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REVIEW ARTICLE

Adolescent Heroin Use: A Review

Richard H. Schwartz, MD

ABSTRACT. Use of heroin by American teenagers is beginning to show disturbing increases in national and statewide surveys. According to data from the 1997 National Institute on Drug Abuse monograph *Monitoring The Future*, heroin use by American high school 12th graders was 100% higher than it was from 1990 to 1996 (0.90–1.8%). In 1997, there was a further increase to 2.1%. Additional support for an increase in heroin use in the United States comes from analysis of recent survey data from California, Texas, and Maryland. Heroin imported from Colombia and from Mexico is now cheaper and of high potency, permitting novices to start with nasal administration of the drug. Most American adolescents now initiate heroin use by snorting it; however, frequent use of heroin by any route rapidly leads to tolerance and intense drug craving. Psychological dependence to heroin, and to the often exciting yet chaotic lifestyle of a heroin addict, is very difficult to overcome. Acute heroin withdrawal syndrome is usually not severe and most addicts in withdrawal can be managed in an outpatient setting. Naloxone must be used with great restraint and in smaller than usual doses in known heroin addicts. Successful long-term management often includes acute detoxification followed by long-term residential drug treatment. Managed care payment issues have impeded placement in appropriate treatment programs. Additional long-term management issues include regular attendance at 12-step meetings (Alcoholics Anonymous or Narcotics Anonymous), biweekly urine tests for drugs of abuse, attention to issues of dual diagnosis (group or family therapy), and reapproachment with family, school, and straight friends. *Pediatrics* 1998;102:1461–1466; drug abuse, heroin, chemical dependency, addiction.

ABBREVIATIONS. ADAA, Alcohol and Drug Abuse Administration; IV, intravenous; 6-MAM, 6-monoacetyl morphine.

New heroin users include adolescents in ever-increasing numbers. In 1988 the mean age of heroin use in the United States was 27; in 1995, the mean age of self-reported heroin use was reduced to 19 years (*Substance Abuse Report [Newsletter]* 1997;28(23):2). According to data from the 1997 National Institute on Drug Abuse monograph *Monitoring The Future*, use of heroin by American high school 12th graders was 100% higher than it was in 1990–1996 (0.90 to 1.8%) and there has been a further

increase in 1997 from to 2.1%.¹ There has been a continuing increase in heroin use from 1996 through 1997 from 1.8% to 2.1%.¹ Additional support for an increase in heroin use in the United States comes from analysis of recent survey data from California and Maryland. A 1996 survey revealed that 2.2% of California high school juniors had used heroin during the previous 6 months. This rate was double that of 1994 and represents a 10-year all-time high.² A 1996 survey of high school students in Maryland showed a 35% increase in heroin use by 12th graders since 1994 (3.4% vs 2.2%) [Maryland State Department of Education].

Teenagers in the United States have changed the route of administration from injection to snorting (intranasal use). In 1991, only 15% of American teen heroin users, ages 12 to 17 years, sniffed or smoked the drug, compared with 41% of teen heroin users surveyed in 1995 (*Substance Abuse Report* 1997;28(23):1). During an 15-month period ending March 1998, 39 patients, most of whom were younger than 20 years and of the middle socioeconomic class, were treated in the Emergency Department for acute heroin overdose at Columbia Hospital in Plano, Texas. There were six deaths from heroin overdose in Plano (telephone conversation, March 1998 with Dr Larry Alexander, Emergency Medicine, Columbia Hospital, Plano, TX). According to Drug Enforcement Agency sources, the cause of this epidemic was a single shipment of unexpectedly high-potency heroin manufactured in Mexico.

The Alcohol and Drug Abuse Administration (ADAA) of the Maryland Department of Health and Mental Hygiene issued an ADAA Alert on March 12, 1998 concerning the availability of high-potency, low-cost heroin in that state. The alert stated that intranasal heroin administration now comprises the majority of adolescent admissions to drug treatment programs. Heroin is quickly replacing cocaine as a drug of choice for middle-class white teens in Maryland. In suburban Baltimore County, 25% of teenage new drug treatment program admissions used heroin compared with 17% for the inner city in Baltimore (ADAA Alert, March 12, 1998). Carroll County (Maryland) General Hospital Emergency Department treated 10 teenagers for heroin overdose in a 5-week period ending December 1997 (David Putsche personal communication, April 22, 1998).

This article begins with a review of the pharmacology of the drug. It then presents updated infor-

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mation on drug sources, production, and purity; epidemiology and risk factors for heroin use; and methods of drug administration. The next section describes the effects of heroin, infectious complications of heroin use, and heroin withdrawal syndrome. This is followed by a brief discussion of current methods of laboratory diagnosis and emergent treatment of heroin addiction, with particular emphasis on the adolescent.

PHARMACOLOGY, MECHANISM OF ACTION, AND METABOLISM

Heroin (diacetyl morphine hydrochloride) is a potent Schedule I semisynthetic analgesic produced by anhydrous acetylation of morphine. Although the effects of heroin are stronger and the drug reaches peak effect sooner than morphine,³ it is believed to possess the highest potential to produce rapidly developing dependence and addiction of any of the common opiate narcotic analgesics.^{4,5} Heroin produces intense euphoria by facilitating direct access to the primitive mammalian reward system.⁶ It rapidly enters the brain after intravenous (IV) administration, avidly binding to mu, kappa, and other stereospecific opiate-receptor binding sites in the locus coeruleus.⁷ Heroin reduces anticipatory anxiety associated with emotional or physical pain and it alters the person's perception of pain so that discomfort is reduced or eliminated and causes somnolence ("nodding off"). To counterbalance the soporific effects of heroin, users sometimes mix it with stimulants such as cocaine (speedballing).

The onset of euphorogenic action is about 30 minutes after snorting, 15 minutes after subcutaneous injection, and almost instantaneous after IV injection. The duration of pleasure for heroin is 3 to 4 hours.

Heroin is rapidly deacetylated in microsomes of the endoplasmic reticulum of the liver to 6-monoacetyl morphine (6-MAM), an evanescent intermediate metabolite marker unique to heroin. It is then further deacetylated to morphine and excreted in the urine, over a 30–40-hour period, as free morphine as well as its major metabolite, morphine 3-glucuronide.

HEROIN: PURITY AND METHODS OF ADMINISTRATION

After the opium poppies (*Papaver Somniferum*) ripen, farmers score the poppy capsules with precision. Opium sap exudes out, hardens, and is scraped off, collected, and converted in clandestine laboratories to heroin hydrochloride. Large amounts of heroin of southeast Asian origin (28% of seized heroin), predominantly Burma, come into the United States. Three crops of Colombia, South America opium poppies can be harvested each year. Increasingly large amounts of air passenger-smuggled heroin now enter the US East Coast from Colombia. This heroin is carried in 1- to 2-kg amounts, wrapped in latex condoms, and hidden in luggage or ingested in small pouches by the trained couriers.⁸ Impurities in the illicit manufacturing process, particularly in heroin from Mexico, cause some samples of heroin to turn a brown or "black tar" color, the predominant type

available in the western half of the United States. The Drug Enforcement Agency's Domestic Monitor Program indicates that the purity of Colombian and Mexican heroin powder has been steadily increasing and now averages 40%–60% when quantities of at least 1 g are purchased.⁹ The average price of heroin has decreased by nearly two thirds, and the purity has gone from 10% to more than 50%.⁹ From the distribution point to the consumer, heroin hydrochloride is always adulterated by the addition of quinine, lactose, mannitol, dextrose, or talc at each level of distribution so that dime bags (costing \$10.00/plastic bag) often contained only 6% heroin hydrochloride.

RISK FACTORS AND OFFICE DETECTION OF HEROIN USE

Persons who heavily misuse alcohol or abuse marijuana, those with parents or siblings who are addicted to alcohol or other drugs, those whose best friends are addicts are certainly at higher risk for experimenting with heroin.¹⁰ How can a pediatrician learn if there is a teenage heroin problem in the local community? Information about adolescent heroin abuse in your community can be obtained by a telephone call to the narcotics section of the local county police and by asking teenagers if they have heard about kids using heroin in your area. There are few clues for heroin abuse on physical examination, particularly if heroin is snorted. What matters is a heightened clinical suspicion of generic drug abuse because of falling school grades combined with smoking cigarettes, and antisocial acts for rebellion or for "fun". Confirmation of heroin use specifically often requires help from the clinical laboratory and telephone advice from a specialist in adolescent drug abuse.

PRAGMATIC STREET USE

Infrequent users do not experience pharmacologic addiction.¹¹ There are credible reports of individuals who have dallied with intranasal, inhalation, or subcutaneously administered heroin for many years and lived productive lives without progression to IV use. Heroin users, including adolescents, can look and act normal and attend school or hold down jobs. They do not fit stereotyped lifestyles of a heroin addict.^{12,13} Pediatricians are often unaware that they are caring for a few heroin-abusing teenagers.

Snorting (intranasal insufflation) is now the method of choice of heroin hydrochloride experimentation for most American teenagers. The relatively insoluble heroin base itself can be used without acidification by heating the powder until it is vaporized on a piece of aluminum foil. The upwardly-curling smoke is rapidly inhaled, a technique known as "chasing the dragon."^{14,15} The average injection heroin dose for novices 5 to 8 mg.⁴

Tolerance and Addiction

As tolerance develops, the dose of heroin and/or its route of administration can be expected to change. In the United Kingdom and in the Netherlands, at least 30% of adults who are addicted to heroin by

smoking it will graduate to injection use.^{16,17} The pharmacologic definition of drug dependence means that a withdrawal syndrome occurs after drug use is discontinued: no withdrawal, no physical dependence. The psychiatric definition of heroin dependence also includes compulsive use despite serious medical and social problems clearly related to heroin use, an inability to reduce the frequency or intensity of use, a preoccupation with drug-seeking behaviors, and a strong tendency to relapse after a period of abstinence.⁴

CLINICAL MANIFESTATIONS

Drug reward is great with heroin and seems to be the primary factor in sustaining drug-seeking behavior.^{18,19} Heroin's desired effects include intense tranquility, euphoria, analgesia, and clouding of the sensorium. The effect most desired by heroin addicts is referred to as a "rush," a craved for state of ecstasy and contentment that occurs almost immediately after IV injection, inhalation of heroin vapors, or intranasal insufflation. The time from initiation into daily use to serious physiologic and psychological addiction is highly variable. Approximately 40% of heroin novices experience adverse effects such as mild nausea and vomiting. Although tolerance to these effects is soon achieved with continued use, tolerance to heroin's well-known constipation effect and pupillary miosis is unusual. Most addicts suffer from serious constipation. Complications of regular snorting of heroin include mucosal dryness, spotting, and septal perforation.²⁰

Addiction and Overdoses

The desire to replicate the most intense rush ever experienced may lead to acute heroin overdoses.^{21,22} A 1994 British study of 438 heroin users found that 23% of injectors compared with 2% of noninjectors who smoked heroin had overdosed.²³ Most heroin overdoses occur in the home environment or at a friend's house, in the company of other people. Addicts who overdose are usually drunk or have taken sedatives plus heroin.²⁴ Overdoses may also occur from unexpectedly potent heroin, as has already occurred among US teenagers, or using a larger than usual amount.

The lifestyle of heroin addicts seriously decreases life expectancy. Age adjusted mortality rates among 555 opioid addicts followed for 6 years was at least seven times greater than the general population, adjusting for age. Approximately 30% of the deaths were attributable to violence and 50% to drug effects.²¹ The most feared acute adverse effect is respiratory depression caused by direct suppression of the brain stem respiratory center. This leads to bradypnea, shallow respirations, and a significant overall reduction of tidal volume.

Withdrawal

Heroin withdrawal syndrome is believed to be a result of mu-agonist withdrawal.^{25,26} Cessation of use of heroin in an addict is characterized by a withdrawal cascade that begins approximately 8 hours after the last dose taken. Acute withdrawal symp-

toms begin slowly, peak at 48 to 72 hours, and attenuate during the next 4 to 7 days. Withdrawal symptoms include agitation, anxiety, piloerection, tachycardia, mild hypertension, and pupillary mydriasis, even in a lighted room. Early symptoms also include yawning, itchy skin, irritability, and insomnia. Rhinorrhea, lacrimation, sweating, vomiting, diarrhea, and urinary frequency often occur. Within 8 to 12 hours after the last dose, there are increases in vital signs, pulse, blood pressure, and respiratory rate. Finally, a high anxiety state, tremors, shakes, smooth and skeletal muscle cramps, and joint and deep bone pain of greater or lesser magnitude, begin and intensify. Although withdrawal is greatly feared by heroin addicts, withdrawal symptoms generally resemble little more than influenza with myositis.⁴ Mild to moderate gastrointestinal symptoms, insomnia, and muscle and joint aches are bothersome but often not intolerable. Many individuals who are physically dependent on heroin and who are in withdrawal, can be managed without additional narcotics.

LABORATORY DETECTION OF HEROIN USE

Tests for opioid abuse are among the most difficult to interpret, even using a two-tiered system (screening and confirmation by gas chromatography/mass spectrometry).²⁷ This is because opioids are found in a variety of medications including antitussives, pargoric, codeine and hydrocodone (Percocet), and poppy seed-containing breads or pastries²⁸ and many of these will give a positive test for morphine.²⁹

A positive urine specimen for morphine/codeine, using the current 300 ng/mL cutoff point, can be expected for about 48 hours after the last use. Some laboratories can examine a urine specimen for 6-MAM, a unique fingerprint metabolite that proves heroin abuse. However, the test is costly and 6-MAM is present for only a few hours after use of heroin. Positive urine tests should be confirmed by patient admission of use or by physical signs of opioid abuse (miotic pupils, somnolence, or needle puncture marks).

Hair analysis for remote (weeks to months) use of opioid drugs is an investigational or forensic technique.^{30,31} Meconium as a body fluid for drug testing has been shown to be more sensitive and to give a longer window of opportunity than urine specimens for opioid detection in the neonate.³²

EMERGENCY MANAGEMENT OF HEROIN OVERDOSE

Toxidrome symptoms of a heroin overdose include mental clouding, stupor or coma, miotic pupils, bradypnea, and diminished response to painful stimuli and mottled, cool skin.³³ Needle tracks are often overlooked or not present. Baseline evaluation of the heroin overdose patient includes evaluation of the airway, breathing, circulation, and drugs administration of oxygen and naloxone (Narcan).^{34,35} A diagnostic trial of low-dose naloxone (Narcan) 0.1 to 0.2 mg for suspected addicts, administered intravenously, clinches the diagnosis. Higher doses are indicated for nonaddicts. Naloxone has a 2-minute on-

set and an average duration of action of a few hours. If the initial test dose does not reverse coma, a second dose should be administered after a few minutes. The target symptom for naloxone administration is the reversal of profound respiratory depression, not complete arousal to a fully conscious state. Full arousal for the addict may precipitate an acute withdrawal syndrome with an angry, aggressively mean person taking the place of the former comatose one.

The heroin overdose patient who is not admitted to hospital should remain in the emergency medicine department for at least 12 hours to observe them for delayed complications.^{35,36}

Naloxone has no role in the treatment of acute heroin withdrawal after the first few hours of immediate emergency care. To soften the noradrenergic signs of acute withdrawal two options are possible: clonidine,³⁷⁻³⁹ which is preferred, or methadone (15-20 mg/day for 2-4 days only). Clonidine, an α -2 agonist, may be initially administered as single dose of 0.1 mg, orally or sublingually. It permits a rapid and substantial decrease in most acute opiate withdrawal signs and symptoms in individuals addicted to heroin.⁴⁰

INFECTIOUS COMPLICATIONS OF HEROIN USE

A multitude of infectious diseases are associated with injection heroin use.⁴¹⁻⁴⁸ Sixty percent to 90% of heroin injectors have chronic hepatitis C infection. Other infectious diseases include acquired immunodeficiency syndrome from using human immunodeficiency virus-contaminated syringes and needles⁴⁶⁻⁴⁹ and from engaging in unprotected sex with an infected partner.

Bacterial infections associated with injection use include *Staphylococcus aureus* cellulitis and abscesses around injection sites, pneumonia, and bacteremia.

LONG-TERM ADDICTION TREATMENT

Although the value of treatment for adolescent heroin addiction has not been researched, without appropriate aftercare, relapse into heroin use after detoxification of an addict is almost a certainty. Assessment of the extent and duration of drug abuse, the integrity and function of the nuclear family, family members who are alcoholics or drug users, the immediate risk for adolescent suicide, and eliciting the current major stresses in the teenager's life is essential before discharge from a short-stay detoxification unit. An adolescent heroin addict usually requires a drug treatment program of at least moderate intensity, serial, spot urine tests for drugs of abuse, and skillful assessment of dual diagnosis such as depression.^{50,51} Attendance at 12-step groups such as Alcoholics Anonymous or Narcotics Anonymous⁵²⁻⁵⁴ is believed by many addiction specialists to greatly decrease the rate of relapse, at least for the adult addict. There may be need for additional individual counseling or group therapy.⁵⁵

Long-term treatment (12-18 months) in therapeutic communities is most appropriate for highly uncooperative teens, those who run away from home for protracted periods, only to return home in crisis, girls or boys who have been prostitutes, and those

who have relapsed with programs of lesser intensity. Although there are no published reports of teenage heroin addicts who graduate from drug treatment programs, there is some information about the outcome of adolescents who were dependent on marijuana, alcohol, and cocaine. Of those who completed long-term programs, 40% to 60% remained abstinent, were gainfully employed, and were not in conflict with police or judicial authorities.^{67,68}

Naltrexone (Revia), a potent opioid mu-antagonist, is of proven value in the long-term management of adult heroin addicts.⁵⁶ The dose is 50 mg on day one, followed by 100 mg every other day. Current federal regulations do not permit addicts younger than 21 years old to be enrolled in methadone maintenance programs without parental consent. There is scant information on methadone maintenance during adolescence,⁵⁷ although it is of proven value with many adult opiate addicts.⁵⁸⁻⁶¹ Methadone will not be detected in the usual tests for opiates and requires its own immunoassay test. The dose of methadone is 40 mg to 80 mg daily and its effects last for at least 24 hours. Doses are usually administered mixed in an orange drink on site but weekend single doses can be given out in some programs. Methadone maintenance clients often continue to abuse cocaine, benzodiazepines, cannabis, and other drugs so it is worthwhile to conduct multi-drug screening tests in addition to testing for methadone itself. A methadone analogue, Levo- α acetyl-methadol (LAAM), administered thrice weekly, is also approved for long-term maintenance of adult heroin addicts.

PAIN MANAGEMENT IN THE RECOVERING ADOLESCENT HEROIN ADDICT

Among the specific concerns that may arise during recovery from heroin addiction is the thorny issue of pain management for moderate or severe pain including fractures, migraine headaches, and childbirth. This problem should be discussed in consultation with a certified specialist in addiction medicine. General rules to follow have been outlined by the American Society for Addiction Medicine.⁶²⁻⁶⁴

MANAGED CARE

Ideally, the primary care physician, with help from addiction medicine experts, should attempt to place the adolescent in an appropriate drug treatment program.⁶⁵⁻⁶⁸ An appropriate treatment slot may be unavailable locally or may be unaffordable. Adolescent addiction treatment may not be paid for by many managed care contracts. Managed care organizations often do not offer adequate substance abuse services of any kind. Some managed care companies subcontract evaluation and treatment of substance abuse and mental health matters to groups of mental health professionals who may have little training, experience, or motivation to assess and appropriately place an addicted teenager into drug treatment.^{69,70} High-ranking executive parents of a teenage addict and parents or primary care physicians who can be persuasive and persistent enough to speak to a high-ranking executive or the medical director may be able to convince the appropriate managed care exec-

utive that addiction is a life-threatening medical condition and that the managed care group must pay for treatment. Moreover, successful treatment for addiction has been shown to be cost-effective (personal observation, David Lewis, MD, Center for Alcohol and Addiction Studies, Brown University School of Medicine, Providence, RI). There are real potential savings in money that may otherwise be spent by managed care companies for treatment of heroin-related accidental injuries, overdoses, violence, and suicides. If all else fails, it may be possible to bypass the managed care bureaucracy. For example, long-term addiction treatment services may be provided at low cost or gratis by some community or religious organizations, or be mandated by the courts at state expense.

THE PREGNANT ADOLESCENT HEROIN ADDICT

Heroin addiction in adolescent girls may be associated with oligomenorrhea or amenorrhea, which occurs in 20% of female addicts.⁷¹ Nonetheless, pregnancy remains a possibility in these young women addicts. Heroin rapidly crosses the placental blood barrier. Naloxone should never be given to a pregnant addict except as a last resort to reverse severe opioid overdose because it can result in premature labor and fetal death. Methadone maintenance is an effective harm-reduction strategy that has been shown to reduce acute neonatal withdrawal problems, including seizures.⁷²⁻⁷⁴ The dose of methadone should be the lowest effective dose (averaging 20–25 mg/day), divided into two daily doses. Because methadone has a long half-life, it may produce relatively mild but more protracted neonatal withdrawal syndrome.

One third of babies born to injection heroin addicts show symptoms and signs of neonatal withdrawal and a small minority have neonatal seizures.⁷⁵ The diagnosis and management of neonatal withdrawal syndrome is well-described in the literature.^{32,76-79}

AFTER CARE

The intermittent intense craving for heroin,⁸⁰ the nostalgic images of the sometimes fun-filled lifestyle of the addict, and the difficulties in early recovery particularly with reapproachment into the family and school have a high likelihood of triggering relapse.⁸¹ Recovery is a complex and integral part of the treatment process. In addition to managing the primary addictive disease and any other medical or psychiatric diagnoses, there are inevitable problems with parent-child conflicts⁸² and management of intense guilt and shame for things done or said during active use. It is a very long road to reestablish trust; to ask for and receive forgiveness from parents, and oneself, and to learn to become dependable and trustworthy. This task is quite difficult for an adult and may be even more so for an adolescent addict.

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