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# Which Methods of Treating Attention Deficit Hyperactive Disorder are Most Effective and Most Closely Match Patient Lifestyle?

By Yehudit Erlbaum

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## Abstract

ADHD, attention deficit hyperactive disorder, is a disorder characterized by hyperactivity, inattentiveness, inability to remain on task, fidgetiness, and impulsivity. An over absorption of dopamine by the dopamine transporters leads to a lack of dopamine, the inhibiting neurotransmitter in the brain, resulting in the inability for the individual to inhibit their impulses. The disease is most likely seen in children but may continue into adulthood. The length of the disease across the individual's life span, results in expensive treatment, whether it be medication or Cognitive Behavior Therapy, CBT. Therefore, these medical costs have caused researchers to find the most efficient drugs to provide the ADHD patients with the most effective, cost effective, and beneficial results. Different individuals require different treatment options, whether it be due to sex, age of onset, socioeconomic group, and attitude toward medication. This paper will provide an overview of the different treatment options with their side effects, causes and remedies.

## Introduction to ADHD

Attention deficit hyperactivity disorder (ADHD) is a disorder most commonly seen in children and adolescents, but also may present or persist into adulthood. It is a neurocognitive behavioral disorder that presents with symptoms of maladaptive behaviors such as impulsivity and or hyperactivity, the inability to pay attention and remain on task. ADHD is also associated with other maladies such as, mood disorders and learning disabilities (Journal of Attention Disorders, 2014). ADHD is costly because it is usually diagnosed in childhood and may become a lifelong disorder that causes a wide range of symptoms. In addition, children with ADHD have been shown to be more likely to sustain major injuries and need both inpatient and outpatient emergency care. Median medical costs for children with ADHD were double those of children without the disorder when studied over a nine year period.

Because of its prevalence amongst American children and adults and its high cost to the health care system, treatment of ADHD is important. Today, many treatments are available, these may include, behavioral as well as pharmaceutical therapies. Medications available range from non-stimulant options to stimulants available in both extended release, long acting or traditional dosages (Journal of Attention Disorders, 2014). This paper will attempt to understand the causes of ADHD on a neurological level and evaluate possible treatment options, analyzing how physicians may be better able to match treatment to a patient lifestyle and disease.

## What is ADHD?

ADHD, attention deficit hyperactivity disorder, is a neurobiological developmental disorder that is characterized by the inability to remain on task, difficulty to remain focused and the tendency to be overly energetic with impulsive behaviors. It is most commonly found in school-age children but can frequently continue into adulthood. ADHD is a widespread disease, having been found in all countries surveyed with a prevalence of about 7-8%

of youths and 4-5% of adults. Furthermore, interestingly enough, ethnicity did not seem to be a factor in the frequency, however, social groups, were found to be most likely to play a role in the diagnosis (Journal of Attention Disorders, 2014).

ADHD, attention deficit hyperactivity disorder, is broken up into three different categories, ADHD-I; ADHD, Predominantly Hyperactive-Impulsive Type; and ADHD, Combined Type: Inattentive and hyperactive/impulsive. ADD, attention deficit disorder, is an alternate name for ADHD-I, the first type of ADHD. ADHD is the broad term for the hyperactive, inattentive disease and ADD is a classification of ADHD. Firstly, ADHD-I, also known as ADD or ADHD-Inattentiveness, is diagnosed by the inability to keep on task or follow and understand instructions. Furthermore, children with ADD tend to make careless mistakes and use minimal effort in accomplishing difficult tasks. Additionally, the ADHD Predominantly Hyperactive-Impulsive Type is categorized by the individual suffering with the symptoms of hyperactivity, such as, fidgeting, squirming, trouble playing quietly or interrupting constantly. Lastly, the combined type of ADHD is characterized by a pattern of inattentiveness and over activity. Meaning, an individual with the combined type of ADHD will exhibit symptoms of fidgetiness, and inability to concentrate and remain seated, in addition to, signs of constant distraction and failure to remain on task (diffen.com).

## Causes of ADHD

Attention deficit hyperactive disorder can be triggered by many matters. For instance, ADHD is mainly prompted by genetics, but, it can also be the result of the environment or specific brain injuries. Firstly, many studies have proven heritability to be the most common cause of ADHD. Genes can have the greatest impact on one's children, whether it means passing down an advantageous trait, or passing down a disease, such as ADHD (myadhd.com). Family studies were performed in order to find the relationship between ADHD and genetics. Results have shown that 25% of closely-related family members with ADHD also have the disease.

Furthermore, adoption studies and twin studies were done in order to support the idea that ADHD is genetically related. If ADHD was not genetic, then adopted children should further resemble their adopted parents than their biological. However, reports have shown that adopted children are more similar to their biological parents, further supporting the point. Twin studies, have shown similar results. Identical twins contain the same genetic materials as each other, and therefore, if one twin has the disease, the other twin does as well. The last study that was done on ADHD patients, was molecular genetic research. Molecular genetic research focuses on the specific genes related to the transmission of ADHD. DAT1 and DRD4 are two dopamine genes that were discovered to have the biggest effect on ADHD gene transmission (myadhd.com).

Additionally, exposure to toxicity can be another cause of ADHD. A relationship has been found between mothers who have smoked tobacco or intoxicated in alcohol during pregnancy, and the probability that learning disabilities and ADHD will develop in their child. Furthermore, lead exposure or poisoning in early years of childhood can have negative effects on the child's progress and advancement. The last, atypical, cause of ADHD can be a head or brain injury. Although somewhat unlikely, tumors, traumas, strokes or diseases can also result in ADHD as well (myadhd.com).

### **ADHD and the Science of the Brain**

Current research has proven that the causes of ADHD are highly related to many dysfunctions of neurotransmitters and of regions in the brain. A highly essential neurotransmitter, dopamine, has proven to have an effect in ADHD, as well as, the prefrontal cortex which requires high amounts of dopamine in order to function. Dopamine is a significant inhibiting neurotransmitter; meaning, that it plays a major role in preventing certain impulses in the brain, and ultimately, preventing the causes of ADHD (dnalc.org). Dopamine transporters are found to be responsible for the lack of dopamine in the brain since they absorb too much dopamine, disabling it to transfer from one brain cell to another, thereby causing a dopamine deficiency in the brain. The basal ganglia, a collection of nuclei located throughout the brain, also suffer from the lack of dopamine, DA, present in the brain. The basal ganglia are responsible for motion or normal voluntary movement and are excited by dopamine transmitters. Therefore, a lack of dopamine also effects the role of the basal ganglia, causing ADHD. When the levels of dopamine are low, there are high risks for attention deficit hyperactivity disorder because the main neurotransmitter which inhibits impulses is lacking (dnalc.org).

Therefore, the ADHD drugs are specially designed and intended to bind to a dopamine transporter with their nitrogen, oxygen

or carbon atom, enabling it to transfer the dopamine to the brain. The nitrogen and oxygen atoms are surrounded by at least one lone pair which assists in the formation of a hydrogen bond to the dopamine transporter. However, although the carbon atom is lacking such a lone pair, it has interestingly been discovered that it too can form a bond to the dopamine carriers (dnalc.org).

The question still remains, however, how do the ADHD drugs increase the levels of dopamine in the brain by binding to the dopamine transporters? There are three known mechanisms that ultimately inhibit the rise of dopamine in the brain. The dopamine rapidly diffuses into the synapse causing the dopamine transporters to bind to the dopamine and positioning it throughout the nerve cell membrane. Then, extracellular action of dopamine on the auto receptors of the neuron, consequently inhibit the further release of dopamine. Thus, the dopamine stimulating drugs are aimed to prevent the uptake of dopamine by the neurons so that extracellular action will not occur. Furthermore, the drugs can promote additional dopamine release. For example, either the drug can bind to the dopamine transporters hindering it from bringing the dopamine into the neuron. Or, other forms of the drug can excite the release of more dopamine (Molecular Psychiatry, 1998).

Additionally, the prefrontal cortex and its association with further brain regions, such as the striatum, cerebellum are found to be slightly smaller or less active in ADHD victims. Furthermore, the frontal lobe, basal ganglia, and the caudate nucleus, are also related to ADHD and they too play a significant role in regulating behavior. Studies of animals have shown that the prefrontal cortex has a responsibility in regulating behavior and attention, as well as, understanding representational data (sciencedaily.com). Researchers were not surprised to find a smaller prefrontal cortex in patients with ADHD due to the fact that the prefrontal cortex is critical in providing and dividing attention, and inhibiting distractions. Therefore, it was understood why the MRI's of ADHD victims exhibited significantly smaller prefrontal cortexes.

### **Treatment of ADHD: Stimulant vs. Non-Stimulant Drugs**

Treatments for attention deficit hyperactive disorder include pharmacological approaches, as well as, non-pharmacological care. When treated pharmacologically, the patients are cared for using specific prescriptions of drugs that provide them relief from their symptoms. Most often, stimulant drugs, drugs that arouse activity in the brain, are used as pharmacological treatments. However, non-stimulant medications can be used as well (Journal of Attention Disorders, 2014).

## Treating Attention Deficit Hyperactive Disorder

Psychostimulants are stimulant drugs that are psychoactive, meaning, they temporarily generate mental and physical functions in the brain such as increased awareness and attentiveness (Molecular Psychiatry, 1998). Current psychostimulants include D-amphetamine, D, L-amphetamine, Magesium pemoline, Methylphenidate, dexamethylphenidate, mixed amphetamine salts and lisdexamfetamine dimesylate (LDX). Surprisingly, the structural composition of these molecules are all different, however, share a common backbone of phenyl-ethylamine with endogenous catecholamines, such as, norepinephrine and dopamine. Uptake of the psychostimulant drugs provide the brain with significant dopamine, thereby enabling the inhibition of impulses (Molecular Psychiatry, 1998).

Methylphenidate, is an example of a short acting, central nervous system, stimulant drug for children and adults. They have an onset of approximately 30-60 minutes and remain in action for about 2-5 hours. Methylphenidate regularizes certain brain functions, specifically in the frontal lobe, prefrontal cortex, the basal ganglia and cerebellum, by stimulating the brain chemicals dopamine and norepinephrine (Molecular Psychiatry, 1998). Dopamine and norepinephrine are important neurotransmitters in the brain, and, a lack of them can cause dysfunction in brain activity. Drugs that increase the dopamine or norepinephrine levels will, therefore, provide a short-lasting relief to individuals with ADHD. Methylphenidate binds to the dopamine transporters, and blocks them from transporting to the neurons. In this way, the extracellular action in the neurons will not take place and further production of dopamine will not stop (L.E Arnold).

Methylphenidate also provides a therapeutic effect due to the slow and steady increases of the stimulants. In addition to the physical effect, methylphenidate also provides an emotional relief by increasing the child's self-esteem and bettering their interactions with others. Therefore, stimulant medications are usually given gradually until a beneficial, relaxing effect comes about (Molecular Psychiatry). Also, when treated with the sustained-release preparations, they can have longer lasting effects of 8-12 hours. Evidence to the efficacy of the drug can come from functional magnetic resonance imaging tests (fMRI) on ADHD patients, which have shown that after a dosage of methylphenidate, there was increased activations in the brain, verifying the efficacy of this drug. The medication has been continuously proven to positively affect many ADHD victims (L.E Arnold).

Ritalin, Concerta, Quillivant XR, Daytrana, Focalin, Medikinet, Equasym XL and Methylin are all derivatives of methylphenidate and all have similar effects. Firstly, the main byproduct of methylphenidate, Ritalin, is a short-lasting drug providing immediate release of dopamine and norepinephrine in the body (psychcentral.com). Hence, those patients in need of immediate relief will

benefit from Ritalin. On the other hand, Concerta, is a long acting stimulant which increases dopamine levels gradually. Thus, one may not need to take more than one dose a day, due to its all-day symptom relief. Depending on the severity, time and frequency, different patients may have a preference for either the short-acting Ritalin or the long lasting Concerta (healthline.com).

Furthermore, Quillivant XR may be an option to some ADHD patients. Quillivant XR is the only liquid long lasting medication, thereby, attracting young children who cannot swallow pills. In addition, since it is a liquid, it is easily measurable, and, therefore, those patients who only need a small dosage will tend to choose Quillivant XR. Daytrana, has an unusual advantage of existing in patch form. Meaning, a specific dosage of medication is located in a patch that is worn somewhere on the body usually the hip. Throughout the day, the Daytrana is released into the blood. Consequently, the effects on the patient will have a longer duration, usually lasting throughout the entire day. Children typically are the most common ones to use this drug, being that it makes life simpler (adhd-treatment-options 2009). The next drug, Focalin, is also a drug that offers extended-release, and is found to more effective than Concerta. Focalin has proven to offer immediate relief first thing in the morning, and then provide continuous effects throughout the day, thereby allowing children to focus during the day in school. Therefore, Focalin has been a first choice drug option for school-age children (drugs.com).

Another methylphenidate drug, Medikinet, grants immediate-relief and short lasting results. Therefore, it would need to be taken several times a day. However, Medikinet XL is a new version of the drug which splits up the dosage, releasing 50% immediately and holding back the other 50% to be released later on in the day. The latter form of the drug is most probably more beneficial to most people, not needing to retake the medication multiple times a day (netdoctor.co.uk). Similar to Medikinet XL, Equasym XL, is also a pill that releases 30% immediately and stores the other 70% to be released hourly throughout the course of the day. In this case, as well, one morning capsule is enough to last the child the whole day. Lastly, Methylin, is short-lasting pills and requires multiple doses during the course of the day. Additionally, it has many side effects so it is not the best option of an ADHD drug (netdoctor.co.uk).

The second most common type of ADHD stimulant drug, Amphetamine, is similar to Methylphenidate, except that variants of this drug are usually intermediate-acting. For example, D, L-amphetamine, has a slightly longer duration of 4-6 hours. A blend of four amphetamine salts, amphetamine aspartate monohydrate, amphetamine sulfate, dextroamphetamine sulfate and dextroamphetamine saccharate, produce Adderall, which is an equally effective drug (progressivehealth.com). Being that the

two main drugs are especially similar; differences between methylphenidate and amphetamine are not so distinct. However, the chemical activity is different. Ritalin, travels into the brain cells and prohibits them from continuous absorption of dopamine (learn.genetics). On the contrary, Adderall, not only stops the brain cells from absorbing the dopamine, but, also, forces the cells to drain the already absorbed dopamine, thereby, directly increasing the dopamine levels in the brain. Furthermore, when methylphenidate binds to the dopamine transporters, it merely inhibits the uptake of dopamine by the neurons, thereby stopping the inhibition of dopamine. Amphetamine furtherly differs from methylphenidate in that along with the immediate release formulation of the drug, it can provide extensive release as well. Therefore, less dosages per day are needed of Adderall than of methylphenidate. Furthermore, even though Adderall is more powerful than Ritalin, some people react better to Ritalin, some react better to Adderall and some react equally to both drugs (LE Arnold).

Being that stimulant ADHD drugs are similar to cocaine and morphine, many risks and side effects exist. People think that being that many children use it, the drug is harmless and mild. However, being that methylphenidate is highly addictive, many dangers are present. The FDA requires all Ritalin boxes to contain the following notification, "Ritalin is a federally controlled substance because it can be abused or lead to dependence. Keep Ritalin in a safe place to prevent misuse and abuse." The above warning states that the effects Ritalin can be abused and harmful if not used in the correct manner. The use of this drug can also lead to anxiety, agitation, trouble sleeping, decreased appetite, headaches, stomachaches etc. More serious side effects include the chance for seizures, and blurred vision (ritalin.sideeffects.net). The main concern with these stimulant drugs is its potential for physical and emotional abuse. Addiction to the drugs can be caused by increasing dosages due to a buildup of tolerance to the drugs. The higher dosages, may then cause the patient's body to become solely dependent on the drug, craving it and eventually being unable to live life without it. Withdrawal from the medication can lead to panic attacks, depression and hunger. Therefore, limitations to this drug are extremely important to prevent addiction and abuse (drugabuse.gov). Side effects of both medications include vomiting, nausea, anxiety, insomnia, skin rashes, headaches, dry mouth and agitation. Furthermore, Adderall has an additional side effect of increasing the risk of certain heart diseases, such as, heart palpitations, increased heart rates and increased blood pressure.

Although stimulant medication is usually the most effective for treatment of ADHD, these drugs are not for everyone. Whether it being the intolerable side effects, or the ineffectiveness of stimulants, some patients prefer the non-stimulant option remedy,

Strattera, Clonidine, Guanfacine, Intuniv, and Kapvay, are some of the most popular non-stimulant possibilities. Furthermore, Bupropion SR and XL, The tricyclic antidepressants, The Selective Serotonin Reuptake Inhibitors (SSRIs), and Effexor can also be used as non-stimulant relief (ncpamd.com).

The first approved ADHD non-stimulant medication for children and adults, Strattera, also called Atomoxetine, increases the amount of norepinephrine in the brain, thereby increasing a child's attention span and moderating their impulsive behavior (ncpamd.com). Strattera does not directly influence the dopamine levels as do the stimulant medications. Strattera is effective in decreasing the ADHD symptoms, however, it is not controlled and it is less likely to be abused and cause addiction. The clinical effects last throughout the day and therefore, more than one dosage a day is not necessary. Although there are some side effects, they are minimal and tolerable, such as, fatigue, dizziness and nausea (my.clevelandclinic.org).

Clonidine and Guanfacine, have been used in adults mainly to control high blood pressure but has been further used to control ADHD mainly in adults with impulsivity and aggression. Due to its painkilling and soothing characteristics, Guanfacine, is commonly used to help individuals fall asleep. However, due to the major side effects of these drugs including high blood pressure and heart rate, it is important to monitor one's blood pressure with frequent EKG's, electrocardiograms, tests that check the electrical activity of the heart. Guanfacine lasts longer than Clonidine and only one or two dosages are needed per day. Furthermore, these drugs mainly relieve over activity as opposed to inattentiveness.

Intuniv and Kapvay are other non-stimulating drugs approved by the FDA in September 2009-2010 for individuals ages 6-17. Both drugs can be used independently or simultaneously with a stimulant. They also tend to take longer than stimulants to show results. It may take up to a month to see their effects. Furthermore, just like Guanfacine and Clonidine, Kapvay may cause a rise in blood pressure and it therefore should be monitored (ncpamd.com).

Antidepressant drugs can also be used to cure ADHD that is linked to depression. Although its results are not as beneficial to helping children with attentiveness and remaining on task, children who are depressed due to their disease, commonly lead towards anti-depressants for help. The first, most popular, category of anti-depressants are The Tricyclic Antidepressants which include, Pamelor, Norpremine, Aventyl, and Tofranil. They are long-lasting so do not require frequent dosages (ncbi.nlm.nih.gov). Tricyclics, however, can cause dry mouth, blurred vision, constipation, dizziness and sedation. Other antidepressants

# Treating Attention Deficit Hyperactive Disorder

such as Wellbutrin, Effexor, Effexor XR, and MAO inhibitors, are mainly used as antidepressants but can be used to treat ADHD by increasing serotonin in the brain, thereby, increasing concentration in the child. MAO inhibitors are usually a last choice for ADHD patients because of their dangerous side effects including high blood pressure when taken with certain foods. Antidepressants are sometimes mixed with stimulant drugs when the individual is suffering from symptoms of anxiety in addition to their hyperactivity and inattentiveness (Journal of Attention Disorders, 2014). In conclusion, the use of antidepressants to relieve the symptoms of ADHD may be beneficial if monitored by a health professional.

## What is Cognitive Behavioral Therapy for children or adults with ADHD?

Patients diagnosed with ADHD need to manage their symptoms of hyperactivity, impulsivity and inability to focus their attention. CBT, cognitive behavioral therapy, consists of teaching skills to control these symptoms. There are two different arms to this strategy. One is to teach ways of staying focused and organized while the other's goal is to minimize disruptive behaviors that interfere with social and academic growth. CBT is used both alone and in conjunction with pharmaceutical treatment consisting of stimulant and non-stimulant medication (Miller-Behavioral Treatments for Kids with ADHD). CBT is important as, unlike medication, it teaches life skills that can serve the patient even after medication is stopped.

For children with behavior problems that detracts from their academic progress and causes conflict both at home and in school, parent-child interaction therapy, PCIT, may be beneficial. It involves 14-17 week sessions in which parent-child interaction is viewed through a one way mirror and the parent is coached by a psychologist using an ear bud. Parents are encouraged to use positive reinforcement in conjunction with strict consequences for inappropriate behaviors. These techniques are meant to be continued at home and in school. Teacher involvement is encouraged and essential. Goals are set, such as following specific classroom rules with a prize following each positive behavior. Over time, the child learns to control behavior and therefore, have more beneficial interactions with parents, teachers, and peers (Miller, Child Mind Institute).

Another form of behavior therapy involves the attention aspect of the disorder. These include techniques to establish routines to allow the ADHD patient to organize himself, allowing him to stay on task and accomplish his goals. It also focuses on transitioning techniques to allow for less distraction. Everyday tasks such as homework or bed time are broken down into smaller achievable steps (Miller, Child Mind Institute). In general, both methods of CBT have been shown to be more effective the

younger the child is, and less benefit has been seen by those children who have reached adolescence.

## Cognitive Behavioral Therapy as a viable treatment for ADHD

Because the use of pharmacological treatments of ADHD may not be acceptable to some parents of affected children or the affected individuals themselves, cognitive behavioral therapy, CBT, has been an alternative to the use of these medications. CBT has long been used to treat ADHD both in conjunction with medication or on its own. However, not many studies are available comparing CBT applied on its own, to medication alone, to a combination of CBT and pharmaceutical options (Journal of Attention Disorders, 2014). A study by Susan Young and J. Myanthi Amarasinghe view these possible treatment options through the lifespan of the ADHD patient uncovering evidence which suggests different approaches to treatment are more effective during different periods in the patient's life.

The young preschool child, who is still cognitively immature, cannot yet put into practice skills that are taught directly. He responds best to parental training to enforce positive behavior control such as tangible consequences along with positive support to reinforce good behavior. It has been noted that preschoolers that do not meet criteria for diagnosis and therefore do not receive early treatment were further affected into their school years and beyond than those children treated early (Young and Amarasinghe). In addition, parent-child relationships are strained during these early years creating stress that lingers into adulthood. Because the focus of a child's life at this time is his home and parents, parent training is the most effective treatment yielding the most benefits throughout the patient's lifetime. Parenting techniques and interventions include teaching parents about ADHD and addressing and targeting behavioral problems associated with it. Reward and positive reinforcements for appropriate social behaviors are stressed in conjunction with consequences for negative and socially inappropriate behaviors. Parents may also be offered support groups to deal with their own reactions to their child's difficulties (Young and Amarasinghe).

Older, school age children, are cognitively capable of learning skills and techniques to aid in social and academic situations. They appreciate being involved in their care at this stage in their development. This type of behavior therapy can be developed to aid in treatment of older adolescence as well as adult patients. These patients exist in two basic environments: at home and at school, therefore treatment must be tailored to these situations. Home-school connections must be fostered and communication between the two is imperative. Parent training is similar to that of younger children as described above while teachers are

coached to set achievable academic and social goals in addition to positive reinforcement along with tangible consequences for behavioral issues or impulsivity (Miller, Child Mind Institute).

As children move past their elementary school year, a child is able to be more involved in his behavioral therapy. He is able to be involved in role playing to advance social skills and improve communication with eye contact and body language. An adolescent can be taught how to give compliments, accept constructive criticism, take turns and resolve conflicts. He can be taught to actively listen to and follow directions and monitor his own attention. All of these will improve the patient's relationships and academic achievement improving self-esteem. As an adolescent enters adulthood, all of these techniques can be furthered, setting direct treatment goals such as dealing with procrastination and developing strategies to aid in memory and impulsivity control (Miller, Child Mind Institute).

There are ongoing discussions in the medical and psychiatric communities on which avenues of treatment to choose as the optimal way to treat ADHD. Depending on the age of the child, the first line of defense may be different. The ADHD NICE Clinical Guideline advises that parent training be the initial treatment in preschool children and young school age children with behavioral issues. Parent training is not as effective in older children. Parent training has also been shown to be less effective in cases where the parents themselves exhibit symptoms of ADHD (Young and Amarasinghe).

In a Multimodal Treatment study, four treatment possibilities were compared. Firstly, medication, in the form of methylphenidate. Second, CBT including parent training, summer treatment programs and school based treatment. Third, A combined treatment including medication and behavior therapy. And, lastly, a control group of community care consisting of children, many of whom were medicated, but did not receive treatment from the researchers. Results found that the medication and combined tracks were more effective than behavioral therapy alone or the community care. The combined treatment which consisted of medication and CBT in combination was more effective for symptoms reported by parents than medication alone. In addition, CBT, with or without medication was very effective for those patients from poorer socioeconomic groups who were receiving public assistance. The combination treatment was more effective and less costly for patients with many comorbid symptoms. In addition, it is important to note that children in the combination treatment were able to control symptoms with lower doses of medication (JAMA Psychiatry).

As patients enter adolescence, boys and girls may present with different symptoms and, therefore, may need different courses

of treatment. Boys have a tendency to be more aggressive and the need for behavior control is more pressing while girls may have more social and emotional symptoms requiring social and mood altering treatments. It is for this reason that at this stage, teens must be made an integral part of their own treatments. Parent training at this stage includes the same basic premise as younger children with positive reinforcements becoming more age appropriate. For example, positive reinforcement includes more time with friends or more computer time while consequences for negative behavior may be losing privileges (Miller, Child Mind Institute). Working closely with teachers and counselors at this stage is most important as difficulties in school is a major concern. It seems that CBT and parent training alone is not as effective in the adolescent group as in younger children and a combined regimen including medication and behavior intervention is more effective than either alone (JAMA Psychiatry). More studies on adolescents need to be undertaken, however, since most assume that their problems may be successfully addressed using similar methods as those used for their younger counterparts.

### Conclusion

ADHD is a developmental and neuropsychological disease caused by low levels of dopamine release that presents with symptoms including behavioral impulsivity and inability to focus, along with the possibility of comorbid conditions of depression and behavioral defiance. It is a disease which may present at any time throughout a lifespan, but treatment is most effective when diagnosed and treated earlier in life. There are many treatment options available to the ADHD patient including stimulant and non-stimulant medications which may be administered in many modalities and doses to fit many different lifestyles. Non pharmacological approaches include cognitive behavior therapies, including parent and teacher training, student workshops and summer training programs. Individualized approaches to treatments seem to be the most effective based on a patient's age, symptoms, socio-economic group, and sex. In general, combined medication therapy with different forms of CBT tailored to patient lifestyle as he grows is the most effective treatment.

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## Treating Attention Deficit Hyperactive Disorder

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