Narrative Review

Management of Adolescents and Young Adults With Attention-Deficit/Hyperactivity Disorder:

Unique Challenges, Innovative Solutions

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Abstract

Importance: Adolescence and young adulthood can be a period of immense change. Navigating this critical period of development can be particularly challenging, even for healthy individuals, given the immense cognitive, emotional, neurobiological, physical, and social changes taking place during this time. The additional burden of the core symptoms of attention-deficit/hyperactivity disorder (ADHD) and associated functional impairments can further complicate this transitional period through to full adulthood.

Objectives and Data Source: In this review, we focus on the distinctive behavioral and neurobiological characteristics of adolescents and young adults (AYAs) with ADHD. We discuss the variety of contemporary challenges faced by these patients as they transition to full adult maturity. A comprehensive literature search of PubMed was performed on February 23, 2022. We searched for English-language peer-reviewed articles published in the previous 10 years using primary search terms including "attention deficit hyperactivity disorder," "adolescent," and "young adult." Importantly, we provide various innovative and practical strategies and solutions to overcome the challenges faced by AYAs with ADHD, with the aim of improving the management of this unique patient population.

Relevance: This review is intended to support physicians less familiar with the management and treatment of AYAs with ADHD.

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Attention-deficit/hyperactivity disorder (ADHD) is a neurodevelopmental disorder characterized by symptoms of inattention and/or hyperactivity and impulsivity that interfere with functioning or development.[1] Emotional dysregulation is often a prominent feature.[2] Onset is common during preschool years or childhood,[3] with prevalence ranging between 5.5% and 11% in children and adolescents and 2.8% and 4.4% in adults.[4–7] ADHD is a highly heterogeneous disorder in terms of etiology, clinical profiles, long-term trajectories, neurobiological mechanisms, and psychiatric comorbidities.[8] Full diagnostic criteria persist from childhood to adulthood in 50%–65% of cases,[9,10] although more recent findings suggest that this figure may be as high as 90%.[11]

The normal transition from childhood to adulthood can be challenging, even for healthy individuals. Adolescence and young adulthood, spanning the period from 10 to 24 years of age,[12] is a period of immense change, including the onset of puberty and unique cognitive, neurobiological, emotional, physical, and social developments.[13] The additional burden of ADHD symptoms and associated functional impairments further complicates the transition through adolescence and young adulthood.

The challenges related to transition of patients with ADHD from child and adolescent to adult mental health services have been well documented. This review focuses on the unique characteristics of adolescents and young adults (AYAs) with ADHD and the challenges that they face, which together may act as barriers to optimal care. Drawing on our clinical experiences of implementing evidence-based guidelines, and feedback from our patients, we describe innovative strategies and solutions for improving the management of AYAs with ADHD.

Clinical Points

- Adolescents and young adults (AYAs) with attention-deficit/hyperactivity disorder (ADHD) possess distinctive behavioral and neurobiological characteristics, and these individuals face a range of unique challenges that may have an impact on optimal management as they transition to full adulthood.
- When managing AYAs, physicians should view risk-taking behaviors as a red flag for possible ADHD. Evidence continues to accumulate for the positive impact of the early detection and treatment of ADHD, as it can significantly reduce the risk of psychiatric comorbidities and materially change the trajectory of life for this patient population.

METHODS

This narrative review is based on searches of the online literature (PubMed search conducted on February 23, 2022). We searched for English-language peer-reviewed articles published in the previous 10 years. Primary search terms included "attention deficit hyperactivity disorder," "attention deficit disorder with hyperactivity," "attention deficit and disruptive behavior disorders," "ADHD," "adolescent," "adolescence," and "young adult," supplemented by and combined with secondary terms (eg, "comorbidity," "risky behavior," and "brain development"). Reference lists of identified articles were manually searched to identify additional articles of interest.

NEUROBIOLOGY OF BRAIN DEVELOPMENT

Brain Development in Adolescence and Young Adulthood

The brain is in an active state of development just prior to and throughout adolescence, with major anatomic reorganization and maturational events occurring,[14] which help to prepare the brain for the challenges of adulthood. Brain maturation is an important part of the development of AYAs and may be influenced by numerous factors, including sex hormones, nutritional status, sleep patterns, heredity and environment, and use of pharmacotherapy.[15] Basic features of brain maturation include pruning of rarely used synapses in grey matter and increases in myelination of axons in white matter, leading to a higher quality and speed of information transfer between brain regions.[15–17] During adolescence, different regions of the brain grow and mature at different rates and at different times.[18] Thus, the development and maturation of the prefrontal cortex, responsible for executive function, occurs mainly during adolescence and is complete by the time of full adulthood at 25 years of age,[15] whereas subcortical brain areas, in particular the limbic system and the reward system, mature earlier, thereby creating an imbalance that may account for the typical behavior patterns observed during adolescence, including risk-taking (see Figure 1).[16,19] Crucially, during adolescence, the developing brain is particularly vulnerable to the negative effects of environmental influences (eg, alcohol, nicotine, and cannabis) on neuronal plasticity.[16,18] Other psychiatric conditions such as substance use disorders (SUDs) and mood disorders also tend to emerge during adolescence, and the risk of suicide is increased during this period.[13,20]

ADHD and Brain Development

A wealth of evidence indicates that the neurobiology of ADHD is multifactorial, involving structural and functional brain abnormalities and alterations in neurochemical signaling.[21–29] Rather than specific abnormalities characteristic of ADHD, the structural and other differences identified in ADHD brains may be due to a delay in normal development. In a prospective magnetic resonance imaging study, children and adolescents with ADHD exhibited significant delays in cortical maturation versus those without ADHD.[30] Delays were most prominent in prefrontal cortical regions, which are important for control of cognitive processes, including attention and motor planning.[30] The maturation of dopaminergic neuronal pathways in specific brain regions also appears to be delayed in children and adolescents with ADHD.[31]

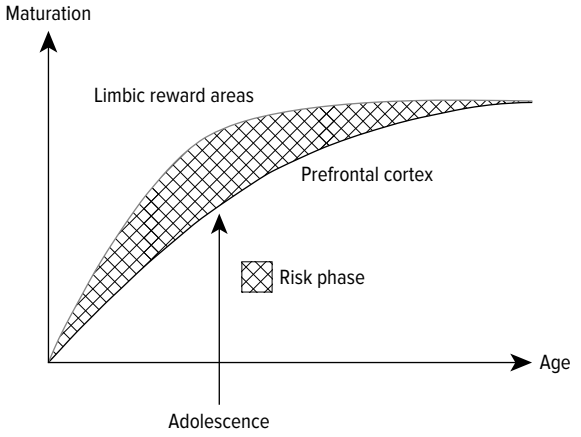
Abnormalities in brain development appear to occur in the first few months of life, before clinical manifestations of neurodevelopmental disorders become evident.[32] Indeed, a systematic review of children later diagnosed with ADHD demonstrated that motor signs of ADHD that emerged during the first year of life appeared nonspecific; this limits their value in clinical screening.[33] Collectively, evidence to date clearly demonstrates that ADHD is a brain disorder; this is an important message to convey to AYAs with ADHD and their parents to help reduce the associated stigma.[21]

BARRIERS TO THE MANAGEMENT OF ADHD IN ADOLESCENTS AND YOUNG ADULTS

ADHD follows a highly variable course throughout adolescence; while hyperactivity and impulsivity tend to decline, inattention can be more persistent.[34] Academic performance[35]; relationships with parents[36]; quality of life[37]; self-esteem[38]; behavioral, emotional, and social functioning[39]; and peer relationships[39] may all be adversely affected by ADHD during adolescence. A diagnosis of ADHD also reduces the life expectancy of young adults[40] and increases the mortality rate.[41]

Figure 1.

Imbalance of Neural Networks in Adolescence Due to Nonlinear Maturation Processes of Subcortical and Prefrontal Brain Areas[a]



[a]Adapted with permission from Casey et al.[19]

In AYAs, normal healthy behaviors are often difficult to distinguish from the subtle symptoms of ADHD. As a result, primary care providers must be vigilant for ADHD symptoms in this age group and should evaluate functional impairment to help differentiate ADHD from normal behaviors. As summarized in Figure 2, AYAs with ADHD face a wide variety of challenges while transitioning to full adulthood. Together with the unique characteristics of AYAs themselves, this means that it can be challenging to achieve optimal symptom control for these patients. Drawn from our own clinical experiences, Table 1 provides a number of innovative and practical strategies and solutions for overcoming the challenges that AYAs with ADHD often have to face, which are discussed in more detail below.

Diagnosis of Adolescent ADHD

When diagnosing patients with ADHD, clinicians should apply the diagnostic criteria of the *Diagnostic and Statistical Manual of Mental Disorders,* Fifth edition (*DSM-5*).[1,42] The definition of ADHD was broadened in the *DSM-5*.[1,43] Firstly, the age of onset criterion changed from the onset of symptoms and impairments before the age of 7 years to the onset of symptoms before the age of 12 years.[43,44] Secondly, the minimum number of symptoms required in the inattention and hyperactivity-impulsivity domains for older adolescents and adults was reduced from 6 to 5.[44] Functional impairments were only required to interfere with or reduce the quality of social, academic, or occupational functioning, rather than be clinically significant.[44] Lastly, ADHD "subtypes" were renamed ADHD "presentations,"[44] to recognize that ADHD symptoms are not stable traits and may change over time.

The diagnosis of ADHD remains a significant challenge in all age groups due to the wide variability in ADHD symptoms, the changes in ADHD symptoms with age, and the presence of comorbidities.[42,45–47] Diagnosis of ADHD in AYAs requires a comprehensive assessment conducted in the primary care setting by a health care professional, with specialist referrals for more complex cases.[42] Lack of awareness and knowledge of ADHD among health care professionals may contribute to misdiagnoses.[46] Technological advances, such as machine learning–based predictive modeling, may facilitate diagnosis and help to minimize misdiagnoses.[48–50]

Puberty

The beginning of adolescence involves the onset of puberty.[13] Sharp rises in sex hormones (estrogen, progesterone, and testosterone) during puberty can impact the development and maturation of the adolescent brain.[15] Sex hormones directly influence myelinogenesis and remodeling of neurocircuitry in the adolescent brain[15] and can have effects on the structure and connectivity of different brain regions.[51] For example, the amygdala is involved in modulating and integrating emotional responses, is rich in sex hormone receptors, and undergoes substantial structural and functional changes during adolescence.[52]

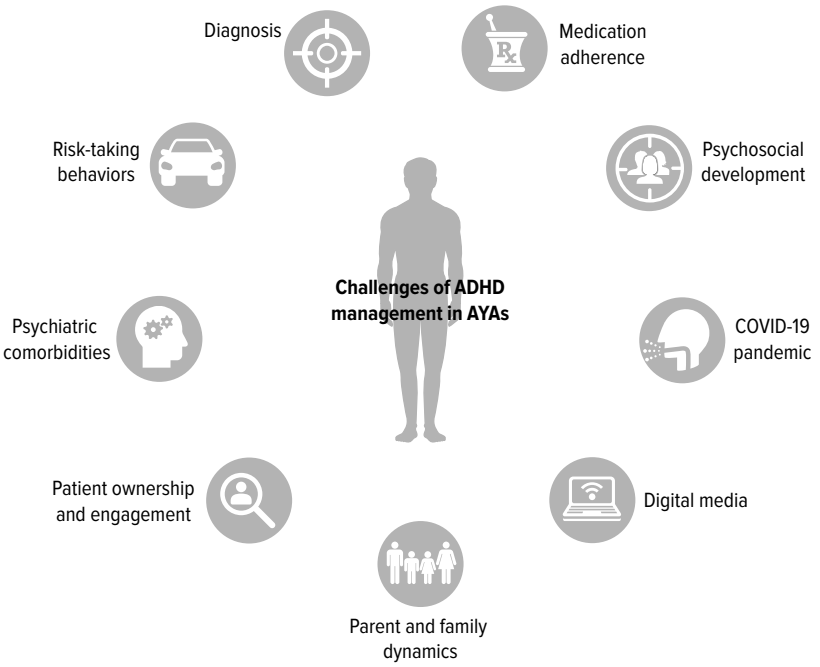
Puberty can be a period of immense emotional turmoil due to the effects of changes in sex hormones. Consequently, puberty can be even more challenging and stressful for adolescents with ADHD, and in females symptoms can be exacerbated by hormonal changes during the menstrual cycle,[53] in response to varying levels of sex hormones.[54]

Risk-Taking Behaviors

Typically, developing adolescents are prone to making impulsive and risky decisions, and this can be further exacerbated by ADHD.[55] AYAs with ADHD are particularly susceptible to risk-taking behaviors, which may have a detrimental long-term impact,[56] and such behaviors should be regarded as red flags for ADHD in this patient population. Adverse outcomes associated with high-risk behaviors include substance misuse (eg, cocaine and marijuana),[57] smoking,[58] having unprotected sex (associated with teenage pregnancies and sexually transmitted infections),[59–61] gambling,[62] dangerous driving,[63] and criminality.[64] AYAs with ADHD are also at increased risk of suicidal behavior,[65] suicide attempts,[66,67] and suicidal ideation.[67]

The main driving force behind risk-taking behavior in individuals with ADHD appears to be the perceived benefits of that behavior, rather than insensitivity to the risks involved.[68] While risk-taking among AYAs is generally viewed negatively, particularly given the high mortality rate in 15–24 year olds,[15] it is an important

Figure 2.
Barriers to Optimal ADHD Management in AYAs



Abbreviations: ADHD = attention-deficit/hyperactivity disorder, AYA = adolescent and young adult.

part of an individual's development and can help to shape their future. Positive (socially acceptable) risks can have favorable outcomes, such as enrollment in a challenging course to learn a new skill, trying new hobbies, and willingness to build new friendships.[55,69]

The link between ADHD and risk-taking behavior in AYAs may involve sensation-seeking personality traits and deficits in executive functioning,[70] but further research is needed to understand the neurobiological origins of the increase in this behavior in AYAs with ADHD. The extent of involvement of the 2 brain areas implicated in typical adolescent risk-taking behavior (ie, the subcortical and prefrontal control regions) is also still to be fully understood.[16,19,55,71]

Psychiatric Comorbidities

ADHD rarely exists in isolation and is commonly comorbid with other neurodevelopmental and mental health disorders throughout adolescence, including mood and anxiety disorders, sleep disorders, SUDs, oppositional defiant disorder, autism spectrum disorders, and tic disorders.[72–75] Approximately 75% of children and adolescents with ADHD develop a comorbid psychiatric disorder[76]; this may increase the severity of ADHD symptoms and worsen functional impairment.[77] Such comorbidities can also mask ADHD symptoms, which can complicate diagnosis[75] and therapeutic interventions for ADHD.[73] Indeed, symptoms of certain comorbid psychiatric disorders, such as bipolar disorder, can overlap with ADHD symptoms and represent a diagnostic challenge for the physician, and in these cases, referral to secondary care should be considered.[42,78] For patients with ADHD and comorbidities, practice guidelines suggest that the diagnosis with highest impairment should be treated first.[42] In AYAs, treatment of ADHD can be delayed and/or deprioritized when comorbid psychiatric conditions with higher impairment are present. Some mental health disorders (eg, suicidal depression) may be treated first, as they are acknowledged to be more impairing. However, ADHD is an eminently treatable condition, and effective treatments can minimize impairment.[79] Therefore, ADHD should be treated as early as possible during adolescence, or preferably before. This approach should maximize the positive impact of treatment on long-term outcomes and reduce the risk of other psychiatric comorbidities.

Ownership and Engagement

In adolescence, individuals become increasingly independent from their caregivers in making decisions and taking responsibility for their actions.[56,80] Adolescents with ADHD need to take responsibility for and ownership of their condition (eg, by adhering to prescribed medication).[3] Some adolescents may fail to realize the significance of an ADHD diagnosis due to

Table 1.

Practical Guidance for Physicians to Overcome the Challenges of Managing AYAs With ADHD[a]

Challenge	Key actions	Notes
Diagnosis	• Be vigilant for ADHD symptoms and risk factors • Teenage pregnancy, increases in criminality and accidents, SUDs, missed appointments, and peer relationship difficulties may indicate underlying ADHD	• Inattention, hyperactivity, and impulsivity must not be ignored ◦ May not only be related to other conditions (eg, anxiety, mood disorders, SUD) ◦ ADHD symptoms often precede such conditions but can be less noticeable
	• Ask to review the patient's old school report cards for information on their behavior	• Risk factors include family history of ADHD or other psychiatric conditions • Gifted individuals and females with ADHD may present with distinct symptoms that have different developmental trajectories from those seen in most patients
Puberty	• Monitor adolescents closely during puberty, particularly if there is a family history of ADHD • Look for high-risk trigger situations which can be challenging for adolescents with ADHD • Engage patients and parents in problem-solving how best to deal with any issue(s) • Establish a wide support network for the patient, depending on their needs; involve the patient and family in selecting and inviting their "virtual" support team • Consider the possibility of gender dysphoria in individuals with ADHD progressing through puberty	• ADHD symptoms can be exacerbated during puberty, or new/previously overlooked symptoms may emerge • Trigger situations include change of school and/or teacher; moving home; parental illness or divorce; end of a close relationship • Encourage patients to lead discussions and propose solutions, while providing appropriate support • May involve parents, teachers, sports coaches, employers, counselors, psychologists, and extended family
Risk-taking behaviors	• Recognize that not all risk-taking is detrimental • Facilitate a balance between the positives of the patient's willingness to take risks vs the potential harms • Encourage patients to engage in structured and supervised activities that provide new skills and develop prosocial behaviors • Look out for changes in the patient that may be due to reduced functioning • Help the patient to identify an adult who can provide them with nonjudgmental and supportive care, while helping to grow a wider support network	• Risk-taking may allow AYAs with ADHD to succeed in areas of life in which their peers might fail (eg, sports) • eg, Charitable activities, artistic endeavors, hobbies, sports, other extracurricular activities • eg, Spending more time on personal devices, a growing interest in youth subcultures, increasing social isolation
Psychiatric comorbidities	• Explain that optimal treatment of ADHD can prevent development of psychiatric comorbidities (eg, mood and anxiety disorders, SUDs) • Consider referring patients with ADHD and challenging comorbidities (eg, bipolar disorder) to specialist care	• The prognosis of psychiatric comorbidities can also be improved if ADHD is optimally managed
Ownership and engagement	• Ensure that patients are involved in key decisions about medication choice, doses, schedules, etc • Be open to parental involvement in patient management decisions, even as the patient approaches full adulthood	• If implemented from the start, this can establish a positive dynamic for long-term ADHD management and encourage patients to take an active role in their own care
Parent and family dynamics	• Establish whether there is a family history of ADHD (given the genetic risk) • Screen parents of AYAs with ADHD for the presence of ADHD; if present, provide optimal treatment	• Ask whether family members have similar traits (eg, parents, siblings, grandparents, cousins) • Successful treatment of a parent with ADHD may improve parent and family dynamics and family socioeconomic status and may facilitate effective implementation of the treatment plan for the AYA with ADHD
Medication adherence	• Encourage patients to take ownership of their condition • Provide patients and parents with ADHD education, including information on the pathophysiology of the disorder • Provide information on the medications available to treat ADHD and the mechanism of action of the currently prescribed medication • Ask the patient and parents/caregivers to document all positive and negative comments about perceived effects of ADHD medication	• Inform patients about the importance of adherence and risks of discontinuation (eg, SUDs, depression, incarceration, unwanted pregnancy, etc) • Draw attention to ADHD resources that are available to patients and parents (eg, websites, online communities, books, etc) • Explain that long-acting psychostimulants are first-line therapy for ADHD in all age groups; provide reassurance that the risk of addiction is low. Explain that risk of addiction to tobacco, alcohol, and street drugs can be greatly increased in patients with ADHD who do not take optimal psychostimulant treatment • Collaboration between the physician, patient, and parents is crucial for achieving positive outcomes. ADHD management should not focus purely on symptom control; improvements in functional impairments can improve QOL

(continued)

Table 1 (continued).

Challenge	Key actions	Notes
	• Explain to the patient about possible side effects and how these must be balanced by improved functioning	
	• Meet separately with the patient after the initial interview	• Can help build rapport; also, the patient may be more likely to talk about risky behaviors in the absence of their parents
	• Ensure parents continue to be actively involved in management of their offspring's condition as they enter young adulthood	• This can be a particularly high-risk period of personal development (eg, leaving home to attend college)
	• Ensure that effective plans are in place for transition from child and adolescent to adult mental health services	
Psychosocial development	• Encourage parents to share family attributes and values	• Highlighting the family's sense of identity can provide a template for AYAs to follow
	• Help patients to understand how to make appropriate decisions, citing recent good or bad examples of their behavior	• May help patients to understand themselves and establish a sense of self
	• Consult practice guidelines for recommendations on psychosocial interventions for ADHD	• eg, CBT, behavioral interventions, parent training, cognitive training, social skills training
COVID-19 pandemic	• Reinforce consistent routines for remote learners with ADHD, to promote good mental and physical health, to develop a more positive outlook on life, a better sense of self, and greater family harmony	• eg, Getting up and going to bed at the same time each day; following daily schedules for school/college work, meals, and exercise
	• Comorbidities such as depression, anxiety, and SUDs may also benefit from a well-structured daily routine	
Digital media	• Encourage parents to restrict AYAs' daily use of personal devices	• eg, 1–2 h maximum per day, after school/college work has been completed; not during the 2 h prior to bedtime
	• Parents should model similar behavior and should be reminded that limit-setting is part of responsible parenting	• Setting limits on screen time is vital for good social rhythm
	• Alert parents to the fact that adolescents may use deception to avoid limits on screen time, eg, claiming that their mobile phone is needed as an alarm clock	• Devices may be kept in the parent's room or locked away, to ensure compliance with time limits

[a]The practical guidance outlined in this table originates from clinical experiences and suggestions provided by the authors.
Abbreviations: ADHD = attention-deficit/hyperactivity disorder, AYA = adolescent and young adult, CBT = cognitive-behavioral therapy, QOL = quality of life, SUD = substance use disorder.

limited insight into their condition.[56,81] Some health care providers may fail to communicate to patients that ADHD can persist into adulthood and become a life-long condition, with increased risk of comorbidities and significant negative consequences if not treated.[77,82] This may perpetuate the tendency of AYAs with ADHD to lack ownership of their condition, leading to disengagement from treatment plans. However, as adolescents with ADHD mature and approach adulthood, they can become more engaged in managing their medication.[83] Over time, they may be more accepting of the negative and positive aspects of their condition and more prepared to live with the "bad and the good" aspects of the disorder.[84]

Given the nature of symptoms experienced by AYAs with ADHD (eg, impulsivity and difficulty in processing and managing information), when they are asked to make decisions about treatment, support from their parents can be crucial. Ideally, patients, parents, and clinicians should all play an active role in ADHD management, taking joint ownership of the condition and sharing decision-making.[85]

Parent and Family Dynamics

As discussed, adolescence and young adulthood is typically a challenging period of life due to the rate and extent of physical, cognitive, and emotional changes. Parents and families can also be affected. Increased conflict, miscommunications, and misunderstandings are commonplace among families as individuals progress through adolescence and can be magnified by ADHD.[86] Interpersonal problems are common among young adults with ADHD,[87] which can negatively affect relationships between adolescents, parents, and siblings.[88]

A large community-based online study in 10 European countries demonstrated that caregivers (eg, parents or legal guardians) of children and adolescents with ADHD reported missed or altered work patterns, avoidance of social activities, increased worry and stress, and general strain on family life.[89] A greater severity of ADHD symptoms and a higher number of comorbidities were significantly related to a greater burden on the caregivers.[89]

In another study, caregivers of children and adolescents with ADHD expressed concern that their relationship with their other offspring (without ADHD) could be negatively affected due to greater attention and focus on the sibling with ADHD.[90] Conversely, adolescents with ADHD sometimes felt that their parents treated them differently from their siblings, which could lead to friction and arguments between siblings.[90] Parents often become frustrated with their adolescents with ADHD and may withdraw from

contact with them, which can magnify any relationship difficulties.[86] Indeed, perceived parental rejection during early adolescence has been linked to persistence of ADHD symptoms in later adolescence,[91] possibly due to the parents' failure to provide emotional support. Given the key role of genetics in the etiology of ADHD,[92] AYAs with ADHD frequently have parents who themselves have ADHD, which increases the tendency to have an impaired parenting style.[93] In contrast, positive parenting during early adolescence may provide the emotional warmth that individuals with ADHD find supportive during this challenging period.[91] Indeed, positive parenting at this time has been shown to initiate structural changes in areas of the adolescent brain that are key to reward processing and emotional regulation.[94]

Medication Adherence

Achieving adherence to ADHD medication is a well-documented challenge in the management of adolescents with ADHD, despite evidence suggesting that continued treatment into adulthood improves long-term outcomes.[85,95–97] A retrospective claims database analysis reported that more than 30% of patients diagnosed with ADHD and using ADHD pharmacotherapy at 17 years old had stopped taking medication by the age of 21 years.[98] The likelihood of treatment disruptions or discontinuations increased as patients transitioned from adolescence to young adulthood, and they rarely reinitiated treatment.[98] Consequences of poor adherence to ADHD medications can be significant and include reduced effectiveness of medications and increases in adverse events.[79]

There may be additional risks of nonadherence in certain patient groups, for example, in adolescent females with ADHD.[61,99] Use of oral hormonal contraceptives can increase the risk of experiencing adverse effects such as depression, which may affect adherence to contraception and increase the risk of unplanned pregnancies.[100] Providing information to female AYAs with ADHD on alternative contraceptive options that provide long-term protection without increasing the risk of depression, as well as discussing safe sex practices, may help prevent unplanned pregnancies.[61,99,100]

Adherence to medication is a complicated issue; adherence may be influenced by a variety of factors, some related to the ADHD medication itself, including the impact of adverse events, perceived effects on sense of self and personality, stigma of medication use, and inconvenience of taking regular medication.[101] Clinician-related factors can also influence adherence.[102] Clinicians are responsible for educating patients and their families about ADHD, and making them fully aware of all aspects of treatment, with the aim of optimizing adherence.[102] For example, clinicians should help the patient to understand the need to take their medications at the correct time and advise them how best to manage adverse events.[102] Changes in life circumstances (eg, moving home) and personality traits may also impair medication adherence in AYAs with ADHD.[96,103] Some AYAs may stop taking their medication because they regard ADHD as a childhood disorder and so assume that medication is no longer required as they grow older; some clinicians still retain this misunderstanding.[96] Also, young people may regard the use of ADHD medication as a means of coping with school life and incorrectly assume that medication can be stopped once they have left the education system.[96]

Given adolescents' desire for more control of their own destinies, they often decide themselves to stop taking their ADHD medication.[101] However, as they may have limited insight into their condition,[81] their decision will usually be scrutinized by their parents, whose beliefs about ADHD and attitudes toward treatment may also impact their child's adherence behavior.[85]

Psychosocial Development

Adolescence marks a time of significant cognitive, physical, and sexual development, second only to infancy in the scale of the changes that occur. Psychosocial development also occurs, as individuals begin to develop an identity and sense of self and to establish their place in society.[104] Adolescents begin to seek autonomy and independence from parents, and parental support becomes less important for their emotional adjustment.[104,105] However, adolescents can become increasingly concerned about how they are perceived by other people, in particular their peers and family members.[104,106]

Adolescence can be an emotionally challenging time, even for healthy individuals who have a desire to establish their identity and sense of self and to feel like they "fit in."[106] The additional burden of ADHD symptoms complicates and may worsen the individual's experience of this crucial step in their personal development. Indeed, an adolescent's sense of self is thought to be distorted by ADHD.[107]

COVID-19 Pandemic

The COVID-19 pandemic was a challenging and stressful period. Individuals with neurodevelopmental disorders, such as ADHD, were particularly at risk due to the distressing impact of the pandemic.[108,109] Government-imposed lockdowns and requirements for social distancing may have negatively impacted this vulnerable patient population.[110] Compared with other adolescents, those with ADHD may have been at greater risk of increases in mental health symptoms and substance use during the pandemic.[110] Problems with social isolation, difficulties engaging with online learning, lack of motivation, and

boredom were also common among AYAs with ADHD.[111]

The global pandemic resulted in closure of schools, colleges, and universities and necessitated an extended period of online remote learning for millions of AYAs. Adolescents with ADHD experienced more difficulty with remote learning than their peers without ADHD[112]; this also increased their risk of depression and dropping out of school.[111]

Positive coping strategies may have been valuable for minimizing the impact of the increases in mental health problems and substance misuse among adolescents with ADHD during the pandemic.[110] The concept of social rhythm is critical to the functioning and development of AYAs, especially those with ADHD. It relies on applying consistent routines to sleep, meals, and exercise to ensure that frequent social connections (eg, with family, peers, etc) are maintained. Implementing a regular and structured social rhythm throughout the pandemic and afterward may have been helpful to reduce the disruption caused by social isolation and frequent changes in schooling experienced by AYAs with ADHD.

Digital Media

Modern digital media has many different applications, including for social networking, streaming films or music, and videogaming.[113] Digital media is widely used, easy to access at all times, and can provide users with instant high-intensity stimulation.[113] Use of interactive digital media is ubiquitous in adolescents[114]; those with ADHD may be particularly vulnerable to the appeal of digital media, which can satisfy their need for peer and social connections and provides rapid feedback and immediate rewards via continual notifications and updates.[113] Consequently, constant and uncontrolled use of digital media may be more likely to have negative consequences for these patients, such as academic failure, behavioral problems, social withdrawal, family conflict, and physical and mental health problems.[114] Thus, adolescents with ADHD were found to be at increased risk of developing internet gaming disorder,[115] described as "persistent and recurrent use of the internet to engage in games, often with other players, leading to clinically significant impairment or distress" (*DSM-5*).[1] The COVID-19 pandemic also exacerbated problematic use of digital media in adolescents with ADHD, resulting in an increase in the severity of ADHD symptoms and associated difficulties (eg, lower motivation to learn).[116]

TREATMENT OF ADOLESCENT AND YOUNG ADULT ADHD

Given the personal, societal, and economic burden of untreated ADHD, there is a crucial need to accurately identify and treat ADHD in AYAs.[117–121] Clinical practice guidelines recommend a multimodal and multidisciplinary treatment approach tailored to patients' individual needs.[42,122] Pharmacotherapy and psychosocial interventions, including psychoeducation, cognitive-behavioral therapy, social skills training, parent management training, and ADHD coaching (by an accredited coach), may all be included in individualized multimodal therapeutic regimens.[42,119] School-based interventions also have an important role to play in the multimodal treatment approach,[42] including individualized education plans that provide special accommodations and modifications to meet the unique needs of individuals with ADHD and help them to fulfil their potential in the classroom.[42,123] Several factors should be considered before deciding on appropriate treatment approaches; these may include severity of ADHD symptoms and impairments, levels of patient discomfort, impacts of psychiatric comorbidities, and global psychosocial functioning.[79,124] Clinicians should involve the patient, parents, and any other caregivers (eg, teachers) in a collaborative treatment decision-making process to determine the specific needs of patients and their families.[122,124]

Pharmacotherapy comprises one part of a multimodal treatment plan.[79] Table 2 provides an overview of medications approved for the treatment of AYAs with ADHD; these include psychostimulants such as methylphenidate (eg, osmotic release oral system-methylphenidate hydrochloride), amphetamines (eg, lisdexamfetamine), and nonstimulants (eg, atomoxetine, clonidine, and guanfacine).[42,79,122,124] Psychostimulants are available in short-acting and also long-acting formulations (adherence to the latter appears to be superior, most likely due to the convenience of once-daily dosing).[125,126] Extended-release formulations of nonstimulants such as guanfacine also offer once-daily dosing.[79] For adolescents with ADHD, psychostimulants are generally recommended as first-line therapy and nonstimulants as second-line therapy.[42,122] However, this depends on the approval status of the medications in specific countries and/or regions.[79]

Pharmacotherapy has been proven to be efficacious for the treatment of ADHD in adolescents.[120,127] In general, the efficacy of psychostimulants has been shown to be greater than that of nonstimulants in adolescents with ADHD (the effect size is almost 1.0 for stimulants vs 0.6 for nonstimulants),[128] and compared with nonstimulants, long-acting psychostimulants may provide greater improvements in ADHD symptoms and overall functioning.[128,129] Psychostimulants have been reported to reduce structural and functional abnormalities in the brains of individuals with ADHD[130] and are proposed to "normalize" the ADHD brain.[131] The repair of structural and

Table 2.

Overview of Available Medications for the Treatment of ADHD in AYAs[a]

Class	Substance	(Likely) mode of action	Potential adverse effects[b]	Parameters to be monitored under therapy	Potential advantages	Potential disadvantages
Stimulants	Methylphenidate, amphetamines	Reuptake inhibition (plus release in amphetamines) of dopamine and norepinephrine	• Decreased appetite • Sleep disturbances • Increased BP and pulse • Headaches • Irritability • Stomach pain	• Height • Weight • Pulse • BP	• Large effect sizes for reducing ADHD core symptoms • Rapid onset of treatment effects • Available in short- and long-acting formulations • Chewable tablets, liquid formulations, and transdermal patches are available • Positive effects on CD and ODD	• Limited daily duration of effects • Partial potential for rebound of symptoms when effect wears off in the afternoon/evening • Controlled substance (may vary according to country regulations)
Nonstimulants	Atomoxetine	Norepinephrine reuptake inhibition	• Decreased appetite • Headache • Stomach pain • Nausea • Vomiting • Sleep disturbances • Increased BP and pulse	• Suicidality • Clinical worsening • Unusual changes of behavior (ie, during the first few months of treatment or at times of dose change) • Pulse, BP	• "Around-the-clock effects" • Uncontrolled substance • Possible first-line option in comorbid SUDs, tic/Tourette disorder • Augmentation of stimulant treatment possible	• Smaller effect size vs stimulants • 6–12 wks until effects are observed • Best taken with food to minimize abdominal discomfort
	Clonidine, guanfacine	Agonism at α_2 adrenergic receptors (leading to enhanced noradrenergic neurotransmission)	• Somnolence/sedation • Fatigue • Hypotension • Bradycardia • Irritability • Insomnia	• Pulse, BP	• "Around-the-clock effects" • Uncontrolled substance • Possible first-line option in comorbid sleep disorder, SUD, disruptive behavior disorders, tic/Tourette disorder • Augmentation of stimulant treatment possible • Clonidine: transdermal patch available	• Smaller effect size vs stimulants • 2–4 wks until effects are observed • Somnolence/sedation frequent AE (administration in the evening preferable) • Clonidine: twice-daily dosing necessary

[a]Adapted from Mechler et al,[79] which is an open-access article distributed under the terms of the Creative Commons CC-BY license.
[b]In our clinical experience, these side effects are not common and are generally mild and often transient, especially in adolescents with ADHD.
Abbreviations: ADHD = attention-deficit/hyperactivity disorder, AE = adverse effects, AYA = adolescent and young adult, BP = blood pressure, CD = conduct disorder, ODD = oppositional defiant disorder, SUD = substance use disorder, wks = weeks.

functional brain abnormalities may underpin the beneficial clinical effects of this class of ADHD medication.[130]

Reports of the effects of psychosocial treatments on ADHD symptoms in adolescents are inconsistent,[127] but they appear effective for functional impairments such as poor academic and organizational skills.[127] A combination of pharmacologic and psychosocial interventions should therefore improve the core symptoms of ADHD as well as reduce functional impairments and thereby improve quality of life.[42] The benefits of psychosocial interventions may also be enhanced by ADHD medication, which may allow patients to focus more effectively.[42]

Optimal management of AYAs with ADHD may be time-consuming for physicians,[3] but they should be prepared to proactively follow up with the patient to provide ongoing support, monitor medication use, and reinforce the importance of medication adherence. Factoring in the perspectives and feedback from across stakeholder groups (eg, patients, parents, and caregivers) is another important responsibility of the physician that helps shape the ADHD treatment plan. Setting realistic

Table 3.

Practical Guidance for Physicians When Treating AYAs With ADHD[a]

	Guidance
Goals	Identify the goals to be achieved in discussion with the AYA and parent(s), setting realistic expectations. Goals (eg, less procrastinating, less impulsive behavior, and improved emotional control) may differ between individuals depending on age, symptoms, and personal circumstances
Treatment options	Discuss available pharmacologic and psychosocial treatment options with the patient and parent(s)
	Remember that a multimodal treatment approach should always be considered
Medication dosage	Provide the AYA and parent(s) with written handouts including step-by-step instructions on when/where/how to start the ADHD medication
	Titrate the dose to meet the individual patient's needs. Follow a "start low, go slow" approach. Start at the lowest dose for the individual's age (unless switching) and increase at weekly intervals. Always consult the prescribing information of the medication for dose titration guidance. Remember that unlike nonstimulants, stimulants are not weight-based. As a result, adolescents may require higher dosages than adults
	Continue to increase the dose barring any intolerable side effects until the core symptoms of ADHD are normalized using a rating scale and functional impairments and quality of life improve
	Dosage may increase over time particularly in adolescents due to hormonal and physical changes, but can decrease over time in young adults
Medication side effects	Common side effects (eg, decrease in appetite, abdominal pain, and sleep disturbances) should be discussed with the patient and parent(s) prior to initiating treatment and at subsequent follow-ups. Remember to establish baseline levels of appetite and sleep (in addition to standard baseline parameters such as BP, heart rate, and weight)
	Return to a lower dosage if signs of too much medication occur (eg, feeling jittery, more hyperactive, irritable, subdued, or sad). Also, if significant side effects (eg, major appetite or sleep issues) continue even on a lower dosage and/or there is no apparent improvement in the patient's symptoms, consider discontinuing the medication and switching to another class. Stimulants do not have to be tapered, but nonstimulants should be tapered gradually to avoid rebound side effects
Follow-up	Book a follow-up appointment with the patient no longer than 3–4 wks after initiating ADHD treatment
	Discuss with the AYA and parent(s) about any positive benefits or negative side effects of the ADHD medication, and whether the medication can be continued or if switching should be considered
	Optimally treat ADHD (and any psychiatric comorbidities) into symptomatic remission with functional improvements, as measured by structured rating scales/questionnaires supplemented by feedback (written and verbal comments) on perceived progress from the patient, parents, caregivers, etc

[a]The practical guidance outlined in this table originates from clinical experiences and suggestions provided by the authors.

Abbreviations: ADHD = attention-deficit/hyperactivity disorder, AYA = adolescent and young adult, BP = blood pressure, wks = weeks.

expectations of the treatment plan with all stakeholders from the outset (eg, what ADHD medications can and cannot achieve) and ensuring treatment goals are tailored for each patient can help to achieve positive outcomes and minimize adverse events. Based on our own clinical experience, Table 3 provides hints and tips for physicians treating AYAs with ADHD (please refer to evidence-based guidelines, specific product monographs, and prescribing information for comprehensive guidance).

FUTURE PERSPECTIVES

Adolescence is a period of substantial cognitive, neurobiological, and social development, which prepares individuals for the challenges of adulthood.[13] The rapid development of brain structure and function during adolescence, plus the simultaneous increase in cognitive ability, is referred to as a "critical period" of development.[13]

Beginning at the onset of puberty, this period is thought to be triggered by various factors, including

the development of the mesocorticolimbic dopamine system.[13] This may provide the necessary neurochemical and behavioral impetus to initiate the critical period of neurodevelopment in adolescence.[13] The interaction of experiences and neurobiological factors (eg, development of excitatory and inhibitory neurocircuitry; changes in expression of brain-derived neurotrophic factor) during the critical period may help to shape the normal development of the adolescent brain and permanently change behavior.[13] The critical period is brought to a close by "braking factors" (eg, creation of perineuronal nets on neuronal cell bodies; increase in axonal myelination) that restrict further neuronal changes and stabilize neuronal circuitry, in preparation for the transition of the adolescent into adulthood.[13]

The increase in neuronal plasticity that occurs during adolescence may render the brain more vulnerable to psychiatric and neurodevelopmental disorders, adverse experiences (eg, trauma), and other pathogenic insults, all of which could lead to abnormal development of the adolescent brain and detrimental long-term outcomes.[13,18] Nevertheless, the neuronal plasticity underlying the critical period of adolescence also offers a window of therapeutic opportunity for appropriate interventions to "normalize" the abnormal neurodevelopmental trajectory and positively impact or correct long-term outcomes.[13] The treatment of ADHD in AYAs should therefore be prioritized, and unnecessary delays should be avoided, given that adolescence is a time when the adaptive neurobiological mechanisms of the adolescent brain may be at their most responsive to therapeutic interventions for ADHD.

The early months of postnatal life are also a critical period of brain development, during which neuronal plasticity is prominent.[132] Potentially, therapeutic interventions during the earliest months of life could therefore have beneficial effects on the neurodevelopmental trajectories of people at risk of neurodevelopmental disorders such as ADHD.[32] For this to become a realistic proposition, at-risk individuals would need to be identified as early as possible, either prenatally or in early infancy.[32] Currently, no biomarkers can reliably identify and facilitate the diagnosis of individuals with ADHD.[124,133] Should such a biomarker be discovered, this would allow screening (at birth) of the offspring of parents with ADHD and the possibility of providing prophylactic treatment, long before ADHD symptoms usually emerge.

In summary, the burden of ADHD and associated functional impairments can magnify the difficulties encountered during the transitional period of adolescence and young adulthood. AYAs with ADHD are faced with an array of challenges that can negatively impact the management of such patients. With regard to what can be achieved by ADHD management approaches, there are often major differences between the findings reported in clinical trial settings and observations of real-life outcomes from clinical practice.

Based on our combined clinical experience, we have provided practical hints and tips relating to ADHD diagnosis, puberty, risk-taking behaviors, psychiatric comorbidities, ownership and engagement, parent and family dynamics, medication adherence, psychosocial development, the COVID-19 pandemic, and digital media. By utilizing such strategies and solutions, the management of AYAs with ADHD may become more straightforward and achievable. Given the burden of untreated ADHD and the impact of psychiatric comorbidities, it is imperative that the management of ADHD in AYAs be prioritized.

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