary approach, including professionals from different fields such as clinical psychologists, school psychologists, and pediatricians (Calderon & Ruben, 2008; McGonnell et al., 2009). The Colchester East Hants ADHD Clinic in Nova Scotia provides a model for this approach. As reported by McGonnell and colleagues (2009), this clinic's ADHD evaluations include the following: classroom observation by a school psychologist, phone interview by a clinical psychologist with the child's teacher, parent interview co-led by a clinical psychologist and pediatrician, and a psychoeducational assessment battery with a school psychologist. All professionals involved then meet as a group to reach a consensual diagnostic decision. The researchers reported that, while all

children assessed at the clinic previously met criteria for diagnosis based solely on symptom rating scales, only 58% of the children assessed were diagnosed with ADHD after the full interdisciplinary evaluation. After the evaluation, 34% of children were diagnosed with a disorder other than ADHD such as ASD or SLD. This demonstrates the importance of a comprehensive interdisciplinary approach in allowing for accurate differential diagnosis (McGonnell et al., 2009).

Calderon and Ruben (2008) also advocated for an interdisciplinary approach to ADHD diagnosis. They stated that this approach is necessary due to the wide range of symptoms and impairments seen in children with ADHD; impairments on behavioral, emotional, cognitive, academic, social, and motor domains are often seen, and may require a range of professionals to properly assess them. They suggested including input from physicians, psychologists, education specialists, and social workers. In addition to an interdisciplinary approach, they emphasized the importance of a contextual approach and thorough assessment for differential and/or comorbid diagnoses. Taking a contextual approach means assessing the contexts in which symptoms or impairments are occurring, and determining any relationship between the child's environment and his or her difficulties. A contextual approach often includes naturalistic observations in school and home (or more realistically, playing with parents in a clinic play room) environments. As we have seen many others do, Calderon and Ruben emphasized assessment for differential and comorbid diagnoses due to the high rates of comorbidity with ADHD and misdiagnosis of the disorder due to shared symptoms (Calderon & Ruben, 2008).

Carroll and colleagues (2013) proposed the use of an objective, computerized decision aid for making ADHD diagnoses. This computer system, the Child Health

Improvement through Computer Automation (CHICA), aims to ensure that clinicians adhere to clinical guidelines when making diagnoses. According to the researchers, the CHICA system provides a "prescreeener" form and customizes a clinician checklist based on the child's age and other characteristics. The prescreener includes three questions designed to detect signs of ADHD; a positive answer to any of the three questions warrants further evaluation for ADHD. This further evaluation includes administration of the Vanderbilt parent and teacher forms, which can be scored by the CHICA system. The system then provides recommendations for diagnosis and treatment based on the AAP guidelines (AAP, 2011). In the pilot study of the CHICA system, clinics provided with the system improved their use of structured diagnostic assessment from 60% of the time to 81% of the time, while two control clinics not using the system dropped from using structured diagnostic assessment 50% of the time to 38% of the time. Children in the intervention group also had higher rates of follow-up assessments, referrals to mental health specialists, and medication adjustments. It is important to note that this system was implemented in a medical setting by physicians rather than by mental health professionals; however, children diagnosed using the CHICA system received frequent referrals to mental health specialists (74%) for further assessment and treatment (Carroll et al., 2013). The CHICA system provides a promising example of an efficient, accurate, and objective way to assess for ADHD in doctor's offices; however, it is still recommended that at-risk children are referred to mental health professional for thorough assessment and diagnosis.

ADHD is often diagnosed by PCPs; however, arguments can be made that PCPs are not properly trained on the presentation and implications of mental disorders and

particularly differential diagnosis to make accurate mental health diagnoses. Pritchard and colleagues (2012) provided a strong argument for thorough neuropsychological assessments for ADHD, with a comprehensive review of the literature in this area. Based on their review, the authors concluded that thorough neuropsychological evaluations by trained mental health professionals are the best way to accurately assess for differential and comorbid diagnoses and individual strengths and weaknesses, and thus allow for significantly more successful treatment for children with ADHD and/or other disorders. They concluded their review by saying that the potential benefits of neuropsychological assessments for ADHD greatly outweigh any additional cost in time, money, or resources, making it truly the best option for those experiencing symptoms of the disorder (Pritchard, Nigro, Jacobson, & Mahone, 2012).

Discussion

Research has shown that ADHD is very impactful on the lives of children who have it, as well as their families (Danckaerts et al., 2010; Kandemir, Kılıç, Ekinci, & Yüce, 2014; Mash & Barkley, 2003). Without treatment, ADHD can be detrimental to a child's social and academic life, and emotional wellbeing. Future outcomes for children with undiagnosed ADHD are highly negative (Barbaresi et al., 2013; Ingram et al., 1999; Kuriyan et al., 2013; Shaw et al., 2012). Therefore, proper diagnosis of this disorder is essential. However, diagnosis of ADHD is especially difficult in relation to other mental disorders due to high rates of comorbid diagnoses, and shared symptoms with numerous disorders such as ODD, SLD, and anxiety disorders (Barkley, 2006; Buhler et al., 2011; Gupta & Kar, 2010; Milberger et al., 1995).

The purpose of this project was to review the current literature on ADHD assessment methods to create updated best practice guidelines to add accuracy and efficiency to the process of diagnosis. These guidelines can be found in Appendix A and will be discussed herein.

Existing guidelines recommend early detection of ADHD via screening; this is consistent with Pelham and colleagues (2005) and Youngstrom and Van Meter's (2016) evidence-based assessment model. School-wide screening is ideal, but is often impractical and has low compliance rates (Barry et al., 2016). A more effective way to screen for ADHD before it becomes a concern is to ask simple screening questions such as, "Does your child often have difficulty remaining seated when asked to do so, causing problems at home or school?" at regular doctor's visits, as suggested by Carroll and colleagues (Carroll et al., 2013); PCPs would then refer children who present with

symptoms for a more comprehensive evaluation by a mental health professional. Alternatively, when a child presents to a mental health professional and clinical hypotheses relate to ADHD, broadband measures such as the BASC-3 (Reynolds & Kamphaus, 2015) or CBCL and TRF (Achenbach & Rescorla, 2001) should be completed by the child's parent(s) and teacher first, to assess for comorbid difficulties or possible differential diagnoses. This is consistent with Youngstrom and Van Meter's (2016) suggestion that psychological assessments should begin broadly, as well as Zhou and colleagues' (2017) application of the EBA model to ADHD assessment. If, after administering these measures, the child continues to show signs of ADHD (or any other clinical disorder), a comprehensive evaluation should begin.

While screening can (and should) be done by PCPs, diagnostic evaluations for ADHD should be administered by mental health professionals—typically clinical and/or school psychologists (Pritchard et al., 2012). Many suggest that using an interdisciplinary approach—which may include clinical psychologists, school psychologists, pediatricians, educational specialists, and/or social workers—is best for ADHD, as its symptoms and related impairments span the behavioral, emotional, cognitive, academic, developmental, and social domains (Calderon & Ruben, 2008; McGonnell et al., 2009).

Symptom rating scales are often the first step following positive screening. According to this review of psychometric properties, the best symptom rating scales for ADHD include the Conners 3 (Conners, 2008), the Vanderbilt parent and teacher rating scales (Wolraich et al., 1998), the ADHD RS-5 (DuPaul et al., 2016), and the CADBI (Burns et al., 2001). Teachers are considered to be the most accurate and reliable raters of ADHD symptoms, but ratings should also be collected from parents to assess for

persistence of symptoms across contexts (Granero et al., 2008). Beginning in late adolescence (around age 13), it is also helpful to include the child's self-report (Granero et al., 2008). As discussed by Martel and colleagues (2015), one potential way to combine ratings from multiple informants, as is necessary in ADHD evaluations, is to average the raters' scores on each item. Effectively, this results in a compensatory gating system rather than a multiple gating system, which has the potential to reduce false negatives.

Symptom rating scales are helpful in ADHD evaluations, but should not be the sole basis for diagnosis (NCCMH, 2009). Rather, detailed clinical interviews with the child's parent(s) and, if possible, his or her teacher provide a better picture of the child's symptoms and impairments, and the contexts in which they are occurring (e.g., Barkley, 2006; Pliszka, 2007). Parent interviews should be sure to cover the child's developmental and brief medical history, social and academic history, as well as family history (Barkley, 2006; Carroll et al., 2013; Pliszka, 2007). Depending on the age of the child, it may be appropriate to interview him or her as well (Barkley, 2006; NCCMH, 2009). Behavioral observations by the clinician, which can be unstructured, should also be included in the evaluation.

There is debate over whether further neuropsychological testing is essential for ADHD diagnosis (NCCMH, 2009; Pliszka, 2007; Pritchard et al., 2012). However, Pritchard and colleagues (2012) strongly argued for its utility. Neuropsychological testing can include CPTs, EF measures, and IQ and achievement testing. While IQ and achievement testing are not necessary to diagnose ADHD, it is recommended that they are completed due to high rates of comorbidity between ADHD and SLD. Utility of CPTs

and EF measures for diagnosing ADHD varies, but is generally low to moderate (see corresponding subsections of Measures section). These types of measures may be used to gain additional information on the child's abilities and impairments in these areas but should not be relied on for diagnosis; furthermore, their use for treatment development is not clear. Acceptable examples of these measures include the TOVA (Leark et al., 2007), QbTest (Knagenhjelm & Ulberstad, 2010), and BRIEF2 (Gioia et al., 2015). At this time, there is not enough evidence to support the use of biological measures such as brain scans for the diagnosis of ADHD (e.g., Sato et al., 2012), and no blood-based testing is currently approved for diagnostic use.

A large part of comprehensive ADHD evaluations should be assessing for comorbid or differential difficulties (e.g., Delavarian et al., 2012; Milberger et al., 1995; Pliszka, 2007). Symptoms of similar disorders such as ASD, ODD, SLD, anxiety disorders, and bipolar disorder should be assessed in the clinical interview. Indication of any of these disorders in the interview or broadband screening measure warrants further testing for these disorders. Thus, clinicians assessing for ADHD should be knowledgeable in these additional areas.

There are particular populations that require special considerations when being assessed for ADHD. Gifted children, children with trauma histories, and children with ID may show ADHD-like symptoms, but these symptoms are likely to be manifestations of other conditions (Deb et al., 2008; Klein et al., 2015; Mullet & Rinn, 2015; Wood, 2012). However, children and adolescents who present with ADHD-related symptoms that are severe and significant beyond that expected for these other disorders may benefit from targeted treatment, and thus a diagnosis of ADHD may be warranted. On the other hand,

ADHD may be difficult to detect in these populations due to shared symptoms and/or masking of the ADHD by more prominent difficulties. In addition, special care should be taken to ensure that children entering school earlier than others are not diagnosed with ADHD solely based on their relative immaturity or developmental level (Merten et al., 2017).

When it comes time to make diagnostic decisions, recent research has indicated that an EBA model should be used (Youngstrom & Van Meter, 2016; Zhou et al., 2017). This model includes using diagnostic likelihood ratios and posterior probabilities to provide a degree of certainty or uncertainty in diagnoses. Zhou and colleagues (2017) suggested using a cutoff of at least 80% posterior probability to make a diagnosis of ADHD. A quantified posterior probability provides the clinician and parents with an indication of how likely it is that the child truly has ADHD, improving understanding of the diagnosis and helping to guide treatment. Lindhiem and colleagues (2013) developed the PPOD index to serve the same purpose. However, few instruments currently provide the data to statistically calculate such indices. While this is considered to be best practice, is it also not commonly available at this time.

Limitations

This study was limited by the availability of data on clinical utility, reliability, and validity of current measures for ADHD. Differing statistics reported from measure to measure at times made it difficult to compare the utilities of those measures. Lack of data on some measures made conclusions as to their utility difficult or impossible. While this limits the ability of the review to discuss their potential, it can also be argued that the use of such instruments in the absence of readily available reliability, validity, and diagnostic

accuracy data is in violation of the *Standards for Educational & Psychological Measurement* (AERA, APA, & NCME, 2014).

Another potential limitation was the key terms chosen. Alternative terms may have resulted in alternative articles identified, which could have altered the results of this review. Further, searching only articles available in full text may have limited results. That said, replication of this project to include alternative terms, alternative databases, and additional years would be valuable.

Directions for Future Research

The logical next step for this project would be to create updated guidelines for ADHD treatment. While the current review and new assessment guidelines are intended to add accuracy to diagnosis, the purpose of assessment and diagnosis is largely to guide treatment. When updating treatment guidelines, an evidence-based treatment model should be used (Pelham & Fabiano, 2008). New treatment guidelines should include psychopharmacological as well as psychosocial interventions.

It is also suggested that more research be done as to the clinical utility and psychometric properties of assessment measures for ADHD. This should include internal consistency, inter-rater reliability, test-retest reliability, discriminative and convergent validity, sensitivity and specificity, and positive and negative predictive power. Too little information regarding the diagnostic accuracy of instruments is readily available to clinicians. It is important that clinicians have accurate information about the measures they are using in order to make informed decisions.

Further, more research regarding posterior probability should be conducted, especially as it pertains to the dissemination and implementation of these strategies for

diagnostic purposes. For instance, posterior probability is often determined via nomographs in evidence-based medicine; nomograph software pre-loaded with data about base rates of ADHD and diagnostic accuracy data from commons instruments may facilitate the use of these strategies.

Conclusion

Guidelines based on the results of this review were compiled and can be found in the Appendix. It is recommended that these guidelines be considered by all clinicians completing ADHD evaluations. Essential takeaways of this review are as follows: (a) ADHD evaluations should be conducted by an individual trained extensively in child and adolescent mental health care; as PCPs often do not have this training, a mental health professional is preferred; (b) the scientific evidence-based assessment model using posterior probabilities should be applied for the most accurate diagnostic decisions; (c) assessment for differential and comorbid diagnoses is necessary in ADHD evaluations; (d) detailed parent interviews should also be included, and information should not come solely from rating scales; and (e) CPTs and other EF measures may contribute useful information regarding the child's strengths and weaknesses, but should not be relied on to diagnose ADHD.

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APPENDIX: Best Practice Guidelines for ADHD Diagnosis

Phase one: Screening

* Brief screening for ADHD should be completed by PCPs at regular doctor's visits. This can be done by asking simple questions such as "Does your child often have difficulty remaining seated when asked to do so, causing problems at home or school?" Children who screen positive (parent answers "yes" on one or more screening question) should be referred to a qualified mental health professional or evaluated by an interdisciplinary team including a mental health professional.
* Upon referral to a mental health clinic, clinicians should begin assessment with a psychometrically strong broadband screening measure, such as the BASC-3, that can assess for comorbid or differential difficulties in addition to ADHD. These should be completed by the child's parent(s) and teacher. Older adolescents and teens can also contribute self-report ratings.

Phase two: Comprehensive assessment

* Positive screening for ADHD necessitates a comprehensive diagnostic assessment. Elevations on any other clinical scales should guide further assessment for comorbid or differential difficulties. When possible, an interdisciplinary approach should be taken, including a medical examination.
* Assessment should continue with a parent interview. This interview should cover frequency, severity, presentation, and context of the child's symptoms; discuss the child's developmental, medical, social, academic, and family histories; and screen for commonly comorbid disorders. Particular focus of this portion of the interview should relate to any problems indicated by the broadband screening measure. Parent

interviews are necessary for best-practice assessments; teacher interviews are ideal but not always practical. Depending on the child's age and developmental level, it may be helpful to interview him or her as well.

* Psychometrically strong narrow rating scales should always be completed by the child's parent(s) and teacher. Adolescents and teens should also complete a self-report scale. Suggested measures include the Conners 3, the Vanderbilt ADHD Rating Scales, and the CADBI. Information from multiple sources may be combined by averaging informants' ratings on each item.
* Ideally, IQ and achievement testing should be completed to assess for cognitive difficulties and/or SLDs. Further neuropsychological testing is optional, as it can contribute information about the child's abilities and impairments; however, CPTs and other EF measures should not be used to make diagnostic decisions.

Phase three: Diagnosis

* Special attention should be given to gifted children, children with trauma histories, and children with ID to ensure ADHD diagnoses are appropriate and not due to manifestations of underlying conditions.
* When combining information from ADHD evaluations, an EBA model should be used when possible. It is suggested that children receive a diagnosis of ADHD if posterior probability reaches 80% or higher.