ABSTRACT

Risks and protective factors interact to produce the symptoms and impairments of attention-deficit/hyperactivity disorder (ADHD). These factors include genetic, medical, temperament, and environmental elements. Details of these risks and protective factors show that treatment outcomes must include a wider array of symptoms than core symptoms alone, which may not be present in some patients because of delayed effects of earlier symptoms or absence of effects that surface later in development. A careful assessment of risks and protective factors is required to identify targets for treatment. Assessment of core symptoms is augmented by determining the impact of symptoms on home, school, academic, social, and self-related impairments, among others. These impairments constitute the immediate targets of treatment, but a thorough understanding of ADHD in individual patients requires consideration of longer-term outcomes.

reviews functional impairments associated with ADHD that can be tracked over time to measure the effects of treatments and interventions.

**Risk Model of ADHD**

ADHD is among the most heritable of disorders; twin studies show a heritability index greater than 0.8. Research also suggests that, compared with controls, first-degree relatives of children with ADHD have higher risk of tobacco abuse, substance abuse, affective disturbances, antisocial behaviors, school problems, and anxiety problems.2,3

Among medical risk factors, the 2 most prominent are smoking and use of alcohol by mothers in the first trimester, both strongly associated with the presence of hyperactivity and learning disabilities at age 7 years. Other impairments to the development of the central nervous system during pregnancy, such as toxemia, premature labor, and birth complications, may also contribute to risk (Table 1). Whereas ADHD is not always a consequence of such circumstances, these risk factors may combine with genetic, temperament, and environmental risks, further contributing to overall risk (Table 2).8-13

Environmental risk factors may interweave to create a complex and compounded risk profile. Lead and fumes, carbon monoxide, a variety of heavy metals, and cadmium have all been implicated in ADHD. These findings suggest that a mother in the inner city who feeds her child cow's milk early rather than breast milk because she has to return to work embodies both socioeconomic and nutritional risk factors. Those risks are compounded by others: the child received inadequate amounts of iron because it is not as absorbable from cow's milk, which in the presence of an environment laden with lead results in an even higher overall risk. A similar interplay of environmental risks has been observed in studies of cadmium, which suggest that high cadmium levels are related to hyperactivity and learning disabilities, but only in those subjects who do not eat whole-wheat bread; zinc in the kernel of the whole wheat is protective against the absorption of cadmium.11-13 Such complexities typify not only the origins of the disorder, but also its manifestations.

**Functional Impairments**

ADHD symptoms may or may not result in a vari-

---

**Table 1. Genetic and Medical Risks for ADHD**

<table>
<thead>
<tr>
<th>Genetic Risks</th>
<th>Medical Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyperactivity</td>
<td>Pregnancy/birth and delivery</td>
</tr>
<tr>
<td>Conduct disorder</td>
<td>Smoking and drug use</td>
</tr>
<tr>
<td>Alcoholism and sociopathy</td>
<td>Toxemia</td>
</tr>
<tr>
<td>Mood and anxiety disorders</td>
<td>Premature labor</td>
</tr>
<tr>
<td>Learning disorders</td>
<td>Low birth weight</td>
</tr>
<tr>
<td>Minor physical anomalies</td>
<td>C-section with complications</td>
</tr>
<tr>
<td>Adoption</td>
<td>Medical history</td>
</tr>
</tbody>
</table>

Data from Boudreault et al,8 Brody et al,9 Weissbluth,10 McGee et al,11 Stewart-Pinkham,12 and Arnold et al.13

---

**Table 2. Temperament and Environmental Risk Factors for ADHD**

<table>
<thead>
<tr>
<th>Temperament Risks</th>
<th>Environmental Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity level</td>
<td>Family stress (death, divorce, marital conflict)</td>
</tr>
<tr>
<td>Novelty seeking, impulsivity</td>
<td>Economic problems</td>
</tr>
<tr>
<td>Inconsolability</td>
<td>Exposure to heavy metals</td>
</tr>
<tr>
<td>Fearfulness</td>
<td>Dietary factors</td>
</tr>
<tr>
<td>Responds with very high intensity</td>
<td>- Poor diet</td>
</tr>
<tr>
<td>Irregular eating and sleeping problems</td>
<td>- Possible role of linoleic acid</td>
</tr>
<tr>
<td>Rigid, tense, not cuddly</td>
<td>- Role of multivitamin supplements</td>
</tr>
<tr>
<td></td>
<td>- Role of exclusionary diets</td>
</tr>
</tbody>
</table>

Data from Boudreault et al,8 Brody et al,9 Weissbluth,10 McGee et al,11 Stewart-Pinkham,12 and Arnold et al.13
ety of functional impairments, depending on the degree to which protective factors are in place. Family environment, educational resources, positive lifestyle, and intelligence all combine to offset negative risk outcomes. These include behavioral self-regulation deficits (impulsivity); cognitive processing deficits (intelligence quotient, learning disabilities); affective processing deficits; and interpersonal processing deficits; which manifest in diverse impairments in children at different ages.

It is essential for clinicians to measure changes in impairments over time to determine the effectiveness of treatment. In the school-aged child, areas to watch include academic performance, deportment at school, social interactions, involvement in recreational and sports activities, sleep patterns, eating habits, and family interactions. Social impairments may include a propensity for lying as well as other malevolent behaviors (Figure 1).

In adolescents, we know from Barkley’s research that sexually transmitted diseases, early pregnancy, risk of contracting human immunodeficiency virus, death by accident, and high insurance costs are all significantly higher among ADHD patients compared with control groups. ADHD subjects were nearly 4 times as likely to be involved in serious motor vehicle accidents compared with the control group (Figure 2).

In adults, impairments tend to be more subtle as the change occurs from a protected environment in which the child has been operating to one in which the adult must plan and organize activities independently. Such activities involve executive function processes, the management system of the brain’s cognitive functions, which research suggests is impaired in patients with ADHD. One way of thinking about executive dysfunction is to picture the busy Chief Executive Officer (CEO) whose secretary is absent. The CEO may be, in effect, brain damaged—his or her ability to plan, organize, or keep track of daily appointments has been compromised. The “secretary” of the brain is seated in the frontal lobe, in an area that controls a wide range of central processes responsible for prioritizing and integrating functions needed for self-management. In adults, executive dysfunction may become a source of considerable impairment, affecting occupational, marital, and social performance. This suggests a distinct evolution of the consequences of ADHD from childhood into adulthood, where patients are more likely to be fired, change jobs frequently, and experience marital difficulties.
ASSessing Symptoms Against Impairments

A simple tool for assessing symptoms against functional impairments is presented in Table 3. The clinician inquires how the listed symptoms affect the child. For example, the clinician may say, “You said your child is very hyperactive. How does that play out at home, at school, and with his friends?” The parent may respond, “He’s up and down at the dinner table and he’s running around like crazy at 5:00 AM; he runs around the room at school, disrupting class, and when interacting with peers, he frequently disrupts games his friends play.” All of these impairments then become targets of improvement, which can be measured to determine the effectiveness of medical and behavioral interventions. The area of self-domain is more difficult to assess, as it requires self-reporting from the child and some psychotherapy to get the child to explain how he feels about himself in response to his symptoms. Feeling rejected and isolated and having low self-esteem are internal consequences or impairments of this disorder.

The clinical history should assess ADHD impairments as well as risk factors. Clinicians are advised to interview the patient and the patient’s family for ADHD symptoms to determine which specific impairments are caused by the symptoms, using the assessment tool presented in Table 3. If possible, clinicians should use a method that measures both impairments and symptoms, such as a rating scale. Clinicians should also track the effect of treatments over time on all impairments and symptoms. Treatments should be adjusted as needed to deal with major impairments resulting from the disorder.

Conclusion

The median age for treatment of ADHD is 9 years, creating ample opportunity for early intervention. Whether clinicians treat patients at an earlier or later age, it is important to be mindful of the developmental trajectory associated with this disorder and to educate patients that ADHD-associated impairments will change. Physicians should be aware of risk factors associated with ADHD that may create impairments not directly due to ADHD symptoms. Treatment planning should consider the chain of secondary causes of impairment (e.g., low self-esteem may lead to risky peer relations, which may then lead to substance abuse). Finally, treatment of comorbid impairments, such as anxiety, depression, and oppositional and conduct disorders, may be just as important as treatment of the core impairments usually seen in ADHD.

References