Case Scenario:
Mom walked into the older sibling’s room to find her 23-month-old son with open bottles of clonidine and Ritalin®. It is unknown how many pills have been ingested. The child is transported to the ED.

What is ADHD (Attention Deficit Hyperactivity Disorder) and what medications are used to treat it?
ADHD is a common diagnosis in both pediatric and adult populations. Symptoms of ADHD in children and teens include inattention and/or hyperactivity and impulsive behavior inappropriate to the child’s age. Symptoms in adults may vary from that of children, with emphasis on restlessness, trouble concentrating and staying focused, disorganization and forgetfulness, impulsivity, and difficulties with interpersonal relationships and employment.

Amphetamine-related drugs such as methylphenidate (eg, Ritalin®, Metadate®), dextroamphetamine/amphetamine (eg, Adderall®, Concerta®), and lisdexamfetamine (Vyvanse®); atomoxetine (Strattera®); and alpha-2 agonists such as clonidine (eg, Catapres®) and guanfacine (eg, Intuniv®, Tenex®) are useful in the treatment of ADHD. These drugs regulate norepinephrine which appears to be an important neurotransmitter for mental concentration. These medications are often found in schools and homes, making them prominent agents of pediatric poisoning.

Case Scenario continued…
The child arrived in the ED at 45 minutes post-ingestion. He developed periods of unresponsiveness alternating with agitation; episodes of apnea lasting 10 to 20 seconds, and acidosis (pH 7.28.) The child’s HR was 110 to 120, BP was 86/58.

What is the mechanism of toxicity and symptoms of overdose for ADHD medications?
Methylphenidate, dextroamphetamine/amphetamine, and lisdexamfetamine boost dopamine and norepinephrine by blocking reabsorption, though the exact mechanism of action in treating ADHD in children and adults is unknown. Overdose is characterized by CNS and cardiovascular toxicity, and hyperthermia. Overall, the effects are one of sympathomimetic excess with elevated levels of norepinephrine, dopamine, and serotonin. Neurological effects include restlessness, irritability, insomnia, hyperactivity, hallucinations, convulsions, and coma. Cardiovascular effects include arrhythmias (atrial and ventricular), hypertension (systolic and diastolic), palpitations, tachycardia, and circulatory collapse. Hyperthermia may be severe and rhabdomyolysis with elevation of CK may occur. Serotonin Syndrome can arise in overdose. Teens may abuse methylphenidate by snorting or injecting IV to attain a “high” which according to recent research, has a more sustained pharmacodynamic effect than IV cocaine.

Atomoxetine is a nonstimulant drug for the treatment of ADHD in children and adults. The mechanism of action is selective inhibition of the presynaptic norepinephrine transporter. Atomoxetine has little affinity for other neurotransmitter systems, thus minimizing adverse effects. Symptoms of overdose are an extension of side effects, most commonly somnolence, agitation, hyperactivity, and GI upset.

Alpha-2 Agonists are used to treat ADHD in children by stimulating norepinephrine. Clonidine may cause cardiovascular effects via stimulation of central imidazoline sympathomimetic receptors. There may be interactions between central adrenergic receptors and opiate/opioid receptors,
which may explain some of the opiate-like effects in overdose. Hypotension, bradycardia, drowsiness, ataxia, dizziness, lethargy, coma, hyporeflexia, hyperthermia, respiratory depression, and apnea are symptoms of overdose. Onset occurs within 30 to 60 minutes; but can be delayed up to 6 hours. Toxic symptoms generally resolve within 24 to 48 hours. As little as 1 tablet of these agents ingested by an infant or toddler can produce serious hypotension, bradycardia, and CNS depression.

Case Scenario continued...
During the course of hospitalization, lavage, IV fluids, oxygen, intubation, ventilation, and sedation were required. The child recovered uneventfully within 24 hours of ingestion.

What treatment is recommended for overdose with ADHD medications?
Treatment options vary by pharmaceutical agent. It is important to consider kinetics since both methylphenidate and dexamphetamine/amphetamine are available in immediate and extended release forms.

Overdose with Amphetamine-related agents is characterized by agitation which is managed with reduced sensory input in a quiet environment. First-line therapy when indicated is administration of a benzodiazepine (ie, diazepam, lorazepam.) Seizures are treated with diazepam or lorazepam, phenobarbital, propofol, and anesthesia or paralysis, depending on severity. Conservative treatment of hyperthermia is effective in most cases. If rhabdomyolysis and myoglobinuria occur, urine alkalization is instituted to prevent acute renal failure. Hypertension is typically transient and usually responds to sedation with benzodiazepines; although severe hypertension may require sodium nitroprusside or phenolamine. Cardiac conduction changes can include ventricular arrhythmias which are treated with lidocaine; supraventricular tachyarrhythmias may respond to a beta-blocker (ie, propranolol.) Adenosine is also useful. Enhanced elimination for removal of amphetamines is unproven.

Atomoxetine toxicity is generally mild. Mild to moderate hypertension may be managed with observation as hypertensive crisis is unlikely to occur. Seizures are treated as above. Enhanced elimination is of no value with atomoxetine since it is highly protein bound and has a large volume of distribution.

Alpha-2 Agonist overdose is characterized by apnea, bradycardia, and CNS depression. Ventilatory support may be indicated for cyclical apnea or bradypnea. Apnea and coma may respond to naloxone, though response has been variable. Bradycardia following clonidine overdose may not adversely affect hemodynamic status. Bradycardia with hypotension, however, may respond to atropine alone. Enhanced elimination is not effective.

For assistance with diagnosis and specific treatment information, please contact the Missouri Poison Center at 1-800-222-1222.
Keep Energy Drinks Off the Back-to-School Shopping List this Fall

The same energy drinks that students take to cram during late-night study sessions or student athletes take to get themselves through long days of sport practices pose more of a threat to their health than a benefit to their performance. Caffeine-charged drinks such as Red Bull®, Rockstar® and Full Throttle® have flooded convenience and grocery stores in recent years, and many are consumed by teens because they are thought to boost performance and to replenish fluids. They’ve also become go-to drinks for parties and late-night studying.

These drinks are aggressively marketed to teens and young adults. Most energy drinks contain large amounts of both caffeine and sugar along with a combination of legal stimulants and supplements. The caffeine content of energy drinks remains unregulated, and is equivalent to two or three cups of coffee. Young people are especially vulnerable to the harmful side effects of caffeine, and are at a far greater risk of caffeine overdose and related health problems. If improperly consumed, or guzzled, these drinks can cause symptoms that include upset stomach, sweating, tremors, sleeplessness, restlessness, headache, chest pain and heart problems. Caffeine overload is just one of the many hazards of energy drinks. Many people mistakenly think of caffeine as a food rather than a drug. Caffeine is a diuretic drug; therefore large doses can cause water loss and can be very dehydrating. This poses a problem for people drinking energy drinks while playing sports, or during or after exercise. Another concern to students and adults is with the combination of energy drinks and alcohol. These drinks are marketed to help increase fun and improve physical performance, concentration, attention and alertness. A commonly held misconception is that energy drinks can improve driving safety by reversing symptoms of drunkenness and reducing alcohol-related impairment. This is simply not true, and the consequences of this false sense of control could be devastating. It’s also important to know that some energy drinks now contain alcohol such as Tilt® and Sparks® which are frequently on store shelves next to the non-alcoholic brands. This can cause confusion so it is important to always read the label before purchasing.

Talk to your teen and college student about caffeine drinks, alcoholic beverages, the combination of both caffeine and alcohol, and their dangerous consequences.

Safe Use of ADHD Medications

Amphetamine and related medicines are used to treat attention-deficit hyperactivity disorder (ADHD). When used correctly for ADHD these drugs have legitimate uses and positive results for improving the attention span and ability to concentrate. Prescription ADHD medicines which include Adderall® and Ritalin®, are sometimes misused or abused as “brain boosters” or “academic enhancers.” Misusing or abusing these medications could lead to an increased heart rate, restlessness, seizures and difficulty breathing. It is important to use these drugs properly and the way they are prescribed.

- Educate your teens on proper use of these medications.
- Warn children and teens about the risks of sharing medications.
- Do not take somebody else’s medicine for an “academic enhancer.” It can have harmful side effects for people it is not indicated for.
- Use these medications only as directed. Do not take more of it, do not take it more often, and do not take it for a longer time than ordered.
- If you think this medicine is not working as well after you have taken it for several weeks, do not increase the dose. Instead, check with your doctor.
- Report any side effects to your doctor.
- Remember, keep this and all other medicines out of the reach of children.

Anyone who has questions about energy drinks, alcohol, medicines or any other potentially hazardous substance are urged to call the Missouri Poison Center at 1-800-222-1222.
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