Review

Crack Cocaine and Cocaine Hydrochloride

Are the Differences Myth or Reality?

Dorothy K. Hatsukami, PhD; Marian W. Fischman, PhD

Objective.—To review and discuss the differences and similarities between the use of crack cocaine and cocaine hydrochloride; and to determine how these findings might affect policies on the imprisonment and treatment of cocaine users.

Data Sources.—English-language publications were identified through a computerized search (using MEDLINE) between 1976 and 1996 using the search terms "smoked cocaine," "crack cocaine," "freebase," and "cocaine-base." In addition, manual searches were conducted on references cited in original research articles, reviews, and an annotated bibliography, and on selected journals.

Study Selection.—Only those articles that compared various routes of cocaine administration or types of cocaine (cocaine base or crack cocaine vs cocaine hydrochloride) were examined.

Data Extraction.—Studies were reviewed to obtain information on the composition of the 2 forms of cocaine, and the prevalence, pharmacokinetics and pharmacodynamics, abuse liability, pattern of use, and consequences across the various routes of cocaine administration and forms of cocaine.

Conclusion.—Cocaine hydrochloride is readily converted to base prior to use. The physiological and psychoactive effects of cocaine are similar regardless of whether it is in the form of cocaine hydrochloride or crack cocaine (cocaine base). However, evidence exists showing a greater abuse liability, greater propensity for dependence, and more severe consequences when cocaine is smoked (cocaine-base) or injected intravenously (cocaine hydrochloride) compared with intranasal use (cocaine hydrochloride). The crucial variables appear to be the immediacy, duration, and magnitude of cocaine's effect, as well as the frequency and amount of cocaine used rather than the form of the cocaine. Furthermore, cocaine hydrochloride used intranasally may be a gateway drug or behavior to using crack cocaine. Based on these findings, the federal sentencing guidelines allowing possession of 100 times more cocaine hydrochloride than crack cocaine to trigger mandatory minimum penalties is deemed excessive. Although crack cocaine has been linked with crime to a greater extent than cocaine hydrochloride, many of these crimes are associated with the addiction to cocaine. Therefore, those addicted individuals who are incarcerated for the sale or possession of cocaine are better served by treatment than prison.

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FROM THE mid 1970s to the mid 1980s, the United States was in the midst of a cocaine epidemic of a very different nature than the current one. The users were primarily middle class, the drug was primarily powder cocaine hydrochloride taken by the intranasal route. A relative few dissolved the drug in water and injected it intravenously, and a relative few carried out a "gourmet" conversion to the base form in order to smoke the cocaine, using kits purchased in head shops. Results from the National Household Survey on Drug Abuse (NHSDA),[1,2] whose respondents include civilian noninstitutionalized individuals 12 years of age and older, indicated that, in 1974, 5 million people had tried cocaine, with less than 10% having used it in the past year. By 1982 more than 20 million people reported having tried cocaine, with approximately half of them using it in the past year. By 1985, the number of those ever using cocaine had increased to 25 million, and the peak of that epidemic was reached, with steadily diminishing numbers over the next 7 years. However, a new epidemic was beginning: crack cocaine, a readily smokable form of cocaine hydrochloride, was being sold in unit doses for $3 to $5 per rock. The availability of a relatively cheap smokable form led to a marked expansion of cocaine use among the poor and ethnic minorities,[2,3] and its use was accompanied by violent crime and devastation of both inner-city areas and families.

See also p 1615.

The distinction between cocaine hydrochloride and cocaine base (crack cocaine) has received a great deal of attention during the past few years, with primarily a judicial focus. In 1986, Congress passed a federal sentencing guideline that punishes a first-time offender with a minimum mandatory sentence of 5 years in prison for possessing 5 g of crack cocaine (resulting in 50-200 doses), while that same first-time offender would have to possess 500 g of cocaine hydrochloride (resulting in more than 10 000 doses) to obtain the same sentence. With unit dosing approximately the same for the 2 forms, the hydrochloride form represents approximately a 100-fold increase over the crack cocaine form in the number of cocaine doses available for use. Furthermore, in 1988 a law was passed stating that the possession of more than 5 g of crack cocaine triggers a minimum of 5 years in prison, whereas simple possession of cocaine hydrochloride or any other controlled substance by first-time offenders is punished by a maximum of 1 year in prison.

Three problems are perceived to have arisen from these discrepant sentencings. First, low-level retail crack dealers have received more severe sentences than wholesale suppliers of cocaine hydrochloride. Second, crack cocaine users who are

From the Department of Psychiatry, Division of Neurosciences, University of Minnesota, Minneapolis (Dr Hatsukami), and the Department of Psychiatry, Columbia University, and the New York State Psychiatric Institute, New York, NY (Dr Fischman).

Reprints: Dorothy K. Hatsukami, PhD, University of Minnesota, Department of Psychiatry, Box 392 UMHC, Minneapolis, MN 55455.

addicted are more prone to be imprisoned than treated for their abuse. Third, this sentencing guideline has led to 22 times more convictions among African Americans than whites. For example, blacks accounted for 88%, Hispanics for 7%, and whites for 4% of the federal crack cocaine distribution convictions in 1993; in contrast, only 27% of cocaine hydrochloride charges were accounted for by blacks, with 32% white and 39% Hispanic.[4] Furthermore, in actual numbers, fewer blacks report using crack cocaine in the past year compared with whites,[2] although an increasing proportion of blacks and Hispanics were found to comprise the frequent crack as well as cocaine hydrochloride users.[3] As a result, the issue of racial discrimination has surfaced.

In the spring of 1995, the US Sentencing Commission,[4] which establishes guidelines for the federal courts, issued a report strongly opposed to the 100:1 quantity ratio for sentencing between crack cocaine and cocaine hydrochloride. The commission reported that while a greater penalty for crack cocaine is justifiable, the 100:1 sentencing ratio exceeds the differences between the 2 forms of cocaine. The commission stated that at this time there is no substantive evidence to support this differential ratio in sentencing. Furthermore, this sentencing guideline was considered to lead to a lack of sensitivity to differences in individual factors associated with possession of cocaine and to anomalies in sentencing between 2 easily convertible forms of the same drug. The commission therefore called for more flexible sentencing that would take into account the various factors associated with cocaine use. Attorney General Janet Reno recommended that Congress reject the proposal of the commission, although she agreed that the disparity in sentencing should be narrowed but not eliminated. In the fall of 1995, the House and Senate voted to reject the commission's proposals and President Clinton was supportive of Congress on this issue. Proponents for the discrepant sentencing point to the greater violence, gang activities, health problems, and family disruption associated with crack compared with cocaine hydrochoride as well as its greater accessibility to the young, poor, and disadvantaged. Furthermore, crack was considered to be more addictive than cocaine hydrochloride.

This article will examine the scientific evidence demonstrating the similarities and differences between crack cocaine and cocaine hydrochloride. The results from this review will show that the route of administration (eg, intranasal, intravenous, or smoked) is a more important determining factor for the abuse potential, pharmacokinetics, and biological and psychological effects of cocaine than the form of cocaine. Clearly, to some extent, form dictates route (ie, crack cocaine can only be smoked), but cocaine, regardless of whether it is crack cocaine or cocaine hydrochloride, leads to the same physiological and behavioral effects. The more appropriate comparison is between intravenous cocaine hydrochloride and smoked crack cocaine, since both are more likely to lead to abuse, dependence, and severe consequences than intranasal cocaine hydrochloride due primarily to the rate and amount of cocaine reaching the brain via these routes of administration. These results do not support the 100:1 sentencing ratio between crack cocaine and cocaine hydrochloride. Additionally, this article will conclude that it would be more cost-effective in the long term if greater effort were expended in treatment of appropriate cocaine abusers rather than imprisonment of all convicted cocaine abusers.

METHODS

Objective and Study Selection

The objective of this review is to determine similarities and differences between the use of crack cocaine and cocaine hydrochloride. Therefore, for a study to be included in the review, it had to compare the effects of crack cocaine with the effects of cocaine hydrochloride, administered either intravenously or intranasally.

Data Sources

A systematic search of MEDLINE (1976 to 1996) was conducted using the search terms "smoked cocaine," "crack cocaine," "freebase," and "cocaine-base." Names of selected authors who are known to have conducted research in this area were also searched.

Additional references were searched from the reference list of original research and review articles.

Selected publications were searched manually.

An annotated bibliography of articles on cocaine[5] was also reviewed to select any articles that pertained to comparing smoked or crack cocaine with cocaine hydrochloride.

Data Extraction

Because so few studies have been conducted comparing crack cocaine with cocaine hydrochloride, or cocaine administered across various routes, almost all studies were included in the review and consistency of the results across studies was examined. Relevant studies were those that addressed the prevalence of use, the composition of the various types of cocaine, the pharmacokinetics and pharmacodynamics, abuse liability, and pattern of use, including rapidity and probability of developing dependence, and the consequences across the various routes of administration and forms of cocaine. Each study was reviewed and extracted for results relevant to the aforementioned areas and for conclusions. The majority of these studies were conducted in the mid to late 1980s and early 1990s.

RESULTS

Prevalence of Cocaine Use

The 1993 NHSDA report indicated that among those who used cocaine at least once in the past year, 77% snorted, 36% smoked, and 7% injected cocaine intravenously. In this population of cocaine users, 69% were white, 15% were black, and 13% were Hispanic.[2] Among those reporting crack use at least once in the previous year, 46% were white, 36% were black, and 11% were Hispanic. Within racial categories, 2.0% (n=3 153 860) of whites, 2.9% (n=663 058) of blacks, and 3.1% (n=573 531) of Hispanics reported past-year cocaine use (cocaine hydrochloride and crack), whereas 0.3% (n=473 079) of whites, 1.6% (n=368 032) of blacks, and 0.6% (n=111 006) of Hispanics reported past-year crack use. Thus, crack use is more prevalent in the African-American population, although there are fewer absolute numbers of black users compared with white users. Furthermore, if drug availability and social conditions are held constant, then the probability of crack cocaine use within a specific population does not differ by race or ethnicity.[6] Nonetheless, in an analysis of the 1991 NHSDA, an increasing proportion of African Americans and Hispanics and those living in large metropolitan areas were found to comprise the frequent cocaine hydrochloride and crack users.[3] In addition, among frequent users compared with infrequent users, there is a greater rate of crack use (52.5% vs 17.5%, respectively) and intravenous cocaine use (24.3% vs 9.3%, respectively).

In summary, cocaine hydrochloride is the dominant form of cocaine used by the general population. Among cocaine users, a higher percentage of whites use cocaine than blacks or Hispanics, with the percentage of blacks increasing when examining crack cocaine use. On the other hand, within racial groups, a higher percentage of blacks and Hispanics use crack cocaine compared with whites. However, this higher prevalence may be a function of where they live rather than racial background.

Cocaine Hydrochloride and Cocaine Base: Are They the Same Drug?

Cocaine is an alkaloid extracted from coca leaves. The coca leaves are pro-

cessed with different chemicals (eg, alkali, organic solvents, hydrochloric acid, and ammonia) resulting in the intermediate product, coca paste, and the final product, cocaine hydrochloride, which is imported to the United States and other parts of the world from South America. Cocaine hydrochloride is typically used for nonmedical purposes either intranasally (snorting), or intravenously in an aqueous solution since the drug is hydrophilic. Cocaine hydrochloride cannot be smoked because it decomposes at temperatures required to vaporize it. Cocaine base, however, can easily be smoked at temperatures significantly lower than cocaine hydrochloride, and therefore is the form of cocaine used for smoking. It is made by mixing cocaine hydrochloride with an alkaline substance, such as sodium bicarbonate or ammonia to convert it to base, and then heating. The result is waxy chunks or rocks of cocaine often referred to as crack cocaine. One gram of cocaine hydrochloride is typically converted into 0.89 g of cocaine base or crack.[4] Crack cocaine is typically smoked in glass or other pipes, soda cans modified to accommodate the placement of crack cocaine and act as pipes, or tobacco or nontobacco cigarettes. Freebasing is another but less common method of smoking cocaine. Freebase cocaine involves dissolving cocaine hydrochloride in water and an alkaline substance, such as ammonia, and then extracting the cocaine base into ether or another organic substance. Evaporating the organic phase by heating yields a residue that is similar to crack cocaine and can be smoked. The extraction procedure increases the difficulty and hazard (eg, fire) of the conversion process so that crack is considerably more commonly used than freebase. In the following review, smoked cocaine always refers to the use of cocaine base or crack cocaine. Intravenous or intranasal cocaine refers to the use of cocaine hydrochloride.

The rate and extent of cocaine absorption vary considerably across routes of administration and are relevant in the context of abuse liability. Once cocaine is absorbed, however, the pharmacokinetics, regardless of the route of administration, are quite similar. In several studies in which subjects smoked cocaine base or received cocaine hydrochloride intravenously, there were no differences in the elimination half-lives of the 2 forms.[7,8] One study found a shorter half-life for crack (56 minutes) than intranasal cocaine hydrochloride (78 minutes), but the number of subjects was small.[9] A shorter half-life may be associated with more frequent use, although this difference in half-life will not likely have an impact on the issue of use frequency. Urinary excretion of cocaine and total metabolites was also similar for all 3 routes of administration (64%-69% of the dose) with very little excreted as cocaine (<1%) and most as benzoylecgonine and ecgonine methyl ester.[9] Some minor differences in amounts of metabolites generated may exist as a function of the route of administration, with a modestly lower percentage of benzoylecgonine and a higher percentage of ecgonine methyl ester in urine after smoking compared with administration of cocaine by the other 2 routes.[9] It is unlikely, however, that these differences in metabolism contribute to the effects of cocaine since both benzoylecgonine and ecgonine methyl ester appear to have little or no behavioral activity. One notable difference between smoked cocaine and other routes of administration is the production of pyrolysis products during smoking such as methylecgonidine,[10,11] benzoic acid,[12] and methyl-40 (3-pyridine) butyrate.[13] The higher the temperature at which the cocaine is volatilized, the greater the amount of pyrolysis products.[10,12,14] The activity of these products is unknown.

In summary, regardless of whether cocaine is administered as hydrochloride or base, both its rate of elimination and its metabolic profile are similar. It is unclear whether minor differences in metabolite patterns between routes of administration, or the presence of pyrolysis products in smoked cocaine, contribute to cocaine's behavioral effect.

Is Crack More Addictive Than Cocaine Hydrochloride?

Pharmacokinetics, Pharmacodynamics, and Psychotropic Effects.—Although both humans and nonhumans will take cocaine repeatedly, regardless of the route of delivery,[15] the immediacy and magnitude of cocaine's effect is an important factor in its reinforcing effects and thereby its abuse liability.[16] The magnitude of effect is related to dose as well as to the rapidity with which it reaches the brain. The dose, in turn, is determined by both the actual amount of the drug and its bioavailability. The bioavailability of smoked cocaine is between 60% and 70% when cocaine base is volatilized,[7,9,17] but much of this bioavailability is dependent on the temperature at which the cocaine is volatilized and the skill of the smoker in using the cocaine delivery device. As the temperature increases, less cocaine and more of the pyrolysis products are absorbed (as previously noted). The amount of intranasal cocaine absorbed can vary depending on the dose, with higher doses having greater absorption. For example, a 96-mg dose resulted in 58% of the amount absorbed compared with 30% with a 64-mg dose.[18] However, other studies have found bioavailability of intranasal cocaine as low as 25%[19] and as high as 80% to 94%[7,9] with doses as low as 32 mg.[7]

Since the behavioral activity of cocaine resides primarily in the parent compound, cocaine in any form produces the same physiological and subjective effects.[4] However, the route of administration plays a major role in the rate of onset as well as intensity and duration of a drug's effect. The more immediate and greater the magnitude of effect, the greater likelihood that the drug will be abused. Orally ingested cocaine achieves maximum concentration most slowly, followed by the intranasal route. Intravenous and smoked cocaine achieve maximal concentration and effect most rapidly. Peak venous plasma cocaine concentration is achieved at approximately 30 to 40 minutes after intranasal administration and at approximately 5 minutes after intravenous and smoked cocaine administration.[7,14,20] Similarly, for intranasal cocaine, the time of peak physiological (eg, heart rate) and subjective effects is later and the duration of effects is longer than with smoked or intravenous cocaine. The maximum physiological effects of intranasal cocaine occur within 15 to 40 minutes and the maximum subjective effects occur within 10 to 20 minutes.[7,14,20-22] Duration of effects is approximately 60 minutes or longer after peak effects.[20,22] The maximum physiological and subjective effects occur within minutes of intravenous or smoked cocaine use, and the duration of effect is approximately 30 to 45 minutes.[7,17,20-23]

One study that directly compared both arterial and venous blood concentrations for intravenous and smoked cocaine showed that for both routes of administration, the peak arterial cocaine concentrations were 10 times higher than venous concentrations, and that maximal arterial concentrations occurred within 15 seconds compared with 3 to 6 minutes with venous concentrations.[24] Since both routes of administration produce similar pharmacokinetic patterns, the investigators concluded that the abuse liability for these 2 routes of administration could not be differentiated. Thus, both the absorption kinetics and the time course of cocaine effects are strikingly similar for intravenous cocaine hydrochloride and smoked crack cocaine. This finding is surprising given the quickest onset and fastest penetration to the brain is likely to be from inhalation because of the more direct passage to the brain compared with cocaine delivered intravenously.

In the only research study comparing

choice of smoked or intravenous cocaine,[25] experienced cocaine users of both intravenous and smoked cocaine chose to take doses of smoked cocaine as frequently as intravenous doses that yielded substantially higher cocaine plasma levels. At doses that yielded similar cocaine plasma levels and similar cardiovascular and subjective effects after single doses (50 mg smoked vs 32 mg intravenously), these research subjects chose to take the smoked over the intravenous cocaine. This choice occurred even though 80% of the participants reported preferences for intravenous over smoked cocaine outside the laboratory. Research subjects described an unwillingness to see their cocaine "go up in smoke" when using drugs they had purchased, while in the laboratory such concerns were irrelevant (M.W.F.). In addition, although initial effects of the smoked and intravenous doses yielding comparable plasma levels were similar, cumulative doses of smoked cocaine increased some subjective effects (eg, "high," "liking") more than did cumulative doses of intravenous cocaine. Another study comparing subjective effects across routes of administration also found these effects to be greater after smoked cocaine compared with similarly absorbed doses of either intranasal or intravenous cocaine, but even after a single dose.[7] These data confirm the principle that cocaine delivered through inhalation should reach the brain sooner than intravenous cocaine.

In summary, both intravenous cocaine hydrochloride and smoked cocaine base administration are likely to result in a greater potential for abuse than intranasal cocaine because of the greater rapidity and intensity of their effects. Effects tend to be similar between intravenous and smoked cocaine, with possible greater intensity of effect with smoked cocaine. Other factors, such as the ease of administration and cost, may also make smoked cocaine a method of delivery that is more likely to be abused.[7,24,26]

Pattern of Drug Use

Progression From Cocaine Hydrochloride to Crack.—Surveys taken in high schools, treatment centers, and communities show that cocaine smokers typically begin using cocaine hydrochloride via the intranasal route of administration, proceeding to smoked cocaine-base. Kandel and Yamaguchi[27] conducted a survey among 7611 New York State public and private school students in grades 7 through 12. Three times as many cocaine users reported trying crack cocaine after experimenting first with other forms of cocaine as compared with the reverse (44% vs 13%). When sequential models for the progression of drug use were tested, the best-fitting model for males was one in which alcohol use precedes marijuana; marijuana and cigarette use precede both noncrack and crack cocaine; and noncrack cocaine use precedes crack cocaine use. For females, the order was essentially the same except that both alcohol and cigarette use precede marijuana use. A similar pattern of progression of drug use was observed in inpatients from a drug treatment program.[28]

Surveys of individuals who are in treatment, calling a cocaine hotline for help, or in the community setting also show that a significant number of crack cocaine users report having used cocaine hydrochloride prior to crack. For example, approximately 75% to 90% of crack cocaine users reported using intranasal cocaine before smoking cocaine.[29,30] Similarly, in 2 studies conducted with a Veterans Administration Medical Center patient sample, 70% to 80% reported using cocaine intranasally during initial use, and yet about 60% to 70% were smoking cocaine at the time of admission.[31,32] Of note, 1 of the studies found subjects who started using cocaine by the smoking method were least likely to change routes (84% of users who smoked, 64% of intravenous users, and 19% of intranasal users continued to use cocaine by the same route of administration).[32] The most common change of route was from intranasal to smoked cocaine, with 52% of those beginning with the intranasal route switching to smoking. Many other studies have also found this pattern of progression from intranasal to smoked cocaine use.[28,33,34]

Most of these surveys were conducted in the mid to late 1980s, although some were conducted in the 1990s. Since the availability of crack cocaine increased in the mid 1980s, the results of these studies may not be reflective of the most recent patterns of use. For example, a study conducted in London, England, community settings showed that those who first used cocaine before 1986 were more likely to have initially used cocaine either intranasally or intravenously. However, cocaine users who first tried the drug after 1987 were more likely to have begun by smoking cocaine.[35]

Progression: Experimentation to Dependence.—The route of administration (and the related speed with which the drug reaches the brain) may play a role in the development of compulsive use and dependence, including tolerance and withdrawal. Investigators have reported that controlled use commonly shifts to compulsive use, either when access to the drug increases and dosages escalate markedly, or when the user switches to a more rapid route of administration.[36]

In terms of years from first to regular (3 or more times per week) use of cocaine, data collected from street and treatment samples in Miami, Fla, showed more rapid increases in use frequency for crack cocaine compared with intranasal and intravenous use.[37] This finding is concordant with results from a study of jail inmates that reported that the duration of initial use to regular use (undefined) was significantly shorter for smoked cocaine users vs intranasal and intravenous users.[34] Similar evidence exists for the development of abuse, showing that the smoked or intravenous routes compared with the intranasal route lead to more rapid onset of problems associated with cocaine use or dependence and more rapid entry into treatment.[31,38-40]

Several studies examining routes of administration at the time of treatment showed that a high percentage of cocaine users entering treatment used smoked cocaine prior to treatment, with rates exceeding 70%.[31,33] Other researchers have also found higher percentages of cocaine smokers comprising the treatment sample compared with other routes of administration.[38,41,42] These findings possibly reflect a greater occurrence of cocaine-associated problems and dependence among crack cocaine users compared with cocaine hydrochloride users.

Most studies show that cocaine smokers and intravenous users often use more cocaine than intranasal users. These observations have been made among treatment- and help-seeking cocaine abusers[32,39,41,43] as well as among a nontreatment sample,[44] in which highest use occurred among those who smoke cocaine. For example, when crack cocaine users interviewed in various settings (treatment, street, jail, or prison) were compared with cocaine hydrochloride snorters, two thirds of crack users smoked on a daily basis, but only 18% of cocaine snorters used cocaine on a daily basis.[45] In an analysis of the 1991 NHSDA, among frequent users compared with infrequent users, there was a greater rate of crack cocaine use (52.5% vs 17.5%, respectively) as well as intravenous cocaine use (24.3% vs 9.3%, respectively). On the other hand, 1 study examining a treatment sample showed that the intravenous users used larger amounts in short periods of time compared with smokers and intranasal users.[43] In another study that interviewed cocaine users in a community setting in London, intravenous use of cocaine was associated with the highest level of dependence (inability to control the use of cocaine and concern over use of cocaine)

and frequency of use, followed by smoked cocaine and then intranasal cocaine.[35] Yet another study examining a Miami street and treatment sample found the highest total dosage over a 90-day period of time reported among snorters compared with intravenous users and crack cocaine smokers.[37]

With regard to physiological dependence, although no differences in symptoms of withdrawal and tolerance were self-reported by cocaine abusers across routes of administration in 1 study,[32] another study reported that the dysphoria experienced by crack cocaine smokers after using the drug is more intense than that experienced by intranasal cocaine hydrochloride users.[46] This result may be due to differences in the rate of absorption[47] or the amount of cocaine used between smoked cocaine and intransal cocaine.

In summary, these results show that intranasal use of cocaine hydrochloride may be a gateway drug or behavior to crack cocaine use among both white and black populations, although there may have been a change to smoked cocaine as the initial route of administration since the mid 1980s and 1990s. A shift from intranasal to smoked cocaine use is generally accompanied by greater cocaine dependence. The progression to frequent use of cocaine is more rapid when cocaine is smoked. This rapid progression of high-frequency use of smoked cocaine compared with intravenous cocaine is, in part, related to the ease with which a cocaine binge can be accomplished. Repeated intravenous use necessitates specialized paraphernalia and the ability to hit a vein repeatedly while intoxicated. When cocaine is used intranasally, vasal constriction occurs and repeated doses are absorbed less well. Progression to dependence or problems associated with cocaine use is more rapid when it is used by either the intravenous or smoked routes compared with the intranasal route. These findings suggest that how quickly dependence develops may be more a function of rapid absorption rather than the form of cocaine used. In general, small possible differences in the pattern of use or development of dependence between smoked crack cocaine and intravenous cocaine hydrochloride, even if confirmed, are more than overshadowed by differences in the rate of absorption between both these routes of administration and the intranasal route.

Characteristics and Consequences

Regardless of whether the use of cocaine is in the hydrochloride or crack form, cocaine users are heavy users of other illicit and licit drugs.[48] Crack cocaine users in particular are more likely to use a greater variety of other illicit drugs than users of cocaine hydrochloride.[49] This observation has been made even among adolescents.[50] Adolescent crack cocaine users also experience the poorest level of psychosocial adjustment (eg, less closeness with parents, more alienation from peers, greater delinquency, and more psychological problems), poorer grades, and more involvement with drug-using peer groups compared with any other group of drug users, including those students who have used other forms of cocaine.[51] Unfortunately, in both the aforementioned studies, noncrack cocaine was not differentiated by intranasal and intravenous routes, although most adolescents do not inject unless they are already using opiates.

The consequences of cocaine use observed in adolescents from the aforementioned high school survey are strikingly similar to cocaine-related consequences reported by older individuals calling a cocaine hotline or in a cocaine-dependent treatment population. Although intranasal users report consequences of cocaine use that are similar in type to those of smokers and intravenous users, smokers and intravenous users tend to experience greater psychological, interpersonal, financial, and occupational problems and more serious ill effects.[32,39,52] When the amount of cocaine is controlled for, no differences exist across the different routes of administration.[39,53,54] However, both smoking and intravenous use are more likely to involve greater amounts of cocaine use than intranasal cocaine, thereby engendering greater negative consequences.[32,39]

Greater medical illness associated with intravenous and crack cocaine use has been observed in other studies. The Drug Abuse Warning Network (DAWN) gathers information on drug-related emergency room visits and medical examiner cases for selected hospitals and medical examiners in several metropolitan areas. The 1992 DAWN report indicated that 37% of cocaine-related emergency room admissions involved cocaine smoking, 18% involved cocaine injection, and 11% involved cocaine snorting (the route of administration of cocaine was "other" for 4% and unknown for 30% of cases).[55] Similarly, another retrospective study showed a higher percentage of crack cocaine smokers required hospital admission compared with users of cocaine hydrochloride.[56] They also noted more psychotic symptoms and thoughts or acts of violence occurring in this crack cocaine group. The emergence of crack cocaine smoking in the mid 1980s was considered by the authors of these reports to be possibly one of the factors associated with the increase in the number of emergency department visits related to cocaine. Of note, however, is the high rate of these visits for intravenous use given the lower base rate of use via this route. In another study, among cocaine users seen in the medical emergency department during 1986 and 1987, the single most common route of use was intravenous.[57] In the 1992 DAWN report,[58] the most frequent route of administration associated with cocaine-related deaths was intravenous (the route of administration for cocaine was unknown for 73% of the cases). Similarly, in a study conducted between 1988 and 1990 examining a Miami street and treatment sample, intravenous cocaine hydrochloride use led to the greatest number of self-reported overdoses, followed by intranasal and crack cocaine users. The unexpectedly high number of overdoses reported by intranasal cocaine users can be attributed to the higher cocaine dosages reported to be used among this group compared with crack users.[37] Greater toxicity from the intranasal route in this population may have been due to difficulty with titration of the dose because of the longer time between drug use and drug effect and the greater ability to control the total dose of smoked cocaine on a puff-by-puff basis compared with other routes of administration. Because Miami is the gateway to cocaine distribution in the United States, the cocaine tends to be cheaper, more readily available, and more pure, increasing the ease of acquiring it and/or the likelihood of adverse consequences.

A greater number of smoked cocaine users also suffer from certain psychiatric disorders compared with intranasal or intravenous users. In a sample of cocaine abusers seeking inpatient and outpatient treatment, those who preferred the smoking route had the highest rates of intermittent depressive personality disorder compared with other routes of administration, but the lowest rates of alcoholism and antisocial personality disorder as determined using the Schedule for Affective Disorders and Research Diagnostic Criteria.[59] Concordant with the results showing a higher rate of depression, the rate of suicide attempts among crack cocaine abusers was 2 to 4 times greater than that of abusers of other primary drugs of abuse, as reported in a study examining substance abusers entering therapeutic communities.[60] Similar trends were observed in the number of psychiatric hospitalizations across routes of administration, with the highest number among crack users compared with noncrack cocaine users (intravenous and intranasal users

were not differentiated).[60] In addition, in a study of 40 cocaine-dependent subjects admitted to a metropolitan psychiatric inpatient ward for psychiatric symptoms, 88% were crack cocaine users.[61]

Sexually transmitted disease is another area in which increased rates are observed in cocaine smokers compared with those who use cocaine by other routes of administration. In a 1991 survey of drug users, crack cocaine smokers (whether or not they were also injection users) reported more sex partners, more acts of unprotected sex, a higher frequency of exchanging sex for drugs and/or money, and a higher frequency of drug use before or during sex than intravenous cocaine users who did not smoke cocaine.[62] The high prevalence of these sexual behaviors promoting the risk for human immunodeficiency virus (HIV) infection was also found in a study examining crack users from 3 inner-city communities.[63] In fact, crack cocaine smokers have been found to have rates of HIV infection as high as those among intravenous drug users.[64] Crack cocaine users were also more likely to contract other sexually transmitted diseases, such as gonorrhea and syphilis, compared with cocaine hydrochloride users.[62,64]

Fetal cocaine exposure increases both neonatal hospital costs and lengths of stay, resulting from in utero development problems including small head circumference, low birth weight, and urogenital abnormalities.[65-67] Increases in hospital costs and length of stay are greater when mothers specifically admitted to using crack cocaine compared with other forms of cocaine ($6735 vs $1226 and 7.9 vs 2.9 days, respectively), even when controlling for the effects of prenatal care, maternal alcohol and cigarette use, race, gravidity, maternal age, and sex of the infant.[66] The area of effects of cocaine on neonates remains controversial. Other studies have found limited effects of cocaine on neonates. However, these negative results may be due to lower levels of cocaine use and differences in duration of exposure or other factors including nutritional status.[68,69]

Violence and crime associated with cocaine are considered to be in large part related to either the system of drug distribution (systemic crime)[70,71] and/or economically or financially driven due to drug consumption,[72] rather than being pharmacologically driven. In fact, violence directly induced by the pharmacological effects of cocaine hydrochloride or crack is considered uncommon.[71,72] Systemic crime associated with the crack cocaine market has been attributed to a number of social and cultural factors. These include the following: (1) the social and economic deterioration and destabilization in the neighborhoods where crack selling is concentrated; (2) the consequent lack of social control that limits crime, drug use, and drug selling; (3) the lack of economic and social resources to counteract the underground economy; (4) the immaturity and volatility of the crack market; (5) the competitiveness that occurred when new drug distribution groups were developed with the introduction of crack cocaine; and (6) the increased availability of more powerful guns.[70,72,73] Furthermore, those involved in the distribution of crack cocaine are younger than those distributing cocaine hydrochloride.[70] In part, the harsher penalities for crack cocaine may be one of the reasons for the rise in juvenile violence. Penalities for crack have driven drug dealers to recruit juveniles as drug sellers because of the less severe sentencing for juveniles when arrested.[4] These juveniles often carry weapons, leading to a situation in which armed impulsive adolescents are involved in drug dealing.

Possibly because of the convergence of all these factors, crack cocaine sellers are more often involved in drug-related crimes than sellers of other drugs, including cocaine hydrochloride.[4,70,71,73] For example, 1 study examining crack cocaine and other drug users/sellers who were arrestees, residents, and participants in residential drug treatment programs in Manhattan[70] found that approximately 40% to 50% of those selling crack cocaine, cocaine hydrochloride, and heroin or marijuana are involved in various types of violent incidents compared with about 20% of those selling cocaine hydrochloride, heroin, and marijuana. On the other hand, involvement with nonviolent crimes was highest among those selling cocaine product, with no differences in rates between crack cocaine and cocaine hydrochloride dealers. In another study of arrestees from the New York City Police Department,[73] crack cocaine offenders were less likely to have previous arrests for drug and nondrug crimes and prior jail or prison sentences compared with cocaine hydrochloride offenders. Although both cocaine hydrochloride and crack offenders experienced increased arrest between 2 years prior to and 2 years after the sample arrest, the crack offenders had a significantly greater increase in arrest rates for most crimes, including nondrug felonies and violent crimes, suggesting an acceleration of arrests with initiation into distribution of, or other involvements associated with, crack cocaine. This pattern was observed even when examining only arrestees whose sample arrest was a first offense. This finding may have been associated with greater enforcement efforts against crack during the period of the study. In data prepared by the US Sentencing Commission, crack cocaine offenders, who have been sentenced in federal courts and charged with cocaine distribution, were observed to be more likely to carry weapons than individuals trafficking in other drugs including cocaine hydrochloride (27.9% crack cocaine offenders vs 15.1% cocaine hydrochloride offenders) and more likely to have had extensive criminal records for the highest levels of criminal history categories (17.6% crack cocaine vs 7.0% cocaine hydrochloride).[4]

Economically driven crime is primarily committed by offenders who are crack cocaine users selling the drug to support their own consumption.[45,72,74,75] For example, of those arrested by the Detroit (Mich) Police Department for the retail distribution of cocaine, most were users of crack (60%) who sold the drug in order to fund personal use. Only 25% of the population sought cash and not drugs as a reward.[74] Among federal offenders convicted of possessing more than the statutory minimum amount of cocaine and considered to be distributors, a similar percentage of individuals (64%) were identified as having a substance abuse problem or addiction.[4] In another study, cocaine users and dealers were interviewed between 1988 and 1989 from various settings (treatment, street, jail, or prison) in New York City.[45] When crack cocaine users were compared with cocaine snorters and other drug users, crack users were found to be using drugs at higher rates, as well as receiving higher incomes from drug sales and non–drug-related crimes. In addition, a higher percentage of cocaine smokers committed robbery, burglary, thefts, petty larceny, sale of stolen goods, simple assault, and prostitution compared with cocaine snorters. The positive relationship between the amount of cocaine use and the number of crimes committed has been observed in another study.[75] Thus, many individual cocaine dealers are users who may deal to maintain access to the drug or to obtain money to purchase cocaine.[4] Of note, studies also show that crack dealers tended to engage in deviant behavior even prior to the use and sale of crack cocaine.[70,73] This suggests that the higher rate of crime in crack users and sellers may be due to recruitment of already deviant individuals, and involvement with cocaine may only facilitate or intensify existing criminal behaviors.[73] Therefore, concluding that crack distribution, selling, and use leads to violent or criminal

behaviors or that violence only occurs in association with drugs may not be entirely accurate.[73]

In summary, the acute and chronic use of cocaine, regardless of the route of administration, results in similar psychological, social, and medical sequelae (although specific routes of administration have specific medical manifestations). However, because of the greater frequency and amount of use among both crack cocaine users and intravenous cocaine hydrochloride users, the negative consequences among these 2 groups may also be more frequent and severe than among those who use cocaine intranasally. Differences may also exist between cocaine smokers and intravenous users. For example, compared with intravenous cocaine users, cocaine smokers engage in greater sexual activity, experience a higher rate of contracting sexually transmitted disease, and greater neonatal costs, and may experience depressive mood and other psychiatric problems at a higher rate. In addition, crime, including violence, has been more frequently associated with crack cocaine than cocaine hydrochloride. However, whether this finding is a function of the cultural context in which crack distribution and use emerged, is inherent to the method of cocaine delivery (ie, greater potential for abuse), or both, is unclear. In addition, the greater number of psychiatric problems and hospitalizations experienced by crack cocaine users may have an impact on the crime and violence occurring with this group. Unfortunately, several limitations exist in some of the current studies making it difficult to come to any specific or clear-cut conclusions. For example, most studies do not differentiate between intravenous and intranasal cocaine hydrochloride use, so that distinctions in consequences between intravenous and smoked cocaine are difficult to assess. Furthermore, polydrug use, use of multiple routes in the same participants, and after-the-fact analysis make careful interpretation of the data difficult.

COMMENT

Differences Between Crack and Cocaine Hydrochloride

It is very clear that both smoked crack cocaine and intravenously administered cocaine hydrochloride have greater abuse liability, greater propensity to produce more substantial dependence, and lead to more severe social and personal consequences than cocaine hydrochloride that is administered intranasally. Crack cocaine is a cheaper (by the individual dose) and more readily and easily administered form of cocaine than intravenously administered cocaine hydrochloride, and therefore fewer individuals are inclined to use intravenous cocaine hydrochloride. Fear of HIV seroconversion has added to this disinclination, although in reality the use of crack cocaine has led to rates of HIV infection similar to intravenous drug use because of the increased rate of sexual activity associated with crack use. However, these differences may not warrant a dramatically unbalanced punishment for the possession of crack cocaine vs cocaine hydrochloride. Several other factors must be taken into account. First, cocaine hydrochloride can be readily converted to the smokable form, which occurs most often on the wholesale and retail levels of the distribution chain. Second, the behavioral effects are a result of the parent compound regardless of the form in which the cocaine was ingested or the route of administration. Third, the rapidity and magnitude of effect determines the abuse liability of the drug and development of dependence, rather than the form in which it was ingested, although the ease of administration and availability of the drug will also play a role in the abuse liability of a drug. Fourth, many who progressed to crack cocaine use began with intranasal cocaine hydrochloride. Therefore, controlling the use of cocaine hydrochloride may be important. Fifth, the final pathway for heavy use of either cocaine hydrochloride or crack cocaine is the same. Both forms of cocaine can lead to a lack of control over use and the same psychological, social, legal, and physiological consequences. However, crack cocaine users, as well as intravenous cocaine hydrochloride users in some instances, tend to experience more severe consequences and more rapid development of problems due to the amount and frequency of use, not because of the form of cocaine. Therefore, the issue is not the differences between crack cocaine and cocaine hydrochloride because they are essentially the same drug and can cause the same effects and consequences. The primary issues are the speed and intensity of delivery of the drug, the accessibility and cost of the unit price of the drug, and the cultural environment and social context in which the drug is used.

Based on these findings, the current federal sentencing guideline that markedly differentiates the penalties for crack cocaine and cocaine hydrochloride is not warranted. This conclusion concurs with similar recommendations made in 1995 by the US Sentencing Commission. Furthermore, these findings also concur with the US Sentencing Commission proposal for a reduction rather than elimination of the differential ratio for sentencing of crack cocaine offenders, since it is notable that crack cocaine compared with cocaine hydrochloride is easier to use and more accessible to a broader population, leads to more rapid increases in use, and is associated with more harm in some areas, such as crime. It is difficult, however, to determine what the actual sentencing ratio should be or the criteria on which to base this ratio. If this ratio is based on abuse liability, then the data on which to determine the ratio still remains problematic. A possibility, although not the optimal method, would be to compare the percentage of past-month users among those who ever used cocaine or crack. With this method, and using the 1994 NHSDA, the ratio would be 2 to 3:1 (11.1% reporting ever using crack cocaine compared with 4.5% of those reporting ever using noncrack cocaine are past-month users) rather than 100:1. Other factors to be considered might include social context, current availability, and associated deleterious consequences, all of which contribute in various degrees to a somewhat more severe penalty for crack cocaine–related convictions. Limited research in these areas precludes any definite ratio to be established at this time. Clearly, more systematic research needs to be conducted to specifically deal with these issues.

Implications for Policy

The federal sentencing guideline places a significant emphasis on penalizing sellers and/or possessors of crack cocaine, many of whom are also users of cocaine and addicted to it, so that much of the selling (crack cocaine or cocaine hydrochloride) and cocaine-related crime are driven by the addiction. Therefore, there are 2 issues to be considered in evaluating the rationale for treating the sale or possession of crack cocaine vs cocaine hydrochloride differently. One is the question that has been directly addressed here: are crack cocaine and cocaine hydrochloride different, and if so, in what ways? A second question is whether it is cost-effective to imprison addicts selling or possessing crack cocaine and addicted to it.

Drug addiction of the convicted seller or possessor of any form of cocaine should be a mitigating factor in the way sentencing is carried out, much as other psychiatric disorders currently influence sentencing. The report from the US Sentencing Commission stated that the unique approach to emphasizing severe punishment of those who possess crack for personal consumption is at odds with the prevailing treatment-oriented approach prescribed by Congress for other

drug users and/or possessors. Prison is a scarce commodity in the United States, and if treatment has the potential to decrease the likelihood that the individual treated will return to selling cocaine, it makes sense to try that approach first. In fact, drug abuse treatment has been shown to work about as well when mandated by the courts or under conditions in which users have the option to go into treatment or go to jail as when it is voluntary.[76] Furthermore, crack cocaine has been targeted on the most vulnerable population, one that does not have extensive resources available to them. Unfortunately for the typical inner-city crack user, drug use has become, or at least appears to be, normative, and with limited available resources, the benefits of quitting may not outweigh the powerfully reinforcing effects of cocaine.

Increasing the availability of personal and social reinforcers has been found to increase treatment success among cocaine users,[77] and the development of community resources and involvement has been recommended to reduce the demand for drugs.[73] Research using modeling has demonstrated that greater efforts at interdiction and enforcement will not have significant effects on the nation's cocaine problems,[78,79] primarily because of the adaptability of the distribution of cocaine, whether on our borders or on our streets. In addition, by imprisonment of these individuals, society is choosing the most expensive option to deal with a problem that, for some, can be managed more effectively by intensive outpatient therapy combined with meaningful supervision from the criminal justice system. The treatment of heavy users of cocaine has been found to be far more cost-effective than supply control programs that include source-country control, interdiction, and domestic enforcement.[80] Current studies clearly indicate that treatment is effective in promoting abstinence from cocaine as well as reducing the amount of cocaine use.[81] Although no specific pharmacological agent has been found to be effective in the treatment of cocaine abuse and dependence,[82] various psychotherapeutic and behavioral interventions have demonstrated significant treatment outcome effects.[83-85] Despite these findings, the estimated federal drug control spending for 1995 is budgeted at 65% for interdiction efforts compared with 35% for controlling cocaine demand. There is no doubt that efforts to reduce supply must continue. However, instead of using the differences between crack cocaine and cocaine hydrochloride to justify enormous differences in prison sentences for those convicted of selling cocaine, focusing on approaches that could lead to better treatment and prevention is a more constructive and ultimately more cost-effective approach to this issue.

The fact does remain that not all of those convicted of selling cocaine or engaging in cocaine-related crime are in need of drug abuse treatment, nor are all of those convicted appropriate for treatment. At least 25% or more of those convicted are not selling or committing crimes to support their own cocaine use, and many others do not respond to treatment. For them, a prison sentence appears to be the only current option. Furthermore, addiction to cocaine does not preclude total avoidance of a jail sentence. However, unlike the current federal sentencing guidelines for possession of crack cocaine, the minimum statutory sentence should reflect the comparability of these 2 forms of cocaine, perhaps with a 2 to 3:1 (crack cocaine to cocaine hydrochloride) ratio.

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