SPECIAL ISSUE ARTICLE

An Overview of Adolescent Psychostimulant Use

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ABSTRACT

Adolescence marks a period of significant neural maturation and development of lifelong habits, including the potential use of recreational psychostimulant drugs. Increased prevalence of drug adulteration and fatalities related to drug overdose pose new challenges for individuals who use drugs recreationally. As the prevalence of recreational psychostimulant use drastically increases during young adulthood, pediatric and adolescent health care providers can play a crucial role in the lifelong well-being of their patients by identifying those with risk factors for consequences associated with substance use at an early age. This article discusses the epidemiology, pharmacology, clinical manifestations, complications, and common methods of use for three types of psychostimulant drugs—amphetamines, methamphetamine, and 3,4-Methylenedioxymethamphetamine. This article aims to provide pediatric and adolescent health care providers with practical knowledge to effectively perform substance use screening, brief intervention, and referral to treatment with the goal of reducing drug-related morbidity and mortality among the adolescent age group. **[*Pediatr Ann*. 2023;52(5):170–e177.]**

According to the 2020 National Survey on Drug Use and Health, 13.8% of those age 12 to 17 years used any illicit substance in the past year; that is roughly 3.4 million adolescents in this age group.[1] In 2020, 1.6 million adolescents age 12 to 17 years were diagnosed as having a substance use disorder (SUD).[1] **Table 1** shows specific psychostimulant-type substance use in this age group including past-year use, first-time use, and use disorders in 2020. Past-year use, initiation of use, and use disorders increase by at least 3-fold and up to 9-fold in the group age 18 to 25 years for all substances.[1] In 2020, 3,4-methylenedioxymethamphetamine (MDMA) use alone was initiated by 78,000 (0.3%) adolescents age 12 to 17 years. In the same year, 28.6% of adolescents with a past-year major depressive episode used illicit substances.[1] Compared with the 10.7% of past-year illicit substance users without a major depressive episode, this statistically significant difference supports the role of mental health decline as a risk factor for substance use. In the fourth quarter of 2020, 46.4% of adolescents who reported using substances other than alcohol in the past year felt that they used fewer than they did before the onset of the COVID-19 (coronavirus disease 2019) pandemic, which may be attributable to the temporary loss of access to their substances of choice because of decreased social activity during peak pandemic times.[1] However, 15.2% of this age group felt that they used drugs more frequently during this time.[1]

In general, the annual prevalence of amphetamine, MDMA, and methamphetamine use among 8th, 10th, and 12th graders has been declining during the last 2 decades. However, these substances are far from obsolete. In 2021, the third most prevalent substance illicitly used by 8th, 10th, and 12th graders was amphetamines—that is, without medical supervision or instructions. Use was highest among 8th graders (3%),

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in particular 8th grade girls (3.5% of 8th grade girls vs 2.1% of 8th grade boys).[2] It is possible that girls in this age group use amphetamines for weight loss purposes.[2] Across all three grades from 2020 to 2021, both the lifetime and 2-year combined prevalence of amphetamine use was highest among White adolescents when compared with Hispanic and African American/Black adolescents.[2] From 2019 to 2021, high school seniors most commonly obtained amphetamines from friends, either for free (41.6%) or purchased (32.8%).[2] Other times (32.2%), amphetamines are obtained from leftover previous prescriptions.[2] Taken together, the diversion to nonmedically supervised use of amphetamines has been a progressively increasing problem among adolescents.

In 2021, less than one-half (41%) of 12th graders and only one-third (33%) of 8th graders viewed experimentation with MDMA as risky.[2] During this year, 0.6%, 0.7%, and 1.1% of 8th, 10th, and 12th graders, respectively, used MDMA.[2] MDMA use is variable across grades and ethnicities. The lifetime prevalence of MDMA use among 8th graders is highest in Hispanic students, whereas 10th and 12th grade use is highest among African American/Black and White students, respectively.[2]

Although adolescent methamphetamine use continues to decline, 0.3% to 0.6% of 8th, 10th, and 12th graders have used the drug in their lifetime, and 0.2% of each grade used the drug in 2021.[2] In 8th and 10th grade, Hispanic students show the lowest prevalence of methamphetamine use compared with White and African American/Black students.[2] However, by 12th grade, Hispanic students have both the highest lifetime and annual prevalence (2.4% and 2%, respectively).[2] By 12th grade, the lifetime prevalence of methamphetamine use is higher among boys (0.7%) compared with girls (0.2%).[2]

TABLE 1

Past Year Use, Initiation of Use, and Substance Use Disorders by Drug Category Among Adolescents Age 12 to 17 years During 2020

Drug category	Past year use		Initiation of use	Substance use disorders	
	Number of individuals	Percentage	Number of individuals	Number of individuals	Percentage
Methamphetamine	21,000	0.1	6,000	21,000	0.1
Hallucinogens[a]	370,000	1.5	251,000	-	-
Prescription stimulant misuse[b]	288,000	1.2	116,000	43,000	0.2

[a]Hallucinogens include MDMA (3,4-methylenedioxymethamphetamine), LSD (lysergic acid diethylamide), psilocybin, PCP (phenylcyclohexyl piperidine), mescaline, peyote, Salvia divinorum, DMT (N, N-dimethyltryptamine), and ketamine.
[b]Stimulant misuse includes amphetamine and methylphenidate products.

COMMON METHODS OF USE

Recreational amphetamine use is usually via smoking, snorting, or injection, as these routes quickly deliver high concentrations of the drug to the brain, amplifying dopaminergic effects. Smoking bypasses first-pass metabolism and is associated with a greater subjective high. Oral intake is a less popular route for recreational use because gastrointestinal absorption significantly delays the onset and intensity of psychoactive effects.[3]

Methamphetamine can be taken orally as a pill or powder, intranasally as a powder, intravenously as a solution, or inhaled as a crystalline solid. The onset of action depends on the route of administration. Oral intake is slowest with an onset between 15 and 20 minutes, whereas inhalation is fastest with an onset within minutes. The addictive potential and severity of methamphetamine increases with the speed of drug delivery. Methamphetamine doses are typically between 50 and 2,000 mg/day. However, chronic users may binge multiple doses up to 5,000 mg/day. These binges can last days to weeks. Binge termination is followed by a "crash" characterized by acute withdrawal symptoms and cravings, which may lead to repeat binge-and-crash patterns of use.[4]

MDMA is usually taken orally in the form of pills or tablets. MDMA may be used in powder form for snorting or smoking. Onset is usually within 1 hour, and effects can last up to 6 hours. Generally, MDMA is used infrequently and recreationally. Abuse, dependence, and consequent withdrawal syndrome are uncommon. However, individuals who use chronically may use MDMA more frequently and by injection.[5] **Figure 1** contains additional information on these substances, including common street names.[6]

PHARMACOLOGY

Amphetamines are central nervous system (CNS) stimulants that primarily inhibit reuptake of dopamine, norepinephrine, and serotonin. Also acting as indirect neurotransmitters, amphetamines increase monoamine levels in the cytosol.[3,7] Recreational use of amphetamine is generally at higher doses than what is available therapeu-

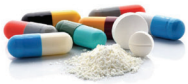
Drug	Image	Description	Street Names
Amphetamine		Amphetamines can look like pills or powder. Common prescription amphetamines include methylphenidate (Ritalin or Ritalin SR), amphetamine and dextroamphetamine (Adderall), and dextroamphetamine (Dexedrine).	Bennies, Black Beauties, Crank, Ice, Speed, Uppers
Methamphetamine		Regular meth is a pill or powder. Crystal meth resembles glass fragments or shiny blue-white "rocks" of various sizes.	Batu, Bikers Coffee, Black Beauties, Chalk, Chicken Feed, Crank, Crystal, Glass, Go-Fast, Hiropon, Ice, Meth, Methlies Quick, Poor Man's Cocaine, Shabu, Shards, Speed, Stove Top, Tina, Trash, Tweak, Uppers, Ventana, Vidrio, Yaba, Yellow Bam
3,4-methylenedioxy-methamphetamine (MDMA)		MDMA is mainly distributed in tablet form. MDMA tablets are sold with logos, creating brand names for users to seek out. The colorful pills are often hidden among colorful candies. MDMA is also distributed in capsules, powder, and liquid forms.	Adam, Beans, Clarity, Disco Biscuit, E, Ecstasy, Eve, Go, Hug Drug, Lover's Speed, MDMA, Peace, STP, X, XTC

Figure 1. Amphetamine, methamphetamine, and 3,4-methylenedioxymethamphetamine.

tically and causes an additional release of dopamine, leading to euphoria.[3]

As a sympathomimetic amphetamine derivative, methamphetamine has similar pharmacologic properties as amphetamine. The increased lipophilicity of methamphetamine's additional N-methyl group increases the speed and amount of drug that crosses the blood-brain barrier, leading to faster distribution in the CNS. Similar to amphetamine, methamphetamine increases the synaptic release of monoamines, most predominantly dopamine.[8,9]

MDMA, a sympathomimetic and synthetic amphetamine derivative, increases the release of dopamine, norepinephrine, and serotonin in the brain. MDMA also inhibits the reuptake of these monoamines. Compared with the large dopaminergic effect of methamphetamine and amphetamine, MDMA has a more potent effect on the serotonergic system, with subsequent increases in serotonin levels.[10]

PHYSICAL AND PSYCHOLOGICAL EFFECTS

Amphetamine

At prescribed doses, amphetamines target the prefrontal cortex to enhance the neurotransmission of norepinephrine and dopamine, leading to therapeutic effects on concentration, focus, and vigilance. However, at the higher recreational doses, there is a substantial release of dopamine in the nucleus accumbens, which can incite psychosis.[3] Amphetamine-induced psychosis presents similarly to schizophrenic-type psychosis, but recovery is more rapid. However, approximately 30% of individuals who experience amphetamine-induced psychosis eventually have primary psychosis.[7]

Acute amphetamine intoxication (**Table 2**) most commonly presents with signs of sympathomimetic toxidrome, characterized by tachycardia, hypertension, vasoconstriction, hyperthermia, diaphoresis, mydriasis, and agitation.[7] Intoxication may cause mood alterations, altered mental status, delirium, anxiety, or aggression. Further complications of acute intoxication or overdose may include acute renal failure, rhabdomyolysis, gastrointestinal irritation, cardiac arrhythmias, seizures, coma, and intracerebral hemorrhage secondary to sympathomimetic vasospasm.[11] Amphetamine withdrawal often occurs within 24 hours of last use and may involve intense cravings, mood dysphoria, suicidal ideation, anxiety, irritability, vivid dreams, sleep disturbance, fatigue, appetite stimulation, and psychomotor agitation or slowing.[12]

Methamphetamine

The clinical features of methamphetamine intoxication (**Table 3**) can be difficult to distinguish from amphetamine intoxication. Similar to amphetamines, the toxicity of methamphetamine is highly dependent on dose, method of intake, and frequency of intake.[4] Key differences can be attributed to methamphetamine's greater and more rapid effect on dopaminergic activity.[9] In addition to manifestations seen in amphetamine intoxication, methamphetamine intoxication may be associated with repetitive or compulsive movements (ie, choreoathetosis, cracking knuckles, scratching, or picking scabs), rapid eye movement, mood lability, paranoia, grandiosity, delusions, hallucinations, decreased appetite, decreased fatigue, increased sensitivity to noise, and tremors. High doses of methamphetamine can cause fatal elevations in body temperature and liver damage.[4,8]

Binges, high doses, or both can incite agitated delirium and psychotic states, which may include severe paranoia; fear of persecution; irrational fears; and visual, auditory, or tactile hallucinations.[4,8] Acute psychosis is associated with high doses, whereas persistent psychosis is associated with chronic methamphetamine use.[4] Severe cases of acute intoxication may involve pulmonary edema, pulmonary hypertension, stroke, myocardial infarction, and cardiomyopathies.[8]

Excess sympathomimetic activity can induce vomiting and diarrhea and even bowel ischemia.[13] Focal neurologic deficits can reflect CNS ischemia, infarction, or hemorrhage. Seizures are a severe sign and are generally present within 24 hours of use.[14]

Chronic use can have profound and lasting cognitive effects, specifically on memory, executive functioning, attention, information processing speed, language, visuospatial abilities, and motor skills.[15] Chronic low-dose methamphetamine use has been reported to damage up to 50% of dopamine-producing cells and may increase the risk of early-onset Parkinson's disease.[4,6] Idiosyncratic features of chronic methamphetamine use, regardless of the route of administration, include cavities, gingivitis, and missing teeth as a result of poor dental hygiene and xerostomia.[4]

Abrupt cessation may result in a withdrawal syndrome that can last for weeks. The inability to sleep during withdrawal may lead individuals to supplement with sleep-enhancing drugs (ie, benzodiazepines, alcohol, or barbiturates); they may may experience anhedonia and dysphoria for months. Withdrawal-associated severe depression significantly increases the risk of suicide.[4]

In children and adolescents, agitation, tachycardia, and crying are the most common signs of methamphetamine exposure or intoxication. In addition, vomiting, hyperthermia, ataxia, mydriasis, seizures, and roving eye movements are commonly seen. In children, exposure is usually accidental or secondhand, unlike in adolescents, for whom recreational use is the predominant source of exposure.[8,16]

MDMA

MDMA (or, as it is commonly known, "ecstasy") is described as the model empathogen, a substance that generates an altered state of consciousness with feelings of closeness, empathy, interrelatedness, and emotional openness, making MDMA a favorable party drug.[3] A dose-dependent relationship has been described, whereby lower doses (less than 100 mg) are more likely to produce positive effects, with larger doses (greater than 100 mg) potentially contributing to more negative overall effects.[17] In addition to pleasurable effects, it can also induce distressing cognitive and sensory distortions, altered perception of sensory input and time, and mild hallucinations.[3] MDMA shares some adverse effects with amphetamines, such as insomnia, xerostomia, bruxism, tachycardia, and diaphoresis.[10]

TABLE 2

Potential Effects of Amphetamine Intoxication

Organ system	Effects
Cardiovascular	Hypertension, tachycardia, vasospasm, arrhythmias
Neuropsychiatric	Hyper-alertness, mood alterations, anxiety, mydriasis, deranged hunger/thirst signaling, delirium, agitation, seizures, psychosis, intracerebral hemorrhage
Dermatologic	Diaphoresis
Gastrointestinal	Nausea, vomiting, diarrhea
Renal	Acute renal failure, metabolic acidosis, metabolic derangements, rhabdomyolysis
Other	Hyperthermia
Sympathomimetic toxidrome	Hypertension, tachycardia, mydriasis, vasospasm, and diaphoresis

TABLE 3

Potential Effects of Methamphetamine Intoxication

Organ system	Effects
Psychiatric	Hypervigilance, akathisia, aggression, unpredictable/erratic behavior, sleep disturbances, mood changes, paranoia, hallucinations, formication, suicidal ideation
Neurologic	Mydriasis, ataxia, roving eye movements, choreiform movements, central nervous system ischemia and infarction (with resulting focal deficits), seizures
Cardiovascular	Hypertension,[a] tachycardia,[a] cardiac ischemia, myocardial infarction, cardiomyopathy, cardiovascular collapse, aortic dissection, coronary vasospasm
Dermatologic	Diaphoresis, excoriations
Pulmonary	Tachypnea, acute lung injury, pulmonary edema, pulmonary hypertension
Gastrointestinal	Nausea, vomiting, diarrhea, bowel ischemia
Renal	Metabolic acidosis, acute renal failure
General	Malnourishment
Dental/periodontal	Bruxism, xerostomia, poor dentition
Reproductive	Placental insufficiency, hemorrhage, abruption

[a]*Universal signs of methamphetamine intoxication.*

MDMA is commonly used in dance club settings in which the combination of a hot environment and dancing may exacerbate lethal side effects and neurotoxicity. Diaphoresis and hypovolemia with subsequent hyponatremia, rhabdomyolysis, cardiac arrhythmias, acute renal failure, and widespread organ damage are common causes of death.[3,10]

Excess use, or use in combination with other serotonergic agents, can precipitate serotonin syndrome, which may include symptoms such as diarrhea, mydriasis, restlessness, tremor, ataxia, agitation, hyperreflexia, myoclonus, intractable shivering, and autonomic instability (eg, tachycardia, hyperthermia >40°C, or hypertension), which can lead to cardiovascular collapse, seizures, altered mental status, coma, and death.[3]

Users of MDMA often report a "come down" effect, likely because of serotonin depletion, described as irritability, dysphoria, impaired concentration, memory impairment, and sleep disturbances. The come-down phenomenon remains controversial; it may be a normal sequela of ecstasy use or equivalent to a withdrawal syndrome. Long-term mental health effects of regular MDMA use are less clear, but may include chronic changes to mood, impulsivity, aggressive behavior, heightened anxiety, disruptions in appetite, and impairments in short-term, long-term, and working memory that do not improve with cessation of use.[17]

ADULTERATION

Some ecstasy adulterants are known to have greater acute toxicity than MDMA alone. Paramethoxyamphetamine and paramethoxymethamphetamine are some of the most dangerous ecstasy adulterants and have led to cases of fatal overdose. Adulteration with methamphetamine and caffeine increases the risk for neurotoxicity. A study in 2017 tested 529 nominally MDMA-containing products. Only 60% of these samples tested positive for MDMA, and most adulterants were unidentifiable (43%) with colorimetric assay. Identifiable contaminants were methylone (7%), other cathinones (4%), methamphetamine (3%), benzylpiperazine (2%), dextromethorphan (2%), mephedrone (1%), and 2C compounds (1%), among others. The consideration that "molly" is pure MDMA is an incorrect assumption.[18]

Adulteration of psychostimulants with fentanyl and its derivatives has been on the rise. From 2013 to 2018, urine toxicology tests with positive results for both methamphetamine and fentanyl increased by almost 800%.[4] During the first half of 2019, one-third of all drug overdose fatalities involved a combination of opioids and stimulants; 80% of these fatalities involved unregulated fentanyl.[4] Currently, the Centers for Disease Control and Prevention and the Substance Abuse and Mental Health Services Administration (SAMHSA) encourage health care providers to educate individuals who use drugs, their peers, and family members on adulteration and harm reduction strategies, including the use of fentanyl test strips and the proper use of naloxone, in addition to providing access to naloxone prescriptions.[4]

SCREENING

Screening for substance use involves asking questions pertaining to drug use and helps direct patient-centered plans of care and clinical decision-making. Screening is not used for the formal diagnosis of an SUD. Adolescence (age 12 years to the early 20s) is a significant period for neural maturation and development of drug-related problems.[19] This age group has increased risk factors for consequences associated with drug use, including physical and mental health problems, legal issues, unprotected sexual activity and unplanned pregnancy, and poor academic functioning.[19-21] Screening for drug use allows for the identification of patients with risk factors for SUDs, promotion of well-being, intervention and guidance for treatment, and reduction of drug-related morbidity.[21,22] Current United States Preventive Services Task Force guidelines claim that evidence is not sufficient to evaluate the advantages and disadvantages of screening for substance use in adolescent populations.[23] However, the American Academy of Pediatrics (AAP), the Bright Futures Initiative, and the SAMHSA consensus panel provide guidelines for adolescent substance use screening. The AAP recommends screening all adolescents for substance use at every annual visit as well as in the emergency or urgent care settings.[20] The Bright Futures Initiative recommends including screening as part of a routine psychosocial history for every adolescent patient.[24] Screening is also suitable for patients who are under evaluation for psychiatric conditions, display inappropriate behavioral alterations, or are at an increased risk for SUDs.[20,25]

SAMHSA and the AAP recommend the incorporation of the substance use screening, brief intervention, and/or referral to treatment (SBIRT) model in routine health care practice. Using SBIRT, validated screening tools triage substance use into risk categories, ranging from abstinence to severe SUD, and results guide evidence-based intervention. It is important for health care providers to become familiar with current validated adolescent screening tools to select and apply the tool most appropriate for their patients. Some tools selectively screen for alcohol use (eg, the National Institute on Alcohol

Abuse and Alcoholism Youth Alcohol Screen [Youth Guide]), whereas others are designed to screen for a range of illicit substances (eg, Screening to Brief Intervention [S2BI] and Brief Screener for Tobacco, Alcohol, and Other Drugs [BSTAD]).[19,20]

The S2BI and BSTAD are validated screening tools for patients between ages 12 and 17 years, can be self- or interviewer-administered within 2 minutes, and are easily accessible on the National Institute on Drug Abuse website.[21] The S2BI screens for the frequency of past-year use of commonly used substances as well as illegal drugs (eg, ecstasy or cocaine), prescription medications (eg, stimulants or opioids), inhalants, and synthetic substances (eg, bath salts). It is highly sensitive and specific for identifying SUDs, especially severe SUDs.[22] Similar to the S2BI, the BSTAD screens for the frequency of use for commonly used substances. However, the BSTAD also asks about friends' substance use and directly asks about the use of heroin, amphetamines, methamphetamine, and hallucinogens (eg, lysergic acid diethylamide or psilocybin).[26] Any positive screening, especially for high-risk substance use, should be followed by further assessment using a validated assessment tool as well as the initiation of brief intervention. Contingent on the assessment results, referral to treatment, a formal diagnosis of SUD, or both may be warranted.[20,22,26] Validated adolescent assessment tools that address illicit substances are CRAFFT (car, relax, alone, friends/family, forget, trouble), Global Appraisal of Individual Needs, and Drug Abuse Screen Test.[19,21] The AAP Substance Use Screening and Intervention Implementation Guide provides step-by-step details for various SBIRT scenarios.[20]

Diagnosing SUD

The *Diagnostic and Statistical Manual of Mental Disorders*, fifth edition[27] (*DSM-5*) provides criteria to diagnose an SUD, which is diagnosed when 2 or more criteria occur within a 12-month period (**Table 4**). *DSM-5* criteria allow for specifiers of severity (eg, mild, moderate, or severe), remission status, and comorbid diagnoses. It is important to be aware of some drug class-specific criteria exceptions. For example, withdrawal is not included in the diagnostic criteria for hallucinogen use disorder. Amphetamine and methamphetamine abuse would fall under the category of stimulant use disorder, whereas MDMA abuse would be categorized as a hallucinogen use disorder.[27]

BRIEF INTERVENTION

Levy et al.[19] provide details on brief intervention strategies and goals that are dependent on the substance use severity identified during screening. In short, abstinence or no SUD indicates positive reinforcement and medical home follow-up; limited use or substance use without SUD indicates brief advice to stop, education on harms related to substance use, and medical home follow-up; and any SUD indicates motivational interventions to assess for use-related problems, advice to stop, develop a plan, and reduce use or risky behaviors, followed by medical home care. However, weekly use or a severe SUD further indicates the need for evaluation by a substance use specialist, additional assessment of mental health disorders, and referral to treatment.[19] At this point, the provider should engage in a discussion about confidentiality, as parent or guardian involvement is necessary in medical care planning and support of their child throughout treatment and recovery. Referral to treatment and confidentiality discussions are especially important if the patient is at risk of acute harm (eg, suicidal or homicidal ideation, injection substance use, or withdrawal symptoms) and requires immediate attention.[19,20]

TABLE 4

Diagnostic Criteria for Substance Use Disorder

- The [substance] is often taken in larger amounts or over a longer period than was intended
- There is a persistent desire or unsuccessful efforts to cut down or control [substance] use
- A great deal of time is spent in activities necessary to obtain the [substance], use the [substance], or recover from its effects
- Craving, or a strong desire or urge to use the [substance]
- Recurrent [substance] use resulting in a failure to fulfill role obligations at work, school, or home
- Continued [substance] use despite having persistent or recurrent social or interpersonal problems cause or exacerbated by the effects of the [substance]
- Important social, occupational, or recreational activities are given up or reduced because of [substance] use
- Recurrent [substance] use in situations in which it is physically hazardous
- [Substance] use is continued despite knowledge of having a persistent or recurrent physical or psychological problem that is likely to have been caused or exacerbated by the [substance]
- Tolerance
  - A need for markedly increased amounts of the [substance] to achieve intoxication or desired effects, or
  - A markedly diminished effect with continued use of the same amount of the [substance]
- Withdrawal
  - The characteristic withdrawal syndrome for the [substance], or
  - The [substance] (or a closely related substance) is taken to relieve or avoid withdrawal symptoms

REFERRAL TO TREATMENT

In 2020, 1.6 million (6.4%) of those age 12 to 17 years needed substance use treatment. Of these patients, only 3.5% (55,000 adolescents) received treatment.[1] In following the SBIRT model, referral to treatment is the last step. The two objectives in referral to treatment are patient and family acceptance of the necessity for treatment and facilitation of their engagement with appropriate programs and professionals.[19,20] Appendix 12 of the AAP Substance Use Screening and Intervention Implementation Guide describes treatment referral steps, including a management and support decision flowchart for adolescents in need of SUD treatment.[20] Appendix 11 of the AAP guide[20] outlines the various outpatient and inpatient treatment programs, including their suitability for particular SUD patterns. Patients may be referred to addiction or mental health specialists to determine the appropriate type of treatment. However, familiarity with the large variety of treatments options can help pediatricians to select the appropriate type and level of treatment for their patients, which should be in the least restrictive setting possible. Providers should also be familiar with the treatment services in their area. The National Drug and Alcohol Treatment Referral Routing Service (1-800-662-HELP) and the Substance Abuse Treatment Facility Locator website (www.findtreatment.samhsa.gov) can help providers identify their local treatment services.[20]

Optimal treatment is typically multidisciplinary and can include self-help groups or behavioral psychotherapy. Participation in associated treatment services can be simultaneous or sequential depending on individual patient needs. Pediatricians play a crucial role in the continued care of adolescents with SUDs. This role includes, but is not limited to, coordination of the involved patient care services, collaborative support, detection of relapse, and additional assessment of risky behavior, such as screening for sexually transmitted diseases.[4,19]

ACUTE INTOXICATION MANAGEMENT

Management of acute psychostimulant intoxication is similar in adolescent and adult populations and is primarily supportive with symptomatic treatment. Clinicians should follow standard-of-care protocols and direct management according to alterations in vital signs, hydration status, urine output, serum electrolytes, and electrocardiogram abnormalities. Intravenous benzodiazepines are used for a variety of intoxication symptoms, including hypertension, agitation, seizures, chest pain, and hyperthermia. Clinicians should avoid the administration of beta-blockers, antipyretics, haloperidol, and phenytoin.[28,29] However, in the case of methamphetamine intoxication, haloperidol may be used as an adjunct after the titration of benzodiazepines in pediatric populations experiencing signs of sympathomimetic toxicity.[30]

REFERENCES

1. Substance Abuse and Mental Health Services Administration. Key substance use and mental health indicators in the United States: Results from the 2020 National Survey on Drug Use and Health. U.S. Department of Health & Human Services; 2021. Accessed March 16, 2023. https://www.samhsa.gov/data/sites/default/files/reports/rpt35325/NSDUHFFRPDFWHTMLFiles2020/2020NSDUHFFR1PDFW102121.pdf 2. Miech RA, Johnston LD, O'Malley PM, Bachman JG, Schulenberg JE, Patrick ME. Monitoring the future: National survey results on drug use, 1975–2021. Volume 1: Secondary school students. Institute for Social Research, The University of Michigan; 2022. Accessed March 16, 2023. https://monitoringthefuture.org/wp-content/uploads/2022/08/mtf-vol1_2021.pdf
3. Stahl SM. *Stahl's Essential Psychopharmacology: Neuroscientific Basis and Practical Applications*. 5th ed. Cambridge University Press; 2021.
4. Substance Abuse and Mental Health Services Administration. Treatment for stimulant use disorders. Treatment Improvement Protocol (TIP) Series 33. U.S. Department of Health & Human Services; 2021. Accessed March 16, 2023. https://store.samhsa.gov/sites/default/files/pep21-02-01-004.pdf
5. Favrod-Coune T, Broers B. The health effect of psychostimulants: A literature review. *Pharmaceuticals (Basel)*. 2010;3(7):2333-2361. https://doi.org/10.3390/ph3072333 PMID:27713356
6. United States Drug Enforcement Administration. Drugs of abuse. U.S. Department of Justice. Published April 13, 2020. Accessed March 16, 2023. https://www.dea.gov/documents/2020/2020-04/2020-04-13/drugs-abuse
7. Mullen JM, Richards JR, Crawford AT. Amphetamine related psychiatric disorders. In: *StatPearls*. StatPearls Publishing; 2022. Accessed March 16, 2023. http://www.ncbi.nlm.nih.gov/books/NBK482368/.
8. Schep LJ, Slaughter RJ, Beasley DMG. The clinical toxicology of metamfetamine. *Clin Toxicol (Phila)*. 2010;48(7):675-694. https://doi.org/10.3109/15563650.2010.516752 PMID:20849327
9. Vearrier D, Greenberg MI, Miller SN, Okaneku JT, Haggerty DA. Methamphetamine: history, pathophysiology, adverse health effects, current trends, and hazards associated with the clandestine manufacture of methamphetamine. *Dis Mon*. 2012;58(2):38-89. https://doi.org/10.1016/j.disamonth.2011.09.004 PMID:22251899
10. Dunlap LE, Andrews AM, Olson DE. Dark classics in chemical neuroscience: 3,4-Methylenedioxymethamphetamine. *ACS Chem Neurosci*. 2018;9(10):2408-2427. https://doi.org/10.1021/acschemneuro.8b00155 PMID:30001118
11. Chiang WK. Amphetamines. In: Nelson LS, Lewin NA, Howland MA, et al, eds. *Goldfrank's Toxicologic Emergencies*. 9th ed. McGraw-Hill; 2011:1078.
12. Shoptaw SJ, Kao U, Heinzerling K, Ling W. Treatment for amphetamine withdrawal. *Cochrane Database Syst Rev*. 2009;2009(2):CD003021. https://doi.org/10.1002/14651858.CD003021.pub2 PMID:19370579
13. Johnson TD, Berenson MM. Methamphetamine-induced ischemic colitis. *J Clin Gastroenterol*. 1991;13(6):687-689. https://doi.org/10.1097/00004836-199112000-00015 PMID:1761842
14. Alldredge BK, Lowenstein DH, Simon RP. Seizures associated with recreational drug abuse. *Neurology*. 1989;39(8):1037-1039. https://doi.org/10.1212/WNL.39.8.1037 PMID:2788249
15. Mizoguchi H, Yamada K. Methamphetamine use causes cognitive impairment and altered decision-making. *Neurochem Int*. 2019;124:106-113. https://doi.org/10.1016/j.neuint.2018.12.019 PMID:30611760
16. Kolecki P. Inadvertent methamphetamine poisoning in pediatric patients. *Pediatr Emerg Care*. 1998;14(6):385-387. https://doi.

org/10.1097/00006565-199812000-00001 PMID:9881979
17. Meyer JS. 3,4-methylenedioxymethamphetamine (MDMA): current perspectives. *Subst Abuse Rehabil*. 2013;4:83-99. https://doi.org/10.2147/SAR.S37258 PMID:24648791
18. Saleemi S, Pennybaker SJ, Wooldridge M, Johnson MW. Who is 'Molly'? MDMA adulterants by product name and the impact of harm-reduction services at raves. *J Psychopharmacol*. 2017;31(8):1056-1060. https://doi.org/10.1177/0269881117715596 PMID:28693371
19. Levy SJL, Williams JF, Ryan SA, et al; Committee on Substance Use and Prevention. Substance use screening, brief intervention, and referral to treatment. *Pediatrics*. 2016;138(1):e20161211. https://doi.org/10.1542/peds.2016-1211 PMID:27325634
20. American Academy of Pediatrics. Substance use screening and intervention implementation guide: No amount of substance use is safe for adolescents. American Academy of Pediatrics; 2016. Accessed March 16, 2023. https://www.healthvermont.gov/sites/default/files/documents/pdf/ADAP_Adolescent-PC-SU-Screening-Guide.pdf
21. National Institute on Drug Abuse. Screening tools for adolescent substance use. National Institutes on Health. Published May 30, 2019. Accessed March 16, 2023. https://nida.nih.gov/nidamed-medical-health-professionals/screening-tools-resources/screening-tools-adolescent-substance-use
22. Levy S, Weiss R, Sherritt L, et al. An electronic screen for triaging adolescent substance use by risk levels. *JAMA Pediatr*. 2014;168(9):822-828. https://doi.org/10.1001/jamapediatrics.2014.774 PMID:25070067
23. Krist AH, Davidson KW, Mangione CM, et al; US Preventive Services Task Force. Screening for unhealthy drug use: US Preventive Services Task Force recommendation statement. *JAMA*. 2020;323(22):2301-2309. https://doi.org/10.1001/jama.2020.8020 PMID:32515821
24. Hagan JF, Shaw JS, Duncan PM, eds. *Bright Futures: Guidelines for Health Supervision of Infants, Children, and Adolescents*. 4th ed. Bright Futures/American Academy of Pediatrics; 2017.
25. Center for Substance Abuse Treatment. *Screening and Assessing Adolescents for Substance Use Disorders*. Substance Abuse and Mental Health Services Administration (US); 1999. Accessed March 16, 2023. http://www.ncbi.nlm.nih.gov/books/NBK64364/
26. Kelly SM, Gryczynski J, Mitchell SG, Kirk A, O'Grady KE, Schwartz RP. Validity of brief screening instrument for adolescent tobacco, alcohol, and drug use. *Pediatrics*. 2014;133(5):819-826. https://doi.org/10.1542/peds.2013-2346 PMID:24753528
27. *Diagnostic and Statistical Manual of Mental Disorders*. 5th ed. American Psychiatric Association; 2013.
28. Hoffman RJ. MDMA (ecstasy) intoxication. *UpToDate*. Accessed March 16, 2023. https://www.uptodate.com/contents/mdma-ecstasy-intoxication
29. Arnold TC, Ryan ML. Acute amphetamine and synthetic cathinone ("bath salt") intoxication. UpToDate. Updated September 7, 2022. Accessed March 16, 2023. https://www.uptodate.com/contents/acute-amphetamine-and-synthetic-cathinone-bath-salt-intoxication
30. Malashock HR, Yeung C, Roberts AR, Snow JW, Gerkin RD, O'Connor AD. Pediatric methamphetamine toxicity: Clinical manifestations and therapeutic use of antipsychotics-one institution's experience. *J Med Toxicol*. 2021;17(2):168-175. https://doi.org/10.1007/s13181-020-00821-4 PMID:33442836