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Clinical Toxicology of Cannabis Use

FOREST S. TENNANT, JR., MD, Dr PH

1. INTRODUCTION

Clinical reports of toxicity in cannabis users have often engendered considerable controversy since observations of patients cannot be interpreted in the same manner as experimental studies. These observations, however, are extremely important to the body of knowledge on cannabis because they deal with the realities of health care and treatment. In addition, the public wants to know whether cannabis smoking can cause someone to become "sick" and require medical treatment. The credence of clinical reports on toxicity appears to be increasing, since reports dating back to the *Indian Hemp Drugs Commission, 1893–1894* (1969) are now being validated by various research methods.

This paper reviews nonendocrine, nonimmunological, and nonbehavioral toxic effects of cannabis as observed in clinical settings. Major attention is directed at problems that clinicians detect in populations that use cannabis. Possible toxic effects that have received little attention in scientific and lay literature are reviewed.

2. REPORTS OF TOXIC EFFECTS BY USERS

Clinical Complaints

Analysis of clinical toxic effects of cannabis begins with the review of studies of user-reported side-effects significant enough to warrant clinical treatment (Tennant, 1974). Clinicians in describing toxic effects of cannabis have usually detected complications because a patient complained about a problem and temporally related it to cannabis use. Included among the clinical complaints are certain respiratory, cardiovascular, gastrointestinal, dermatological, neurological, or allergic effects.

FOREST S. TENNANT • Division of Epidemiology, School of Public Health, University of California at Los Angeles (UCLA), Center for the Health Sciences, Los Angeles, California.

TABLE 1

Common Clinical Presenting Complaints of Cannabis Users

Abdominal cramps	Dyspnea
Chest pain	Headache
Constipation	Nausea and/or vomiting
Cough	Rhinorrhea
Diarrhea	Sore throat
Dizziness or vertigo	

Table 1 lists the common complaints voiced by cannabis users seeking clinical treatment.

Nonclinical Surveys of Users

In at least three studies, cannabis users have been surveyed outside of clinical settings and asked whether undesired drug effects were experienced (Halikas *et al.*, 1971; Fisher, 1974; Tennant, 1974). Tennant (1974) surveyed 492 smokers of high potency hashish by anonymous questionnaire and found that 290 (58.3%) experienced one or more of the following undesired side-effects: bronchitis, 6.1%; sore throat, 24.8%; running nose, 8.7%; diarrhea, 4.7%; headache, 14.2%; emotional problems, 8.5%. In addition, 69 (14.2%) claimed they had to visit a physician at least once for an ailment caused by hashish. Sixteen (3.3%) stated that they needed to visit a physician five or more times for the hashish-induced ailment. Halikas *et al.* (1971) surveyed 100 regular marihuana users and found that a large proportion experienced, at least occasionally, unwanted behavioral or somatic side-effects. These included dizziness reported as occurring at least occasionally by 82% of the respondents, dyspnea (28%), headache (30%), periorbital edema (22%), nausea (9%), vomiting (2%), diarrhea (4%), and constipation (4%). Fisher (1974) reported that 13.9% of 530 Los Angeles marihuana users felt that they had harmed themselves in some psychological or emo-

tional way, and 157 (31.8%) stated that they knew of someone else who they felt had been harmed by marihuana. Only 10 (1.9%) felt, however, that they had been physically harmed themselves by marihuana.

Effects of Toxicity on Use Rates

Even though there are few nonclinical surveys of toxic effects in populations of cannabis users, they are impressive in that they reveal that users frequently experience numerous unwanted toxic effects. These effects, albeit minor and not permanent in most cases, probably serve to limit cannabis use in the general population. The development of tolerance to such acute toxic effects as anorexia, nausea, abdominal distress, diarrhea, and stuffy nose was demonstrated in a closed-ward study by Jones *et al.* (1976), although tolerance to the effects did not apparently develop in all subjects. Cannabis use historically has never achieved the popularity of alcohol, nicotine, and caffeine use even in permissive cultures. Persons who tolerate the numerous acute toxic effects of cannabis are probably the only persons who are able to use the drug chronically. This factor undoubtedly contributes to the relative lack of toxic effects found in long-term users.

3. STUDIES OF CLINICAL TOXICITY

Types of Study

Three major types of study since 1970 have contributed to current knowledge of clinical toxicity: (i) evaluations of clinical subjects: (ii) short-term, closed-ward administration of marihuana: and (iii) field comparisons of chronic users with controls. To date, information gathered in all three types of study tends to be very consistent.

Systematic Evaluation of Clinical Subjects

Tennant *et al.* (1971) performed a systematic evaluation of U.S. Army soldiers in Europe who smoked large quantities of potent hashish over a period of several months. All temporally related their habit to one or more medical complaints which were severe enough for the users to seek treatment. Systematically, each patient was given a complete physical examination and a variety of laboratory tests. Respiratory ailments and slightly impaired pulmonary functions were found to be the primary toxic effects. No evidence of cardiac, hepatic, hematological, neurological, renal, or gastrointestinal toxicity was detected. Some subjects voiced gastrointestinal complaints or gave a history of aggravation of an allergic or dermatological disease.

Since this study, numerous clinical reports and other more sophisticated studies have confirmed these early observations.

Closed-Ward Administration Studies

There have been three closed-ward studies in which subjects were given regular marihuana doses for periods ranging from 21 to 94 days (Cohen *et al.*, 1976; Jones *et al.*, 1976; Mendelson *et al.*, 1976). The potency of the marihuana was low (less than 3% THC). Even with the low dosage and relatively short administration period, subjects showed a decrease in pulmonary function (Cohen *et al.*, 1976; Mendelson *et al.*, 1976). There was slight decrease of hematocrit value and hemoglobin in the Jones *et al.* (1976) study group, but this was believed to be due to a plasma volume increase. Just as in the systematic evaluation of clinical subjects by Tennant *et al.* (1971), no evidence of significant cardiac, hepatic, neurological, hematological, renal, or gastrointestinal toxicity was found in any of these closed-ward studies.

Controlled Field Studies

In an effort to compensate for methodological defects in systematic clinical evaluations and closed-ward administration studies, three controlled field studies have been conducted in Greece, Costa Rica, and Jamaica (Table 2) (Boulougouris *et al.*, 1976; Coggins *et al.*, 1976; Cruickshank, 1976). All three involved relatively small numbers of chronic cannabis users who had no clinical complaints and who were evaluated by history, physical examination, and a variety of laboratory tests. Subjects were matched with non-cannabis smoking controls. There was more bronchitis in Greek subjects and more postexercise hypoxia in Jamaican subjects than in controls, indicating the presence of subclinical pulmonary disease. Costa Rican and Jamaican smokers had more weight loss, and Costa Rican users had more gastrointestinal complaints than did controls although there was no consistent pattern. The Greek hashish users had slightly more peripheral neurological findings. Hepatomegaly, in the Greek study, was attributed to concurrent alcohol abuse. In one of the closed-ward administration studies, a low hematocrit value was found (Jones *et al.*, 1976), but the opposite was found in the Jamaican study. Like both the systematic clinical evaluation and closed-ward administration studies, the controlled field studies revealed no significant findings of cardiac, hepatic, neurological, hematological, renal, or gastrointestinal toxicity.

Methodological Defects in Toxicological Studies

A systematic evaluation of a clinical population (Tennant *et al.*, 1971) suffers from the methodological defects of having neither control subjects nor controlled administration of drug. The closed-ward administration studies are deficient in that low doses of low potency cannabis were administered for short periods of time. Subjects in the foregoing field studies were a special group of cannabis users. They regularly used

TABLE 2

Summary of Toxicological Field Studies of Long-Term Cannabis Users

Population	Length of Use	Number of Subjects	Control Subjects	Respiratory Abnormalities	Author
Adult male Greek hashish smokers.	40 years	44	Yes	Slightly more bronchitis than controls.	Boulougouris *et al.*, 1976
Adult male Costa Rican marihuana smokers.	10 years	84	Yes	Chest x-rays normal.	Coggins *et al.*, 1976
Adult male Jamaican peasant ganja smokers.	15 years	30	Yes	Slightly more postexercise hypoxia in users.	Cruickshank, 1976

Cardiovascular Abnormalities	Gastrointestinal Abnormalities	Neurological Abnormalities	Author
None found	Hepatomegaly common but alcohol-related.	Slightly more peripheral findings than controls.	Boulougouris *et al.*, 1976
Slightly lower blood pressure in users.	Users complained of more weight loss, indigestion, nausea, and abdominal pain.	None found	Coggins *et al.*, 1976
None found	None found	None found	Cruickshank, 1976

TABLE 2 (CONTINUED)

Renal Abnormalities	Hematological Abnormalities	Comments	Author
None found	None	One user with splenomegaly. More cigarette smoking and alcohol abuse in hashish smokers.	Boulougouris *et al.*, 1976
None found	Low hematocrit value in users.	Users used other drugs more and had more testicular atrophy	Coggins *et al.*, 1976
None found	High packed cell volume in users.	Slightly lower weight in users.	Cruickshank, 1976

relatively moderate doses of cannabis for many years. These subjects obviously had developed tolerance to common toxic side-effects which many users experience and which appear to be unpleasant enough to cause cessation of cannabis use after minimal experience (Tennant, 1974). Most importantly, these same subjects were selected from a group that did not have any symptoms of illness or disease temporally related to cannabis which were severe enough to require medical care.

Although various toxicological studies have been quoted as substantiation of the relative lack of clinical toxicological effects, this interpretation is erroneous. The results produced in any of these toxicological studies described above could be identical to those of any study of tobacco smokers or alcohol drinkers if selection of subjects and the natural history of tobacco or alcohol use and abuse were not considered (Auerbach *et al.*, 1961; Lesesne and Fallon, 1973). A group of asymptomatic, non-clinical, chronic users of alcohol or tobacco could easily be selected in a field study and would be found to have suffered no toxicological effects when compared with nonusing controls. It takes approximately 20 yr of smoking a pack of cigarettes a day ("pack-years") to develop clinically significant respiratory disease (Auerbach *et al.*, 1961). One must regularly consume a significant dose of alcohol almost daily for ap-

proximately 10 yr ("wet-years") to develop cirrhosis of the liver (Lesesne and Fallon, 1973; Lelbach, 1974). Toxicological complications of tobacco, alcohol, cannabis, and all other drugs, are, therefore, the end result of a time-dose factor that must be exceeded before a toxic complication will occur. An understanding of this provides a simple but obvious explanation of why low potency doses of marihuana administered for a short time in a closed-ward setting may not produce any significant toxic effect. It may also explain why users consuming potent cannabis preparations (containing 5% to 15% THC) would be the most likely group to experience toxic effects severe enough to require clinical treatment (Tennant *et al.*, 1971).

At this time, little is known regarding the time-dose factor for cannabis, but when considered, it may explain minor differences in the findings reported in various toxicological studies.

4. PULMONARY EFFECTS

Historical and Present-Day Concerns

Since marihuana is usually smoked, the possible adverse effects on the lung and pulmonary function have long been of concern. This area has been reviewed by Petersen (1980) and the conclusions are discussed here. It is noteworthy that one of the earliest attempts to assess the health and social implications of cannabis use by the Indian Hemp Drugs Commission, 1893–1894 (1969) includes observations about its pulmonary effects that are surprisingly similar to more modern observations. For example, that *Report* mentions a possible value in the treatment of asthma because of the drug's "pulmonary sedative" qualities. However, it goes on to say that "long continued smoking . . . doubtless results in the deposition of finely divided carbonaceous matter in the lung tissues, and the presence of other irritating substances in the smoke ultimately causes local irritation of the bronchial mucous membrane, leading to increased secretion, and resulting in the condition which is described as chronic bronchitis in ganja smokers." The *Report* makes still another observation strikingly descriptive of present day marihuana use, viz.: "In ganja smoking . . .the inspiratory act is far greater and more prolonged, a larger volume of smoke entering the lungs than in cigarette smoking." Such deep inhalation of marihuana may well offset the typically smaller amounts smoked as compared with cigarette smoking. One indication of this is to be found in a study comparing marihuana and cigarette smokers which found that smoking less than one "joint" per day decreases specific airway conductance as much as smoking 16 cigarettes per day (Tashkin *et al.*, 1980). This change appeared to be due to increased resistance in the large airways. Although the ratio found needs to be confirmed by more extensive research, it suggests that the mode of mari-

huana inhalation and the way in which it is consumed may result in disproportionately adverse pulmonary effects as compared with those produced by modern tobacco cigarettes. Part of this difference may be accounted for by the fact that present day cigarettes are filtered and produce significantly lower levels of "tar" than was true in the past. Marihuana "joints" are unfiltered and virtually entirely consumed. Moreover, under conditions of ready availability there is some evidence that the number of "joints" consumed may approach that of tobacco cigarettes (as high as 10 or more per day) (Cohen *et al.*, 1976).

Clinical Reports

Several clinical studies of users have reported symptoms such as laryngitis, cough, hoarseness, bronchitis, and cellular change in chronic marihuana and hashish smokers, which resemble those of heavy tobacco smokers (Tennant *et al.*, 1971; Henderson *et al.*, 1972; Chopra, 1973). A study of American soldiers stationed in Europe showed that these symptoms were serious enough to induce some of the chronic hashish users to seek medical treatment (Tennant *et al.*, 1971).

Chronic marihuana smoking frequently precipitates bronchitis in adolescents (Waldman, 1970; Cugell, 1971; Louria, 1971), and Tennant *et al.* (1971) believe that a clinical finding of lower respiratory disease in a young adult or adolescent should raise immediate suspicion of marihuana abuse. A swollen uvula secondary to irritation by cannabis smoke may be a useful clinical sign suggestive of recent abuse (Tennant *et al.*, 1971).

Field studies of small numbers of chronic cannabis users in Jamaica, Greece, and Costa Rica (Table 2) found only limited evidence of lung pathology (Boulougouris *et al.*, 1976; Coggins *et al.*, 1976; Cruickshank, 1976). This may have been due to multiple reasons: (i) traditional users in those countries do not inhale cannabis smoke as deeply and retain it in their lungs as long as do American users; (ii) persons who found cannabis irritating to the respiratory tract probably chose to cease use long before complications occurred; and (iii) techniques to measure pulmonary function were not particularly sophisticated in these studies. Tashkin *et al.* (1976) found, by using sophisticated techniques, that after 59 days of daily marihuana smoking there was a decrease in mid-expiratory flow rate indicating significant airway obstruction.

Impairment of Pulmonary Defense System

The irritation produced by cannabis smoke appears to have a considerable adverse effect. Cilia which assist in moving inhaled dust and other small foreign particles from the lungs have been found to be injured by marihuana smoke. Following exposure to marihuana smoke,

anti-bacterial defense systems in lungs of animals have been shown to be less effective against *Staphylococcus aureus*, a bacterium causing a serious form of pneumonia (Huber *et al.*, 1975). While similar effects have not yet been demonstrated in humans, it would be surprising if they did not occur and may be expected to be dose-related. The greater the amount and frequency of use, the greater the likelihood of adverse pulmonary and other consequences.

Cannabis Use With Pre-existing Pulmonary Disease

It appears hazardous for patients with pre-existing pulmonary disease to smoke cannabis. A 17-yr-old boy with chronic granulomatous disease smoked marihuana contaminated with Aspergillus and contracted the disease (Chusid *et al.*, 1975). Subsequent studies by these investigators revealed that cultures of street marihuana showed a high prevalence of Aspergillus and other fungi. Another case of aspergillosis occurred in a 27-yr-old marihuana smoker with a history of atopy, asthma, and bronchitis (Llamas *et al.*, 1978). Other reports describe worsening of respiratory symptoms in patients with pre-existing asthma and chronic bronchitis, on smoking cannabis (Henderson *et al.*, 1972; Lewis and Slavin, 1975).

Cancer Potential

Analysis of cannabis smoke, animal studies, and a recent report by Tennant (1980) suggest that cannabis may have significant lung cancer potential. Certain napthalenes, particularly benzopyrene, are known to be cancer-producing; benzopyrene is reported to be about 70% more abundant in marihuana smoke than in tobacco smoke (Novotny *et al.*, 1976).

One assay to determine the carcinogenic potential of tobacco tars is application of tobacco smoke condensate on mouse skin. Marihuana smoke condensate was applied to mice for five days by Cottrell *et al.* (1973). They observed metaplasia of the sebaceous glands, an effect that correlates well with carcinogenicity of the compound. Hoffmann *et al.* (1975) painted marihuana and tobacco smoke condensates on separate groups of mice for 74 wk. They saw tumors in both groups of animals, with a larger number in the tobacco group.

Using explants of human lung tissue exposed to either tobacco or cannabis smoke, the Leuchtenbergers (1976) found cellular abnormalities, and alterations in DNA content and in chromosome number. They then employed hamster lung explants because of their longer survival time and noted malignant transformation after exposure of three to six months to both tobacco and marihuana smoke. When the malignant cells were injected into mice, fibrosarcomas developed. Marihuana

smoke produced the changes more readily than tobacco smoke. In this experiment, the smoke from both plants acted as a tumor accelerator, not an initiator, since the control group also developed malignant tumors over a 12- to 24-mo period.

Serious lung effects have been found in rats exposed to marihuana smoke in quantities producing blood cannabinoid levels similar to those of human daily users (Fleischman *et al.*, 1979). The animals were made to inhale smoke in a specially constructed apparatus at daily intervals for periods corresponding to one eighth to one-half of their normal life-span. Extensive lung inflammation and degenerative changes were found that were similar to but more severe than those produced by exposure to tobacco smoke.

The only human evidence of carcinogenic potential is a study of 30 U.S. Army soldiers stationed in Europe who smoked large quantities of hashish, experienced respiratory symptoms, and volunteered for bronchial biopsies (Tennant, 1980). All 23 smokers of hashish plus cigarettes had one or more pathological alterations consisting of atypical cells, basal cell hyperplasia, or squamous cell metaplasia. Two of seven hashish users who did not smoke tobacco showed such pathological changes. Three nonsmoker control subjects who volunteered for bronchial biopsy did not demonstrate any pathological abnormalities. The histopathological lesions found among the users were identical to those associated with the later development of carcinoma of the lung when it occurs in tobacco smokers.

Concurrent Cannabis-Tobacco Use

Smoking both cannabis and tobacco is a very common practice. Current evidence suggests that the combined use is additive or even supra-additive insofar as irritation, inflammatory reaction, or carcinogenicity is concerned (Tennant, 1980). It seems obvious that the inflammatory reactions and inhibition of macrophage activity would be at least additive when both substances are smoked. Therefore, it is in the subgroup of heavy tobacco and cannabis users that the first evidence of increased incidence or severity of pathologic changes and possibly cancer will likely be found.

5. CARDIOVASCULAR TOXICITY

Acute Effects

Cannabis is known to have significant cardiovascular effects and EKG changes may occur during acute intoxication (Savary *et al.*, 1974; Clark, 1975). A number of studies, however, in which cardiovascular

dynamics were studied some time after administration of large doses of THC, indicate that cannabis produces only minimal if any EKG changes in young healthy subjects (Benowitz and Jones, 1975; Clark, 1975; Malit *et al.*, 1975). Nonspecific P or S wave changes are most commonly noted (Kochar and Hosko, 1973). Occasional premature beats may also occur. Tachycardia is the most common and prominent physiological response to acute doses (Schaefer *et al.*, 1975). Cardiovascular effects during acute intoxication appear to be temporary and of no clinical consequence in persons with a normal heart. No consistent and lasting changes in blood pressure have been found (Jones *et al.*, 1976).

Clinical Studies

Several studies have investigated the possible cardiotoxicity of cannabis use. To date, however, clinical trials have shown no EKG evidence of long-term toxicity (Benowitz and Jones, 1975; Nowlan and Cohen, 1977). One group of investigators studied 21 male, experienced marihuana users who participated in a 94-day in-hospital study of heavy marihuana smoking (Nowlan and Cohen, 1977). During 64 days of the study the subjects smoked one to three marihuana cigarettes per day. These investigators found a significant increase in heart rate after marihuana smoking, although it was not as clearly dose-related as had formerly been reported by others. They attributed the lack of a clear dose-response relationship to the tolerance that develops to the cannabis-induced cardiovascular effects during chronic exposure. Other changes observed in cardiac function were secondary to transient tachycardia and did not appear to be clinically significant. The field studies of long-term users in Costa Rica, Jamaica, and Greece did not disclose any cardiovascular abnormalities (Table 2).

Effect on Pre-existing Heart Disease

Cannabis, in all likelihood, does not have significant, long-term toxic effects on a normal heart, but it is clear that it is a potential danger to patients with pre-existing heart disease. In patients with already impaired heart function, use of cannabis may precipitate chest pain (angina pectoris) on exertion (Angelico and Brown, 1974; Aronow and Cassidy, 1975). Smoking either marihuana or high nicotine cigarettes decreases exercise performance prior to the onset of angina by increasing myocardial oxygen demand and decreasing myocardial oxygen delivery (Aronow and Cassidy, 1975). Marihuana, however, appears to precipitate angina more rapidly than tobacco cigarettes, and following less effort. Cardiovascular hemodynamics were evaluated by EKG (Prakash and Aronow, 1976). After marihuana smoking, stroke index and ejection fraction decreased, and carboxyhemoglobin levels were elevated. One case of pulmonary edema and myocardial infarction following marihuana use has been reported (Charles *et al.*, 1979). This case is

disturbing since it occurred in a 25-yr-old male with no known history of pre-existing heart disease. Similar observations have been made in animals (Forney and Kiplinger, 1971).

In summary, it is clear that persons with heart disease would be wise not to consume cannabis. Further observations need to be made on the potential of cannabis to produce infarction.

6. GASTROINTESTINAL TOXICITY

Clinical Toxic Effects

The occurrence of diarrhea, abdominal cramps, and vomiting has been observed in laboratory animals administered cannabis products, and these symptoms are reported to occur frequently in humans using the drug (Halikas *et al.*, 1971; Tennant, 1974). They may be severe enough to induce users to seek medical treatment (Tennant *et al.*, 1971). In contrast, other reports indicate that THC may be an antiemetic compound (Borison *et al.*, 1978), and that in some individuals cannabis may produce constipation, rather than diarrhea (Halikas *et al.*, 1971; Burton, 1979). The explanation for these apparently contradictory reports may lie in differences of dosage, or in other circumstances surrounding the cannabis use.

The field study conducted on 84 Costa Rican chronic marihuana smokers showed that users had more weight loss and more complaints of indigestion, nausea, and abdominal pain than did controls (Coggins *et al.*, 1976). Cruickshank (1976) found a slightly lower weight in Jamaican ganja smokers compared with controls. In closed-ward administration studies, observations of weight gain were made during subchronic administration of marihuana or THC, but the subjects lost weight rapidly when drug treatment was discontinued (Greenberg *et al.*, 1976; Jones *et al.*, 1976). Despite the occurrence of gastrointestinal complaints that may even require symptomatic medical treatment, there is no evidence that cannabis produces any direct, long-term gastrointestinal effects in a normal individual.

Mechanism of Diarrhea

Nalin *et al.* (1978) found that cannabis reduces gastric acid secretion and renders the smoker more susceptible to *Vibrio cholerae* and *Escherichia coli* infection, which may result in aggravated diarrhea. In particular, the investigators believed that the cannabis user was particularly susceptible to traveler's diarrhea. This study is important since it provides a possible explanation for the diarrhea, abdominal distress, and

TABLE 3

Contraindications and Inappropriate Consumption of Cannabis

Contraindications	Inappropriate Consumption
Tobacco smoker	Sharing of cannabis product or paraphernalia
Alcohol abuser	Swallowing a cannabis product
Pre-existing allergy, skin condition, pulmonary disease, heart ailment, neurological disease	Intravenous injection
Traveler to foreign country	Regular use of high potency cannabis

weight loss that are commonly observed in chronic cannabis users (Tennant *et al.*, 1971; Coggins *et al.*, 1976; Mendelson *et al.*, 1976).

Inappropriate Use and Adverse Effects

Cannabis has been consumed in ways other than by a single person smoking a single portion of the plant, and these practices have often resulted in adverse clinical effects (Table 3). Abrahm (1972) reported a young man who contracted multiple intestinal parasites after sprinkling raw marihuana leaves on salads. Dassel and Punjabi (1979) encountered three patients who swallowed marihuana-filled balloons. Two of these individuals developed intestinal obstruction and the third experienced rupture of the balloon with subsequent nausea, dizziness and sedation severe enough to require hospitalization.

LIVER TOXICITY

Clinical Reports

Kew *et al.* (1969) performed liver-function studies on 12 regular cannabis users in England and found evidence of hepatotoxicity in eight.

Hochman and Brill (1971) found abnormal liver function in 10 of 50 chronic marihuana users, but attributed this to concurrent alcohol abuse. Boulougouris *et al.* (1976) found hepatomegaly to be more common in Greek hashish users compared with controls and also concluded it was due to concurrent alcohol abuse. Other investigators have studied clinical and experimental populations to verify the hepatotoxicity of cannabis but have not found any (Tennant *et al.*, 1971; Coggins *et al.*, 1976; Cohen *et al.*, 1976; Cruickshank, 1976).

Explanation of Diverse Findings

In addition to alcohol abuse, other explanations have been offered for the occasional finding of liver dysfunction in clinical populations. Drachler (1975) found that sharing a pipe of hashish among smokers was associated with transmission of hepatitis. Regardless of whether this mechanism is always the cause of liver dysfunction in cannabis users, prudence indicates that users should not share for fear of hepatitis transmission. Mellors (1974) suggested that lysosomes may be damaged by THC and result in hepatotoxicity. Shapiro *et al.* (1975) found that some marihuana users who developed antibodies to marihuana also had abnormal liver function, which suggests a possible adverse antigenic response. Since alcohol abuse has been very common in cannabis users who have demonstrated liver dysfunction, it is quite possible that THC potentiates the toxic effect of alcohol on the liver by virtue of an antigenic or lysosome destruction mechanism.

8. DERMATOLOGICAL EFFECTS

Considerable public controversy was evoked when Lubowe and Huss (1969) described two patients with seborrheic dermatitis and acne which improved with discontinuation of marihuana use. Since then, essentially no studies of the association between cannabis and acne have been reported although at least one clinical report describes three patients who temporally related severity of acne and seborrheic dermatitis to hashish dosage (Tennant *et al.*, 1971). This is a particularly complicated area to study, since acne most commonly occurs in an age-group with a high prevalence of cannabis use. Poor personal hygiene is prevalent among drug users and may be the factor most directly responsible for acne in this group. A direct effect of cannabis on sebaceous gland function cannot be ruled out, however, since Cottrell *et al.* (1973) found that marihuana smoke condensate has a significant pathological effect on the sebaceous glands when applied to the skin.

Another temporal relationship has been reported by Juel-Jensen (1972), who described four patients who repeatedly developed recurrent herpes simplex after smoking cannabis, to the degree that they had to give up use of the drug. Although very little is known about cannabis' ef-

fects on the skin, patients who have acne, recurrent herpes, or other skin problems and who smoke cannabis should he advised to observe a possible temporal relationship between smoking and worsening of their problem.

9. ALLERGIC MANIFESTATIONS

Periorbital edema is a well-known occurrence with acute cannabis intoxication (Ames, 1958). Both urticaria and angioneurotic edema have been reported with cannabis use. However, it is unclear whether these were due to true cannabis allergy or to contaminants in the cannabis preparations since patch tests and agar-gel diffusion studies using the patient's serum did not show true allergy in 10 subjects (Tennant *et al.*, 1971). These investigators felt that hashish tended to worsen symptoms, however, in patients who had a known allergy to pollens or house dust. This observation has been supported by Lewis and Slavin (1975) who had three atopic patients who developed asthma or rhinitis after smoking marihuana, despite the fact that all three had negative skin tests to marihuana. Shapiro *et al.* (1975) found that marihuana is antigenic and capable of eliciting an antibody response in the indirect Coombs test. It is interesting to note that some marihuana smokers with a positive antibody response also had abnormal liver function tests; hepatic dysfunction might explain the antibody response in some persons. Liskow *et al.* (1971) reported a patient with known allergy to ragweed who had an anaphylactoid response after smoking a marihuana cigarette for the first time. Scratch testing and passive transfer studies confirmed an immunologic basis for the response, indicating that some individuals may be significantly allergic to Δ^9-THC. Despite the paucity of reports available so far, it would appear clinically prudent to advise allergic patients that cannabis may worsen their symptoms.

10. PERIPHERAL NERVOUS SYSTEM TOXICITY

Dizziness and vertigo just following smoking have been reported by users (Halikas *et al.*, 1971), and auditory, vestibular, and peripheral nerve toxicity has been studied in chronic cannabis users (Spector, 1974; DiBenedetto *et al.*, 1977). Sophisticated testing showed vestibular function to be impaired but the detected deficit was of questionable clinical significance (Spector, 1974). Studies in a group of 27 male subjects administered cannabis for three weeks showed no deterioration in nerve conduction (DiBenedetto *et al.*, 1977). More peripheral neurologic defects were found among 44 Greek hashish users than among controls, but they consisted of a variety of types (Boulougouris *et al.*, 1976).

At this time there is no convincing evidence that cannabis causes any permanent neurologic impairment, and there is no explanation for

the findings in the Greek field study, other than the possibility that some of the cases may have been alcoholic peripheral neuropathy.

11. HEMATOLOGICAL ABNORMALITIES

No significant hematologic abnormalities have been found consistently in clinical populations of cannabis users (Tennant *et al.*, 1971). Marihuana users in the Costa Rican field study had a lower mean hematocrit value and higher prothrombin time than did controls. This finding is difficult to evaluate since almost half of all subjects had intestinal parasites (Coggins *et al.*, 1976). Hematocrit value was slightly lowered in one closed-ward marihuana administration study (Jones *et al.*, 1976). The opposite effect was found in 30 Jamaican ganja smokers, most likely due to concomitant cigarette smoking which is known to produce polycythemia (Cruickshank, 1976). In Jamaica, ganja is customarily mixed with tobacco. At the present time there is no evidence to make one believe that cannabis consistently produces any hematologic disorder that can be measured by standard techniques.

12. RENAL-URINARY TOXICITY

To date, there have been no reports of renal toxicity except in cases of the cannabis injection syndrome (see Section 13). One case of urinary retention has been reported (Burton, 1979). In this case, a 55-year-old man ate cannabis butter and developed constipation and urinary retention which required urethral catheterization. Although the mechanism of action in this case is unknown, it may be due to interference with peripheral cholinergic activity. Cannabis is known to produce other anticholinergic effects such as dry mouth and constipation (Halikas *et al.*, 1971).

13. INJECTION SYNDROME

The most dramatic clinical toxicity is that seen following i.v. injection of aqueous extracts of cannabis plant products. Intravenous administration of marihuana may initiate a syndrome that was first reported by Herberson and Pugsley (1968) and later by King and Cowen (1969). Lundberg *et al.* (1971) found that most marihuana-related hospitalizations are due to injection. Characteristic early effects of i.v. injection of marihuana extracts include the rapid onset of nausea, vomiting, generalized pains, shaking chills, fever, tachycardia, and diarrhea. Within 12 hours, hypotension appears and is followed by a reversible renal insufficiency and possible rhabdomyolysis (Farber and Huertas, 1976). Initial

TABLE 4

Major Areas of Deficient Knowledge

Time and dosage requirements for acute and chronic toxic effects
Interactions of cannabis and tobacco on respiratory tract
Interactions of cannabis and alcohol on liver
Ability of cannabis to aggravate pre-existing cardiovascular, pulmonary, gastrointestinal, allergic, and dermatological diseases
Ability to cause cancer of lung

leukopenia is followed by a dramatic leukocytosis within the first 24 hours (Gary and Keylon, 1970). Early in the course of the syndrome, thrombocytopenia appears, which seems to be caused by a direct toxic effect of the injected extract.

The evidence is clear that cannabis extracts should not be injected i.v. since severe toxicity may occur.

14. MAJOR AREAS OF DEFICIENT KNOWLEDGE

The decade of the 1970s has witnessed a remarkable accumulation of knowledge on the clinical toxicity of cannabis. There still remains, however, considerable lack of knowledge. Table 4 lists some of the major areas of deficient knowledge.

The most needed information is that concerning the time-dose factor of cannabis toxicity. While considerable knowledge has been acquired about the time-dose relationship of clinical toxic effects with alcohol and nicotine, little is known about the dosage of cannabis and the duration of exposure required to produce toxic effects. This problem is particularly complex with cannabis since THC is fat-soluble and has a long serum half-life during the ß or elimination phase.

The interaction of cannabis with other drugs, particularly nicotine and alcohol, is poorly defined. Current evidence suggests that tobacco

and cannabis when smoked concurrently produce more pulmonary damage than either smoked alone. Carcinogenic potential may therefore be enhanced by combined use. Liver dysfunction has frequently been observed in cannabis users and this may be due to a potentiation of the effects of alcohol brought about by simultaneous cannabis consumption.

Cannabis may have considerable ability to aggravate pre-existing disease. There is an increasing number of clinical reports which suggest that it can greatly complicate cardiovascular, pulmonary, gastrointestinal, hepatic, allergic, and dermatologic diseases.

Unfortunately, only long-term epidemiologic studies of humans will be able to confirm these relationships. That cannabis may lead to a higher incidence of lung cancer is of great concern.

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The Decline of Drugged Nations

By Gabriel G. Nahas

Americans seem agreed today that the rise in consumption of tobacco and alcohol, two legal addictive drugs, is associated with such staggering individual and social costs that restrictive measures to limit their consumption, especially by the young, should be considered. At the same time some prestigious opinion-makers suggest that illegal addictive drugs, such as marijuana, heroin and cocaine, be made available commercially as well.

In this verbal tug-of-war it seems that opinions have replaced established facts derived from pharmacological, epidemiological and historical studies.

First, the distinction between licit and illicit addictive drugs is not arbitrary, as we might be led to believe. While both types of drugs have properties in common, they also have basic differences. In terms of similarities, they both induce certain biochemical changes in the brain that are usually pleasant and lead to a repeat experience; eventually, their use leads to daily drug-seeking and drug-consuming behavior. Once instilled, this behavioral pattern is difficult to alter. In the case of illicit addictive drugs, however, the pleasant experience is associated with a temporary impairment of brain mechanisms that results in distorted perceptions.

While the legal, addictive drugs tobacco (nicotine), alcohol (in small amounts), and coffee (caffeine) do not impair mental acuity, cocaine, heroin and marijuana do, even in minute quantities. Furthermore, the addictive potential of illicit addictive drugs is greater than for licit drugs. It takes very low exposure to cocaine or heroin to become dependent on these drugs, as reported in epidemiological studies of drug-consuming populations.

Moslems vs. Hashish

Among those who drink alcoholic beverages world-wide, 8% consume daily amounts that are damaging to their health and to society. Epidemiological studies of the populations of marijuana and hashish, cocaine and opiate consumers show that about 50%, 90% and 95%, respectively, of the consumers will use these drugs daily, in doses damaging to their health and to society, when they are readily available. Finally, history shows that when illicit addictive drugs are socially accepted and easily available, they are widely consumed, and their use is associated with a high incidence of individual and social damage.

The use of cannabis in the Islamic-dominated world surfaced in the 11th century, when the Moslem Empire extended from the Atlantic to the Indian oceans. Historians of the 12th to the 16th centuries have documented the damage done by the widespread use of hashish in Moslem medieval society. (An account of their writings has been compiled by Franz Rosenthal of Yale University in his book, "Hashish vs. Moslem Medieval Society.")

In the 15th century all restrictions against hashish were set aside. As a result, according to the contemporary historian Al Maqrizi, a general debasement of the people was apparent. A large number of people from all walks of life were in a constant state of intoxication. All the scholars and religious leaders of the time condemned the weed—but the habit of hashish-taking had become ingrained in society and could not be eliminated.

In ancient Peru, the chewing of the coca leaf, which began 1,500 years ago, was restricted by the Inca leaders to religious ceremonies. After the Spanish conquest in 1554, this habit spread among the farmers and laborers, who were paid in coca leaves, which they chewed nearly continuously. As a result they were in a state of continuous low-grade intoxication. This drug use continues today. The farmers and miners of the Andes thus are able to work under the most adverse conditions with limited food intake. As a result, their social condition has not changed in centuries; their general health and life expectancy are poor.

History shows that when illicit addictive drugs are socially accepted and easily available, their use is associated with a high incidence of individual and social damage.

In 1858, the legal trade of opium and the Opium Wars were imposed on China by British mercantilism. By 1900, 90 million Chinese were addicted to opium. It took a national revival at the turn of the century that stressed traditional Chinese values to stem the tide. The support of the U.S. and the international community stopped the international opium trade. But it took 50 years of coercive measures for the country to become opium-free. Today, opium and other dependence-producing drugs are banned from China, as well as from Taiwan and Singapore.

In Egypt in the 1920s, the unrestricted commercial availability of cocaine and heroin resulted in an epidemic use of these drugs. This use was curtailed in the 1930s following national and international interdiction, and punitive measures meted out to all addicts.

In the 1950s, Japan experienced a major epidemic of intravenous amphetamine use involving half a million addicts. A national campaign aimed at restricting demand and supply with sanctions applied against users and traffickers brought the number of addicts down to a few thousand within four years. A heroin epidemic was curtailed in the same manner in the 1960s, reducing the number of heroin addicts from several thousand to a few hundred.

In contrast, the British in 1925 adopted a medical model allowing physicians to prescribe heroin to heroin addicts. This "British system" worked satisfactorily as long as addicts were few in number and all registered: 500 a year between 1930 and 1960. It became unmanageable after 1960 when heroin had to be dispensed to more than 1,000 users of the drug. Each addict had to be provided with daily doses of heroin, as well as the equipment required for the injection of the drug four to six times a day.

Because of this logistical problem and because of the potential for diversion of the drug to nonregistered addicts, heroin began to be progressively replaced by methadone maintenance. (Methadone, a long-lasting opiate, needs to be absorbed only once a day, by mouth.) But the number of registered British addicts had grown by 1980 to 2,500, double the total seeking treatment seven years earlier. In 1985 there were an estimated 80,000 heroin addicts in Britain, most of whom were not in drug-treatment programs. Despite this failure of the British system, it is still advocated by some in the U.S.

These scientific and historical facts demonstrate that supply and demand reduction are needed in the U.S. to control the present epidemic of illicit drug use.

U.N. Assistance Needed

Supply reduction will require national and international interdiction measures. The gradual eradication of coca-bush plantations must be initiated in the producing countries, together with a program for planting basic food crops. Such a scheme calls for a new multibillion-dollar, ecologically sound United Nations assistance program (with the cooperation and contribution of the U.S.S.R.) staggered over many years.

At the same time, the consuming country must lower its demand by more strictly enforcing existing laws that ban use and possession of cocaine. Dealers should be subjected to the same sentences imposed on murderers; users should be forced to enter rehabilitation programs, as is currently done in Japan.

Such measures rely upon a strongly expressed sentiment of societal disapproval of cocaine and other illicit drug use by all segments of society. Prohibitive measures cannot be effective in a climate of cultural acceptance of "recreational" drug use, which has led some opinion makers to advocate the legalization of all drugs. Only when the vital grass-roots forces of America, feeling their existence threatened, become determined to fight drugs will they be able to wage a war and win it.

The battle primarily will be one of the mind—for the constraints that have to be accepted by a progressive and free society. Americans need to know the truth about our common enemy and must be encouraged, as they were during the great wars, by the same unambiguous media that helped the nation to victory.

Dr. Nahas, a pharmacologist at Columbia University's College of Physicians and Surgeons, has studied the effects of addictive drugs over the past 30 years.

Marijuana Legalization Flouts U.N. Treaty

By Gabriel G. Nahas

Next month, the people of Oregon will vote on an initiative that would legalize the cultivation and possession of marijuana for personal use by anyone over age 17. While polls show the initiative is likely to lose, Americans also should be aware of the national and international implications of the vote. The Oregon initiative runs counter to a major treaty signed by the U.S. that attempts to control the traffic of illicit dependence-producing drugs: The Single Convention of the United Nations.

In 1973, the Oregon legislature eliminated criminal penalties for possession of marijuana for personal use. Within a few years similar "decriminalization" measures were adopted by 12 additional states. This trend was slowed and then halted by a mounting pile of scientific and medical evidence that marijuana is a serious health hazard.

This message has not seemed to have had sufficient impact in Oregon, which is a major domestic marijuana producer. With the help of the National Organization for the Reform of Marijuana Laws (NORML), over 87,000 signatures were collected to place a marijuana-legalization initiative on the November ballot. Because of the treaty commitments mentioned earlier, its passage would be a major international embarrassment for the U.S.

Twenty-five years ago, acting on the recommendation of a World Health Organization expert committee, the U.N. recommended that member nations adopt a single convention that would supersede all of the multilateral treaties negotiated since the turn of the century to control the illicit traffic of dependence-producing drugs (mainly opium, cocaine and cannabis). These conventions included the First Opium Conference of The Hague, called in 1913 at the initiative of Theodore Roosevelt, and the Second Opium Conference of Geneva of the League of Nations, held in 1924. These conferences had been organized by enlightened statesmen who were convinced that the gradual suppression of drugs that enslave the mind and body of men would be beneficial to mankind.

The Single Convention on Narcotic Drugs of the United Nations was drafted and approved by 500 delegates from 74 nations, all of whom assembled in New York in 1961. It obligates the parties to "limit exclusively to medical and scientific purposes" the production, manufacture, export, import, distribution of, trade in, use and possession of drugs covered by the Convention. These drugs include, in addition to opium, coca leaves, and all of their known derivatives, "the flowering or fruiting tops of the cannabis plant, marijuana, excluding the seeds and leaves when not accompanied by the tops, from which the resin has not been extracted, by whatever name they may be designated."

The leaves of the plant were excluded from the convention as a compromise gesture to the delegates from India and Pakistan, where bhang, a concoction made of cannabis leaves, was still widely used. However, in order to limit the use of cannabis leaves, the following article was added: "The parties shall adopt such measures as may be necessary to prevent the misuse of, and illicit traffic in, the leaves of the Cannabis plant."

Finally, the convention recognized the need for transitional reservations in countries where cannabis preparations had been used for centuries. "The use of Cannabis for other than medical and scientific purposes must be discontinued as soon as possible, but in any case within 25 years from the coming into force of this Convention." However, countries where cannabis had never been cultivated for its intoxicating properties were requested to make a special pledge: "Whenever the prevailing conditions in the country or a territory of a Party render the prohibition of the cultivation of opium poppy, the coca bush or the cannabis plant, the most suitable measure in its opinion for protecting the public health and welfare and preventing the diversion of drugs into the illicit traffic, the Party concerned shall prohibit cultivation." This convention, ratified by the U.S. in 1967, has become the law of the land.

Approval of the Oregon initiative would not only violate the Single Convention but also hinder the efforts of the U.S. to curtail the traffic of illicit drugs entering the U.S. from abroad. The U.S. has frequently requested that producing countries comply with the terms of the Single Convention and prohibit the growing of the opium poppy, coca bush or the cannabis plant. U.S. support for the marijuana-eradication programs carried out by Jamaica, Colombia and Mexico could hardly be justified if a U.S. state voted for the legalization of marijuana.

Approval of the Oregon initiative would also impede efforts to limit the social acceptance of "recreational" intoxication through the use of marijuana and other dependence-producing drugs. It also would be more difficult for parents to persuade their children to say "no to drugs," a message endorsed by President and Mrs. Reagan in a recent television address.

Whatever the fate of the Oregon initiative, it is indicative of the cultural revolution that has swept the U.S. since World War II—a revolution that has set self-gratification as its primary goal. It is time to turn back that revolution, beginning in Oregon. Surely we all should be committed to the American dream of building a country in which children may grow up in a drug-free environment.

Dr. Nahas is a professor of anesthesiology at Columbia University. He is also a consultant to the United Nations Commission on Narcotics.

Carry-Over Effects of Marijuana Intoxication on Aircraft Pilot Performance: A Preliminary Report

Jerome A. Yesavage, M.D., Von Otto Leirer, Ph.D.,
Lt. Cdr. Mark Denari, and Leo E. Hollister, M.D.

Ten experienced licensed private pilots were trained for 8 hours on a flight simulator landing task. They each smoked a cigarette containing 19 mg of Δ^9-tetrahydrocannabinol (THC), and 24 hours later their mean performance on the flight task showed trends toward impairment on all variables, with significant impairment in number and size of aileron changes, size of elevator changes, distance off center on landing, and vertical and lateral deviation on approach to landing. Despite these deficits, the pilots reported no awareness of impaired performance. These results may have implications for performance of complex tasks the day after smoking marijuana.

(Am J Psychiatry 142:1325–1329, 1985)

The widespread recreational use of marijuana in both the private and military sectors suggests the need for more detailed research concerning its effects on pilot performance. For the past 10 years cases of its use by flight trainees, active pilots, and pilots in fatal accidents have been documented (1, 2). A 12-year-old study (2) revealed that some 250 of the 500,000 people who applied to the Federal Aviation Administration (FAA) for medical certificates freely admitted to previous use of marijuana. We suspect that actual use by today's pilots is much higher.

How long is the behavioral and cognitive performance of complex tasks affected by Δ^9-tetrahydrocannabinol (THC)? While plasma concentrations are usually negligible 3–4 hours after smoking, urine screens for THC metabolites remain positive at least 48–72 hours after oral administration (3, 4). Recent accidents involving railroad crews performing complex tasks have documented positive urine THC screens (5). The pilot in a recent fatal commercial air crash was found to have smoked THC some 24 hours before the crash (6). A particular concern is whether using the drug can lead to impaired piloting performance (a complex task) after a 1-day delay, i.e., a carry-over effect.

Although the topic is widely discussed, we have found only one scientific investigation of the effects of THC on pilot performance (7–9). In a comparison of THC and placebo, observer-rated performance was evaluated after pilots smoked cigarettes containing approximately 0.09 mg of THC per kilogram of body weight. The pilots were trained to fly holding patterns on an ATC-510 instrument flight simulator (a simulation without an outside visual display). Despite the limitations of the simulation and a relatively insensitive quantification method, significant effects on all dependent measures were found up to 4 hours after smoking. To date, no further studies have examined the persistence of THC effects on piloting tasks.

The purpose of this study was to examine THC carry-over effects on a simple piloting task 24 hours after smoking of the drug. The task chosen was a standard maneuver involving a simple landing procedure. The dependent measures related to how precisely the landing was performed. We reasoned that a simple piloting task would provide a conservative test of THC effects 24 hours after administration. If any effects were found on simple piloting tasks, we would be justified in further investigation of THC effects on complex piloting tasks. We employed a highly quantified, computerized flight simulator in this study. Since on-line computerized quantification is a precise measuring technique, it provides a more sensitive measure of prolonged drug effects on pilot performance than previously used methods (10).

METHOD

Testing Device and Quantification

The experiment was conducted in a computerized laboratory specifically designed for pilot performance research (AIRSIM-R; the simulations cited are available from Dr. E. Kurtz, MSC Corp., P.O. Box 506, Northampton, MA 01061; 413-586-6463). The com-

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puter-generated visual displays, instrument read-outs, and aircraft control systems are controlled by a 6502 microcomputer and 6502 coprocessor. Data about the aircraft's orientation, position, altitude, and speed are collected every 0.5 second. The data collected during experiments are transformed and stored by a 68000-based microcomputer. The data analyses are completed on an IBM 3081 mainframe computer.

The subjects are seated in the aircraft simulator chamber. The chamber is sound attenuated and the interior is designed to simulate a generic small aircraft cockpit. The aircraft controls consist of a standard yoke that controls the elevators and ailerons. Flaps and engine speed controls are located at approximately the same distance (20 cm) from the pilot as those same controls in a Cessna 172. All instruments are displayed across the bottom and lower right side of an 18-in. CRT. The visual angle (retinal image) of these instruments approximates those found in a Cessna 172. AIRSIM-R includes a computer-generated graphic display of landscape (as seen from the pilot's perspective). This display includes horizon, mountains, buildings, and airport runways. The landscape perspective is corrected every 0.5 second in response to the subject's manipulation of the aircraft controls.

There are two typical methods of quantifying pilot performance. These are the "measure everything" approach and the measurement of certain critical points on selected maneuvers (10). Our approach combined aspects of both. We measured every control yoke and throttle movement to determine general changes in method of controlling the flight simulator, and we measured critical points of certain maneuvers to determine how well the overall procedure was performed. The maneuver involved a takeoff, a climb to 700 feet, two turns, and a descent and landing. The pilots were instructed to maintain a stable descent rate of between 100 and 200 feet per minute and to land as near the runway threshold and center line as possible. Every adjustment of the aileron, elevator, and throttle during the maneuver was recorded by the computer. These three control characteristics were used to measure the pilot's attempts to manipulate the simulator. Also recorded were seven different aircraft situation parameters: latitude, longitude, altitude, angle of bank, angle of climb, rate of climb, and velocity. Together these data can be used to calculate overall measures of performance, e.g., average lateral deviation from an ideal glideslope and glidepath or number of feet off-center from the runway center line on landing. Once calculated, these performance data are ready for statistical analyses and for graphic display. Figure 1 shows a graphic display of one pilot's flights at baseline and 1 hour after smoking THC.

Before this experiment we compared the performance on the flight simulator of eight nonpilot volunteers and eight pilot volunteers with more than 200 hours of flying experience. Using the same task as in our THC studies, we trained the subjects until they were able to make three successful landings in a row. We found that the nonpilots required significantly more practice landings to reach that criterion: mean±SD=6.2± 2.6 for the nonpilots versus 2.9±1.7 for the pilots ($t=3.05$, $df=7$, $p<.02$). We also found that on the three landings completed successfully, the pilots performed substantially and significantly better in terms of deviations from glidepath and glideslope. The average lateral deviation for nonpilots was 72.7±34.7 feet, and for the pilots it was 30.3±16.8 feet ($t=3.11$, $df=7$, $p<.02$). The average vertical deviations for the two groups were 46.8±21.4 feet and 12.6±4.5 feet. Thus, we found a correspondence between performance on the simulator and previous piloting experience.

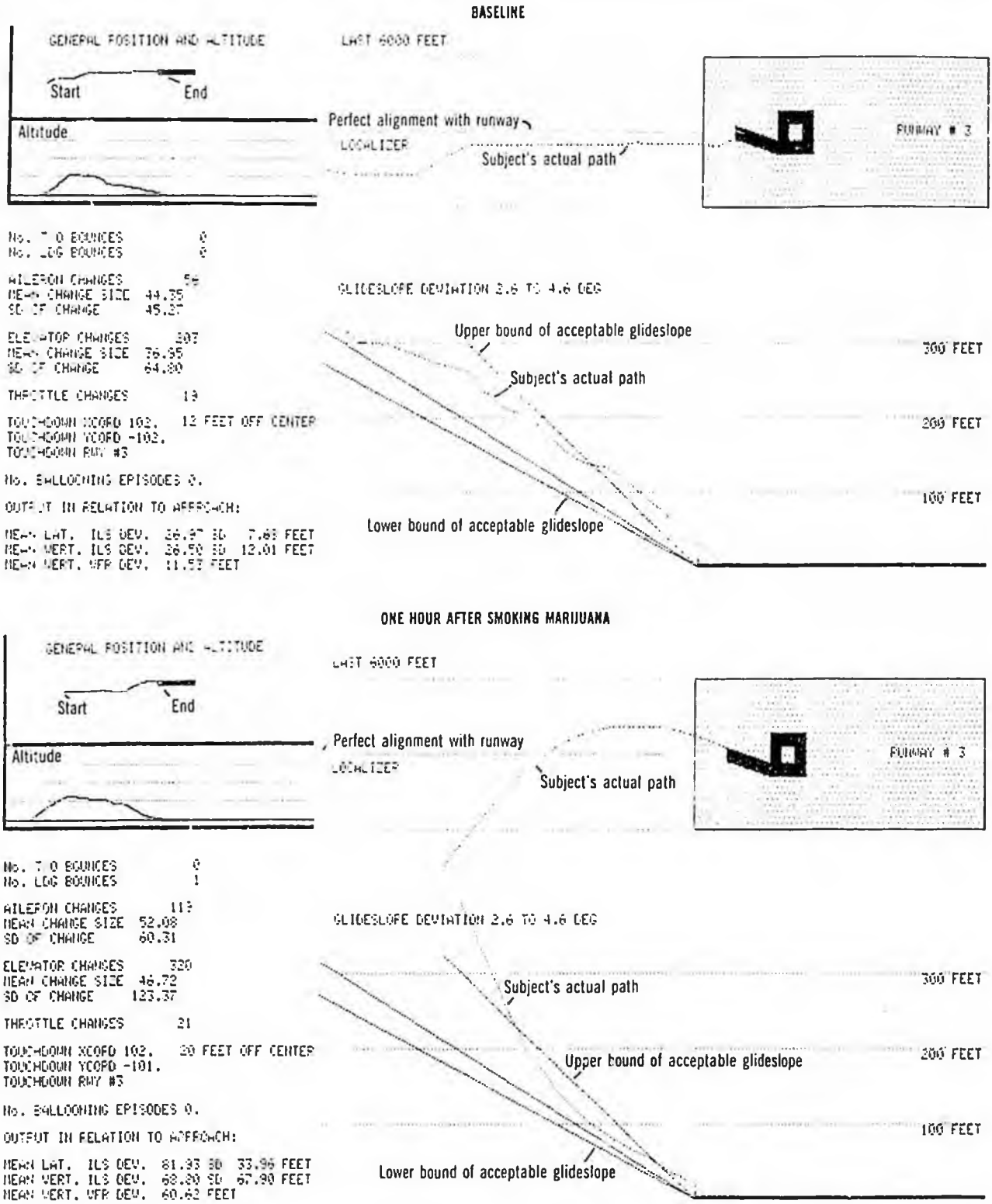
Subjects and Procedures

The subjects were 10 pilots recruited by advertisement at a local airport. All volunteers were currently licensed private pilots with a (Class III) medical certification. They had a mean age of 29 years and a mean of 303 hours of flying experience. Only subjects experienced in smoking marijuana were used, but subjects were admitted only if they smoked it less than daily and if they could abstain from THC and other drug use for the period of testing. Before the subjects smoked the marijuana, samples of their urine were screened for other drugs of abuse. All subjects gave informed consent for the project.

The subjects were trained for 8 hours on the flight simulator landing task. During the testing periods, which were clearly distinguished from practice flights, they were told to take the task as seriously as if they were on an FAA examination flight and to perform to the maximum of their ability. On the day of testing, baseline performance was measured between 8:00 and 9:00 a.m. and consisted of one recorded flight, which was preceded by two practice flights. At 9:00 a.m. a marijuana cigarette furnished by the National Institute on Drug Abuse and containing 19 mg of THC was smoked. This is probably the equivalent of a strong social dose. The entire cigarette was smoked at a rate comfortable to the subject. At 9:30 a.m. and 12:30 p.m., performance on the task was tested again (hour 1 and hour 4). The subject returned at 8:00 a.m. the following day and took two practice flights, and then a flight was recorded. No placebo was used, since prior studies using the same cigarette found that 90% of the subjects could identify the active drug. Subjective ratings on a 10-point scale of "high," "anxiety," "happiness," and "alertness" were obtained at each testing session.

We were also concerned that the subjects might be tempted by alcohol or marijuana during the evening before the final performance test. Since there is no way to quantify the results of urine tests (or breath analysis) to rule out such possibilities, the subjects were strictly informed (verbally and on the consent forms) that they should not use any alcohol or other drugs of potential abuse during this period and that they would in fact be

FIGURE 1. Output[a] From Highly Quantified Computerized Flight Simulator for One Pilot at Baseline and 1 Hour After Smoking Marijuana



[a]The upper left-hand corner shows 1) the general position of the aircraft as it takes off, turns left then right, and lands and 2) an altitude map in 500-feet increments. The lower left-hand corner lists the quantified data produced for one flight; these were used to compute the overall results in table 1. The right-hand side of the figure shows a detailed view of the last 6,000 feet of the approach to landing. The ideal position is shown by the "localizer," which defines the center line of the approach, and by the "glideslope," which defines the proper (3.6°) angle of descent (the center of the three descending straight lines).

TABLE 1. Flight Simulator Performance of 10 Licensed Private Pilots at Baseline and 1, 4, and 24 Hours After Smoking Marijuana

	Baseline		1 Hour After THC			4 Hours After THC			24 Hours After THC		
Dependent Measure	Mean	SD	Mean	SD	t[a]	Mean	SD	t[a]	Mean	SD	t[a]
Distance off-center on landing	12	6.5	32	14.0	−3.57[b]	29	8.5	−6.38[c]	24	8.2	−3.52[b]
Mean lateral deviation	19	6.4	56	26.7	−4.42[b]	45	15.9	−7.41[c]	34	11.2	−3.25[d]
Mean vertical deviation	26	13.0	61	37.6	−4.00[b]	45	12.9	−4.08[b]	40	18.4	−1.90
Aileron											
Number of changes	60	6.7	102	25.2	−4.87[c]	82	6.9	−6.66[c]	76	13.8	−3.66[b]
Mean size	53	7.6	68	10.6	−7.31[c]	65	6.0	−3.79[b]	65	10.5	−2.61[d]
Elevators											
Number of changes	264	56.0	361	59.8	−4.42[b]	306	65.8	−1.74	285	61.8	−0.83
Mean size	54	15.0	88	32.4	−3.29[d]	76	18.2	−3.40[b]	74	28.6	−2.46[d]
Number of throttle changes	22	0.9	29	9.8	−2.56[d]	27	13.2	−1.53	25	6.2	−1.83
Subjective ratings											
High	0	0	9.3	0.9	−31.01[c]	1.7	0.5	−11.12[c]	0.1	0.3	−1.00
Less alert	1.3	0.7	5.2	1.5	−7.41[c]	1.7	1.6	−0.60	1.1	0.3	0.80
More anxious	1.6	0.8	3.9	1.2	−3.98[b]	1.3	0.5	1.15	1.3	0.7	0.90
More happy	2.4	0.8	3.3	1.4	−1.59	1.5	0.7	5.01[b]	1.6	1.1	2.06

[a]Paired test of baseline versus 1-, 4-, or 24-hour values; two-tailed p.
[b]p<.01.
[c]p<.001.
[d]p<.05.

tested for those substances. Any variance with the protocol was reason for exclusion from the study and from payment of the experimental subject fee.

RESULTS

Table 1 summarizes the mean flight simulator performance at baseline and 1, 4, and 24 hours after marijuana smoking. The variables of interest are the number of aileron (lateral control), elevator (vertical control), and throttle changes; the size of these c... changes; the distance off the center of the run... landing; and the average lateral and vertical de... from an ideal glideslope and center line ove... mile of the approach. Compared to baseline ... nance, significant differences occurred in all ... bles 1 and 4 hours after smoking, exce... number of throttle and elevator changes at ... 24 hours, there were trends in all variab... impaired performance and there was signi... pairment in number and size of aileron change... elevator changes, distance off-center on landin... vertical and lateral deviation on approach to lan... The subjective measures of anxiety, alertness, hap... ness, and high did not differ between 24 hours and baseline. In separate calculations we found a significant increase in variance between baseline and performance at 24 hours on the number of aileron and elevator changes.

DISCUSSION

The difficulty the subjects experienced in aligning and landing precisely at the center of the runway is a particular cause for concern. It may be related to the trend toward more and larger aileron changes on approach. Elevator control seems less affected by the drug. It is important to note that the near doubli... of lateral deviation on a landing at 24 hours may ... an extremely serious error. In actual flight, where there is wind and turbulence, such errors can easily lead to crashes. One of the pilots did land off the runway 24 hours after THC ingestion. Despite these performance changes, the pilots reported no significant subjective awareness of impaired performance at 24 hours. It is noteworthy that the recent fatal crash in which the pilot had a positive THC screen involved a similar landing misjudgment (6).

There is an extensive literature on THC use and human performance under the influence of THC. Several studies have shown effects on memory, attention, and perception; however, these effects were only rarely significant 4 hours after smoking. Kielholz et al. (11) found general impairment in driving performance to last as long as 6 hours after the intake of THC. One study by the FAA (12) found impaired performance on a number of cognitive tasks some 14 hours after enough alcohol had been ingested to produce a blood level of 0.1 mg/dl (12). The current data, from an even more complicated task, indicate impaired performance 24 hours after smoking THC. Thus, it appears that our ability to identify drug effects may depend on the complexity of the task tested.

These results suggest a need for concern about the performance of those entrusted with complex behavioral and cognitive tasks within 24 hours after smoking marijuana. The subjects in this experiment were unaware of any effects on their performance, mood, alertness, etc. Some results may be applicable to other tasks, such as operating complicated heavy equipment or railway trains and switching procedures. Further research on these complex tasks should continue in an attempt to define the point after smoking THC at which the performance of complex tasks returns to

baseline. Such research should be objectively measured and precisely quantified; otherwise, important differences in performance may go unrecognized.

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PULMONARY HAZARDS OF SMOKING MARIJUANA AS COMPARED WITH TOBACCO

TZU-CHIN WU, M.D., DONALD P. TASHKIN, M.D., BEHNAM DJAHED, M.D., AND JED E. ROSE, PH.D.

Abstract To compare the pulmonary hazards of smoking marijuana and tobacco, we quantified the relative burden to the lung of insoluble particulates (tar) and carbon monoxide from the smoke of similar quantities of marijuana and tobacco. The 15 subjects, all men, had smoked both marijuana and tobacco habitually for at least five years. We measured each subject's blood carboxyhemoglobin level before and after smoking and the amount of tar inhaled and deposited in the respiratory tract from the smoke of single filter-tipped tobacco cigarettes (900 to 1200 mg) and marijuana cigarettes (741 to 985 mg) containing 0.004 percent or 1.24 percent Δ^9-tetrahydrocannabinol.

As compared with smoking tobacco, smoking marijuana was associated with a nearly fivefold greater increment in the blood carboxyhemoglobin level, an approximately threefold increase in the amount of tar inhaled, and retention in the respiratory tract of one third more inhaled tar ($P<0.001$). Significant differences were also noted in the dynamics of smoking marijuana and tobacco, among them an approximately two-thirds larger puff volume, a one-third greater depth of inhalation, and a fourfold longer breath-holding time with marijuana than with tobacco ($P<0.01$). Smoking dynamics and the delivery of tar during marijuana smoking were only slightly influenced by the percentage of tetrahydrocannabinol.

We conclude that smoking marijuana, regardless of tetrahydrocannabinol content, results in a substantially greater respiratory burden of carbon monoxide and tar than smoking a similar quantity of tobacco. (N Engl J Med 1988; 318:347-51.)

WE have previously shown that the habitual smoking of 3 or 4 marijuana cigarettes a day is associated with the same frequency of the symptoms of acute and chronic bronchitis[1] and the same type and extent of epithelial damage in the central airways[2] as the regular smoking of more than 20 tobacco cigarettes a day. A possible explanation for these findings is that a greater quantity of smoke particulates and noxious gases is delivered to and deposited or absorbed in the lungs by marijuana than by a similar amount of tobacco, possibly as a result of differences in the way each type of cigarette is smoked. To investigate this possibility, we examined the dynamics of smoking a marijuana or a tobacco cigarette and measured the particulates delivered to the smoker's mouth during the smoking of a single cigarette of each type.

METHODS

We studied fifteen men who were habitual smokers (mean age [±SD], 31.5±7.1 years), each of whom smoked both tobacco and marijuana. The subjects smoked an average of 29.9±16.7 tobacco cigarettes per day and had smoked an average of 16.1±12.2 pack-years of tobacco (one pack-year equals one pack of tobacco cigarettes per day times the number of years of smoking); they smoked an average of 16.5±17.1 marijuana cigarettes per week, and had smoked an average of 54.8±34.8 joint-years of marijuana (one joint-year equals one cigarette [joint] of marijuana per day times the number of years of smoking). All were in good general health and had normal or nearly normal values for forced vital capacity (101±8.7 percent of predicted values[3]) and forced expiratory volume in one second (96±14 percent of predicted values[3]). None reported intravenous drug abuse or smoking other illicit substances besides marijuana.

Each subject was studied on a single day after refraining from smoking tobacco for at least one hour and marijuana for at least six hours. During the study session, each subject smoked his own brand of filter-tipped tobacco cigarette, followed, in single-blind fashion, first by a placebo marijuana cigarette (from which nearly all Δ^9-tetrahydrocannabinol [Δ^9-THC] had been extracted, so that the concentration was 0.004 percent) and next by a marijuana cigarette of similar weight containing 1.24±0.06 percent Δ^9-THC. An interval of approximately 30 minutes separated the smoking of each two cigarettes. The tobacco cigarettes weighed 900 to 1120 mg and had a tar yield of 4.6 to 23.1 mg (mean, 12.0±5.7 mg) and a nicotine yield of 0.4 to 1.4 mg (mean, 0.84±0.32 mg) by Federal Trade Commission analysis. The placebo marijuana cigarettes weighed 741 to 940 mg (mean, 840 mg) and those containing 1.24 percent Δ^9-THC weighed 849 to 985 mg (mean, 907 mg); both were supplied by the National Institute on Drug Abuse, were stored at 4°C to minimize chemical degradation, and were maintained in a humidifier at 60 percent humidity and 21°C for 24 hours before the study, to reduce harshness.

The subjects were asked to smoke both the tobacco cigarette and the two marijuana cigarettes in a manner as similar as possible to their usual pattern of smoking tobacco and marijuana. Peripheral venous blood was withdrawn anaerobically immediately before and two minutes after the first two cigarettes were smoked for measurement of the percentage of carboxyhemoglobin saturation, with use of a carbon monoxide–oximeter (Model 282, Instrumentation Laboratory, Lexington, Mass.). After smoking each of the marijuana cigarettes, the subjects were asked to rate their level of intoxication on a scale of 0 to 100 percent, with 100 percent representing the greatest "high" they had ever experienced.

The volume, duration, and number of puffs and the intervals between puffs were measured with a 60 Fleisch pneumotachygraph (linear from 5 to 100 ml per second) connected through a differential pressure transducer (Model MP54-3, Validyne, Northridge, Calif.) (range, ±2 cm of water) to an oscilloscopic recorder with a differential integrator–computer and a rapid photographic writer (Model VR6, Electronics for Medicine, Pleasantville, N.Y.). To prevent the pneumotachygraph screen from becoming clogged by smoke particles,[4] the pneumotachygraph was connected through wide-bore Tygon tubing (length, 70 cm; internal diameter, 1 cm) to the distal end of a glass cylinder (length, 12 cm; diameter, 5 cm) that contained two ventilation ports (each 1 cm in diameter) and was sealed at its proximal end by a rubber stopper. The tobacco or marijuana cigarette was held in a small plastic holder inserted through the rubber stopper. The ventilation ports were left open between puffs to prevent either the extinction of the lighted cigarette or the excessive accumulation of carbon monoxide. During a puff, the smoker covered the ventilation holes with his index and middle fingers so that the entire volume of air drawn through the cigarette could be measured by the pneumotachygraph. The resistance of the pneumotachygraph (0.0068 cm of water per milliliter per second) was considerably lower than that of the cigarette (0.51 cm of water per milliliter per second for tobacco; 0.17 cm of water per milliliter per second for marijuana); therefore, the pneumotachygraph itself was

From the Department of Medicine, University of California at Los Angeles School of Medicine, and the Departments of Psychiatry and Biobehavioral Sciences, Neuropsychiatric Institute, University of California at Los Angeles School of Medicine. Address reprint requests to Dr. Tashkin at the Department of Medicine, University of California at Los Angeles School of Medicine, Los Angeles, CA 90024.

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not likely to have a substantial effect on smoking dynamics. The duration of a puff was timed from the pneumotachygraphic flow tracing. The interval between puffs was defined as the period between the end of one puff and the start of the next.

To measure "wash-in" volume (the volume of air inhaled), inductive plethysmographic coils (Respitrace Ambulatory Monitoring Systems, Ardsley, N.Y.) were placed around each subject's rib cage and abdomen.[5,6] A demodulator converted changes in electrical inductance in the coils during respiratory movements into voltage signals proportional to changes in the volume enclosed by the coils. Changes in the volume of the respiratory system were calculated from the weighted sums of the signals from the rib cage and abdomen; the weights were determined by the least-squares calibration method.[7] The accuracy of the calibration was confirmed by comparing the inhaled volumes calculated from respiratory inductive plethysmography with spirometric values; the measurements obtained by spirometry and inductive plethysmography agreed within ±10 percent. The amount of time the inhaled smoke was retained in the lungs (smoke-retention time) was calculated as the interval between the times corresponding to one third of the maximum inhaled volume and two thirds of the maximum volume exhaled following breath holding (Fig. 1). The no-smoking interval was timed from the end of the smoke-retention time to the start of the next puff.

A previously described proportional smoke-[illegible]ping device[8] was connected to the apparatus for measuring the volume of puffs in order to measure the amount of smoke particulates delivered to the smoker's mouth. This device consisted of a plastic cigarette holder through which the mainstream smoke was diverted into two parallel pathways, one containing one capillary tube (pathway A) and the other seven parallel capillary tubes (pathway B). A Cambridge filter pad trapped the smoke that passed through pathway A. The tar trapped by the filter was extracted with methanol and analyzed by means of a spectrophotometer (wavelength, 400 nm). A constant fraction of the tar (12.5±0.53 percent) was retained in the filter over a wide range of puff volumes (30 to 60 ml), puff durations (1 to 4 sec), and puff flow rates (20 to 100 ml per second).[8] This apparatus, therefore, permitted the actual quantity of smoke particulates delivered to the mouth to be calculated by multiplying the amount of particulates trapped in the Cambridge filter pad in pathway A by seven. At the end of the period of breath holding after each puff, the subjects turned their heads slightly to one side and exhaled the smoke into the large end (diameter, 26 cm) of an adjacent megaphone device, the distal end (diameter, 4.5 cm) of which was fitted with a high-efficiency filter attached to a vacuum system as described by Hinds et al.[9] After the tar was extracted from the filter with methanol, the exhaled particulates were measured with a spectrophotometer. The amount of smoke retained (deposited) in the respiratory tract was expressed as a percentage of the amount inhaled: percentage deposited = [1 − (amount of exhaled particulates/amount of inhaled particulates)] × 100.

Each subject's measurements were averaged for each cigarette smoked. These mean values, as well as the number of puffs, the quantity of particulates inhaled, the percentage of inhaled particulates deposited, and the increment in carboxyhemoglobin saturation per cigarette, were averaged for all 15 subjects for each type of cigarette smoked. The subjects' ratings of their degree of intoxication after marijuana smoking were also averaged for all subjects for each type of marijuana cigarette (placebo and 1.24 percent Δ^9-THC). Two-way analysis of variance (for subject and type of cigarette) was used to determine the significance of differences in smoking patterns, the delivery and deposition of particulates, and the increase in carboxyhemoglobin saturation among types of cigarette.[10] Pairwise comparisons were then performed using testing for least significant differences[11]; differences were considered significant if P values were <0.05.

Results

Descriptive data about smoking in the group of 15 subjects are shown in Table 1. Placebo marijuana and marijuana containing approximately 1.24 percent Δ^9-THC were smoked in a similar manner. However,

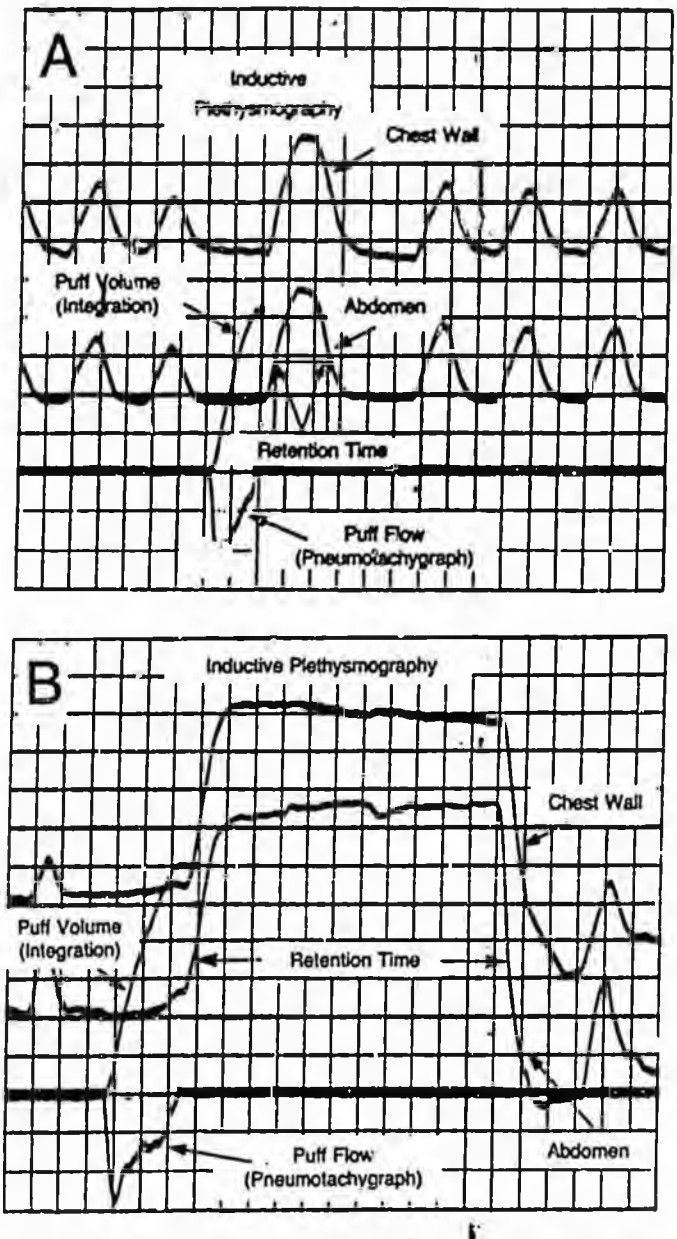

Figure 1. Analogue Tracings of Voltage Signals from Inductive Plethysmographic Coils around the Chest Wall and Abdomen of a Representative Subject and Simultaneous Flow and Integrated Volume Signals from a Pneumotachygraph Incorporated into a Puff-Volume Measuring Device during the Smoking of a Tobacco Cigarette (A) and a Marijuana Cigarette (B).

Note that during marijuana smoking, there is greater amplitude of the voltage signals representing puff volume (measured by the pneumotachygraph) and inhaled volume (measured by the inductive plethysmograph) than during tobacco smoking.

the average volume of puffs was about 70 percent larger (P<0.001) and the duration of puffs about 60 percent longer (P<0.01) during the smoking of marijuana than the smoking of tobacco, regardless of whether the marijuana contained 1.24 [illegible]0.004 percent Δ^9-THC; significantly more puffs were taken from the tobacco cigarette than from either the placebo marijuana cigarette or that containing 1.24 percent Δ^9-THC (P<0.001). Although the interval between puffs was less for tobacco than for marijuana smoking (P<0.05), the no-smoking interval, which did not include the breath-holding time after

Table 1. Characteristics of 15 Subjects' Smoking of Tobacco, Placebo Marijuana (0.004 Percent Δ^9-THC), and Marijuana Containing 1.24 Percent Δ^9-THC.*

Index	Tobacco	Marijuana		P Value†
		0.004% Δ^9-THC	1.24% Δ^9-THC	
	mean ±SD			
Puff volume (ml)	49.4±15.2	58.3±24.8	78.0±22.8	<0.001
Puff duration (sec)	2.4±1.1	3.8±1.9	4.0±2.2	<0.01
No. of puffs	13.5±4.0	7.5±2.3	8.5±3.1	<0.001
Interval between puffs (sec)	27.0±8.2	35.3±12.2	37.6±14.5	<0.05
Inhaled volume (liter)	1.31±0.22	1.82±0.66	1.75±0.52	<0.002
Smoke-retention time (sec)	3.5±1.3	13.8±9.2	14.7±10.2	<0.001
No-smoking interval (sec)	23.5±8.5	21.5±6.4	23.0±8.9	NS

*All subjects were habitual smokers of both tobacco and marijuana. They smoked their own brands of tobacco cigarettes. Δ^9-THC denotes Δ^9-tetrahydrocannabinol; NS denotes not significant.

†P values indicate the significance of comparisons between tobacco and each strength of marijuana; none of the comparisons between the two different strengths of marijuana (0.004 percent vs. 1.24 percent Δ^9-THC) was statistically significant.

smoke was inhaled, was similar for both substances. The mean inhaled volume was 36 percent greater ($P<0.002$) and the smoke-retention time was four times longer ($P<0.001$) during marijuana smoking than tobacco smoking.

The volume of the portion of the proportional smoke-trapping device through which smoke was delivered was approximately 13 ml. After the first puff, this volume was filled with smoke that was delivered in subsequent puffs; thus, after the first puff, no additional volume of air not containing smoke was included in the measurement of puff volume. When the pneumotachygraph was disassembled from the proportional smoke-trapping device and used to measure puff volume, the difference in the mean volume was negligible (4.2±2.0 ml lower without the smoke-trapping device). Similarly, inhaled volumes determined directly from the cigarette by the inductive plethysmograph, without the attachment of either the pneumotachygraph or the proportional smoke-trapping device, were similar to (within 50 ml) the inhaled volume determined when the subjects smoked through these devices.

The amounts of particulates inhaled, the percentage of inhaled particulates deposited in the respiratory tract, and the differences between the carboxyhemoglobin levels before and after smoking each type of cigarette are shown in Table 2. The major significant difference between smoking marijuana cigarettes containing 0.004 percent Δ^9-THC (placebo) and smoking cigarettes containing 1.24 percent Δ^9-THC was that the latter caused a greater degree of intoxication. In addition, the amount of particulates inhaled from marijuana containing 1.24 percent Δ^9-THC was slightly but significantly greater (20 percent) than that delivered from placebo marijuana ($P<0.05$). In contrast, smoking either type of marijuana was associated with the inhalation of 2.8 to 3.3 times more insoluble particulates (tar) and with the deposition of 32 to 35 percent more of these inhaled particulates than smoking the subject's own brand of tobacco ($P<0.001$). Consequently, marijuana smoking resulted in a tar burden to the respiratory tract that was 3.5 to 4.5 times greater than that produced by tobacco smoking in the same subjects. Furthermore, smoking a single marijuana cigarette caused a fourfold greater increment in carboxyhemoglobin saturation ($P<0.001$) than did smoking a single tobacco cigarette.

Discussion

Long-term adverse pulmonary consequences of tobacco smoking have been shown to be related to dose.[12] For example, the incidence of chronic obstructive pulmonary disease or bronchogenic carcinoma in smokers of fewer than 5 to 10 tobacco cigarettes a day is substantially less than in habitual smokers of more than 20 tobacco cigarettes a day.[13] Although regular tobacco smokers consume more than 15 tobacco cigarettes a day, most current smokers of marijuana smoke less than 1 marijuana cigarette a day.[12] Even among the estimated 6 million daily smokers of marijuana in the United States,[14] smoking more than five marijuana cigarettes a day is unusual. In view of the many similarities in the smoke contents of marijuana and tobacco,[15,16] it has been argued that habitually smoking only a few marijuana cigarettes a day may have a proportionately less harmful long-term effect on the lungs than regularly smoking several times more tobacco cigarettes. This argument assumes that the number of cigarettes smoked is directly proportional to the dose of smoke contents inhaled; however, this assumption ignores the ways in which the characteristics of smoking may influence the delivery of the combustion products of cigarettes.[17,18]

Table 2. Inhalation and Deposition of Particulates, Increases in Blood Carboxyhemoglobin Saturation, and Levels of Intoxication Associated with the Smoking of Tobacco and Marijuana in 15 Smokers of Both Substances.*

Index	Tobacco	Marijuana	
		0.004% Δ^9-THC	1.24% Δ^9-THC
		mean ±SD	
Inhaled particulates (optical density)	4.9±2.0	13.5±6.0†	16.3±6.3†‡
Percentage of particulates deposited	64.0±8.9	84.4±6.9†	80.1±6.7†
Increase in carboxyhemoglobin saturation (%)	0.60±0.52	2.99±1.51†	—§
Degree of intoxication (maximum "high" = 100%)	—	15.3±16.9	63.9±18.3‡

*Δ^9-THC denotes Δ^9-tetrahydrocannabinol.

†Significantly greater than values for tobacco ($P<0.001$ by analysis of variance and testing for least significant difference).

‡Significantly greater than values for marijuana containing 0.004 percent Δ^9-THC ($P<0.05$ by analysis of variance and testing for least significant difference).

§Not measured.

Few studies have been carried out in which the actual dose of smoke contents delivered to and retained in the respiratory tract during natural smoking has been measured. In our study, both the amount of particulate matter that was inhaled and the amount that was deposited in the respiratory tract were quantified during tobacco and marijuana smoking by means of a simple, new, noninvasive device.[8] These measurements allowed us to compare the actual dose to the smoker of particulate matter from the smoke of marijuana with that from tobacco. At the same time, the characteristics of smoking were determined in order to ascertain the relation between behavioral variables in smoking and the delivery and retention of smoke contents in the respiratory tract for each type of cigarette. The proportional smoke-trapping device had little measurable influence on smoking dynamics.

Findings from the present study indicate that approximately three times as much particulate matter is delivered to the smoker's mouth during the smoking of a single marijuana cigarette than during the smoking of a single tobacco cigarette of the smoker's own brand. These results are similar to those obtained in studies that used smoking machines to simulate conditions thought to be representative of marijuana and tobacco smoking.[19,20] Our results also revealed that approximately one third more of the particulates inhaled from the smoke of marijuana are retained in the respiratory tract than is the case when tobacco is smoked. Consequently, the net respiratory burden of particulates was approximately four times greater during marijuana smoking than tobacco smoking.

Several explanations are possible for the greater burden of particulates to the lungs from marijuana than from a similar quantity of tobacco. First, in all 15 cases, the tobacco cigarettes were more densely packed than the marijuana cigarettes and, unlike the marijuana cigarettes, were filter-tipped; therefore, the filtration efficiency of the tobacco cigarettes was greater. Second, the average residual length of the marijuana cigarettes (23±13 mm) was smaller than that of the tobacco cigarettes (37±12 mm), thereby further reducing the filtration efficiency of the marijuana cigarette. However, because the tobacco cigarettes were initially longer and because the filter tip was included in the tobacco butt, the actual quantities of tobacco and marijuana consumed were similar. Third, the subjects' patterns of inhalation in smoking the two types of cigarettes were markedly different; marijuana was smoked with a puff volume that was more than two thirds larger, an inhaled volume one third greater, and a retention time four times longer than the values for tobacco. Although the larger puff volumes for marijuana were partially offset by a smaller number of puffs, this factor may still have contributed to the greater mass of smoke particulates delivered to the mouth in marijuana smoking. The deeper inhaled volumes and, in particular, the severalfold longer retention times during marijuana smoking than during tobacco smoking may have accounted for the greater percentage of the inhaled particulates from marijuana smoke deposited in the respiratory tract.

The four-to-five-times-greater increments in carboxyhemoglobin saturation during marijuana smoking than tobacco smoking were probably due mainly to differences in how the cigarettes were smoked rather than in the amount of carbon monoxide produced, since syringe-simulated puffs of similar volumes and durations from lit cigarettes yielded approximately 25 percent lower concentrations of carbon monoxide from marijuana than from tobacco. This finding is consistent with the more complete combustion of the more loosely packed marijuana. On the other hand, the subjects' deeper inhalations and, in particular, their considerably longer retention of smoke in the lungs during marijuana smoking than during tobacco smoking made possible a greater uptake of carbon monoxide by the pulmonary microcirculation by means of passive diffusion. We measured the increment in blood carboxyhemoglobin after placebo marijuana (from which the cannabinoids had been extracted), and not after marijuana containing Δ^9-THC. However, we would not expect appreciable differences between the effects of real marijuana and those of placebo marijuana on blood carboxyhemoglobin levels, since the smoking dynamics and the carbon monoxide delivery of the two types of marijuana cigarettes were similar. The expected physiologic consequences of the markedly greater boost in carboxyhemoglobin levels from a single marijuana cigarette are a higher degree of impairment in oxygen transfer in the lung,[21] a reduction in the oxygen-carrying capacity of the blood, and impairment in the release of oxygen from hemoglobin in the tissues.[22] Moreover, the Δ^9-THC in marijuana causes dose-related increases in heart rate[23,24] and thus in cardiac work and myocardial oxygen requirements. Therefore, in persons with underlying coronary artery disease who smoke marijuana, the combined effects of a marked rise in the level of carboxyhemoglobin and the cardioacceleration induced by Δ^9-THC could lead to a critical imbalance between reduced myocardial oxygen supply and increased demand.

Interestingly, no significant differences in smoking dynamics were noted between placebo marijuana and marijuana containing 1.24 percent Δ^9-THC, despite marked differences in the subjects' perceived level of intoxication. These findings differ from previous observations in tobacco smokers that puff volume increases when low-nicotine cigarettes are smoked.[25] Our results in marijuana smokers are consistent with data from other studies,[26,27] however, and suggest that the pattern of smoking marijuana is not immediately adjusted to alter the inhaled dose of Δ^9-THC but, instead, probably represents a learned technique based on previous experiences and interactions.

In conclusion, our findings demonstrate that smoking behavior differs markedly between marijuana and tobacco smoking and that these differences are associ-

ated with a respiratory burden of smoke particulates and absorption of carbon monoxide that are approximately four times greater in the case of marijuana smoking. These results may account for previous findings that smoking only a few marijuana cigarettes a day (without tobacco) has the same effect on the prevalence of acute and chronic respiratory symptoms[1] and the extent of tracheobronchial epithelial histopathology[2] as smoking more than 20 tobacco cigarettes a day (without marijuana). These observations justify concern about the potential long-term pulmonary consequences of the habitual smoking of only a few marijuana cigarettes a day.

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Correlation between Drug Use by Teenagers and Drug Use by Older Family Members*

Joseph Gfroerer, BA

Division of Epidemiology and Statistical Analysis
National Institute on Drug Abuse
Rockville, Maryland 20857

ABSTRACT

This study examines the relationship between drug use by teenagers and older family members living in the same household, using data from the National Survey on Drug Abuse. Drug use by teenagers was found to be correlated with drug use by fathers, mothers, and older siblings, in that teenagers were more likely to be drug-users if the older adult was also a drug user. Correlations were significant across different drug types, but the most consistent relationship was between marijuana use by youth and marijuana use by the adult.

INTRODUCTION

The purpose of this paper is to examine the relationship between teenage drug use and drug use by older family members living in the same household, in terms of the statistical correlations in the prevalence of use of various drugs. Drug use here includes cigarette and alcohol use, as well as use of marijuana and cocaine. Rittenhouse and Miller recently performed a similar analysis using data from 1974-1977 [1]. The present study analyzes more recent (1979-1982) data from the same source and compares results to the previous study. Several new issues are also examined in the present

*The views presented in this paper are not necessarily those of the National Institute on Drug Abuse or the U.S. Department of Health and Human Services.

study, including the relationship between marijuana use by parents and teenage drug use.

A number of previous studies indicate that teenage drug use is correlated with drug use of older family members [1-13]. Generally, mothers' and siblings' drug use have been found more highly correlated with teenage drug use than has drug use by fathers [1, 2, 6-8]. However, some studies have shown a high correlation between fathers' drug use and drug use by their offspring [2, 3, 7, 9-13].

Relatively few studies have been done which involve pairs of teenagers and older siblings [1]. Also, much of the previous research on adult and youth drug use has been based on specialized populations or has been based on adult drug use reported by youth. Thus, although the research is consistent in supporting the relationship between teenage drug use and older adult drug use, questions still remain regarding the relative strength of the relationship for the different older family members. There have also been conflicting results regarding differences in parental influence depending on the sex of the teenager [7-9, 12, 13]. In addition to these questions concerning more refined descriptions of the relationship between teenage and adult drug use, there has also been debate regarding the explanation of the relationship in general. As Fawzy *et al.* state [10], the two prominent interpretations are the social learning model and the family circumstance model. The social learning model suggests that teenagers imitate adult behavior by responding to what adults define as appropriate. One version of this theory [9] is that teenagers imitate their parents' use of alcohol and cigarettes and thus become more likely to advance to the use of illicit drugs. The family circumstance model implies that correlations between adult and teenage drug use are not drug specific, but are more general and result from unfavorable family circumstances related to adult drug use. Thus, drug use by youths becomes more likely as a result of the circumstances in the household, not because of imitation.

The present study is intended to further investigate these issues, using a nationally representative sample of youth-adult pairs in which each individual reported his/her own drug use.

METHODS

A file of youth-adult pairs from the 1979 and 1982 National Surveys on Drug Abuse was used for the study [14, 15]. The National Survey is a

national probability sample survey of households which is sponsored by the National Institute on Drug Abuse (NIDA) and conducted periodically. In sample households, interviews are conducted with either (1) no persons, (2) one adult (age 18+) only, (3) one youth (age 12-17) only, or (4) one adult and one youth. To encourage honest reporting, respondents use self-administered forms to answer drug use questions. Data from each sample person are assigned sampling weights which reflect selection probabilities, nonresponse adjustment, and poststratification. These weights allow the computation of nationally representative estimates of drug use in the household population.

Using data from households in which both a youth and adult were interviewed, a file of youth-adult pairs was created. Based on data from several questions regarding relationships between household members, the youth-adult pairs file was restricted to pairs in which the adult was a parent or older sibling of the youth. All youths in this study are age 14 to 17, older siblings are 18 to 25, and parents are 30 to 64. The restrictions on youth and older sibling age were made because levels of drug use for 12-13 year olds are low and also to be consistent with the earlier study. The restriction on parent age was made to exclude cases that involve unlikely age combinations of youth and parent which may have occurred if the adult was incorrectly coded as the parent.

These selection criteria resulted in a file of 1,177 youth-adult pairs. Of these, 303 included fathers, 450 included mothers, and 424 included older siblings. To compensate for varying selection probabilities and nonresponse, each pair was assigned a weight equal to the product of the individual youth and adult weights. This is appropriate since within every household, the selection of a youth and an adult was independent. Some bias is introduced by factoring the household nonresponse adjustment twice into the pair weight, but this bias is probably small since the survey obtains over 80% response. In any event, the data necessary to correct this bias were unavailable. Pair weights were further adjusted to provide estimates that give equal weight to the 1979 and 1982 data.

Analyses were carried out separately for each of the three types of youth-adult pairs: youth-father, youth-mother, and youth-older sibling. Logistic regression analysis was used to test the significance of the correlation between adult drug use and drug use by youth [16]. All test statistics were adjusted to account for the design effect (deff = 1.5625) of the survey and the equal weighting of the 1979 and 1982 data.

The first stage of the analysis was the computation of estimates of drug use prevalence for youths in each of the three subsamples. In each sub-

sample, estimates of youth drug use were computed separately for youth-adult pairs in which the adult was a drug user and for pairs in which the adult was not a drug user. Differences in prevalence were evaluated using *t* tests, and zero-order correlations between adult and youth drug use were also computed. This preliminary analysis provided a basic description of the relationship between youth drug use and older adult drug use. However, the *t* tests and zero-order correlations can be misleading in studying the relationship, since high correlations could result from the fact that both persons in each youth-adult pair are living in the same environment. To control for this effect, logistic regression analysis was used to test the correlation between adult drug use and drug use by youth, with geographic region and population density, as well as age of youth included as independent variables in all logistic regression models. Several measures of youth drug use were employed as dependent variables one at a time, and several measures of adult drug use were entered one at a time as independents and tested for statistical significance with *F* tests. In this manner, the relationship between youth and adult drug use was tested for significance, after controlling for age of youth, geographic region, and population density.

To investigate specific issues such as differences in correlations by sex of the youth and the degree to which family circumstances explain correlations, other independent variables were introduced into the models as controls and also to be tested for significance. Also, some models were tested on specific subgroups of the population as a way of controlling for certain factors.

The methodology used in this study is similar but not identical to the approach taken by Rittenhouse and Miller. The inclusion of nonresponse and poststratification adjustments to the weights here was not done in the previous analysis, but this should have little impact on the results. The use of logistic regression analysis is an enhancement on the previous study, but should not yield significantly different results. The *F* tests used in the present study are equivalent to two-tailed *t* tests, whereas the previous study employed one-tailed tests. Two-tailed tests are used here to allow for the possibility that adult and youth drug use may be negatively correlated in some cases. For positive correlations this difference in testing, in addition to variance adjustments done in the present study, will make the tests slightly more conservative than in the previous study so that some nonsignificant results here may have been determined significant using the methodology of the previous study.

RESULTS

Tables of prevalence estimates were too numerous to include, but Tables 1-3 serve as examples of these data. Tables 1-3 demonstrate that teenagers are more likely to be drug users if their father smokes, if their mother has used marijuana, or if their older sibling uses marijuana. In particular, these three measures of adult drug use are highly correlated with youth marijuana use. Teenagers are twice as likely to have tried marijuana if these older adult drug use patterns are present in the household. Other tables such as these also show significant differences in youth drug use according to use of other drugs by older adult family members.

Table 1. Youth Drug Use (in %) According to Past Month Cigarette Use by Father

Youth drug use[a]	Father current smoker (n = 146)	Father not current smoker (n = 157)	Statistical significance (p value)	Correlation coefficient
Current cigarette use	18.9	7.6	.026	.17
Current alcohol use	52.3	27.1	.001	.26
Moderate alcohol use	24.8	6.8	.001	.25
Lifetime marijuana use	58.6	33.3	.001	.25
Current marijuana use	34.8	9.9	.001	.31
Lifetime cocaine use	10.8	2.4	.025	.17

[a]Current use is defined as used at least once in the past month. Moderate use is defined as used at least 4 days in the past month. Lifetime use is defined as used at least once in lifetime. p values greater than or equal to .1 are designated N.S.

Table 2. Youth Drug Use (in %) According to Lifetime Marijuana Use by Mother

Youth drug use[a]	Mother has used marijuana (n = 165)	Mother never used marijuana (n = 28.)	Statistical significance (p value)	Correlation coefficient
Current cigarette use	37.2	11.2	.001	.25
Current alcohol use	42.1	37.1	N.S.	.04
Moderate alcohol use	31.1	16.1	.009	.13
Lifetime marijuana use	76.7	34.2	.001	.30
Current marijuana use	48.3	23.5	.001	.19
Lifetime cocaine use	38.7	9.9	.001	.29

[a]Current use is defined as used at least once in the past month. Moderate use is defined as used at least 4 days in the past month. Lifetime use is defined as used at least once in lifetime. p values greater than or equal to .1 are designated N.S.

Table 3. Youth Drug Use (in %) According to Past Month Marijuana Use by Older Sibling

Youth drug use[a]	Older sibling used marijuana (n = 130)	Older sibling did not use marijuana (n = 294)	Statistical significance (p value)	Correlation coefficient
Current cigarette use	35.5	15.3	.002	.23
Current alcohol use	50.1	37.0	.067	.12
Moderate alcohol use	24.9	11.1	.017	.18
Lifetime marijuana use	66.8	35.0	.001	.30
Current marijuana use	30.2	13.0	.005	.21
Lifetime cocaine use	3.6	7.3	N.S.	-.07

[a]Current use is defined as used at least once in the past month. Moderate use is defined as used at least 4 days in the past month. Lifetime use is defined as used at least once in lifetime. p values greater than or equal to .1 are designated N.S.

The results of the basic logistic regression analysis which included controls for age of youth, geographic region, and population density are summarized in Tables 4-6. The tables show the level of statistical significance for each measure of adult drug use in the models when different measures of youth drug use are inserted as the dependent variable. Current marijuana use by fathers and mothers were excluded from models because there were too few cases in the sample in which parents reported such use. An example of the interpretation of the data in Tables 4-6 is that the relationship between fathers' and youths' current cigarette use (Table 4) is significant at the .031 level. Small p values indicate strong relationships. Readers should be aware that significance levels refer to individual tests and are not adjusted for multiple testing. Since many tests are performed in this analysis, it is expected that a small number of the significant results are incorrectly specified.

In general, the analysis showed a strong correlation between drug use by youths and drug use by the mothers, fathers, and older siblings of youths. Although not shown by these tables, every significant correlation was positive in that for families where the parent or older sibling used a drug, the youths were more likely to be drug users.

Youth cigarette use was related less with fathers' drug use than it was with mothers' and older siblings' drug use. Alcohol use by youth was related to drug use by all three adult categories. Youth marijuana use was the most strongly related to adult drug use. Youth lifetime marijuana use was significantly related to use of each drug by fathers, mothers, and older

Table 4. Significance (p values) of Correlation between Drug Use of Fathers and Youths, after Controlling for Age of Youth, Geographic Region, and Population Density

	Fathers' drug use			
Youth drug use[a]	Current cigarette use	Current alcohol use	Moderate alcohol use	Lifetime marijuana use
Current cigarette use	.031	N.S.	N.S.	N.S.
Current alcohol use	.001	.001	.001	.051
Moderate alcohol use	.015	N.S.	N.S.	N.S.
Lifetime marijuana use	.001	.001	.001	.001
Current marijuana use	.001	.006	.002	.001
Lifetime cocaine use	.041	N.S.	N.S.	N.S.

[a]Current use is defined as used at least once in the past month. Moderate use is defined as used at least 4 days in the past month. Lifetime use is defined as used at least once in lifetime. p values greater than or equal to .1 are designated N.S.

Table 5. Significance (p values) of Correlation between Drug Use of Mothers and Youths, after Controlling for Age of Youth, Geographic Region, and Population Density

	Mothers' drug use			
Youth drug use[a]	Current cigarette use	Current alcohol use	Moderate alcohol use	Lifetime marijuana use
Current cigarette use	.001	.065	.051	.001
Current alcohol use	N.S.	.001	.003	N.S.
Moderate alcohol use	.054	.012	.073	.002
Lifetime marijuana use	.008	.001	.001	.001
Current marijuana use	.007	.001	.001	.001
Lifetime cocaine use	.001	.001	.010	.001

[a]Current use is defined as used at least once in the past month. Moderate use is defined as used at least 4 days in the past month. Lifetime use is defined as used at least once in lifetime. p values greater than or equal to .1 are designated N.S.

siblings at the .008 level of significance or less. Of the drugs used by adults, marijuana was the most strongly associated with both lifetime and current marijuana use by youth. Youth cocaine use was not significantly related to drug use by fathers or other siblings, but was related to mothers' drug use.

The relationship between adult drug use and youth lifetime marijuana use was explored further by repeating significance tests using a restricted sample of youths—those who had used both cigarettes and alcohol in their

Table 6. Significance (p values) of Correlation between Drug Use of Older Siblings and Youths, after Controlling for Age of Youth, Geographic Region, and Population Density

	Older siblings' drug use				
Youth drug use[a]	Current cigarette use	Current alcohol use	Moderate alcohol use	Lifetime marijuana use	Current marijuana use
Current cigarette use	.011	.014	.054	.001	.001
Current alcohol use	N.S.	.001	.012	.006	N.S.
Moderate alcohol use	N.S.	.016	.001	N.S.	.001
Lifetime marijuana use	.008	.001	.001	.001	.001
Current marijuana use	.030	.051	N.S.	.001	.004
Lifetime cocaine use	N.S.	N.S.	N.S.	N.S.	N.S.

[a]Current use is defined as used at least once in the past month. Moderate use is defined as used at least 4 days in the past month. Lifetime use is defined as used at least once in lifetime. p values greater than or equal to .1 are designated N.S.

lifetime. For this restricted sample, the strength of the relationship was reduced, but it remained significant in most cases, indicating that even among youths who have already tried cigarettes and alcohol, marijuana use is more likely to occur if parents or older siblings use drugs. This is especially true if older adults have used marijuana. However, current cigarette and current alcohol use by fathers, current cigarette use by mothers, and current alcohol use by older siblings were not significantly related to youth lifetime marijuana use in this restricted sample of youths.

The significant correlations found between adult marijuana use and youth drug use were explored further by introducing controls for adult cigarette and alcohol use. If these controls diminished the strength of the correlations, it would have indicated that the correlations may have occurred spuriously, simply because parents who used cigarettes and alcohol were more likely to have tried marijuana. However, this was not the case. The inclusion of current cigarette and moderate alcohol use by adults as independent variables in the models generally resulted in little change in the significance levels of the relationship between youth drug use and adult marijuana use (Table 7). Thus, even after controlling for adult cigarette and alcohol use, marijuana use by adults was still correlated with youth drug use. Two exceptions were found, however. The significant relationship between mothers' lifetime marijuana use and youth current marijuana use became nonsignificant when the mothers' moderate drinking was included as an independent variable. Similarly, the significant relationship between siblings' lifetime marijuana use and youth current alcohol use became nonsignificant when siblings' moderate drinking and current smoking were included in the model.

The interactive effect of current cigarette and moderate alcohol use by adults was also tested during this stage of the analysis. The interaction was significant in only one of 18 separate tests (six youth drug use measures for father, mother, and sibling pairs), and that was at the .015 level of significance. The significant result implies that the effect of sibling use of both cigarettes and alcohol on youth current alcohol use is less than the sum of the effect of cigarettes and alcohol separately. The fact that most tests were not significant indicates that, in general, the effects of adult cigarette and alcohol use are additive.

Differences in parental influence for teenage boys and girls were studied by testing the interaction of sex of youth with fathers' and mothers' drug use in relation to current alcohol and lifetime marijuana use by youths. Only three tests out of 16 were significant at the .1 level. Current alcohol use

Table 7. Significance (p values) of Correlation between Marijuana Use of Adults and Drug Use of Youths, after Controlling for Age of Youth, Geographic Region, Population Density, Adult Current Smoking, and Adult Moderate Alcohol Use

	Adult marijuana use			
Youth drug use[a]	Fathers' lifetime marijuana use	Mothers' lifetime marijuana use	Older siblings' lifetime marijuana use	Older siblings' current marijuana use
Current cigarette use	N.S.	.009	.002	.002
Current alcohol use	N.S.	N.S.	N.S.	N.S.
Moderate alcohol use	N.S.	.076	N.S.	.081
Lifetime marijuana use	.001	.001	.001	.004
Current marijuana use	.025	N.S.	.016	.042
Lifetime cocaine use	N.S.	.074	N.S.	N.S.

[a]Current use is defined as used at least once in the past month. Moderate use is defined as used at least 4 days in the past month. Lifetime use is defined as used at least once in lifetime. p values greater than or equal to .1 are designated N.S.

by mothers was more strongly correlated with boys' current alcohol use than with girls' current alcohol use (p value = .003). The relationship between mothers' moderate alcohol use and youth current alcohol use was stronger for girls than for boys (p value = .058). Fathers' current cigarette use was more strongly related to their sons's lifetime marijuana use than it was to their daugher's lifetime marijuana use (p value = .021). There appeared to be no consistent overall pattern to these interactions, and since most tests were not significant, the general result is that parental influence is similar for teenage boys and girls.

To study the relationship between levels of drug use by older adults and teenage drug use, the independent variable "days used alcohol in the past month" was tested in the logistic models for all three adult-youth groups. These models were tested on the subset of adult-youth pairs in which the adult had used alcohol at least once in the past month. Also, "days used marijuana in the past month" by older siblings was tested, again restricting the analysis to siblings with at least one day of marijuana use in the past month. For most measures of youth drug use, days of use by older adults was not significantly correlated. Several exceptions were noted, however. Youths became more likely to be lifetime marijuana users as days of alcohol use by fathers (p value = .004) and mothers (p value = .091) increased, and also as older siblings' days of marijuana use increased (p value = .017). Increases in days of marijuana use by older siblings were also associated with

a greater likelihood of current cigarette use by youth (p value = .006). Finally, teenagers became more likely to have moderate alcohol use as older siblings' days of alcohol use increased (p value = .091).

Data collected in the National Survey on Drug Abuse regarding family circumstances are rather limited, so investigation of the impact of this factor must be considered as merely suggestive. All statistical testing shown in Tables 4-6 was redone after adding family circumstance variables into the models as controls. These variables were family income for fathers, mothers, and siblings, and marital status for fathers and mothers. Significance levels were essentially unchanged for youth-father and youth-sibling samples, indicating little impact of family circumstances and supporting the social learning theory. For the youth-mother sample, marital status was highly correlated with youth drug use, in that teenagers with divorced or separated mothers were more likely to be drug users. As a result, when marital status was included in the logistic models, several of the significant correlations indicated in Table 5 became nonsignificant. Most did remain significant, however, providing evidence that the social learning process is an important factor in teenage drug abuse.

DISCUSSION

The results of this study clearly support previous results which show a strong relationship between teenage drug use and drug use by older family members. The majority of the statistical tests of regression coefficients for adult drug use were significant, and all of these coefficients, without exception, indicated a positive correlation.

More specific issues can be addressed by the results of the study. In contrast with the previous study using 1974-77 data [1], the present study found fathers' drug use, as well as that of mothers and older siblings, to be correlated with teenage drug use. The previous study found no correlation with fathers' drug use. The reason for this different result is unknown. Given the more conservative nature of the statistical testing done here, it is unlikely that the different result is due to random variation. Regarding the different theories attempting to explain the correlations, the results suggest that although family circumstances are an important factor, the social learning process plays a major role in youth drug use. While the results are not conclusive, they may provide evidence of a "generalized imitation" of older adult behavior which is not drug-specific and which occurs for all older

adult types. Significant relationships were found across different drug types for fathers, mothers, and older siblings. However, some specificity was evident, particularly for marijuana, as indicated by the significant correlations between adult and youth marijuana use after controlling for adult cigarette and alcohol use (Table 7). The specificity of the youth and adult marijuana correlation is further supported by the significance of the relationship even among youths who have already used cigarettes and alcohol. This result contradicts the theory [9] that youths learn alcohol and cigarette use from parents, and thus become more likely to use marijuana mainly because of their experience with the licit drugs. On the contrary, there appears to be a more direct relationship between parent and youth marijuana use.

Since teenagers and their older siblings have the same parents, the parental influence on their children's drug use would be expected to occur for the older siblings also. Thus, correlations between youth and older sibling drug use might occur as a result of this common parental influence. It is not possible from this study to evaluate the independent effect of older sibling drug use on teenage drug use, after controlling for parental drug use, since only two persons per household were interviewed. However, the fact that youth-older sibling correlations were just as strong as youth-parent correlations suggests that there is some independent effect of older sibling drug use.

The level of alcohol use by adults, measured by the number of days used in the past month (excluding adults with no use), was not correlated with youth drug use as strongly as was the qualitative variable, defined as use vs nonuse of alcohol in the past month. In other words, for most drugs the likelihood that teenagers had used that drug did not significantly decrease as the level of adult alcohol use decreased, except when the level of adult use became total abstention. This was the case for all three older adult groups and also for the level of marijuana use by siblings. This suggests that even infrequent use of drugs by adults may influence teenagers to experiment with drugs themselves.

The interactive effect of adult cigarette and alcohol use on youth drug use was not found significant, in contrast to the previous study which did find significant interaction. In both studies this test did involve small cell sizes, so random variation could possible explain the different results.

The results here indicate that fathers' and mothers' influence on teenage drug use is not significantly different for teenage boys and girls. Once again, however, small cell sizes suggest caution in interpreting this result.

Differences in results between this study and the previous study involving a similar design indicate the need for further investigation of these issues.

Certainly the issue of differences and similarities in influence by fathers, mothers, and older siblings has not been resolved since the two studies had conflicting results for fathers. Also, the significant correlation between adult and youth marijuana use found here needs further study. Since the only measure of parent marijuana use that was tested in this study was "ever used," questions arise regarding the meaning of the correlation. In some cases, parental use may only have occurred before the youth was born. Information on recency of parental use in relation to the age of the youth would be helpful in addressing this. Unlike cigarette and alcohol use, some parental and older sibling use of marijuana might occur without the knowledge of the teenager, raising further questions about interpreting the relationship between adult and youth marijuana use. Youth perception of adult marijuana and other illicit drug use may therefore be important to consider. Parental attitudes about marijuana use may also be important to consider since the correlation between parents' lifetime use and teenage use may reflect a more tolerant attitude on the part of parents who have previous experience with marijuana. Further study of the impact of parental marijuana use on teenage marijuana use will have increasing importance in the coming years as larger proportions of teenagers will have parents that have used marijuana. This phenomenon is shown by comparing marijuana use of parents of teenagers in this study to that of parents of younger children. Application of weights to produce nationally representative estimates from this study resulted in lifetime marijuana prevalences of 17% for fathers of 14-17 year olds and 14% for mothers of 14-17 year olds. For comparison, estimates of lifetime marijuana prevalence for parents whose oldest child is under age 12 were computed from the 1982 National Survey on Drug Abuse [17]. Results showed that 54% of these fathers and 42% of these mothers had used marijuana. This represents a tripling of marijuana experience among parents of future teenagers.

Unfortunately, the analysis conducted here and in the previous similar study will not be possible with future National Survey data, since a maximum of one respondent will be selected per household beginning with the 1985 Survey. However, further and more powerful analyses could be done by combining data from all of the Surveys from 1974 through 1982.

In conclusion, despite some unanswered questions regarding specific issues in this study, there is clearly a strong correlation between drug use by teenagers and drug use by older family members. While there are certainly other influences on youth drug use (such as peer influence) which were not addressed, the data analyzed here indicate that prevention of drug use by

teenagers may be promoted by fathers, mothers, and older siblings abstaining from the use of cigarettes, alcohol, and marijuana.

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Heroin Availability and Aggregate Levels of Use: Secular Trends in an Urban Black Cohort

Peter A. Messeri, PhD
Ann F. Brunswick, PhD

Public Health (Sociomedical Sciences)
Columbia University
New York, New York 10032

ABSTRACT

The influence of heroin availability on the aggregate level of use of this drug was investigated for a normal Black cohort (born between 1952 and 1957) who grew up in Harlem (New York City). Data obtained on the second and third waves of a panel study were used to estimate annual rates of heroin initiation and cessation from the mid-1960s through 1983. The aggregated time-series variables indicated that initiation into heroin use was largely confined to adolescence and that cessation rates exhibited substantial year-to-year fluctuations with no apparent relationship to either chronological age or calendar year. Respondents born before 1955, however, had much higher rates of heroin use than those born in later years. Temporal trends in initiation and cessation were uncorrelated with changes in the purity of heroin sold in New York City between 1973 and 1983, suggesting that aggregate levels of heroin use in this sample were little affected by changes in supply. More speculatively, cohort differences in lifetime prevalence may reflect varying availability at the times younger and older cohorts entered adolescence. This possibility could not be directly tested because of the absence of reliable purity data going back sufficiently far in time.

INTRODUCTION

Over the last decade or so, considerable information has been gathered for tracking national, state, and local trends in the nonmedical use of psychoactive substances (see Reference Note). These data, augmented with studies documenting ebbs and flows in drug use for more remote times [1, 2], clearly

permit separate sentences; the two offenses violate the same societal interest, namely the regulation of the availability of harmful drugs. Alley v. State, Ct. App. Op. No. 498 (File No. A-368), 704 P.2d 233 (1985).

Convictions and sentences for misconduct involving cocaine affirmed. — See Adams v. State, Ct. App. Op. No. 525 (File No. A-450), 706 P.2d 1183 (1985).

Sentence excessive. — Sentence for one count of misconduct involving a controlled substance under AS 11.71.040(a)(3)(A) and five counts under AS 11.71.030(a)(1) totaling eight years with four years suspended was excessive; the court of appeals remanded for resentencing not to exceed six years with two years suspended where the defendant had a favorable criminal record, a good employment history, and was a good prospect for rehabilitation. The court of appeals also believed that the presumptive sentences established by the revised criminal code for the defendant's most serious offense should constitute a ceiling on his sentence. Rivas v. State, Ct. App. Op. No. 539 (File No. A-671), 706 P.2d 1202 (1985).

Sentence for possession of cocaine upheld. — See Smith v. State, Ct. App. Op. No. 757 (File No. A-2021), P.2d (1987).

Cited in Hodsdon v. State, Ct. App. Op. No. 467 (File No. A-241), 698 P.2d 1224 (1985); Pooley v. State, Ct. App. Op. No. 505 (File No. A-310), 705 P.2d 1293 (1985); Webb v. State, Sup. Ct. Op. No. 3338 (File No. S-1714), P.2d (1988).

Sec. 11.71.050. Misconduct involving a controlled substance in the fifth degree. (a) Except as authorized in AS 17.30, a person commits the crime of misconduct involving a controlled substance in the fifth degree if the person

(1) manufactures or delivers, or possesses with the intent to manufacture or deliver, one or more preparations, compounds, mixtures, or substances of an aggregate weight of one-half ounce or more containing a schedule VIA controlled substance;

(2) manufactures or delivers, or possesses with the intent to manufacture or deliver, one or more preparations, compounds, mixtures, or substances of an aggregate weight of less than one-half ounce containing a schedule VIA controlled substance, for remuneration;

(3) possesses

(A) less than 25 tablets, ampules, or syrettes containing a schedule IIIA or IVA controlled substance;

(B) one or more preparations, compounds, mixtures, or substances of an aggregate weight of less than three grams containing a schedule IIIA or IVA controlled substance;

(C) less than 50 tablets, ampules, or syrettes containing a schedule VA controlled substance;

(D) one or more preparations, compounds, mixtures, or substances of an aggregate weight of less than six grams containing a schedule VA controlled substance; or

(E) one or more preparations, compounds, mixtures, or substances of an aggregate weight of one-half pound or more containing a schedule VIA controlled substance; or

(4) fails to make, keep, or furnish any record, notification, order form, statement, invoice, or information required under AS 17.30.

(b) Misconduct involving a controlled substance in the fifth degree is a class A misdemeanor. (§ 2 ch 45 SLA 1982; am § 10 ch 146 SLA 1986)

Effect of amendments. — The 1986 amendment deleted "or AS 17.35" following "AS 17.30" in the introductory language of subsection (a).

NOTES TO DECISIONS

Required marijuana content. — In order to be charged with misconduct involving a controlled substance involving marijuana, a person must be in possession of a substance that contains its seeds, leaves, buds or flowers; merely possessing stalks, fibers or sterilized seeds would not be enough. Gibson v. State, Ct. App. Op. No. 621 (File No A-917), 719 P.2d 687 (1986).

Aggregate weight. — In order to be convicted of misconduct involving a controlled substance, defendant need only to have delivered a combination of ingredients that included marijuana; it is the total weight of the entire substance delivered that determines the degree of the offense. Gibson v. State, Ct. App. Op. No. 621 (File No. A-917), 719 P.2d 687 (1986).

The weight of marijuana should be determined absent stalks, fiber and sterilized seeds. Gibson v. State, Ct. App. Op. No. 621 (File No. A-917), 719 P.2d 687 (1986).

Cited in Jones v. State, Ct. App. Op. No. 651 (File No. A-1513), 727 P.2d 6 (1986).

Sec. 11.71.060. Misconduct involving a controlled substance in the sixth degree. (a) Except as authorized in AS 17.30, a person commits the crime of misconduct involving a controlled substance in the sixth degree if the person

(1) uses or displays any amount of a schedule VIA controlled substance or possesses one or more preparations, compounds, mixtures, or substances of an aggregate weight of one ounce or more containing a schedule VIA controlled substance on a public street or sidewalk or on the premises of a public carrier or business establishment or in any other public place;

(2) knowingly possesses any amount of a schedule VIA controlled substance within the immediate control of that person while operating a propelled vehicle;

(3) being under 19 years of age, possesses one or more preparations, compounds, mixtures, or substances of an aggregate weight of less than four ounces containing a schedule VIA controlled substance;

(4) possesses one or more preparations, compounds, mixtures, or substances of an aggregate weight of four ounces or more containing a schedule VIA controlled substance; or

(5) refuses entry into a premises for an inspection authorized under AS 17.30.

(b) Misconduct involving a controlled substance in the sixth degree is a class B misdemeanor. (§ 2 ch 45 SLA 1982; am § 11 ch 146 SLA 1986)

Effect of amendments. — The 1986 amendment deleted "or AS 17.35" following "AS 17.30" in the introductory language of subsection (a).

Sec. 11.71.070. Misconduct involving a controlled substance in the seventh degree. (a) Except as authorized in AS 17.30, a person commits the offense of misconduct involving a controlled substance in the seventh degree if the person

(1) manufactures or delivers, or possesses with the intent to manufacture or deliver, one or more preparations, compounds, mixtures, or substances of an aggregate weight of less than one-half ounce of a schedule VIA controlled substance; or

(2) possesses one or more preparations, compounds, mixtures, or substances of an aggregate weight of less than one ounce containing a schedule VIA controlled substance on a public street or sidewalk or on the premises of a public carrier or business establishment or in any other public place.

(b) Misconduct involving a controlled substance in the seventh degree is a violation and is punishable as authorized in AS 12.55, except that if a fine is imposed it shall not be more than $100. (§ 2 ch 45 SLA 1982; am § 12 ch 146 SLA 1986)

Effect of amendments. — The 1986 amendment deleted "or AS 17.35" following "AS 17.30" in the introductory language of subsection (a).

Sec. 11.71.080. Aggregate weight of live marijuana plants.

NOTES TO DECISIONS

Applicability of definition. — The definition in this section did not apply where the marijuana was already dried and processed. Gibson v. State, Ct. App. Op. No. 621 (File No. A-917), 719 P.2d 687 (1986).

Article 2. Standards and Schedules.

Sec. 11.71.120. Authority to schedule controlled substances. (a) If, after considering the factors set out in (c) of this section, the committee decides to recommend that a substance should be added to, deleted from, or rescheduled in a schedule of controlled substances under AS 11.71.140 — 11.71.190, the governor shall introduce legislation in accordance with the recommendation of the committee.

(b) If a substance is added as a controlled substance under federal law, the governor shall introduce legislation in accordance with the federal law.

(c) In advising the governor of the need to add, delete, or reschedule a substance under AS 11.71.110(1), the committee shall assess the

and physical disabilities. Furthermore, ırful of giving care to these frail-looking, ıve babies."

spensive hospital and home treatments, ort and encouragement for parents, mark- look for "low-birthweight babies" during l life, according to a report in the July 255 infants born weighing 4 pounds or less them from poor, rural families. About half ned to an "infant development program." asive care unit, these babies were put on and provided with daily activities, includ- nd motion exercises, oral stimulation with recordings of parents' voices, classical an heartbeat. Parents participated in tart and were taught exercises to use with e from the hospital. Parents also received n infant care needs and difficulties. ies and their parents were given the care arily provided in such cases.

rimental program had significantly higher d physical development scales at 1 and 2 hael B. Resnick and his colleagues of the College of Medicine in Gainesville. Only 4 imental group had severe impairments of at age 2, compared with 26 percent of the

ho[illegible]terventions cost about $3,600 per low-cost" preventive technique, say the esearch will focus on how long-lasting the h methods were most critical.

recent research, done while he was at the Agriculture Department's Human Nutrition Research Center on Aging in Boston, indicates that is not necessarily the primary reason malnutrition affects night vision.

Rats fed a growth-stunting diet (having only a third to a fifth of their normal protein intake) along with four times the daily requirement for vitamin A suffered night blindness, despite maintaining sufficient levels of vitamin A in the eye. Rats fed a fully balanced diet, but with only enough calories to maintain the size and weight of animals on the protein-deficient diet, suffered even worse night vision — again while maintaining normal eye levels of vitamin A. Bankson says this suggests that a lack of protein and/or energy can also cause night blindness.

How marijuana may affect immunity

It has been known for years that smoking marijuana harms the body's immune system, says Eliezer Huberman of Argonne (Ill.) National Laboratory. His new cell-culture studies now suggest why. He has found that although tetrahydrocannabinol (THC), the main psychoactive ingredient in marijuana, stimulates maturation of key immune-system cells called monocytes, "this maturation is defective." Monocytes not only help stimulate antibody production, but also can kill and engulf foreign cells, like bacteria.

When Huberman treated "highly immature" monocyte-precursor cells with THC, the maturation suddenly stopped in a middle, incomplete stage. Huberman says that if similar monocyte impairment occurs in heavy marijuana smokers, it could heighten their susceptibility to infection. Details of the study will appear in the Aug. 15 PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES.

limited success, possibly becai donor islets were collected. C surgeons time to collect many ish Rajotte says his group has also extracting high yields of pure isle surgeons isolate sufficient quant trials scheduled to begin shortly.

Another potential advantage certain freeze-thaw conditions selectively killing off donor "passe blood cells that trigger an imm tissue. Rajotte's group has cryopreserved rat islets grafted in rejection longer than grafted fre searchers have not yet proved that are in fact solely responsible for t

Working on the assumption that tissue and leukocytes differentl colleagues at the Medical Resea England, are looking for the best fi rejection of the transplanted islet that the survival of islets is optimal thaw procedure. Taylor suspects leukocytes. Since there has been s cytes do poorly when frozen quickl least some islets can survive under nary conclusion is that they can. F says Taylor, islets appear to be able range of cryopreservation conditi system. "Why this should be," he s uppermost in cryobiologists' mind

While no actual link between marijuana use and disease has been shown, immunological tests have produced some troubling results.

Frequent marijuana smokers may be at increased risk from viruses, foreign bacteria, and disease, warn researchers at the University of Illinois in Chicago.

When THC, or tetrahydrocannabinol, the psychoactive ingredient in marijuana, was placed into human blood samples, researchers David Ou and Mark Wiederhold noticed blood-cell changes that could suppress the ability of the body's immune system to combat disease.

What they observed were decreased numbers of proteins, called receptors, on the outer membrane of disease-fighting white blood cells. Without the receptors, immunologist Wiederhold says, the white blood cells can't identify or interact with other substances and thus might not be able to coordinate counterattacks against invader diseases.

Although no actual link between marijuana use and disease has been shown, the two researchers' findings not only cast a shadow across the frequent recreational use of marijuana but raise doubts about the medical advisability of using marijuana and its chemical components, known as cannabinoids, to prevent nausea in patients undergoing chemotherapy for cancer and to treat increased eye pressure associated with glaucoma.

"Possibly a slight modification in the structure of the cannabinoid molecule," Ou, a pathologist, says, "would be all that is required to preserve the drug's useful purposes, while decreasing undesirable effects."

—Eric Mishara

"Jesus said love one another. He didn't say love the whole world."

—Mother Teresa

Relaxing may be hazardous to your mental health.

"We were relaxing a woman whom we had hooked up to an apparatus that measures heart rate, muscle temperature, and finger temperature," explains Dr. David Barlow, director of the Phobia and Anxiety Disorders Clinic of the State University of New York at Albany. "She was doing very nicely and beginning to relax. Then, much to our, and certainly to her, surprise, she had a massive panic attack: full-blown, unadulterated terror. Her heart rate doubled in a minute."

When a second patient had the same response, Barlow and colleagues looked back and found that sharply increased anxiety

Relaxation exercise: Lay back, tune in, freak out?

was often reported by clinicians as a side effect of relaxation therapy. Thomas Borkovec of Pennsylvania State University noted that as many as 54 percent of his patients reported anxiety during meditation; 30 percent,

Behavior

VIP: 'Very important peptide' in AIDS?

Scientists at the National Institute of Mental Health (NIMH) in Bethesda, Md., recently found a small protein that blocks the AIDS-causing virus, known as human immunodeficiency virus (HIV), at receptor sites on critical T4 immune cells (SN: 12/20&27/86, p.388). The protein, dubbed Peptide T, was isolated from the HIV envelope protein and is being tested on Swedish and U.S. AIDS patients (SN: 6/13/87, p.376).

At a seminar last week, the NIMH investigators described evidence suggesting that Peptide T may protect brain and immune cells by mimicking a naturally occurring peptide – vasoactive intestinal peptide (VIP). The two peptides contain a similar "core" sequence of five amino acids, says one of the researchers, Candace B. Pert, and both appear to attach to T4 receptors in the brain.

In experiments directed by Douglas E. Brenneman, VIP and Peptide T similarly protected mouse neurons in laboratory cultures from dying after exposure to low concentrations of the HIV envelope protein. On their own, significant numbers of the neurons perished at the same concentrations. Three other peptides that act on the brain and are related to VIP offered no protection against the cell destruction inflicted by the AIDS virus, says Brenneman.

Preliminary work suggests that VIP acts at three T4 receptor subtypes, says NIMH's Joanna M. Hill. Peptide T may act at only one of those subtypes, she notes. Furthermore, there are numerous T4 receptors in the cerebellum and basal ganglia, brain structures implicated in the dementia and muscular disorders that often accompany AIDS.

"My working theory, which is still largely speculative," says Hill, "is that much of AIDS dementia and motor dysfunction is caused by HIV envelope protein binding to T4 receptors in the brain and preventing normal VIP functions."

A preliminary clinical trial of five patients in the early stages of AIDS injected with Peptide T for 30 days resulted in all the subjects reporting more energy, says Peter Bridge of NIMH. Skin diseases, such as psoriasis, subsided in three of the patients, as did persistent, watery diarrhea in one subject. But the ability to copy a complex geometric figure from memory was severely impaired in four of the patients, observes Bridge.

Peptide T's usefulness in treating AIDS, and particularly in reversing the loss of concentration and memory, remains unclear, he says. A trial of six patients treated with the protein and six given a placebo is now underway at the University of Southern California in Los Angeles. Subjects have been difficult to recruit, he adds, often because they are unwilling to give up other unconventional AIDS treatments during Peptide T trials.

Facelift for newborn imitation

Within days of birth, can a newborn infant imitate the facial expressions of an adult, such as a happy face, a sad face or a look of surprise? Several recent studies have suggested that newborns are indeed capable of this skill, but a report in the January DEVELOPMENTAL PSYCHOLOGY sounds a note of caution

Marsha Kaitz of Hebrew University in Jerusalem and her colleagues say that 1- to 2-day-old babies often respond to facial expressions of an adult by opening their mouths or pouting their lips, but do not actually imitate the expressions. The 20 female and six male newborns in their sample were held by a female who modeled a happy, sad and surprised expression on separate trials. Two observers rated the newborns' facial responses. When the model stuck her tongue out, however, the infants usually did so as well. The researchers say this indicates that a motor response associated with breast feeding, such as protuding the tongue, can be triggered by an adult's expression, but voluntary imitation of emotional expressions is not within a newborn's repertoire.

Biomedicine

Gold-filled discovery in transplants

Tissue transplantation may have a shining future – if gold proves to be as precious as recent research on neural transplants suggests. By filling envelopes made of viruses with colloidal gold and fusing them with nerve cells, scientists at the University of South Florida in Tampa have been able to track the migration of transplanted cells and measure their survival.

Used for years as a cell marker, the gelatin-like colloidal gold is easily distinguished by its yellow or bright white appearance through a microscope. Gary W. Arendash and his co-workers took advantage of gold's shining qualities and devised a model system applicable to transplantation science. As reported in the Feb. 5 SCIENCE, the researchers used a known technique to introduce the gold into cells: They mixed gold with a solution of harmless Sendai viruses that had been broken apart by a detergent. Pieces of the viral envelopes spontaneously regrouped as detergent was removed, forming whole envelopes that contained the gold colloid. Made from a virus that avidly fuses to vertebrate cells, the gold-filled Sendai virus envelopes attached to neural cells that were later transplanted into rats.

By scanning transplanted tissue for signs of gold, the scientists were able to follow the migration of transplanted cells through areas of the rats' brains, and to determine that the transplanted cells survived at least three months. Both location and viability are crucial to understanding the fate of nerve-tissue transplants, which have attracted attention and controversy as potential treatments for conditions like Parkinson's disease (SN: 11/28/87, p.341). Arendash said in an interview that it should be possible to similarly label other types of cells used for transplants, and that the gold/Sendai system might settle the debate over whether adrenal cells transplanted into the brain for treating Parkinson's actually survive, or instead release nerve-cell-stimulating factors before their death. Although tissue must be removed when the colloidal gold technique is used, the scientists are now evaluating another marker that is already being used in clinical imaging techniques and that might be engulfed by reforming Sendai virus envelopes – thus providing a way to follow grafts *in vivo*.

Lungs hit harder by pot than by cigarettes

Taking a puff from a marijuana cigarette carries more punch than previously thought, according to study results released last week by the University of California at Los Angeles. By measuring carbon monoxide in the blood and inhaled tar in the lungs of men who had smoked tobacco or marijuana cigarettes, researchers found that a single marijuana cigarette may be as unhealthy as smoking five cigarettes made of tobacco.

In research published last year, the same scientists had concluded that habitual smoking of three or four marijuana cigarettes a day caused the same amount of bronchitis symptoms and lung-cell damage as smoking more than 20 tobacco cigarettes daily. The group reports its more recent findings in the Feb. 11 NEW ENGLAND JOURNAL OF MEDICINE.

Included in the study were 15 men who had smoked both marijuana and tobacco for at least five years. Measurements were taken after they had smoked one or the other type of cigarette, as well as after they had smoked marijuana from which the active ingredient THC had been removed. Carbon monoxide levels, which have been associated with coronary heart disease, were nearly five times higher after marijuana smoking than after tobacco smoking. Marijuana smoking also resulted in three times the amount of tar inhaled and one-third more tar retained in the lungs and respiratory tract. The presence or absence of THC had minimal effects on test results, say the scientists, who attribute the differences to the way marijuana is inhaled more deeply and held in the lungs.

Preliminary Communication

Clarification and Standardization of Substance Abuse Terminology

Robert C. Rinaldi, PhD; Emanuel M. Steindler, MS; Bonnie B. Wilford; Desiree Goodwin, MPA

A four-stage Delphi survey of substance abuse experts was conducted to help achieve greater clarity and uniformity in terminology associated with alcohol and other drug-related problems. This multidisciplinary group of experts was asked to reach a consensus on alcohol and other drug-related terms and definitions. Results produced a list of 50 substance abuse terms deemed important, along with the most agreed on definition for each term.

(*JAMA* 1988;259:555-557)

IN AUGUST 1983, the American Medical Association's (AMA's) Council on Scientific Affairs' Panels on Alcoholism and Drug Abuse considered the need for providing greater clarity and uniformity in the terminology associated with substance abuse disorders. It was recommended that a task force be established to develop standard definitions.

Once constituted, the Task Force determined to collect data from a cross-disciplinary group of researchers, clinicians, administrators, and academicians in the field of substance abuse. The Delphi technique, a method for eliciting opinions from experts to reach a commonly accepted view, was used.

This report provides a description of the Delphi process used, definitions for 50 drug- and alcohol-related terms as developed and agreed on by the substance abuse experts, and comments on each definition by the Task Force. (Members of the Task Force were the late Sidney Cohen, MD, Chairman, Sheila B. Blume, MD, Stanley E. Gitlow, MD, and George D. Lundberg, MD.)

TERMINOLOGY

Problems of terminology and classification related to the use of psychoactive drugs are long-standing.[1-4] As early as 1952, the World Health Organization (WHO) acknowledged difficulties in this field and attempted to develop a definition of "addiction" that could be applied to drugs then under international control.[3] In 1957, a WHO expert committee introduced nomenclature to distinguish between "addiction" and "habituation," but in practice, this terminology led to confusion.[4] The next attempt at clarification came in 1964, when the same WHO committee recommended substitution of the word "dependence" for both "addiction" and "habituation."[5]

Several difficulties arise from the lack of consensus on a substance abuse lexicon. First, an array of concepts and terms is in active use. Second, a variety of professional disciplines are involved in research, treatment, and education regarding alcohol- and other drug-related problems, with each discipline tending to utilize different terms. The lack of precise definitions and universal agreement on language has hampered effective communication among professionals.[6] Finally, for public policy and third-party reimbursement purposes, the confusing panoply of terms and definitions has tended to impede understanding and appropriate responses.

Advances in classification and nomenclature are needed in dealing with the major public health problems posed by excessive use of alcohol and other drugs.[7] Such advances are required to facilitate research and analysis, provide a better understanding of disease etiology, and improve management and decision making in clinical treatment.[8,9]

METHODS

The research method used in this study was the Delphi technique, a multiple-stage survey process intended to produce a consensus. Information is obtained from a defined target group and resubmitted to that group for ranking, rating, or both.[6]

The Delphi technique is well suited to drawing unpublished technical and scientific information from experts.[6] It assures anonymity and, thus, enhances the participants' ability to make statements disregarding expressed public opinion and eliminating peer pressure.

In this study, a pool of experts was established by requesting nominees with drug- and alcohol-related expertise from among the membership of appropriate professional organizations (Table 1). From this pool, 99 experts from 23 organizations representing relevant disciplines and professions were nominated (Table 2).

Four rounds of data gathering were conducted: (1) A list of terms was collected, (2) the terms were rank ordered, (3) definitions were assigned to the terms, and (4) the definitions were rank ordered. Both AMA staff and Task Force members were involved in condensing, editing, and combining like terms between rounds of data collection to keep the project at a manageable level.

Table 1.—Professional Organizations Represented in Study

American Medical Association
Alcoholism and Addiction Research Foundation
American Academy of Pediatrics
American Association for Counseling and Development
American College of Health Associations
American College of Physicians
American College of Preventive Medicine
American Medical Society on Alcoholism Inc
American Nurses Association Inc
American Psychiatric Association
American Psychological Association
American Society for Clinical Pharmacology and Therapeutics
American Society of Clinical Pathologists
American Society of Internal Medicine
Association for Medical Education and Research in Substance Abuse
Association of Labor-Management Administration and Consultation on Alcoholism Inc
Journal of the American Medical Association
Illinois Department of Public Health
National Association of State Alcohol and Drug Abuse Directors
National Association of Social Workers
National Federation of Parents for Drug Free Youth
Research Society on Alcoholism
Vista Hill Foundation

From the Departments of Mental Health (Dr Rinaldi, Mr Steindler, and Ms Goodwin) and Substance Abuse (Ms Wilford), American Medical Association, Chicago.

Reprint requests to Department of Mental Health, American Medical Association, 535 N Dearborn St, Chicago, IL 60610 (Dr Rinaldi).

Table 2.—Professional Degrees Represented in Study

Degree	No. of Professionals
MD	48
PhD	19
MSW	4
RN	3
MS or MA	5
EdD	1
Other	13

Stage 1

In stage 1, a letter explaining the scope and goals of the project was sent to the 99 experts nominated by professional organizations. Each participant was asked to generate a list of terms related—but not necessarily limited—to the diagnosis, treatment, education, and research of alcohol- and drug-related problems.

Of the 99 participants contacted, 72 provided lists of terms, four declined participation, and 23 failed to respond even after one follow-up telephone call. This constituted a 77% expert participant response rate.

More than 1200 terms were submitted. By combining similar terms and eliminating those judged to be already well defined, the list was reduced by approximately two thirds.

Stage 2

In stage 2, the list of 447 terms was sent to 80 participants (72 stage 1 respondents and eight original nominees who sought late admission). Respondents were asked to rate each term according to its relative importance to the field of substance abuse. A six-point Likert-type summated rating scale was used, with 6 representing "most important," and 1, "least important."

After one follow-up telephone call to nonresponders, 68 completed lists were returned, yielding a response rate of 85%.

Stage 3

Mean and median scores were calculated for each ranked term from stage 2. Ninety-three terms received a mean score of 5 or above, and 23 of these terms received a median score of 6.

The 23 terms that received a median score of 6 were retained for use in stage 3 in that they formed a "natural grouping." The remaining terms that received a mean score of at least 5 were edited to eliminate duplicates and already well-defined terms; this process yielded a complement of 22 terms. Five additional terms that received mean scores of less than 5 were deemed important enough by investigators and the Task Force to include in the final list. Thus, a list of 50 terms was compiled.

Participants were then instructed to define each of the 50 top-ranked terms. Ninety-two participants (80 individuals who were asked to respond in stage 2 plus 12 original nominees who sought late admission) were asked to respond. After one follow-up telephone call, 42 completed lists were returned, yielding a response rate of 46%.

Intermediate Stage

After systematic analysis of stage 3 data, five definitions were selected for each term. With use of a *Q*-sort rank-ordering technique, definitions were selected on the basis that they fairly represented the range of all definitions submitted for a particular term. In the process, "drug addict" was subsumed under "addict," "drug addiction" under "addiction," and "drug dependence" under "dependence."

In a continuing effort to keep this project at a manageable level, Task Force members were asked to evaluate and rank the five definitions for each term based on perceived quality and usefulness. Mean scores were calculated on Task Force choices to select the three top-ranked definitions for each term.

Stage 4

In the fourth round, participants were sent the list of terms with three definitions assigned to each. They were instructed to select one definition considered best for each term.

Ninety-three participants (92 individuals who were asked to respond in stage 3 plus one original nominee who sought late admission) were asked to respond. After one follow-up telephone call, 65 completed lists were returned, yielding a response rate of 70%.

RESULTS

Ratings for definitions were summated across respondents. Those receiving the greatest number of votes are listed below, following their respective terms. This list represents 50 substance abuse terms deemed important, with the most agreed on definitions, by a cross-disciplinary national group of substance abuse experts. (Only 47 terms and definitions appear because "drug addict" was subsumed under "addict," "drug addiction" under "addiction," and "drug dependence" under "dependence.") The list includes the following terms:

Abstinence: Cessation of use of a psychoactive substance previously abused, or on which the user has developed drug dependence.

Abuse Potential: The property of a substance that, by its physiological or psychological effects, or both, increases the likelihood of an individual's abusing or becoming dependent on that substance.

(Drug) Addict: A person who is physically dependent on one or more psychoactive substances, whose long-term use has produced tolerance, who has lost control over his intake, and would manifest withdrawal phenomena if discontinuance were to occur.

(Drug) Addiction: A chronic disorder characterized by the compulsive use of a substance resulting in physical, psychological, or social harm to the user and continued use despite that harm.

Alcohol Abuse: Use of ethyl alcohol in a quantity and with a frequency that causes the individual significant physiological, psychological, or sociological distress or impairment.

Alcohol Addiction: Physiological and psychological dependence on alcohol.

Alcohol Dependence: Chronic loss of control over the consumption of alcoholic beverages, despite obvious psychological or physical harm to the person. Increasing amounts are required over time, and abrupt discontinuance may precipitate a withdrawal syndrome. Following abstinence, relapse is frequent.

Alcoholic: Person who has experienced physical, psychological, social, or occupational impairment as a consequence of habitual, excessive consumption of alcohol.

Alcoholics Anonymous: An international, nonprofessional organization of alcohol-dependent persons devoted to the achievement and maintenance of sobriety of its members through self-help and mutual support.

Alcoholism: A chronic, progressive, and potentially fatal biogenetic and psychosocial disease characterized by tolerance and physical dependence manifested by a loss of control, as well as diverse personality changes and social consequences.

Blackout: Acute anterograde amnesia with no formation of long-term memory, eg, a period of memory loss during which there is no recall for activities, resulting from the ingestion of alcohol and other drugs.

Cannabis Dependence: The psychological need for a routine pattern of cannabis use to the point where social-occupational functioning is impaired to some degree.

Chemical Dependency: Generic term relating to psychological or physical dependency, or both, on an exogenous substance.

Chronic Alcoholism: An obsolete term that should be abandoned. Synonymous with "alcoholism." The contrasting term "acute alcoholism" is now

rarely used, and means only severe intoxication by alcohol.

Cross-dependence: The ability of one drug to suppress the manifestations of physical dependence produced by another and to maintain the physically dependent state.

Cross-tolerance: Tolerance, originally produced by long-term administration of one drug, which is manifested toward a second drug that has not been administered previously (eg, tolerance to alcohol is accompanied by cross-tolerance to volatile anesthetics or barbiturates).

(Drug) Dependence: A generic term that relates to physical or psychological dependence, or both. It is characteristic for each pharmacological class of psychoactive drugs. Impaired control over drug-taking behavior is implied.

Detoxification: A process of withdrawing a person from an addictive substance, in a safe and effective manner.

Disease Concept: Recognition that chemical dependency is a chronic, progressive, and potentially fatal biogenetic and psychosocial disease characterized by tolerance and physical dependence manifested by a loss of control, as well as diverse personality changes and social consequences.

Drug Abuse: Any use of drugs that causes physical, psychological, economic, legal, or social harm to the individual user or to others affected by the drug user's behavior.

Drug Free: Ongoing disassociation from the use of any psychoactive substance.

Drug Intoxication: Changes in physiological functioning, psychological functioning, mood states, or cognitive processes, or all of these, as a consequence of excessive consumption of a drug; usually disruptive.

Drug Misuse: Any use of a drug that varies from a socially or medically accepted use.

Enabling Behavior: Any action by another person or an institution that intentionally or unintentionally has the effect of facilitating the continuation of abuse or dependence.

Familial Alcoholism: Pattern of alcoholism occurring in more than one generation within a family, due to either genetic or environmental factors.

Family Intervention: Specific form of intervention involving family members of alcohol and drug addicts designed to benefit the target patient as well as family constellation.

Impaired Physician: A physician whose clinical conduct does not meet accepted standards of practice and that is secondary to alcohol-drug use, or psychiatric illness, or physical illness, or all three.

Intervention: Act of interceding in behalf of an individual who is abusing, or is dependent on, one or more psychoactive drugs, with the aim of overcoming denial, interrupting drug-taking behavior, or inducing the individual to seek and initiate treatment.

Loss of Control: The inability to limit the use of substances via an internal locus of control.

Maintenance: A form of therapeutic intervention applied to opiate addicts, and consisting of the oral administration of a substitute opiate drug to minimize the reinforcement of drug taking and prevent a withdrawal reaction, while permitting rehabilitation to be achieved.

Overdose: The inadvertent or deliberate consumption of a much larger dose than that habitually used by the individual in question, and resulting in serious toxic reactions or death.

Physical Dependence: A physiological state of adaptation to a drug or alcohol, usually characterized by the development of tolerance to drug effects and the emergence of a withdrawal syndrome during prolonged abstinence.

Polydrug Abuse: Concomitant use of two or more psychoactive substances in quantities and with frequencies that cause the individual significant physiological, psychological, or sociological distress or impairment.

Prevention: Social, economic, legal, or individual psychological measures aimed at minimizing the use of potentially addicting substances, or lowering the dependence risk in susceptible individuals.

Primary Prevention: Attempts to reduce the incidence of new cases (or problems) in a general population.

Problem Drinking: (Two definitions tied for first place): (1) Drinking patterns that have resulted in serious disturbances of health, work, social adjustment, or other areas of functioning. (2) A pattern of alcohol consumption that does not satisfy all the criteria of alcoholism, but that is characterized by sufficiently large intake to have generated problems of health or social functioning.

Psychological Dependence: The emotional state of craving a drug either for its positive effect or to avoid negative effects associated with its absence.

Recovering Alcoholic: An alcoholic who is successfully abstaining; to emphasize the concept that no one is ever cured, and that recovery must be continuously worked at.

Recovery: A process of overcoming both physiological and psychological dependence on a drug or alcohol.

Rehabilitation: The restoration of an optimum state of health by medical, psychological, social, and peer group support for a chemically dependent person and his significant others.

Relapse: Recurrence of alcohol- or drug-dependent behavior in an individual who has previously achieved and maintained abstinence for a significant time beyond the period of detoxification.

Sobriety: Generally refers to the state of complete abstinence from alcohol and other drugs of abuse in conjunction with a satisfactory quality of life.

Substance Abuse: The use of a psychoactive substance in a manner detrimental to the individual or society but not meeting criteria for substance or drug dependence.

Tolerance: Physiological adaptation to the effect of drugs, so as to diminish effects with constant dosages or to maintain the intensity and duration of effects through increased dosage.

Treatment: Application of planned procedures to identify and change patterns of behavior that are maladaptive, destructive, or health injuring; or to restore appropriate levels of physical, psychological, or social functioning.

Withdrawal: Cessation of drug or alcohol use by an individual in whom dependence is established.

Withdrawal Syndrome: The onset of a predictable constellation of signs and symptoms involving altered activity of the central nervous system after the abrupt discontinuation of, or rapid decrease in, dosage of a drug.

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DEATH ON THE "HIGH"-WAYS

Driving on Drink and Pot

PEGGY MANN

WHEN YOU MIX LIQUOR AND MARIJUANA
AND THEN TAKE THE WHEEL
YOU COMPOUND A LETHAL PERIL

A PUBLIC SERVICE OF
DISTRICT 22-C, LIONS CLUBS INTERNATIONAL
DRUG AWARENESS PROGRAM

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FAMILIES, a Reader's
Digest Publication
and from Peggy Mann

The evidence is clear that alcohol and driving do not mix. Every year, more than 50,000 people are killed on the nation's roads, and almost two million are seriously injured. According to the National Highway Traffic Safety Administration, "About half of the traffic deaths are related to alcohol abuse."

Eighty percent of fatal accidents are first accidents. This figure underscores one of the most tragic parts of today's grim picture: those at greatest risk are the youth of our nation.

In 1980, the U.S. Surgeon General revealed that although the overall death rate for every other age group dropped in the period between 1960 and 1978, the dealth rate for 15- to 24-year-olds rose. And the Insurance Institute for Highway Safety reports that nearly half of all teenage deaths are due to motor-vehicle accidents.

The most common explanation offered by researchers for the consistently high accident involvement of young drivers is the inexperience of this group with driving, and with drinking and driving. But it is now clear that death on the road has received a considerable transfusion of tragedy via a wave of marijuana users.

America's young people form a generation in which large numbers smoke marijuana. The magnitude of the involvement is shown by the fact that in 1962 only four percent of Americans ages 18 to 25 had ever used marijuana, while by 1979, 35 percent reported "current use" (within the past month). Furthermore, the marijuana available today is stronger than it was ten years ago, when the average Delta-9 THC potency was only about one-half percent. (THC is the chief mind-altering chemical in the drug.) Today, the THC potency of "street pot" is 4.5 percent.

Surveys reveal that "60 to 80 percent of the marijuana users questioned indicated that they sometimes drive while cannabis-intoxicated." (Cannabis is the plant from which marijuana, hashish and the extremely potent hash oil are prepared.)

Highway officials, drug treatment professionals, research scientists and police officers from Maine to California all express profound concern about marijuana's mounting impact on our national highway-death problem. They also worry about the fact that many pot smokers say they often drive high because they *enjoy* doing so.

Hugh Alcott, a California State Department of Corrections probation agent assigned to the special narcotics section, points out a particularly dangerous phenomenon: "A lot of poeple who've had too much to drink and know their driving skill will be affected smoke a joint 'so they can drive better.' They actually believe that marijuana acts as an antidote to the effects of alcohol. All the pot does, of course, is to make them *feel* that they're driving better. In fact, their driving is far more impaired than if they'd used alcohol alone."

How Does Marijuana Affect Driving?

Herbert Moskowitz, a research psychologist at the University of California, has done more work than any other U.S. researcher on marijuana and simulated driving studies. In summing up his findings, he said, "The preponderance of evidence indicates that marijuana impairs skills performance, perceptual processes, attention and tracking behavior. All important components of driving are thus clearly affected."

Some of these components are impaired after only a low dose of marijuana—for example, impairment of "search and recognition abilities." After one joint, some drivers may become totally involved with a single facet of driving or with music from the car radio or even with a private reverie. Therefore, they might simply "not notice" a car exiting from a crossroad or a pedestrian who has just stepped into the street.

Other effects of marijuana intoxication on driving skills:

- Impairment of traffic-signal detection.
- Impairment of reaction time. Inability to brake quickly in rush-hour traffic or to move over quickly if another driver cuts in ahead.
- Impairment of short-term memory function and information storage. The driver may forget where to get off the highway or which crossroad to take—on a route he or she knows well.
- Impairment of coordination skills. Difficulty in backing up and turning around.

One test done by Harry Klonoff, professor of psychology at the University of British Columbia, involved 64 psychologically stable students, male and female. All had used marijuana before. Roughly a third of the students received a low-dosage marijuana joint. One-third were given a high-dosage joint. The third group received a placebo (a joint with the THC removed).

All 64 students drove through a closed course with no other traffic, and 38 of the students also drove a 16-mile route from the university campus to the traffic-heavy downtown area and back again. They were rated, before and after, according to the system used by British Columbia's Department of Motor Vehicles in examining drivers for licensing.

Final figures for the street-traffic test showed that those who had received the low-dose joint had a 42-percent decline in driving skills. Those who received the high-dose joint had a 63-percent decline in driving skills.

Even the "careful" pot smoker who "comes down" from his high before driving may well be a menace to himself and others on the highway. One and a half ounces of alcohol (the equivalent of a shot of whiskey) is excreted from the body in several hours. Marijuana, on the other hand, has 61 known cannabinoids (including THC) that appear to be fat soluble. It is speculated that they collect in body tissue—including the brain.

One mechanism the body uses to rid itself of these cannabinoids is to allow those in fatty tissue to leak slowly back in to the bloodstream to be metabolized and excreted. It takes about 2½ days for *half* the cannabinoids in a single joint to leave the body; it takes about two weeks to get rid of all the cannabinoids in a single joint. As one marijuana researcher put it, "Though the high is gone, the pot is not."

Deadly Duo

The National High School Senior Survey, conducted by the Institute for Social Research at the University of Michigan, is the only national drug-abuse survey conducted annually. The 1980 survey showed that one out of every 11 seniors smoked pot daily, averaging 3½ joints a day. More than half of the 49 percent who had smoked marijuana "usually stayed high" for up to two hours each time they smoked, and 20 percent of those who smoked pot said that they usually drank at the same time.

How much of a driving impairment does such a mix of pot and alcohol really present?

In a study published in June 1980,

Moskowitz and Marcelline Burns, a research scientist at the Southern California Research Institute, tested 12 healthy men (average age 26½) who used pot no more than twice a week and who did not take other drugs. The subjects performed a series of laboratory tasks, each related to a specific driving component (tracking, information processing, and so on). Each subject was tested at different times, under four different conditions. (No one knew what he was getting at any one time.) The conditions ranged from low alcohol and placebo marijuana to placebo alcohol (orange juice with a few drops of vodka floating on top) plus one marijuana cigarette.

Following this study, Moskowitz and research scientist Alison Smiley did a related one, but this time the subjects sat in a driving simulator, where they "drove" for 21 miles.

The results of both studies were virtually the same. The "alcohol only" subjects showed the well-recognized alcohol-caused driving impairments in reaction time, coordination, visual perception, attention and information processing. The "pot onlys" had all the same impairments.

But the results of dual use of alcohol and pot were, explained Moskowitz, "essentially additive." (One plus one equals two.) "Driving," he explained, "is obviously a multitask process. You must be able to do two or more things simultaneously. Alcohol impairs this ability in one way, and marijuana impairs it in another way. The alcohol-impaired driver tends to concentrate on one driving element to the exclusion of everything else. By sticking close to the center line for reference, the driver can keep the car from weaving but may be totally unable to attend to any unexpected highway happening. The marijuana-impaired driver, on the other hand, appears to have brief total 'dropouts' in his driving attention. Thus, taken together, alcohol and marijuana undermine the ability of the driver to process the roadway information necessary to control the vehicle safely."

Moskowitz summed up both the studies by saying, "Drivers under the combined influence of alcohol and marijuana have a greatly increased likelihood of initiating an accident."

In August 1980, Lawrence Sutton, executive director of Pittsburgh's Institute for Driver Research and Substance Abuse, tested the effects of marijuana and alcohol in a "closed" driving course. Sutton selected nine students from the University of Pittsburgh. All were experienced drivers, pot smokers and drinkers. Each drove on four successive afternoons, under four different "conditions":

1. pot (one joint) plus alcohol;
2. placebo alcohol plus one joint;
3. placebo joint plus alcohol;
4. placebo alcohol plus placebo joint.

During the 36 driving trials, patrolman Donald Dolfi followed the subjects in his own car, noting their performance, which included executing common procedures for a driver's license examination in Pennsylvania. He "pulled over" those drivers he would have suspected of "DUI" (driving under the influence)—if they had been on the road.

When the test was completed Dolfi said to Sutton, "I guess I spoiled your study. I only pulled over drivers 15 times."

But when the "double blind" code was revealed and Sutton looked at the figures, a chill went through him. Of the 15 incidents in which Dolfi "pulled over" drivers, three students were under the "marijuana only" condition, two were under the "alcohol only" condition, and one bad driver was under the double placebo. But all nine of the rest—100 percent—were under the alcohol plus marijuana condition.

The results of Sutton's study are striking indeed. They show that the impairments caused by pot plus alcohol are *more* than additive. They are synergistic. One drug potentiates ("fires up") the other. One plus one equals three or four on the impairment scale.

A further sobering fact is that *if* they had been on the highway, none of these drivers could have been prosecuted for DUI since they had such a low blood-alcohol-concentration level and since there is, as yet, no viable roadside test for the pot-high driver. All 15 "pulled over" for DUI by Dolfi would, therefore, have been "home free"—unless, of course, they had injured or killed themselves or others.

What Can Be Done?

In addition to horrendous personal costs in wrecked and lost lives, what are the dollar costs of the ever-mounting highway mayhem?

According to a study published in April 1981, "Only cancer outranks motor-vehicle crash deaths and injuries in dollar costs to the nation. The killing and injuring of people on the highways can be conservatively estimated as costing the United States some *$20 billion* annually in wasteful, unproductive expenditures, including $6.7 billion in medical, rehabilitation and other direct outlay."

William Haddon, Jr., M.D., president of the Insurance Institute for Highway Safety, which sponsored the 420-page report, points out, "With the appearance of this study, public policy makers must face the immensity of this tragedy in terms of its burden on the national economy—and, it is hoped, do something about it."

At this time, most public policy makers have done very little about it. A few, however, are taking steps, at least along the alcohol/driving route.

Rep. Michael Barnes (D-MD) and 50 other members of the House of Representatives have introduced a bill (HR 2488) calling for a mandatory sentence of at least ten days' community service, plus fines, participation in alcohol-treatment or traffic safety programs, and mandatory license suspension for up to one year for first-time drunk-driving offenders—and for repeat offenders, the same, plus mandatory sentencing of at least ten days' imprisonment and suspension of driver's license for at least one year. An identical bill (S 671) has been introduced in the Senate by Sen. Claiborne Pell (D-RI).

Candy Lightner of Fair Oaks, California, has formed a national organization called MADD—Mothers Against Drunk Drivers. "As it stands now," says Lightner, "drunk-driving manslaughter is a socially acceptable form of homicide. That is why we are MADD!"

The organization has some 32 chapters in seven states. They work to alert the public to the serious consequences of drinking and driving, as well as to educate victims of drunk drivers and other concerned citizens as to what they can do to help resolve the problem in their state and community.

One state that has taken a giant step forward on the marijuana/driving front is Minnesota. In many states an open liquor bottle in the car of a DUI is considered *prima*

facie evidence of a crime. In Minnesota, there is also an "open baggie" law. Anyone with any marijuana in the car—whether smoking it or not—is considered to have committed a crime. If involved in an accident or driving recklessly "in a serious way," he or she is treated within the criminal-justice framework. First offenders who have not endangered anyone must attend a mandatory "pot course" on the hazards of marijuana with emphasis on pot-impaired driving.

A second-possession offense usually means a fine of up to $500 and incarceration for a series of weekends in a county jail or work farm. But of the 9000 first-offenders who have gone through the four- to six-hour course, only 22 have been arrested a second time.

For more information on this award-winning "mandatory pot course," write Bruce Bomier, Director, Minnesota Institute, 2829 Verndale Avenue, Anoka, Minnesota 55303.

Think of this: each man, woman and child in the United States can expect to be in a car crash once every ten years. Since any of us can be imperiled at any time by the most deadly drug-related disease of all—Death on the "High"-ways—it behooves us to do what we can to halt this menace.

Copies available from
Alan B. Mackall
12204 Piscataway Road
Clinton, Maryland 20735
(301) 292-3917

Legal Limbo

The drunk driver usually finds it hard to hide his condition if stopped by the police. But the pot-high driver often has the ability to "hide the high"—to collect himself, "come down" and carry on a normal conversation with a police officer and thus escape detection, making enforcement all the more difficult.

Also, with alcohol, we have the roadside "breath test" as a deterrent. Every state has specific laws so that the drunk driver can be defined and, if warranted, prosecuted. For marijuana intoxication, however, we have no roadside test.

In March 1980, an inexpensive, reliable method was finally perfected for detecting cannabinoids in urine. According to the National Institute on Drug Abuse's Research Technology Branch, "The cannabinoid test can determine in 60 seconds, with 95-percent accuracy, the presence of cannabinoids in the urine for up to 48 hours after a joint has been smoked."

This is a step in the right direction. Many hospitals and private clinical laboratories have the facilities for running the test, and now at least physicians and parents can be alerted about pot problems with youngsters. But until a roadside test is available to highway police, we are in a legal limbo in which no driver can be prosecuted for being marijuana intoxicated.

STATEWIDE ACTIVITIES

January 1, 1986
thru
June 30, 1987

DRUG SEIZURES

Type of Drug	Quantity	Street Value
Cocaine	87.2 pounds	$8,573,326
Marijuana	626 pounds	2,527,950
Marijuana plants	3,649	866,190
Hashish	520 grams	9,912
Amphetamines	622 tablets	9,394
Mushrooms	137 grams	1,470
Heroin	90 grams	50,642
Dilaudid	697 tablets	54,180
Look-a-likes	807 dosage units	1,986
LSD	4,595 dosage units	26,580
Other Drugs		63,530
TOTAL		$12,185,160

$3,404,052

NON-DRUG SEIZURES

Cash	$393,076
Vehicles (13)	101,845
Property	496,720
TOTAL	$991,641

SOURCE: State of Alaska Department of Public Safety/Scientific Crime Detection Laboratory. George M. Taft, Jr., Laboratory Director. 5500 East Tudor Road, Anchorage, Alaska, 99507; (907) 269-5740.

People who didn't say no

Hospital emergency rooms are the MASH units of the drug wars, places where rhetoric is irrelevant and "cool" turns deadly. In 1986, for the first time, the number of cocaine-related visits passed those from any other cause.

Drug-related emergency-room visits in 1986 and change since 1983—

	VISITS	CHANGE
Atlanta	2,045	Up 22%
Baltimore	2,703	Up 19%
Boston	2,757	Up 7%
Buffalo	1,442	Down 25%
Chicago	6,873	Up 40%
Cleveland	2,143	Down 8%
Dallas	3,037	Up 106%
Denver	3,154	Up 19%
Detroit	11,865	Up 21%
Indianapolis	1,114	Down 24%
Kansas City	1,940	Up 32%
Los Angeles	10,894	Down 5%
Miami	4,616	Down 1%
Minneapolis	2,373	Up 39%
New Orleans	2,552	Up 11%
New York	15,484	Down 31%
Norfolk	796	Up 20%
Oklahoma City	934	Up 23%
Philadelphia	7,178	Up 20%
Phoenix	3,305	Up 52%
St. Louis	2,276	Down 2%
San Antonio	1,821	Up 45%
San Diego	2,489	Up 20%
Seattle	2,621	Up 17%
Washington, D.C.	6,240	Up 65%

Note: Figures are for metropolitan areas.

Emergency-room visits involving particular drugs in 1986 and change since 1983—

	VISITS	CHANGE
Cocaine	24,847	Up 245%
Alcohol with other drugs	21,801	Down 15%
Heroin or morphine	15,832	Up 23%
Tranquilizers	7,653	Down 30%
PCP, PCP combinations	6,421	Up 3%
Marijuana	6,046	Up 8%
Acetaminophen	5,591	Up 26%
Aspirin	5,589	Down 14%
Ibuprofen	2,491	Up 201%
Methadone	1,993	Down 8%
Over-the-counter sleep aids	1,850	Down 3%
Amphetamines	3,475	Down 8%
Codeine	1,038	Up 4%
LSD	1,002	Down 4%
Caffeine	459	Up 72%
Ampicillin	409	Down 15%
Hashish	256	Up 42%
Mescaline	199	Down 35%
Insulin	151	Down 64%
Mushrooms	114	Down 2%
Glues	107	Down 25%

Note: A sampling of 744 hospital emergency rooms reported in 1986 and 760 in 1983. Figures for individual drugs include those used in combination with other drugs. Visits due to alcohol alone are not available.

USN&WR—Basic data: National Institute on Drug Abuse

LEGALIZATION OF DRUGS WOULD AT ONCE BE POLITICALLY DEAD"

Section One: Page 6
THE SUNDAY STAR-LEDGER, June 5, 1988

Legalizing drugs holds little appeal in Europe

LONDON (AP)—The debate in the ed States over legalization of drugs ving little impact in Western Eu- . Most governments on this side of the Atlantic favor even tougher drug laws, despite claims that severity only aggravates the problem.

Support for legalizing drugs appears confined to certain European law- enforcement officers and drug-rehabilitation workers, who arue that harsh laws encourage crime, help spread AIDS and do little to cure addicts.

Just two years after the European Parliament narrowly rejected a proposal to legalize marijuana, no government or major political party in Europe is calling for legalized drugs.

In Norway, "there is massive and unambiguous support in the Parliament, in the administration and in the population for our official hard-line policy," said Ketil Bentzen, the government's adviser on drugs.

"A politician who would bring up legalization of drugs would at once be politically dead," Bentzen said.

A 1986 report by the European Parliament said heroin abuse has become "an epidemic of serious proportions" since the mid-1970s, and it estimated that there were 1.5 million heroin addicts in the 12-nation European Economic Community.

"The rapidity with which hard drugs, particularly heroin, have taken hold on all Western European nations is alarming," the report said. It predicted a similar explosion in cocaine use.

The Parliament concluded that relaxed drug laws would encourage more addiction.

The debate over decriminalization seems to be gaining momentum from a campaign for repeal of drug laws in the United States, where several congressmen and mayors have suggested that the war on drugs is a losing battle.

For example, the Paris weekly Journal du Dimanche published reader reaction to an article by Baltimore Mayor Kurt Schmoke in the International Herald Tribune. Schmoke has proposed congressional hearings on whether decriminalizing narcotics can reduce drug-related crime.

The French newspaper found few in favor of relaxing the country's drug laws.

But it quoted Georges Assap, prosecutor in the southeastern city of Valence, as saying: "In less than five years, the decriminalization of all drugs will be a reality. Simply because one can't do otherwise. It's been 30 years now I've been putting people in prison for using or selling drugs, knowing all along it served no purpose."

Because of its relaxed attitude toward drugs, the Netherlands has become a haven for foreign addicts, especially those from West Germany and Italy.

Amsterdam alone has an estimated 7,000 junkies and drug abuse has become so entrenched that a bus circulates through the capital distributing free methadone. Addicts have their own union.

Although police turn a blind eye to marijuana, authorities are reluctant to legalize drugs outright.

Utrecht's police commissioner, Jan Wiarda, argues that legalizing drugs would reduce crime but says the Netherlands could not take such a step unless neighboring countries did the same.

Last year, the European Movement for the Normalization of Drug Policy was set up in the Dutch city of Rotterdam to muster support for legalized drugs. It now has representatives in 10 countries.

The group's British representative is Dr. Russell Newcombe, a researcher for the Regional Drug Training and Information Center in the northwest port city of Liverpool, which has one of Britain's worst drug problems.

Newcombe said in an interview that the group wants first to remove penalties for possession. It ultimately hopes to persuade governments to ration supplies to addicts.

"We have patiently failed in our efforts over the past two decades to prevent the use of illegal drugs," Newcombe said. "More importantly, we have failed to prevent the kinds of problems illegal drugs can lead to. Problems like AIDS and crime are not due to drugs, but to the fact that drugs are illegal and users are driven underground."

Geraldine Silverman, Legislative Liaison
New Jersey Federation For Drug Free Communities
23 Audubon Court
Short Hills, N.J. 07078
1-201-376-8927

NORML set up it's base in Rotterdam, Holland and now has representatives in 10 countries! They are carefully watching the efforts of politicians like our Mayor's Barry of Washington, D.C. and Schmoke of Baltimore, Md. and NORML'S efforts in the U.S.

CUTTING THE DEMAND IS OUR GREATEST HOPE.

SOURCE: School Team Approach to Prevent and Reduce alcohol and Drug Abuse by the City and Borough of Juneau School District, April 30, 1984.

NARRATIVE STATEMENT Continued

AWARE

Caren Robinson, Executive Director
Aiding Women from Abuse and Rape Emergencies
City and Borough of Juneau
P. O. Box 809
Juneau, Alaska 99802
Phone: 907-586-6623

"Statistics indicate that nearly 80% of all domestic violence crimes are alcohol/drug related."

"The Department of Law, Criminal Justice Planning Agency's 1981 Crime in Alaska Report presents further evidence that alcohol abuse is one of the major problems facing youth today. The report states that alcohol and drug related crimes comprised 53% of the statewide arrests for 1981, and that juvenile arrests were up to 19% from 1980, with possession of marijuana accounting for over 85% of all juvenile arrests."

The Johnson Human Resource Center (Juneau)...shows that from March 24, 1982, until May 11, 1982, twenty-five juvenile offenders were incarcerated and thirty-four juvenile referrals were made; many of these were for minor consuming and possession of drugs.

M.E.N.

Walter Majoros, Executive Director
211 Fourth Street, #304
Juneau, Alaska 99801
Phone: 907-586-3585

"Alaska has one of the highest rates of alcohol use in the country and Southeast Alaska has the highest alcohol rate in Alaska."

CENTRAL COUNCIL TLINGIT AND HAIDA INDIAN TRIBES OF ALASKA

John Hope, President
One Sealaska Plaza, Suite 200
Juneau, Alaska 99801
Phone: 907-586-1432

ALASKA COUNCIL ON DOMESTIC VIOLENCE AND SEXUAL ASSAULT
USE OF ALCOHOL OR DRUGS AT THE TIME OF ABUSE

Victim's Use of Alcohol/Drugs at Time of Abuse
Reported by New Domestic Violence Victims
FY87

	Number of Victims	Percentage
Alcohol/Drugs Used:	325	15
No Alcohol/Drugs Used:	1074	50
Unknown:	744	35
Total:	2143	

Victim's Use of Alcohol/Drugs at Time of Abuse
Reported by New Domestic Violence Perpetrators
FY87

	Number of Victims	Percentage
Alcohol/Drugs Used:	128	21
No Alcohol/Drugs Used:	222	36
Unknown:	268	43
Total:	618	

Perpetrator's Use of Alcohol/Drugs at Time of Abuse
Reported by New Domestic Violence Victims
FY87

	Number of Perps	Percentage
Alcohol/Drugs Used:	958	45
No Alcohol/Drugs Used:	467	22
Unknown:	718	33
Total:	2143	

Perpetrator's Use of Alcohol/Drugs at Time of Abuse
Reported by New Domestic Violence Perpetrators
FY87

	Number of Perps	Percentage
Alcohol/Drugs Used:	186	30
No Alcohol/Drugs Used:	196	32
Unknown:	236	38
Total:	618	

NOTE: Alcohol and other drugs are lumped into one category and not broken out into specific drug substances.

Treatment of Marijuana Dependence: Preliminary Results

ROBERT S. STEPHENS, PH.D.

ROGER A. ROFFMAN*; ROBERT S. STEPHENS*;
EDITH E. SIMPSON* & DANIEL L. WHITAKER*

Despite the continuing popularity of marijuana in the United States, very little of the scientific literature on this drug focuses on the treatment of dependence. This may be a consequence of several factors: (1) a belief that chronic marijuana use rarely occurs in the absence of concurrent alcohol or other drug abuse; (2) an assumption that the mild physiological withdrawal symptoms preclude the likelihood that chronic smokers will need or seek treatment; (3) an inference from the past decade's declining use rates that the pool of potential clientele for specialized treatment is disappearing without intervention; or (4) a supposition that the treatment of marijuana dependence requires no unique clinical attention.

MARIJUANA VERSUS MULTIPLE DRUG DEPENDENCE

Available data tend to support the assumption that marijuana dependence rarely occurs without concurrent abuse of alcohol or other drugs. Most (83%) of the hospital emergency room mentions of marijuana in a sample of NIDA-monitored hospitals nationwide (NIDA 1986) involved marijuana use in combination with one or more other substances. Surveys of drug abuse treatment clients in New York (Kleinman et al. 1984) and interviews with marijuana smokers who responded to advertisements (Rainone et al. 1987) failed to identify more than a handful of "pure" marijuana smokers when the criteria used to select "marijuana only" category excluded people who had ever used three or more illicit drugs in their lifetimes.

However, pilot work conducted by Roffman and Barnhart (1987) led to quite different conclusions. An anonymous telephone survey, conducted in Seattle in late 1984, assessed the potential unmet need for marijuana treatment services. Public service announcements placed in the local media conveyed the message that a University of Washington researcher wanted to talk anonymously with adults who used marijuana and were concerned about their use. No incentives were offered. Within a period of two weeks, 225 interviews were completed utilizing a 29-item interview schedule. The researchers classified 73.8 percent of the callers as being currently adversely involved only with marijuana. Current multiple drug abusers comprised 18.2 percent of the sample. The remaining eight percent were not currently abusing any substance.

ABSENCE OF NEED FOR TREATMENT

It might be expected that chronic marijuana smokers who are not currently abusing other substances will not need or seek treatment because the physiological withdrawal symptoms, if they occur at all, are mild (Nowlan & Cohen 1977; Jones, Benowitz & Bachman 1976). To the contrary, nearly all (91.6%) of the callers in the Roffman and Barnhart study (1987) were definitely (68%) or possibly (23.6%) interested in participating in treatment if it were available.

*School of Social Work, University of Washington.
Please address reprint requests to: Roger Roffman, D.S.W., School of Social Work, University of Washington, 4101 15th N.E., Seattle, Washington 98195.

POTENTIAL POOL OF SUBJECTS IS DISAPPEARING

It is likely that the number of marijuana dependent people is declining along with the decline in overall use. An estimated 11 percent reduction in the number of current users from 1982 to 1985 (NIDA 1985) is consistent with a similar downward trend in the amount of the drug consumed. The National Narcotics Intelligence Consumers Committee (1987)—a policy analysis group of federal agency representatives formed in 1978 to coordinate the collection, analysis, dissemination and evaluation of drug-related intelligence—reported that the 10.3 million pounds of marijuana consumed in 1985 represented a four percent reduction from 1982. The NIDA-sponsored annual surveys of high-school seniors (Johnston, O'Malley & Bachman 1986) also indicated a reduction in use.

The *National Household Survey on Drug Abuse* (NIDA 1985) suggested that 18.2 million people in the U.S. are current users of marijuana (i.e., used at least once in the month preceding the survey). Weller and Halikas' longitudinal surveys (1980) of marijuana users, employing diagnostic criteria adapted from the National Council on Alcoholism (1972) criteria for diagnosing alcoholism, estimated that 9.3 percent of current users become dependent. Therefore, an estimate of the number of currently dependent marijuana users in the U.S. would be 1,692,600 individuals. These data suggest that the residual population of users possibly needing treatment is substantial.

UNIQUE FOCUS UNWARRANTED

Typical callers in the telephone survey (Roffman & Barnhart 1987) were in their early thirties, having begun marijuana use on average some 15 years before in the early 1970's, when use rates were rapidly increasing and counterculture movements were at their peak. It is likely that the use of marijuana was once, and possibly continued to be, symbolic of deeply held political and cultural values of the time. The cessation of marijuana use in these individuals may therefore have presented a greater disruptive threat to personal identity than the same process would have been in those who began using marijuana in another historical era. The establishment of a program uniquely focused on marijuana dependence may overcome resistance to seeking help in individuals whose perceptions of themselves were influenced by the political and cultural happenings of the early 1970's and who do not see themselves as members of a larger, multiple drug abusing group.

The present study was designed to determine whether or not marijuana dependent individuals could be recruited and effectively treated. The study compares the effectiveness of a relapse-prevention-oriented cognitive-behavioral model with a more traditional nonbehavioral approach emphasizing social support and group discussion. The present report includes findings concerning one-month posttreatment outcomes.

METHODS

Subjects

The subjects were 84 men and 26 women (mean age=32.50 years; range=18 to 62 years) recruited from the Seattle metropolitan area in the winter of 1987. They were derived from a larger sample of 205 potential participants who responded to media announcements and news stories publicizing a program designed to help adults stop their marijuana use.

Inclusion criteria were that participants be at least 18 years of age and have used marijuana at least 50 times in the past 90 days. Exclusion criteria included (a) concurrent—in the past 90 days—abuse of alcohol or drugs other than marijuana, (b) ongoing participation in a treatment program for marijuana, alcohol or other drug abuse—self-help groups, such as Alcoholics Anonymous, were not considered to be treatment for the purposes of eligibility, or (c) severe psychopathology suggesting the need for more comprehensive treatment programs. Of the 205 potential participants, 43 (21%) were ineligible for a variety of reasons: five (2%) had not used marijuana with sufficient frequency in the past 90 days; 36 (18%) were abusing alcohol or other drugs; one (0.5%) was already in treatment for alcohol or other drug use; and one (0.5%) evidenced severe psychological distress. Another 52 (25%) potential subjects failed to complete the baseline assessment procedures.

Study Design

These subjects constituted the first of two cohorts who participated in this treatment-outcome study. Eligible subjects were blocked on sex and randomly assigned to one of two treatments: Relapse Prevention (RP; n=54) or Social Support (SS; n=56). Both treatments involved 10 two-hour group sessions spaced over 12 weeks. Two additional "booster" sessions occurred for all groups at the three- and six-month follow-up assessments.

Assessments of drug use and related intrapersonal and interpersonal variables occurred pretreatment, at the final session, and at one, three, six, nine and 12 months posttreatment. Urine samples were also collected from subjects at the three- and six-month group assessments and were analyzed for the presence of cannabinoid and other drug metabolites.

Posttreatment estimates of the subjects' alcohol and other drug use were also obtained from collateral verifiers. This paper presents data collected through the one-month

posttreatment assessment only.

Procedures

Pretreatment. Each potential participant attended two group-orientation and assessment meetings where the details of participation were explained, informed consent was obtained, eligibility determinations were completed, and baseline data were collected. Participants were told that a refundable $50 deposit would be required to reserve a place in one of the treatment groups, with $10 refunded at each of the posttreatment assessments. Refunds were contingent only on completion of posttreatment questionnaires. In addition, each subject was required to identify a collateral verifier who was contacted independently in order to obtain informed consent for participation.

Treatment. Treatments were conducted in groups of 12 to 15 subjects and led by four male-female cotherapist teams (two RP teams and two SS teams). Therapist teams conducted only one type of treatment in order to maximize therapist enthusiasm for the approach. Treatment groups met weekly for the first eight weeks and biweekly the last four weeks in order to fade out treatment. All treatment sessions were audiotaped in order to validate treatment delivery.

The RP condition was a cognitive-behavioral intervention based on the premise that the process of overcoming drug dependence necessitates first understanding the circumstances that might lead to relapse, and then developing effective skills to cope with those circumstances (Marlatt & Gordon 1985). Subjects were instructed in procedures for monitoring and analyzing marijuana usage and urge patterns as well as their antecedents, with subsequent emphasis on selecting and practicing coping behaviors and cognitions. For example, role playing was employed in demonstrating assertive responses to temptations presented by others and in countering negative self-talk about the possible unpleasant consequences of ceasing marijuana use. The therapists taught the subjects about apparently irrelevant decisions that an individual might make while in the process of relapsing, and steps that can be taken to avoid setting up a "slip."

Moreover, cognitive responses to self-blame and unproductive attributions commonly associated with slipping were covered both in lecture and in training. Frequent debriefings of past high-risk situations and systematic planning for anticipated difficult circumstances assisted subjects in adopting a self-study approach to behavior change. The RP condition incorporated training in relaxation techniques, behavioral rehearsal in soliciting social support, and an emphasis on making lifestyle changes that would facilitate being successful in stopping marijuana use. Numerous homework assignments and summary handouts augmented the work in each session.

The premise underlying the SS intervention was that the process of overcoming drug dependence necessitates purposeful efforts to obtain and make use of support from other people. Subjects were assisted in differentiating the types of support that were both desirable and likely to be available from specific people within the treatment group and in the individual's social network. Considerable discussion was devoted to steps that might be taken in seeking and utilizing social support. Many of the themes dealt with in the RP condition (e.g., dealing with mood swings, faltering in motivation, and relating with peers who continue to smoke marijuana) were also introduced in the SS condition, although SS group leaders facilitated discussion rather than the provision of behavioral and cognitive skill training.

Subjects in both treatment conditions were asked to cease smoking marijuana by the fourth group session, although some individuals had stopped earlier. Suggestions were given in both groups for steps that could be taken in preparation for quitting.

Posttreatment. Questionnaires that assessed weekly alcohol and other drug use for the posttreatment period, participation in subsequent treatment, changes in social support and attributions regarding marijuana use, and relapse experiences were completed by subjects one month following the final treatment session. Similarly, collateral verifiers completed a brief questionnaire about the subjects' marijuana and other drug use in the past month.

Measures

In addition to demographic variables, the remainder of this article will present analyses of the following measures:

Drug use. On a pretreatment questionnaire, subjects indicated if they (a) had ever used, (b) had ever been dependent or had problems because of their use, (c) had used in the past 90 days, and (d) were currently physically or psychologically dependent on each of 12 drugs and drug categories. Additional marijuana use history measures collected pretreatment included age at first use, age of first daily or near-daily use, the total number of years of use, the number of serious attempts at quitting or greatly cutting back use, the longest period of time they were successful in abstaining or cutting back use, and their goal regarding future marijuana use.

In order to assess the nature and extent of current problems associated with marijuana use, 25 items from Skinner's (1986) Drug Abuse Screening Test (DAST) were modified by substituting the word "marijuana" for the word "drug(s)" and by removing the term "ever." Seven additional items were added to this list in order to better assess interference with school, financial difficulties, memory loss, diminished self-confidence, and procrastination related to marijuana use. Subjects indicated whether

TABLE I
NUMBER OF SUBJECTS EVER AND CURRENTLY INVOLVED WITH DRUGS OTHER THAN MARIJUANA (N=110)

Drug	Ever Used		Ever Dependent On		Used in Past 90 Days	
	(n)	(%)	(n)	(%)	(n)	(%)
Heroin	22	20	4	4	0	0
Methadone	5	5	0	0	0	0
Other opiates	36	33	4	4	2	2
Cocaine	108	98	24	22	24	22
Barbiturates	55	50	3	3	1	1
Tranquilizers	67	61	3	3	2	2
Amphetamines	87	79	7	6	8	7
Hallucinogens	100	91	7	6	8	7
Alcohol	109	99	20	18	69	63
Tobacco	94	86	51	46	47	43
Caffeine	102	93	44	40	79	72

or not they had experienced each of 32 items in the past 90 days and a total marijuana problems index was created by summing responses that indicated adverse consequences of marijuana use. In addition, a DAST score was computed from responses to the original items for comparison across drug abuse studies.

Changes in self-reported marijuana use pre- and posttreatment were assessed in the following ways: (1) the number of days in the prior period in which marijuana had been used at least once; (2) the number of times on a five-point scale marijuana had been used during a typical day of use; and (3) a weekly use index compiled from a retrospective diary of marijuana and other drug use (calendars were provided with the diary to assist subjects in reconstructing their usage patterns before estimating the number of times they used each of the substances each week of the specified period).

At one-month posttreatment assessment, the collateral verifiers categorized the subjects as nonusers (abstinent), occasional users (used marijuana once in a while, but not on a daily basis), or as regular users (used daily or almost daily) of marijuana during the month since treatment ended. Collaterals estimated the number of days the subject used marijuana in the past 30 days and the typical daily frequency of marijuana use on the same scale used by subjects. Collaterals also indicated whether the subject had used each of the drugs contained on the retrospective diaries during the posttreatment period.

Treatment validation. Subjects completed scales after the fifth session and at the final treatment session, which allowed for a comparison of treatments on nonspecific therapeutic dimensions. Subjects rated their confidence in being able to abstain from marijuana use, their likelihood of recommending the treatment to someone else, the helpfulness of the treatments, and the therapeutic qualities of the group leaders. In order to discriminate treatments, subjects estimated the frequency of 19 cotherapist behaviors, treatment components, and group experiences designed to tap themes and processes specific to each of the treatments. Finally, subjects were asked about the frequency of attendance at any other treatment programs for drug or mental health issues during and after the marijuana cessation treatments in order to assess confounds in the interpretation of outcome data.

RESULTS

Pretreatment

Demographic characteristics suggest a largely functional sample of subjects of moderate socioeconomic status. The mean age was 32.5 years. A little more than half of the subjects (56%) were married or living with a partner, and 85 percent were employed. The mean annual income of employed subjects was $23,333. Overall, subjects had completed an average of 14.24 years of education, and 46 (42%) held some type of college degree. Only 16 (15%) of the subjects had not completed high school and 11 of these individuals (10%) had qualified for a high-school equivalency diploma. Ninety-three (93) percent of the sample was White.

Several measures indicated substantial and chronic use of marijuana. The mean age of first marijuana use was 16.11 years. Subjects had used marijuana for an average of 15.84 total years and their mean age of "first daily or near-

/ years. Out of the past 90 days, they ıijuana on an average of 80.29 days. 2) percent of the subjects reported using ıore than once on a typical day of use, and 55 ıdicated that they used it four or more times on a ıl day. Ninety-two (92) percent of the subjects re-ıted making at least one serious attempt (mean=6.74 attempts) at quitting or greatly cutting back their marijuana use in the past. Their longest period of success was an average of 11.83 weeks. Eighty-two (82) subjects (75%) indicated that their personal goal regarding future marijuana use was abstinence.

The mean number of current problems related to marijuana use indicated on the 32-problem checklist was 11.12 (range=3 to 21). Items endorsed in the problematic direction by half or more of the subjects included "friends or relatives know or suspect you abuse marijuana" (96%), "abuse marijuana on a continuous basis" (95%), "not able to stop using when you want to" (93%), "feel bad about your marijuana use" (91%), "procrastinating on things you want to or should get done" (88%), "self-confidence has suffered" (80%), "memory loss as a result of marijuana use" (73%), "cannot get through the week without using" (68%), "experienced withdrawal symptoms as a result of heavy marijuana use" (54%), and "spouse or parents complain about your use of marijuana" (50%). These responses suggest that subjects experienced interference in social, emotional, cognitive, and physical functioning as a result of their marijuana use. The mean total DAST score was 13.31 (range=3 to 25). Only one subject did not exceed a proposed case-finding score of five (Skinner 1986).

Table I summarizes subjects' current and lifetime involvement with drugs other than marijuana. Caffeine, alcohol, tobacco and cocaine were the most commonly used drugs in the 90 days before pretreatment assessment. Lifetime use of other drugs was substantial, with over 90 percent of subjects reporting that they had used cocaine, hallucinogens, alcohol and caffeine. Only heroin, methadone and other opiates/opioids had been used by less than half of the sample. Dependence or problems related to the lifetime use of a drug were most common for tobacco, caffeine, cocaine and alcohol. Excluding tobacco and caffeine, 41 of the subjects (37%) experienced dependence or problems related to the use of other drugs at some time in their lives.

One-way analyses of variance (ANOVAs) were performed on all continuous pretreatment demographic and drug use variables in order to compare subjects assigned to the RP and SS treatment conditions. Similarly, χ^2 analyses comparing treatment conditions were performed on nominal-level variables. No significant differences were found on any of these variables, suggesting that randomization was effective.

Treatment Validation

Ninety-six (96) subjects, 87 percent of the original sample, completed the mid-treatment evaluation of the treatments as well as the group leaders. One-way ANOVAs performed on their data did not reveal any significant effects of treatment condition. On a seven-point scale (1=not at all confident; 7=extremely confident), subjects expressed confidence in their ability to abstain from marijuana at the time of assessment (mean=5.18). Similarly, on a scale from 0 to 100 (100=totally certain), subjects indicated their confidence that they would be abstinent from marijuana at the end of treatment (mean=84.94), three months after treatment (mean=78.39), six months after treatment (mean=76.23), and 12 months after treatment (mean=73.32). Subjects' ratings of the helpfulness of treatment in stopping marijuana use on a seven-point scale (1=not at all helpful; 7=extremely helpful) were high (mean=5.72). Similarly, mean ratings of cotherapists on 12 seven-point bipolar adjective scales (e.g., uncaring-caring, incompetent-competent, apathetic-enthusiastic) were all above 5 (7=the more positive adjective). These data suggest that both treatments were credible and helpful.

At the final treatment session, RP subjects rated their treatment significantly higher (mean=4.89; n=46) than SS subjects (mean=4.02; n=53) on a seven-point scale (7=extremely helpful) measuring helpfulness in staying off marijuana—$F(1,97)=5.45$; $p<.05$. These results probably reflect the RP treatment's emphasis on actively preparing to prevent relapse.

No significant differences between treatment were detected in the number of sessions attended (mean=7.54 sessions) or in the number of subjects who missed four or more sessions (RP=12; SS=15). Most of the reasons cited indicated that personal motives rather than treatment content determined nonattendance.

Eight of the 99 subjects participating in the final session assessment (RP=5; SS=3) reported attending alcohol- or other drug-related self-help groups during treatment or in the four-week posttreatment period. Similarly, six subjects (RP=3; SS=3) indicated that they attended other formal treatment programs for alcohol or other drug problems, and 15 subjects (RP=7; SS=8) received help for general psychological issues during the same period. These data do not appear to compromise interpretation of outcome data because of the even distribution of other treatment attendance across the RP and SS conditions.

Significant differences in treatments were detected in 12 of 19 ANOVAs performed on subjects' ratings of the frequency of various treatment components. These differences were consistent with the intent of the two treatment approaches. They characterized the psychoeducational role of RP group leaders and the structured, activity-

CORRECTION

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TABLE II
MEAN SELF-REPORTED MARIJUANA USE (N=97)*

Measure	Pretreatment Assessment RP**	SS***	Total	One-Month Posttreatment Assessment RP	SS	Total
Number of days of use in past month	27.13± 4.60	26.36± 5.79	26.72± 5.26	8.18±10.48	12.96±11.56	10.74±11.27
Typical Daily Use	2.58± .94	2.85± .83	2.72± .89	1.11± 1.11	1.29± 1.00	1.21± 1.05
Weekly frequency of use	17.54±14.67	20.59±17.73	19.17±16.37	3.71± 6.95	5.49± 8.86	4.66± 8.04

*Data are presented only for subjects who completed the one-month posttreatment assessment. Typical daily use ratings were made on a scale where 0=not at all, 1=once per day, 2=2 to 3 times per. 3=4 to 5 times per day, and 4=6 or more times per day.
**n=45
***n=52

oriented cognitive-behavioral approach. Conversely, SS group leaders were seen as facilitators of discussion, raising traditional drug abuse issues and encouraging peer interaction.

Taken together, these data suggest that both treatments were equally engaging and credible. However, they were distinct with respect to group processes, which allowed for valid conclusions regarding the efficacy of the respective treatments.

Marijuana Use

Ninety-seven (97) subjects (88%), completed the one-month posttreatment follow-up. Thirty (30) percent of the respondents (n=29) reported complete abstinence from marijuana for the month following treatment. As indicated by χ^2 analyses, abstinence rates did not differ significantly between RP (n=16; 36%) and SS (n=13; 25%) respondents. Table II presents subjects' self-reported mean use of marijuana before and after treatment. A 2x2x2 (treatment x sex x time) repeated-measures multivariate analysis of variance (MANOVA) was performed on the three marijuana use measures. Multivariate results, presented in terms of Wilks λ converted to an approximate F statistic, revealed significant effects for time and the treatment x time interaction: $F(3,91)=90.90$, $p<.0001$; $F(3,91)= 3.11$, $p<.05$, respectively.

Univariate 2x2x2 (treatment x sex x time) repeated-measures ANOVAs indicated that the effect of time was significant for the number of days of marijuana use in the past month, $F(1,93)=207.45$, $p<.0001$; for ratings of the number of uses on a typical day of use, $F(1,93)=169.39$, $p<.0001$; and for the average number of uses in a week reported on retrospective diaries, $F(1,93)=100.39$, $p<.0001$. The substantial reductions in mean marijuana use on each of these variables regardless of treatment condition illustrated these effects (see Table II).

The treatment x time interaction favoring RP was significant only for the number of days of use in the past month, $F(1.93)=6.42$, $p<.05$. Although there were no pretreatment differences between conditions, a significant posttreatment difference suggesting the superiority of relapse prevention was found. RP subjects had used marijuana on an average of 8.18 days in the preceding month, significantly fewer than the 12.96 average number of days for the SS subjects.

Collateral estimates of marijuana use were received from 105 collateral verifiers (RP=52; SS=53) at the one-month assessment. Collateral and subject estimates of days of use ($r=.81$, $p<.001$) and typical daily use ($r=.66$, $p<.001$) were highly correlated, although examination of the means suggested that collaterals tended to slightly underestimate the subjects' marijuana use. These results indicate that the subjects' self-reports of marijuana use posttreatment are valid when compared to collateral estimates.

OTHER DRUG USE

In order to test for changes in other drug use related to treatment participation, a 2x2x2 (treatment x sex x time) repeated-measures MANOVA was performed on the weekly frequency of use of 11 other drugs reported on retrospective diaries at pretreatment, final session, and one

month posttreatment. The multivariate results did not reveal any significant effects, suggesting that frequency of other drug use did not vary as a consequence of treatment, gender or time of assessment. The average use of other drugs during the posttreatment period was less than once per week for all drugs except alcohol (mean=2.3) and tobacco (mean=27.89). If alcohol and tobacco are excluded, 75 subjects (77%) did not use any other drug in the four weeks following treatment.

Collateral reports were largely consistent with subjects' reports and further document the minimal use of other drugs in this sample. Again, there was a tendency for collaterals to underreport subjects' drug use, which probably reflects their lack of detailed knowledge regarding subjects' behavior.

CONSEQUENCES OF MARIJUANA USE CESSATION

A comparison of the RP and SS treatment conditions was performed—using χ^2 analyses—on subjects' responses to the 44-item checklist assessing potential psychological and physiological consequences of attempting to modify marijuana use. Only two analyses revealed significant differences between groups. RP subjects (87%) were more likely than SS subjects (66%) to endorse the item "remembered something you learned during treatment and used it at the right time," $\chi^2(1, N=99)=4.78$, $p<.05$. SS subjects (42%) were more likely than RP subjects (20%) to endorse the item "able to go to sleep at night more easily," $\chi^2(1, N=99)=4.54$, $p<.05$. Although the former effect may be related to the skill-acquisition focus of the RP groups, there is no apparent explanation for the SS treatment's effect on sleep. Given the large number of comparisons and the inflation of the Type I error rate, both effects should be treated tentatively.

The positive consequences endorsed by 50 percent or more of the 99 subjects who participated in the final-session assessment included the following: "felt more in control" (87%); "felt more productive" (82%); "increased self-esteem" (80%); "better able to communicate with others" (77%); "remembered something you learned in treatment and used it at the right time" (76%); "wanted to do something new and different" (75%); "felt more energetic" (73%); "improved relations with friends" (71%); "able to make decisions more easily" (67%); "felt more at ease in social situations" (66%); "improvement in memory" (65%); "felt calmer or more relaxed" (59%); "increased the amount of time spent with others" (58%), "better able to control temper" (51%); and "experienced fewer periods of depression" (50%). These positive consequences indicated that subjects perceived improved social, cognitive, and emotional functioning as a result of modifying their marijuana use.

The negative experiences endorsed by 25 percent or more of the subjects included the following: "periods of restlessness and agitation" (74%); "experienced withdrawal symptoms" (73%); "difficulty going to sleep at night" (48%); "waking during the night" (44%); "felt tired" (43%); "felt more anxious in social situations" (36%); "increased mood swings" (34%); "increased periods of depression' (32%); "experienced unusual perspiration" (29%); "loss or damage to friendships" (26%); and "problems controlling temper" (25%). The negative consequences of marijuana use cessation appeared to represent a detoxification process, although some subjects experienced affective and interpersonal problems that may have been related to preexisting deficits in personal or social functioning.

DISCUSSION

This project demonstrated that adult, chronic marijuana smokers who were not concurrently abusing other substances could be successfully recruited into an abstinence-oriented treatment program. Two models of group therapy were compared, one of which focused on the prevention of relapse utilizing a variety of cognitive and behavioral skill-building components, while the other emphasized group discussion and a focus on the acquisition of social support. Careful attention to treatment development and therapist training resulted in treatments that were equivalent on nonspecific therapeutic dimensions, thus allowing for valid conclusions regarding the efficacy of the treatment-specific components. Although significant reductions in marijuana smoking occurred in both conditions one month following the completion of treatment, subjects in the RP condition appeared to benefit more on one measure of posttreatment marijuana use. No evidence of concurrent changes in alcohol or other drug use was found, either as a function of time or treatment condition. The use of collateral verifiers established the validity of subjects' self-reports of drug use. Finally, the findings indicated that efforts to reduce marijuana use were accompanied by additional positive outcomes relevant to the quality of subjects' lives.

Lifetime prevalence of drug taking for this sample was substantial, with just over a third reporting having been previously dependent on or having had problems related to the use of alcohol or another mood-changing drug (excluding tobacco and caffeine). Despite this substantial historical involvement with drugs other than marijuana, subjects did not show evidence of current problematic involvement. These findings suggest that a significant population of chronic marijuana users exists independently from multiple drug abusers.

Multiple adverse consequences of heavy marijuana use were acknowledged, including negative effects on per-

sonal, social, cognitive, and physical functioning. Withdrawal symptoms were frequently mentioned in both pretreatment and posttreatment assessments of the consequences of marijuana use and its cessation. Agitation, difficulty sleeping, and mood disturbances frequently occurred in conjunction with efforts to modify use. The extent to which these consequences resulted from a physiological withdrawal process cannot be addressed by the present data, but they have been established previously (Nowlan & Cohen 1977; Jones, Benowitz & Bachman 1976). Regardless of origin, these results further document a potential obstacle to marijuana cessation that may increase the need for treatment in individuals attempting to modify use.

Over 200 people expressed interest in this program in only six weeks of recruitment; of these, 110 were put into treatment. Three months later another 200 potential participants responded to recruitment announcements for the second cohort, resulting in another 102 treatment participants. Reasons for participation may have ranged from the prospect of free treatment to the threat of urine screening in the workplace, but the small number of applicants who had been involved in other drug-related treatment in the three months before recruitment suggests that the specific marijuana focus of this study may have played a role. Future analyses of the present data will address subjects' motivations for treatment. However, strong response to recruitment for this study indicates that there is indeed a need and a demand for treatment and research focused on adult marijuana use regardless of trends suggesting that the number of marijuana users is declining.

Results at the one-month anniversary of treatment indicated that 30 percent of the subjects were abstinent in the preceding month, with no significant difference between conditions. Considering that 75 percent of the sample aspired to abstinence before treatment began, this finding is somewhat discouraging. Nonetheless, the subjects reduced marijuana use to less than 50 percent of their pretreatment levels. The extent to which abstinence and the substantial reductions in use are maintained over time will be addressed in analyses of future follow-up data.

Subjects in the RP treatment condition reported significantly fewer days of use in the preceding 30 days (mean=8.18 days) than did those treated in the SS group (mean=12.96 days). The multivariate analyses employed suggested that this was a reliable finding even though no significant differences were found between treatments on other measures. The number of days of marijuana use may be a more sensitive outcome measure because "any smoking" on a specific day is easier to recall than the "number of times" of use each day or week of the recall period. Although this finding will need to be further assessed in future follow-ups of both cohorts, it suggests that the RP treatment approach is superior to the SS approach in promoting reduced use of marijuana.

The subjects in this study did not significantly change their usage patterns of alcohol or other drugs from baseline to the one-month posttreatment assessment. Reduced use of other drugs might have been expected as a result of generalization of treatment effect. Conversely, increased use of other drugs might have been hypothesized from a symptom-substitution perspective. Although neither of these hypotheses was supported, future follow-ups will continue to examine the apparently benign impact of these treatment approaches on other drug use.

The strong correlation of subject and collateral estimates of posttreatment marijuana and other drug use adds confidence to the interpretation of the outcome data. The consistent finding of lower estimates of use by collaterals in comparison to subjects may represent a lack of detailed knowledge of subjects' drug use and is consistent with other findings of underreports by collaterals in studies of alcoholics in treatment (e.g., Hesselbrock et al. 1983; Polich 1982). The emphasis placed on confidentiality of information in this study may have increased the accuracy of responses (see Babor, Stephens & Marlatt 1987). Subjects were clearly informed of the confidentiality of their reports and that a Certificate of Confidentiality granted to the investigators by the federal government prohibited subpoena or other involuntary disclosure of subject-identified data. Similarly, collaterals were informed that their estimates of the subjects' drug use would not be revealed to the subject or used against the subject in any fashion, thereby eliminating any reason to bias their estimates of use in either direction.

The subjects in this study were primarily in their thirties, well educated, employed and without overt evidence of debilitating psychopathology. The demographic characteristics of this group were consistent with other recent investigations (Haas & Hendin 1987; Roffman & Barnhart 1987) and suggest that many chronic marijuana smokers appear socially and occupationally functional on the surface. However, reports of cessation-related experiences, such as increased anxiety in social situations, loss or damage to friendships and difficulty in controlling anger, suggest that some marijuana users may be using marijuana in either a self-medicating or adaptive manner (Haas & Hendin 1987; Alexander & Hadaway 1982). More than half of the participants reported numerous indicators of improved functioning as a result of modifying their marijuana use. Although subjects may not have been experiencing major disruptions in their functioning pretreatment, they appeared to be reporting improvements posttreatment that indicated a sort of prior underfunctioning related to chronic marijuana use. Future analyses of

social support and personality as well as other indicators of improved functioning posttreatment collected on this sample of subjects may provide insight into these hypotheses.

In summary, these data demonstrate the importance and efficacy of research focused on the treatment of chronic marijuana use. Future components of this research will focus on subjects' drug-use status and correlates at three-, six-, nine- and 12-month anniversaries of treatment completion. Efforts will be devoted to seeking variables that predict treatment outcome and that shed light on the types of treatment this population needs. Ultimately, additional research will be necessary in order to examine the efficacy of matching subjects to the appropriate treatment based on the findings of the present research.

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Strategies for Breaking Marijuana Dependence

JOAN ELLEN ZWEBEN, PH.D.* & KATHLEEN O'CONNELL, PH.D.**

As cultural attitudes and workplace policies shift, and new information emerges about the untoward social and physiological side effects of marijuana abuse, more and more people appear to be deciding to stop smoking marijuana. Many factors seem to be involved, including the increasingly widespread use of urinalysis in the workplace, which can reveal to the unsuspecting user that marijuana is indeed a dependence-producing drug. The introduction of policies permitting drug screens motivates workers who are able to stop smoking to do so, in order to protect their jobs. Others decide to stop in response to pressure from significant others. Increasingly, those who find that they cannot stop smoking on their own are seeking help from treatment facilities. Since the early 1980's, more clients have been presenting at drug treatment facilities asking for help *primarily* for marijuana dependence (Tennant 1986b).

Users with other primary drug preferences, who are expected (by treatment personnel) to give up the use of all intoxicants, provide thought-provoking reports. For example, many who initially seek treatment for cocaine dependence state that giving up marijuana is in some ways more difficult, partly because it has been a part of their lives for a much longer time and is interwoven in ways that they did not recognize. These clients comprise a large group who have been observed by clinicians in inpatient and outpatient settings. Observing their changes as they move into the later stages of recovery has piqued interest because of some of the unanticipated changes in cognitive processing and emotional expression that unfold over time.

There are a variety of other reasons why people are questioning their marijuana use. Some who have been smoking 15 to 20 years begin to be alarmed at the consequences to their respiratory systems, as they suffer more frequent and severe ailments. Adult children of alcoholics painfully take inventory of their own alcohol and other drug use, and begin to opt for abstinence. Parents of adolescents with obviously damaging alcohol and/or other drug problems conclude that their own modeling is relevant and reexamine their involvement with this so-called harmless drug, which many have been smoking since the 1960's. These are some of the subgroups who are beginning to change their beliefs and practices.

Some present because they feel that long-term use of the drug causes them difficulty in expressing emotions like anger, and experiencing feelings of intimacy and closeness with their partner. Still others present with a sense of dissatisfaction in achieving life goals, especially in the area of career. Many of these people appear functional and even successful in the outside world, but in their internal experience they do not feel that they measure up to their original hopes and plans for their lives. Chronic users often describe a mild boredom, lack of zest, or a low-level depression that they rarely connect to their use of marijuana, but which dissipates when they become abstinent. These patterns, which are visible in the treatment situation, are the

*Executive Director, Pacific Institute for Clinical Training, Education and Consultation, 714 Spruce Street, Berkeley, California 94707.

**Clinical psychologist, P.O. Box 433, Capitola, California 95010.

subject of increasing discussion among clinicians, but little is known about how pervasive they are among marijuana smokers as a whole.

Marijuana has a complex chemistry, and consists of 400 known chemicals (Verebey, Gold & Mulé 1986); 60 of which are cannabinoids. Marijuana breaks down into 2,000 chemicals when smoked (DuPont 1984), and this complexity does not facilitate a simple explanation for marijuana's mechanisms of action, which is why it may be some time before its long-range effects are understood. Cohen (1986) indicated that early research was done on samples with a potency of one to two percent tetrahydrocannabinol (THC). Some of the marijuana that exists today (e.g., the sinsemilla that is grown in northern California) may range from seven to 15 percent THC, which is roughly equivalent to the hashish on which research was conducted in the 1960's (Tennant 1986b). Hence the first group of studies (e.g., Grinspoon & Bakalar 1981; National Commission on Marihuana and Drug Abuse 1972) suggested that marijuana was relatively benign. Later studies utilized increased potency and improved methodology (Cohen 1985). Marijuana research techniques have developed to a point where new data may yield a better understanding of this drug during the next few years.

TREATMENT OF MARIJUANA DEPENDENCE

For the pruposes of this article, marijuana dependence exists when someone is using regularly and cannot stop once they choose to. Since the drug's metabolites are stored in the body for long periods of time, resumption of use within the first 90 days of abstinence raises questions about dependence. This article is written from the perspective of helping those who want to stop, for whatever reason, and find it difficult to do so.

Management of withdrawal phenomena plays a key role in the treatment process for marijuana dependence, because improving retention is the key to improving treatment outcome (Craig 1985; De Leon 1984). It appears that those who engage in recovery-related activities over a period of time show improvement across a wide range of treatment modalities. The most dropouts occur during the first 30 days of treatment, when withdrawal phenomena are most intense. Although other factors certainly play a role, easing the stresses and discomforts of the withdrawal period increases the likelihood of the client remaining in treatment and provides a way to build a therapeutic alliance. The skilled clinician uses this opportunity to build a relationship with the client while discouraging the common conviction that the most difficult work of recovery is over once the client is fully detoxified from drugs.

Very few specific strategies have evolved for the management of marijuana withdrawal. The most effective approaches will ultimately derive from a full understanding of the pharmacokinetics of marijuana and the subjective and behavioral correlates. However, clinicians today must operate despite the crudeness of the map. Pharmacological adjuncts are available for alcohol, opiates, and cocaine withdrawal, but not specifically for marijuana. The present article will describe current propositions about withdrawal, review behavioral and other psychological strategies, and comment on how pharmacological adjuncts might prove useful. When possible, strategies that are specifically (or potentially) useful for marijuana will be described. In addition, a number of nonspecific strategies will be described that are generally used by clinicians working in the alcohol and other drug dependence treatment arena.

The Withdrawal Process

Education about the effects of drugs and the recovery process is a key part of treatment (Zweben 1986). Informing the client about the withdrawal process (e.g., what s/he may usually expect, known hazard points, and the time frame within which discomfort is likely to abate) provides reassurance and a good basis for problem solving to meet the expected challenges. For the purposes of this article, the withdrawal process includes both the phenomena associated with clearing the drug from the body, and those associated with the body's reconstituting to a normal, or predrug, state. This latter phase can be quite prolonged, a feature that can be emphasized to clients who become overconfident and are then tempted to terminate their efforts prematurely. Also, many clients interpret their cravings as a sign of failure or lack of motivation. Information on the lengthy withdrawal process can be reassuring, and encourages clients to plan ways to cope with it.

Along with information, a sense of hope can be planted that reinforces the sense of reward that abstinence brings. This sets up a positive reinforcement loop in which the client builds hope upon success upon hope, a loop that grows as it spirals back up on itself through the weeks and months of abstinence. This is important because some clinicians doing long-term work are beginning to suspect that the *full* flowering of the benefits of abstinence does not occur until 15 to 18 months into recovery. There are many signposts along the way, some of which are subtle, and the therapist can share observations with the client about such improvements. For example, the client's ability to concentrate on a theme for a period of time or sustain concentration when doing visualizations or meditations within the treatment session usually increases with abstinence. Some clients report tackling more difficult reading material or developing increased self-discipline or being less accident prone once they are abstinent for six months or more. The source of such changes is difficult to systematically assess, but the growing number of such reports certainly indicates

the need for further investigation. For the client currently in treatment, the sense of hope and positive expectations are especially critical when facing a protracted period of withdrawal.

Everything that is known about marijuana can be useful to the clinician, who weaves the information into the ongoing therapeutic process. In the absence of well-substantiated data, clinicians must draw on their observations and analyses of what clients regularly describe. Researchers, in turn, can draw on the clinician's precise description of behavior to track down the basic mechanisms involved.

Characteristics of Marijuana and the Withdrawal Process

The THC in marijuana is fat soluble, which helps it to penetrate biological membranes, to arrive at its sites of action quickly, and then be stored for long periods of time in lipid tissues (Verebey, Gold & Mulé 1986). Inasmuch as the human body has a water-based disposal system that operates via blood, perspiration, urine and feces, excretion of THC is less efficient than for certain other drugs, such as alcohol and cocaine. Indeed, THC is retained in organs with a high fat content, such as the brain, liver and reproductive organs (Dupont 1984). Because of the slow speed with which it clears the body, urine monitoring on a weekly basis is considered sufficient, with detectable concentrations often present for a month (Verebey, Gold & Mulé 1986; Swatek 1984). Since the long period of withdrawal is not well understood or widely recognized by users, many individuals stop for a week or more and then conclude that they are no longer dependent.

According to Tennant (1986a), significant withdrawal symptoms may not set in for a week or more. Tennant focuses on the plasma life of THC as a key factor in describing the characteristics of marijuana withdrawal. The plasma life is the amount of time it takes for the drug to leave the bloodstream—contrasted with the subsequent point at which the metabolite is no longer measurable in the urine—and is of central importance because it is closely related to use patterns as well as the subjective experience of withdrawal. For example, the plasma life of nicotine determines the frequency with which smokers crave a cigarette.

A second major point in Tennant's work (1986a) is that the manner in which marijuana is metabolized in the body results in withdrawal effects that may be delayed by a week or more. According to his description of the metabolism and pharmacokinetics of marijuana, certain metabolites produce the *high* (significant plasma concentrations for two to six hours); then breakdown products occur that appear to sustain the dependence while producing little or no euphoria (plasma concentrations evident for at least 48 to 72 hours). Thus, Tennant suggested that THC breaks down into components that are addicting, but devoid of subjective effects. The experience of *coming down* is related to the initial conversion of THC, and is noted by the user. However, if mild flulike symptoms occur a week or more later, they may not be seen as connected to marijuana use because the user may not identify them as withdrawal phenomena. Hence the addiction cycle can perpetuate itself for long periods of time, while the user maintains the conviction that s/he is not drug dependent.

MARIJUANA AND THE ENDOGENOUS OPIOID (ENDORPHIN) SYSTEM

Due to the prevalence of marijuana of increasing potency, observers are investigating the similarity between marijuana and opioid dependence. Tennant (1986a) reviewed animal studies in which investigators noted an opioidlike withdrawal syndrome when THC was discontinued. The most common signs observed were diarrhea, teeth chattering, wet-dog shakes, salivation, drooping of the upper eyelid (ptosis), pilcerection (hair standing on end), yawning, and increased activity. Later, human studies (Jones, Benowitz & Bachman 1976)) were consistent with these other reports. Tennant also cited animal studies in which the narcotic antagonist naloxone produced withdrawal symptoms. Kumar, Patel and Millard (1984) showed that THC depletes endogenous opioid peptides in rats, suggesting that marijuana dependence and withdrawal may involve the endogenous opioid system. This suggests that some of what is useful for opiate and alcohol withdrawal may be helpful for marijuana withdrawal as well.

Pharmacological Adjuncts

Blum and Trachtenberg (1986) have formulated a nutritional supplement, SAAVE™ that consists of amino acid precursors of dopamine and serotonin, and is intended to speed the normalization of brain chemistry in alcoholics. Early reports indicate that this product is effective in reducing craving, anxiety, hostility, irritability, insomnia and depressions, and in the long run enhances the recovery of the malfunctioning endorphin system. Blum outlined three ways that alcoholism develops (Blum & Topel 1986; Blum & Trachtenberg 1986), one of which is through a genetically based deficiency of internal opiates. Blum's formulation is intended to restore normal functioning to alcoholics, but is quite possibly beneficial to that subgroup of adult children of alcoholics (ACAs) who share the genetic anomaly, though they may not drink or show signs of alcoholism. Anecdotal reports from ACAs using SAAVE™ suggest that they experience an improved sense of well-being. To the extent that marijuana may interact with the endogenous opioid system, it may be useful for

marijuana users as well, if there is reason to think that they are ACAs. Preliminary clinical observations suggest that this is certainly worth systematic study.

l-Tryptophan has been regularly used in drug dependence treatment programs to help patients cope with the insomnia that is characteristic of withdrawal from any abused drugs. Although Wesson (1987) is currently the only person studying the systematic application of *l*-tryptophan, other researchers have suggested that it is indeed helpful to those with sleep disturbances, without impairing performance (Spinweber 1987; Schneider-Helmert & Spinweber 1986; Hartmann 1982-83; Hartmann 1977). *l*-Tryptophan is thought to be of value because it is a precursor of serotonin and hence would influence behavioral changes in the direction of improved sleep, diminished craving, and less depression (Blum & Trachtenberg 1986; Young, Chouinard & Annable 1981). A major unresolved question is how much *l*-tryptophan is actually absorbed by the body, and practitioners suggest that it be taken in conjunction with high carbohydrate loading (e.g., with a sweet drink, such as fruit juice) to facilitate utilization.

Tennant (1986a) commented that there is currently no recognized medical withdrawal regimen for marijuana dependence, and he and others have noted that patients who do not receive short-term withdrawal medication tend to drop out of treatment more frequently. In this respect, amino acid supplements may be a useful compromise.

IMPROVING PHYSICAL WELL-BEING

Exercise

The consensus among many practicing clinicians is that exercise is usually seen by clients as being very helpful. Inpatient chemical dependence treatment programs often include it as part of the daily regimen, and outpatient therapists encourage it as well. Clients report that regular exercise reduces drug hunger and seems to level out their moods. To the observing clinician, it appears to normalize the body chemistry more rapidly. Its efficacy may also be related to the fact that exercise gives the client something specific to do, and hence a nonchemical means of modifying feeling states.

What is usually recommended is regular aerobic exercise; no less than 30 minutes, at least four days a week. Aerobic exercise involves accelerating the heart rate to 75 to 80 percent of age-predicted maximums (a workable approximation can be obtained by subtracting the client's age from 185) for 15 to 20 minutes. It is important that the client add on time to warm up and cool down.

Clients are urged to list the types of exercise they engage in, and to schedule times in their appointment books and calendars for exercising. If the client's choice of exercise requires a gym or pool, s/he is asked to check schedules while making the exercise plan. Structure and specificity is especially important to clients who are trying to detoxify, as they tend to have difficulty being consistent even under the best of circumstances.

Clinicians have noted an interesting phenomenon reported by clients who have been abusing phencyclidine (PCP) or marijuana. With both of these drugs, vigorous exercise *may* result in the release of metabolites into the bloodstream, causing the client to feel high. In the case of PCP, psychotic behavior characteristic of the intoxicated state may be manifest. This latter phenomenon has been observed by clinicians in residential programs, who have more opportunity to observe it closely. Smith (1987) has suggested that this phenomenon may be an instance of subacute intoxication, in which release of the metabolites from the fatty tissues causes a low level of intoxication, but the relationship between this and subjective effects has not been systematically studied. In any case, if a client experiences this phenomenon, s/he can be reassured that it is usually transitory and of manageable intensity.

Eating Patterns

Counselors need to be attentive to the client's eating patterns, as it is common for clients who are detoxifying to unthinkingly adopt eating patterns that simulate the rushes and crashes of drug use. Others simply eat erratically, exacerbating the possibilities of irritability and depression. Still others substitute addictive eating patterns for those previously used with drugs. Counselors should inquire about eating patterns whenever the client complains of unusual discomfort or extreme mood variability during the detoxification period.

Clearing the Lungs

There are several approaches that can be utilized by the therapist both for assessment and treatment, one of which is to focus on pulmonary congestion. Postural drainage, a technique used to clear the lungs after surgery, can be easily taught in the office. It requires a second person for implementation, and hence is generally practiced by couples. The recovering person is instructed to lie on his/her stomach, positioned so that the trunk and head are lower than the lower body, in order to facilitate drainage by gravity of material trapped in the lower and middle lung lobes. The partner then begins to gently tap on the middle of the back, gradually working in an upward direction toward the upper back for several moments. This produces the release of old material that has been trapped in the lowest mid-pulmonary lobes for some time. It not only increases the profusion of oxygen to the lower lungs, but also demonstrates to the patient the kind of insidious long-term physical side effects of smoking marijuana (and/or tobacco). As a result, this procedure can break through a

level of deep denial concerning the seriousness of the effect of marijuana on the respiratory system. It is a therapeutically positive procedure because it engages the partners in a specific task as participants in the treatment process.

BEHAVIORAL STRATEGIES

There are many ways in which client efforts can reduce hazards and discomforts. Relapse prevention tools can be introduced even while the client is in the detoxification stage, and indeed are necessary to break the addiction cycle. Many of these involve identifying the triggers and stressors that contribute to drug abuse, and developing new coping patterns—several of which are described below. In addition, a number of authors have written about them at great length (Gorski 1986; Marlatt & Gordon 1985; Zackon, MacAuliffe & Chi'en 1985).

The Behavioral Risk Scale

The Behavioral Risk Scale (BRS) is a useful relapse avoidance tool that can be taught quickly to patients in the office (O'Connell 1985). It is useful for two reasons. First, any method that the patient can use mentally to buy time, even a few seconds or minutes, is a valuable commodity in recovery. A person who is pausing to consider the risk of a given factor for possible relapse decreases the temptation to act on impulse with every passing second. Clients can be reminded that cravings will pass (usually within a few minutes) and should be encouraged to use this tool to increase the amount of time between the presentation of the idea of using and actual use, should it eventually occur. Second, the control over the use of the tool is in the hands of the patient and not the therapist or anyone else. Hence the initiative and participation of the patient in the treatment process by the use of the scale is a positive factor in and of itself.

The BSR is a 10-point number scale on which the patient imagines that 1 represents abstinence (no risk) and 10 represents a slip or relapse. The client then mentally places on the scale the people, things, events, places and moods that are potential relapse factors. Any factor that ranks 5 or above is too risky and must be addressed. Combinations of factors can increase risk, and as the client is faced with a situation (either mental or actual) s/he is asked to imagine an intervention that would reduce the risk to below 5 on the scale. The therapist can easily teach this technique in one session and the patient can use it whenever s/he chooses. Many individuals successfully use this scale to avoid or reduce risky situations.

Insomnia

Sleep disturbance is a common feature of withdrawal from all psychoactive substances. Uncomfortable in its own right, insomnia may be a loaded issue for people with charged memories of it from childhood, jail or other sources. Many clients report using marijuana as sedation for sleep and greatly fear the effects of stopping. The following suggestions can be offered to people who anticipate problems with insomnia: (1) Go to bed at the same time every night, and get up at a regular time, no matter how little sleep you actually get. (2) Do not nap. (3) Do not consume caffeine after 6:00 p.m.—significant amounts may be found not only in coffee, but in black teas, Coca Cola®, Pepsi® and chocolate. Also avoid cigarette smoking at night, because nicotine is a stimulant. (4) Engaging in regular aerobic exercise, preferably at the same time of day, appears to help normalize sleep patterns, and (5) Calcium and *l*-tryptophan (both of which are found in milk) are nature's pacifiers and may calm and relax the client. A glass of warm milk at night works well for many. Others may prefer to take *l*-tryptophan (available from health food stores) in doses of 500 to 1,500 mg (taken along with high carbohydrate loading) for sleep dysfunction. Clients taking SAAVE™ should be reminded that it contains *l*-tryptophan, hence caution must be exercised if more is to be added.

Other psychological strategies, such as the use of relaxation tapes or exercises, may be employed. Some clients need to be reminded to avoid initiating a difficult discussion with their spouse or children before bedtime, and to reduce stimulation in general. Often clients will initially resist these behavioral interventions because they seem like a lot more work than taking a pill. They need to be informed that sleep medications tend to disrupt the normal sleep cycle, so that the sleep thus obtained is not the most refreshing. Though the measures recommended above may take several days to a week to help, they do tend to be effective if the client is able to maintain them. Intransigent sleep disturbances of long duration may yield to exploration of anxiety sources that may be operating, or it may indicate the need for a more thorough psychodiagnostic workup.

Urinalysis

The civil liberties controversies surrounding the issue of urine testing have colored public attitudes so that many do not recognize what an enormously valuable clinical tool it can be. Inasmuch as most drug abusers have repeatedly lied to the people they are most intimately involved with, rebuilding trust in relationships is a major task in recovery. Typically, the partner or spouse becomes anxious and mistrustful whenever the user is irritable, distracted or withdrawn; that is, when s/he manifests behavior that is typical of early recovery, particularly the detoxification period. Clients are very sensitive to accusations, tacit or overt, and are often angry and discouraged at being mistrusted even when doing well. The client's insistence on being trusted *now* is met with apprehension on the part of

others, who still may be recovering from the shock of what they discovered once the clouds of denial were lifted. This source of interpersonal tension may persist for many months, even years, as relationships are repaired.

Urinalysis is often welcomed in such circumstances by parents and adolescents as well as couples who view it as a chance for the user to restore credibility. When viewed as a way to document successful abstinence, it is greeted with enormous relief by those seeking to solidify the basis for trust. Clients for whom urinalysis is not mandated by an employer or the criminal justice system often voluntarily enter a urine monitoring program to remove the question of abstinence as a source of tension form their intimate relationships. In this situation, the client can be told to give a urine *only* if drug free; or otherwise voluntarily inform the counselor (and any others previously agreed on) that a slip has occurred. The user often reports that a regular urinalysis strengthens his/her support structure. Clients often report that monitoring makes the option to use less acceptable, and thus it provides an obstacle to impulsive use.

12-Step Programs

Twelve-step programs are an enormous asset to people in recovery, offering a wide range of resources at no cost. Introducing the client to such programs and helping him/her to make productive use of them on an ongoing basis can be seen as one of the key activities of the clinician (Zweben 1987). Unfortunately, primary marijuana users have been among the hardest to connect with these programs, because the more subtle effects of marijuana abuse seem to impede all but the highly sophisticated from making a strong identification. Because the adverse effects are more gradual and less dramatic than some other drugs, individuals may feel that the groups do not hear "their story." However, in the spring of 1987, 12-step groups for marijuana abusers started to emerge. As of early 1988, there were five such meetings of Marijuana Addicts Anonymous (MAA) in the San Francisco Bay Area, and there are probably meetings now appearing in other communities.

CONCLUSION

Marijuana dependence, though less dramatic in its effects, is certainly a phenomenon to be taken seriously. Because THC is lipophilic, traces may remain in the tissues for a long period of time, with effects that remain to be examined systematically. Although this article focuses mainly on the initial period of breaking the dependence cycle, the marijuana abuser can expect that this dependence is not easily ended, and a sustained effort will be required. Hopefully, the next decade of research will clarify the pharmacokinetics of marijuana so that even more specific approaches can be devised.

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MARIJUANA:

A SECOND LOOK AT HEALTH HAZARDS

Every Child Must Make a Decision about Marijuana.

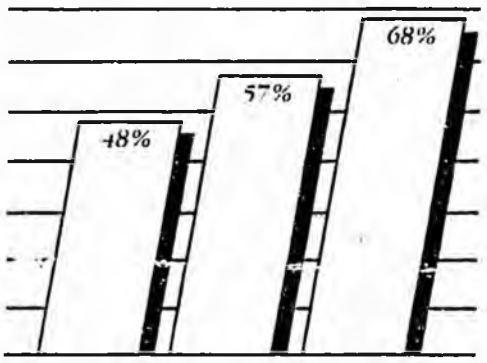
More than two and a half million adolescents smoke marijuana regularly. This includes one in twenty American high school seniors who smoke marijuana daily. Of greater concern is that one-third of high school seniors who smoke marijuana started in 9th grade or before. An increasing number first tried it in the 6th grade. These facts show that marijuana use is widespread among American youth and that the age at first use is declining. It is clear that every child will have to make a decision about marijuana. In order to help children make the smart decision, preventive measures must be taken early. This means teaching children the facts about marijuana and arming them with the skills to say "no" to pot.

Kids face a lot of peer pressure.

According to a 1983 survey by *Weekly Reader* magazine of over 100,000 students in grades 4 through 12, the main reason cited by students for smoking marijuana is to "fit in with other kids." In addition, this survey reported that more than one-quarter (28%) of 4th graders believe that kids their age feel "some" or "a lot" of pressure to use marijuana. These children face increasing peer pressure as they get older; see the bar graph above.

WHAT IS THE PROBLEM?

How much do kids push each other to smoke pot?



The Weekly Reader survey demonstrates increasing peer pressure among school children. A critical period, 7th–9th grades, is shown here.

Marijuana Isn't Kid Stuff.

Today's marijuana is often ten times stronger than the pot of the 1960's and 70's. Marijuana's potency is measured by the concentration of THC, the drug's principal intoxicating chemical. The average increase in THC from 0.5% to 4.5% makes today's marijuana more powerful and much more hazardous.

Kids are vulnerable. Smoking marijuana is especially dangerous during adolescence. Physical, psychological and sexual changes are rapid and complex. Any disruption of the normal processes due to marijuana smoking at this critical stage in development may have harmful and lasting effects. In particular, the THC in marijuana inhibits the hormone which sets adolescent development in motion.

What Makes Pot So Bad? Marijuana consists of the dried flowers, leaves and leaf stems of the plant *Cannabis sativa*. It is composed of over 400 substances which convert to over 2000 chemical compounds when marijuana is smoked or burned. The smoke contains a greater concentration of some of the cancer-causing substances (benzpyrene and benzanthracene) and lung irritants (acetone, acetaldehyde, and hydrocyanic acid) than those found in tobacco smoke. THC (delta-9-tetrahydrocannabinol) is the main psychoactive, or mind-altering, substance; it produces the marijuana "high." THC is fat-soluble and therefore is retained by the tissues of the lungs, liver, reproductive organs, and brain for up to one month after one marijuana cigarette has been smoked. Alcohol and nicotine, on the other hand, are water-soluble and leave the body in a few hours.

Marijuana Is a Gateway Drug.

The peer pressure that leads young people to try pot often leads them to try other, even more hazardous drugs. Half of daily marijuana smokers use amphetamines and one-third use cocaine.

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AMERICAN LUNG ASSOCIATION
The Christmas Seal People ®

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The misuse of psychoactive substances is the nation's foremost public health challenge. The use and abuse of alcohol, cigarettes, illicit drugs (heroin, cocaine, marijuana, etc.), and licit drugs (sedatives and tranquilizers) are by far the largest cause of preventable and premature illness, disability, and death in our society. The annual economic cost of alcohol and drug abuse has been estimated to be $136 billion, over four times that of cancer and nearly a third greater than that of cardiovascular disease (1). Illicit drug use has increased so rapidly over the past 25 years that it may be difficult for someone over age 50 to comprehend the extent to which drugs have permeated our society. Experience with illicit psychoactive drugs was restricted to 2% or less of the population in most areas of the country in the early 1960s (2). In contrast, the 1982 household survey (3) found that almost a third of the household population in the United States age 12 and older had had some experience with illicit drugs. Almost 60 million household residents had tried marijuana, and an estimated 20 million were current users. In 1982, it was estimated (4) that over 20 million had tried cocaine and over 4 million were current users. The prevalence of cocaine use and abuse has increased dramatically in the ensuing 4 years (4).

Illicit drug use is most prevalent in young adults. Typically, children begin experimenting with drugs of abuse by trying alcohol and cigarettes in early adolescence. By the time they complete secondary school, they have established attitudes toward drugs and patterns of use that will carry them through much of their lives. Most adults addicted to nicotine through smoking cigarettes established regular smoking in their teens. Adult users of cocaine and opiates generally began drug use in adolescence and may have been heavy marijuana users (5). In addition to exposing themselves to the risks of drug use (automobile accidents, overdose, or impaired physical, emotional, and psychological development), adolescents are establishing attitudes toward and actual patterns of use that have profound long-term consequences on health. By the time they graduate, more than half (54%) of high school seniors have tried marijuana and a fourth (26%) are current users. Cocaine use tends to begin a few years later than marijuana use, and heavy marijuana use is an important risk factor for cocaine use. Nevertheless, cocaine use now is increasing among our high school population. In the 1985 national survey of high school seniors (6), it was found that 17% had tried cocaine and almost 7% were current users.

In addition to statistics on the prevalence of use, there are now data from National Institute of Mental Health (NIMH) catchment area studies (7) on the lifetime prevalence of substance abuse disorders, which was found to vary from 15.0% to 18.1% among the three sites reported. These rates were significantly higher than the lifetime prevalence of any other group of disorders (except for phobic disorders at one site).

SOCIAL CONSEQUENCES OF USE OF MARIJUANA AND OTHER DRUGS

Young people may use drugs in an attempt to alleviate problematic family relationships. Over the short term, drugs may allow the young person temporarily to ignore intrafamilial strife, including developmental adjustments between child and parents and among siblings. Regular or heavy drug use undermines the adolescent's ability to work through these problems with other family members, thereby exacerbating family problems over the long term. The heavy drug user may withdraw socially from other family members, refuse to consider their needs and concerns, and put his or her own needs above those of the family. Theft from other family members (to obtain drugs) and lying (to hide drug use) undermine the trust necessary for coexistence within the family. Angry outbursts, property destruction, and intrafamily violence can ensue. Alienation of the drug user from the family, once present, is difficult to repair (8). Adult substance abusers also exert powerful effects on their families. Families react variably but often go through stages of denial, overprotection, personal mental illness, and family disruption. The effects on children in such families have been so profound that a national movement, the Adult Children of Alcoholics, has recently emerged to provide support and understanding (9–11).

Heavy drug use can precipitate financial problems in two ways. First, drugs themselves cost money; drug expenses are proportional to the cost of the drug, frequency of use, and dose consumed. Such costs mount as tolerance develops, habitual use becomes established, and larger amounts of drug are consumed more often. A second source of financial problems is unemployment or job loss. Early drug use may seem to facilitate work by alleviating fatigue or boredom or helping the user tolerate work-related stresses. Eventually, continued drug use undermines the person's energy, ambition, concentration, problem-solving abilities, performance, productivity, and social skills in dealing with co-workers and supervisors. Drug-induced paranoia, if present, further exaggerates interpersonal dissensions. In addition to individual financial loss, theft and unpaid loans from other family members can cause financial difficulties for the entire family.

The heavy drug user may resort to criminality to financially support the drug habit. Theft and illicit drug selling are the most

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CORRECTION

THIS DOCUMENT
HAS BEEN REPHOTOGRAPHED
TO ASSURE LEGIBILITY

MARIJUANA:

A SECOND LOOK AT HEALTH HAZARDS

WHAT IS THE PROBLEM?

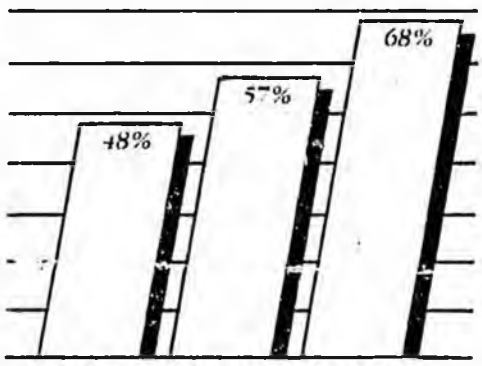
Every Child Must Make a Decision about Marijuana.

More than two and a half million adolescents smoke marijuana regularly. This includes one in twenty American high school seniors who smoke marijuana daily. Of greater concern is that one-third of high school seniors who smoke marijuana started in 9th grade or before. An increasing number first tried it in the 6th grade. These facts show that marijuana use is widespread among American youth and that the age at first use is declining. It is clear that every child will have to make a decision about marijuana. In order to help children make the smart decision, preventive measures must be taken early. This means teaching children the facts about marijuana and arming them with the skills to say "no" to pot.

Kids face a lot of peer pressure.

According to a 1983 survey by *Weekly Reader* magazine of over 100,000 students in grades 4 through 12, the main reason cited by students for smoking marijuana is to "fit in with other kids." In addition, this survey reported that more than one-quarter (28%) of 4th graders believe that kids their age feel "some" or "a lot" of pressure to use marijuana. These children face increasing peer pressure as they get older; see the bar graph above.

How much do kids push each other to smoke pot?



The Weekly Reader survey demonstrates increasing peer pressure among school children. A critical period, 7th–9th grades, is shown here.

Marijuana Isn't Kid Stuff.

Today's marijuana is often ten times stronger than the pot of the 1960's and 70's. Marijuana's potency is measured by the concentration of THC, the drug's principal intoxicating chemical. The average increase in THC from 0.5% to 4.5% makes today's marijuana more powerful and much more hazardous.

Kids are vulnerable. Smoking marijuana is especially dangerous during adolescence. Physical, psychological and sexual changes are rapid and complex. Any disruption of the normal processes due to marijuana smoking at this critical stage in development may have harmful and lasting effects. In particular, the THC in marijuana inhibits the hormone which sets adolescent development in motion.

What Makes Pot So Bad? Marijuana consists of the dried flowers, leaves and leaf stems of the plant *Cannabis sativa.* It is composed of over 400 substances which convert to over 2000 chemical compounds when marijuana is smoked or burned. The smoke contains a greater concentration of some of the cancer-causing substances (benzpyrene and benzanthracene) and lung irritants (acetone, acetaldehyde, and hydrocyanic acid) than those found in tobacco smoke. THC (delta-9-tetrahydrocannabinol) is the main psychoactive, or mind-altering, substance; it produces the marijuana "high." THC is fat-soluble and therefore is retained by the tissues of the lungs, liver, reproductive organs, and brain for up to one month after one marijuana cigarette has been smoked. Alcohol and nicotine, on the other hand, are water-soluble and leave the body in a few hours.

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breathing more difficult. Further, it impairs the special lung cells that fight infection.

Because marijuana smoking is a recent phenomenon, the long-term effects of its use are not yet documented. It is likely, however, that as pot-smokers age, the continuous assault on the delicate tissue of the lungs will cause debilitating lung disease.

Pot Smoking Doesn't Just Hurt the Lungs.

Marijuana also interferes with normal functioning of the cardiovascular, nervous, and reproductive systems.

The heart and cardiovascular system. Marijuana can increase heart rate by as much as fifty percent, depending on the THC concentration of the particular marijuana cigarette. At the same time, oxygen supply to the heart is reduced, causing chest pain and other harmful consequences in people with underlying cardiovascular problems.

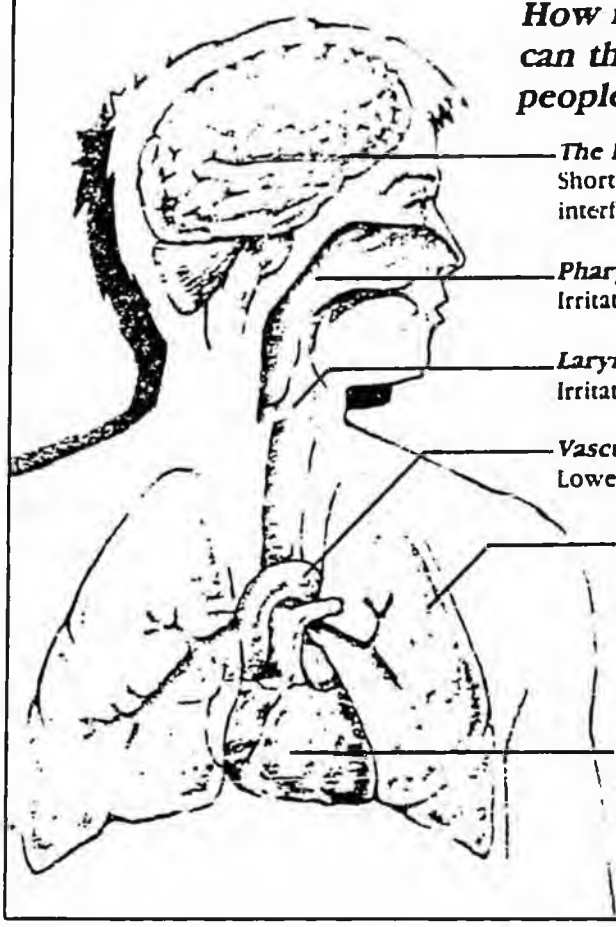
The brain and central nervous system. Marijuana use can result in both short-term and long-term effects on the brain. The short term effects include distortion of time and space perception and interference with thinking and learning. Some marijuana smokers experience "acute panic anxiety reactions" which include paranoia, abnormal fears, and extreme anxiety. Long-term regular users are often dependent on the drug and can experience "burn-out", a feeling of energy loss and apathy.

Sexual development and the reproductive system. In both males and females, marijuana causes impairment of normal sexual development. Marijuana smokers can develop tolerance to the drug but the sperm or eggs they carry inside can be adversely affected by marijuana's toxic chemicals.

Specifically, marijuana causes increased menstrual cycle abnormalities and interference with ovulation. When a pregnant woman smokes marijuana, the drug's chemicals enter her bloodstream, travel through the placenta, and enter the bloodstream of her fetus.

INSIDE STORY

How marijuana smoking can threaten young peoples' health.



In addition, marijuana increases the incidence of abnormal sperm cells (see photograph) and decreases sperm production, sperm motility and male hormone levels.

Healthy vs. Unhealthy Sperm

On the left is a healthy sperm, on the right the sperm of a chronic hashish smoker. Hashish is a stronger form of marijuana.

Other Consequences: Social and Psychological.

Children who smoke marijuana often exhibit a behavior pattern that includes: energy loss, diminished school performance, low motivation, absenteeism, difficult peer and parental relations and low self-esteem. Emotional and psychological development is interrupted when marijuana is used to avoid confronting normal adolescent "growing pains" and problems.

Parents Can Help.

Young children want the opinions and advice of their parents and other adults. They look to them for direction and guidance. Parents and teachers are vital role models during a child's social and psychological development.

Parents must be informed. It is important for parents to learn about the health hazards of marijuana so they can be confident that they are relaying relevant and up-to-date information to their children. As children get older and peer pressures mount throughout junior and senior high school, it becomes more difficult for parents to influence their children's behavior. Children accustomed to discussing the problems of drugs with their parents are more likely to continue this communication when they become teenagers. They will be better equipped to resist peer pressure and to say "no" to marijuana.

Driving High—A Deadly Road Hazard.

Marijuana impairs many driving skills including coordination, reaction time, and perception. Pot smoking can create the false impression that the user is driving capably, when in fact his or her critical driving abilities are badly impaired. Marijuana has been detected in the blood and urine of a disproportionately large number of highway accident victims. This finding indicates that a significant number of highway accidents and deaths are due to "drug driving".

Drugged, drunk and driving. Statistics show that teenagers frequently use marijuana and alcohol together. Since alcohol and marijuana affect the central nervous system in different ways, their combined use doubly impairs the user's ability to drive; and greatly increases the risk of tragedy on the highway.

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common illegal activities, but prostitution, robbery, and drug smuggling also occur. Easy money from criminal behavior impedes later rehabilitation, since the youthful person has been learning criminality rather than a licit occupation during this critical development period. Learning a job skill or profession requires hard work, willingness to make a commitment and risk failure, and learning responsibility, tasks not easily accomplished. Frustration, anxiety, and fear result to a greater or lesser extent, feelings that marijuana, cocaine, and other drugs can alleviate temporarily. Continued drug use undermines the persistence and industriousness needed to succeed at this developmental task. Drug intoxication and, later, withdrawal, impair the ability to concentrate, synthesize, and organize material, learn new material, apply general principles to specific problems, exert judgment in complex tasks and situations, and make timely decisions (12).

In developing friendships and, later, intimacy with persons of the opposite sex, most youthful persons experience anxiety, embarrassment, and fear of rejection. They may believe that drugs can relieve these aversive feelings as well as alleviate premature ejaculation (in males) and vaginismus (in females). However, prolonged heavy use can reverse these temporary gains in sexual performance, leading to anhedonia, amenorrhea, impotence, and rejection by a sexual partner (13). The lack of judgment seen in young drug and alcohol users often results in teenage pregnancy.

Adolescence is the time to acquire hobbies, sports, and other vocations that may last decades, even a lifetime (14). By and large, drug use does not enhance these activities. Drug use may in fact lead to abandonment of these pursuits and may intensify social isolation. Instead, the drug user pursues activities that focus on the drug use experience and that tend to be banal and boring if done without drug use. Thus, without drugs, the chronic user may be bored and at a loss for stimulating and rewarding activities. Recreational pastimes usually require a period of learning and acquiring skills, another lengthy process that is abandoned with drug use. Drug use during activities involving rapid psychomotor coordination, speed, and judgment (e.g., driving a car or motor boat, water or snow skiing) places the intoxicated person at risk of harming self or others.

In the process of becoming an adult, an adolescent learns to accept responsibility and cope with adversity. Maturation demands a focus outside oneself, task orientation, and the ability to delay gratification for a time. This personality development is impaired by the use of drugs, which furthers an egocentric and present-oriented attitude. If regular drug use began early in adolescence and was continued over several years, the recovering abuser often has the personality characteristics and maturation level of a much younger person (15). It is important to note that alcohol and cigarettes are "gateways," predecessors of marijuana use, which is in turn a predecessor of other drug use and abuse (16).

CONSEQUENCES OF MARIJUANA USE

General Medical Consequences

Two distinguished independent scientific groups separately have reported on marijuana in the past 6 years. The Institute of Medicine, National Academy of Sciences, prepared a report on marijuana and health that was published in 1982 (17). The Addiction Research Center, World Health Organization, prepared a report on the Conference of Adverse Health and Behavioral Consequences of Cannabis, which was published in 1981 (18). Both reports concluded that cannabis has both known and suspected health hazards that should be of serious national concern.

The health consequences of chronic marijuana use depend to some extent on the frequency, duration, and intensity of use, the age at which use begins, and biopsychosocial characteristics of the user, which may contribute to risk in still unspecified ways. For example, not all individuals who smoke tobacco cigarettes will go on to develop carcinoma of the lung, but the risk of this disorder is much greater among smokers, and the relative risk increases with the intensity, frequency, and chronicity of use.

Since the two aforementioned studies were published, further evidence of the harmful effects of marijuana has been established. In particular, the clearest evidence for harmful changes in physical health involves the pulmonary system (19–22 and a December 1979 report of the AMA Council on Scientific Affairs). Bronchitis and related inflammatory changes have been shown repeatedly. More recently, it has been shown that marijuana smoking causes a significant reduction in the gas-diffusing capacity of the lung. Moreover, there is considerable evidence to suggest that long-term use, like tobacco smoking, may lead to pulmonary cancer. Indeed, marijuana has up to 50% more aryl hydrocarbons in its smoke than tobacco, and high levels of these are associated with susceptibility to bronchogenic carcinoma. Many marijuana smokers also smoke tobacco, and it is postulated that the combined effects of smoking both substances may substantially increase the risk of cancer. Most important are the profound acute and chronic psychosocial, cognitive, and behavioral effects associated with marijuana use by youth. Acute toxicity is accompanied by negative effects on learning and memory, as well as psychomotor impairment. The typical effects of cannabis resemble a transient acute brain syndrome; they include deficits in attention span, concentration ability, short-term memory, information processing, and the performance of complex perceptual motor tasks. Thus, accidental injury to persons driving motor vehicles, piloting airplanes, or operating heavy machinery while intoxicated with marijuana is of special concern.

Even when marijuana use is discontinued, the memory loss continues for 3 to 6 months. This particularly affects adolescents who have been having difficulties in school. This consequent negative reinforcement leads them to return to marijuana use.

Specific Psychiatric Concerns

Psychiatrists have described three general complications associated with cannabis: acute adverse reactions, flashbacks, and prolonged reactions. Acute reactions are characterized by errors in judgment and confusion, which may be followed by an amnesic period. These are dose related and fall within the general category of deliria (23, 24). Anxiety may progress to acute pain reaction with overwhelming anxiety and a fear of losing control in response to drug-induced symptoms. Factors related to setting and/or personality may lead to severe anxiety.

Flashbacks refer to brief, spontaneous recurrences of mental states experienced during marijuana intoxication that occur sometime after the last drug use. At this writing, the exact mechanism for flashbacks is uncertain.

Prolonged reactions secondary to marijuana use include psychotic and nonpsychotic reactions. Marijuana smoking may trigger a schizophrenic reaction in vulnerable individuals. Descriptions of long-lasting cannabis-induced psychoses appear mainly in medical journals in Asia and North Africa, where individuals may use cannabis at substantially higher doses than in the United States. Descriptions of cannabis psychoses vary by culture, and most reports suggest a persistent delirium, which includes bizarre behavior and the potential for violence and panic feelings in the absence of a "typical" schizophrenia-like psychotic state. There is fairly general agreement that persons suffering from marijuana psychosis do not develop psychotic thoughts or symptoms characteristic of schizophrenia. Most reports describe cannabis psychosis as lasting 1–6 weeks among very heavy users of high doses of cannabis. However, some reports describe longer-lasting marijuana psychoses in which the psychotic episodes do not clear in the usual time but persist in residual form. Repeated intoxications may result in recurrent psychotic episodes. There has been a problem in relating marijuana psychosis to the experience in Western countries because of differences in smoking patterns in the East and the West, the difficulty of translating the psychiatric symptom picture from one body of literature and culture into another, and the impossibility of generalizing from cases that come to psychiatric attention to the overall marijuana-using population.

Nonpsychotic prolonged adverse reactions have also been described. Chronic anxiety states, depressive symptoms, and changes in life style (including an "amotivational syndrome") have been linked to chronic marijuana use by a number of observers. The amotivational syndrome includes apathy, loss of effectiveness, and diminished capacity or willingness to carry out complex long-term

plans, endure frustration, concentrate for long periods, follow routines, or successfully master new materials. Verbal facility often is impaired both in speaking and in writing. Such individuals experience greater introversion, become totally involved with the present at the expense of future goals, and demonstrate a strong tendency toward regressive, childlike, magical thinking. It remains unclear whether those who are attracted to heavy marijuana use already were inclined toward an amotivational syndrome, of which the marijuana use was symptomatic, or whether the amotivational syndrome developed as a consequence of the chronic marijuana use. What is clear is that chronic marijuana smokers who develop amotivational patterns of behavior need to stop marijuana use if they are to be rehabilitated.

Finally, the question of marijuana's dependence-producing capability is raised frequently. Laboratory animals do not self-administer Δ^9-tetrahydrocannabinol as they do opioids, sedative hypnotic drugs, alcohol, and stimulants. Nevertheless, compulsive patterns of cannabis consumption do develop in human beings, and heavy use of marijuana in humans is associated with the development of a dependence syndrome. Moreover, heavy users of marijuana appear to be at substantially greater risk for other forms of drug abuse than persons who do not use marijuana. Finally, the long persistence of cannabinoids in the body after ingestion (up to 9 days after a single dose) raises the additional prospect of toxicity due to accumulation of the drug and its metabolites in the brain and other lipid-containing organs.

CONSEQUENCES OF COCAINE USE

The growing popularity of cocaine, as a drug of both use and abuse, is testimony of the willingness of human beings to consume psychoactive substances without regard to their effects on the brain or other body organs.

The adverse effects of cocaine on health may be divided into the general medical, specifically psychiatric, and social sequelae of acute and chronic use. The probability that adverse effects will occur is, in turn, related to factors such as dose, route of administration, and frequency and duration of use. Changing routes of cocaine administration (such as "free basing" or using "crack") increases the severity of health consequences. Frequent administration, even over short periods of time, leads to the accumulation of cocaine in plasma and presumably in brain tissue and increases the risk of adverse medical and psychiatric sequelae. Cocaine rapidly depletes endogenous neurotransmitters, leaving the user in a depressed state. Individual tolerance and vulnerability to the physical and psychological effects of the drug also play a role.

General Medical Consequences

Some sequalae of cocaine use stem from the drug's local anesthetic properties, its direct effects on small capillaries, and its ability to stimulate sympathetic nervous system activity. Other medical complications are the indirect result of the drug-using life style.

Until the upsurge of smoking crack cocaine, 80% of all cocaine use was by nasal inhalation (snorting). The direct effects of the drug on mucous membranes are responsible for a number of medical complications. These include rhinitis, erosion of the mucous membranes, and in severe cases, perforation of the nasal septum (25). Intravenous cocaine use, favored by some for the rapidity of onset and intensity of drug effects, is associated with all of the complications that one might expect with any type of unregulated intravenous drug use. These include skin abscess, thrombophlebitis, septicemia, hepatitis B, acquired immune deficiency syndrome (AIDS), and tetanus (26). Smoking the basified extract of cocaine (free basing or crack smoking) delivers the drug into the pulmonary capillary bed, where it is rapidly absorbed and results in a dramatically intense effect and a more rapid onset of addiction. Free basing and crack smoking have been associated with the development of chronic bronchitis and impairment in pulmonary diffusing capacity (27).

Cocaine's ability to stimulate the sympathetic nervous system may result in elevated heart rate and increased susceptibility to premature ventricular beats and, in some vulnerable individuals, ventricular fibrillation, respiratory arrest, and death (28). Acute elevations of blood pressure, with headache and the potential for cerebral hemorrhage, also have been described (29). Increased body temperature due to failure of the brain mechanisms controlling heat regulation, coupled with vasoconstriction and hyperactivity, has led to some deaths from hyperthermia (30).

Another untoward effect of cocaine is the development of status epilepticus. This may occur either as an acute response to high-dose use or as a result of a sensitivity to cocaine developed during chronic administration. The latter may be due to a so-called "kindling" phenomenon, in which brain neurons become increasingly sensitized to the effects of cocaine and fire in response to even relatively low doses of the drug (30).

All of the adverse medical complications of cocaine use are far more likely after acute administration of large doses. In many instances overdose is unintentional, since the user has little knowledge of the purity or even the amount of the drug consumed. Overdose deaths have occurred after the first use in apparently healthy individuals with no preexisting illness. In addition, repetitive use is associated with increasing sensitivity in some of the excitatory effects of cocaine. Finally, a small number of individuals suffer from a congenital lack of the enzyme pseudocholinesterase and thus are unable to metabolize the drug. In these individuals, even small doses can produce dramatic effects. The medical complications of cocaine use are more likely to occur in persons with preexisting heart or respiratory disease, hypertension, seizure disorders, or compromised immune function and in those who are taking other drugs whose effects are potentiated by cocaine.

Specific Psychiatric Complications

The acute subjective response to cocaine is characterized by euphoria, insomnia, increased energy, enhanced mental acuity and alertness, and an increase in sensory awareness. However, some individuals become hyperexcitable, while others, particularly those with underlying depressive disorders, experience dysphoria. Anxiety, concentration difficulties, decreased attention span, and memory problems also have been reported after use of cocaine. In individuals with underlying panic disorder, the drug can precipitate panic attacks. Some cocaine users may misperceive reality and/or experience auditory, visual, and tactile hallucinations. Flight of ideas, distractibility, pressured speech, restlessness, impulsivity, and poor judgment are common. Paranoia and delusions of persecution, coupled with profound irritability and grandiosity, may lead to assaultive and/or homicidal behavior by some cocaine abusers. These alterations in thinking, mood, and behavior may last a short time or, in certain vulnerable individuals, may persist long after the drug has been metabolized (31, 32).

Chronic cocaine use also is associated with untoward effects on psychological health. Several studies have demonstrated a direct relationship between cocaine dose, chronicity of use, and the development of cocaine-related psychopathology. Chronic cocaine users frequently complain of fatigue, headaches, impairment of recent memory, concentration difficulties, and sexual indifference. They also are more likely to develop a cocaine psychosis (described previously).

In some individuals the powerfully reinforcing effects of cocaine lead to increased frequency of use, escalation of dose, and the eventual development of psychological and physical dependence. The onset of dependence is particularly rapid with the use of crack. The primary reinforcing effects of the drug are probably mediated through the limbic system mechanisms responsible for the perception of pleasure—specifically, those neural circuits that use norepinephrine and dopamine as neurotransmitters. Other factors that contribute to the development of dependence include psychological variables, peer pressure, drug availability, and (perhaps) some sort of underlying biological vulnerability.

The tendency toward repetitive use is further enhanced by the occurrence of a cocaine withdrawal syndrome characterized by depression, lethargy, fatigue, feelings of guilt, anxiety, and feelings of helplessness, hopelessness, and worthlessness. In some individuals, particularly those with preexisting underlying depression, transient suicidal thoughts may emerge.

The cocaine withdrawal syndrome is particularly marked after chronic high-dose use. The signs and symptoms usually last 12–36 hours. In some individuals, however, the depression may last up to several weeks. To avoid withdrawal, some chronic users will self-administer the drug every 20–30 minutes. This pattern of use is more likely to be associated with the development of cocaine psychosis. The serious psychosocial consequences of cocaine use include loss of job and problems with one's family, friends and finances.

In summary, both acute and chronic cocaine use are associated with adverse effects on health. In addition to medical and psychiatric sequelae, chronic cocaine use also is associated with the hazards of a drug-using life style. These include anorexia and associated weight loss, malnutrition and vitamin deficiencies, accidents, and a greater likelihood that one will be the perpetrator or victim of violence.

ROLE AND RESPONSIBILITY OF PSYCHIATRISTS

Psychiatrists should exercise a leadership role in drawing attention to the major public and mental health consequences of substance abuse in our society. Psychiatrists have a responsibility to educate the public about how ubiquitous drug abuse is and how it is both the cause and consequence of emotional problems. We must be aware that drug and alcohol abuse are often the primary problem among patients who present themselves to psychiatrists. Psychiatrists should take leadership responsibility in assuring that adequate training in substance abuse occurs at all levels of medical education and in influencing physician attitudes and behaviors as part of this training process. Psychiatrists also should interface with nonmedical care givers, such as educators, the clergy, counselors, and self-help groups, in imparting an understanding of the psychiatric implications of substance abuse. The psychiatrist's role in working with the family is essential.

Evidence has accumulated over the past decade that there is a significant association between psychopathology and substance abuse. In some instances, substance abuse has resulted from psychopathology and in other cases has been the cause of it. In either case, for most individuals regular reliance on drugs is incompatible with a life of meaningful relationships, productivity, and satisfaction. Substances of abuse are dangerous because they exert powerful deleterious effects on human emotions and behavior. Mind-altering drugs, including alcohol, create illusions that emotional distress can be avoided, that desired states or behaviors can be augmented, and that performance can be enhanced or improved. During adolescence, when particularly intense emotions, behaviors, and performance concerns loom large, this is a seductive and dangerous effect of drug use. However, these dangers also apply to other phases of life, when other developmental challenges are encountered and need to be mastered.

Psychiatrists should address the emotional and mental health needs of substance abusers. Psychiatrists should educate themselves and the public about how substance abuse affects the psychological and social functioning of individuals and their families and should take active roles in developing and establishing guidelines and protocols for the assessment and management of substance abuse problems. Psychiatrists should provide the public with information on the hazards of substance abuse through the media, public education campaigns, and contacts with other care providers and professional associations. Psychiatrists should take the initiative in developing guidelines and procedures for quality assurance and assessment of treatment outcome for substance abuse treatment programs. Finally, psychiatrists, through the American Psychiatric Association, should exercise an ongoing leadership role to assure nondiscriminatory reimbursement practices for substance abuse treatment services.

Each psychiatrist has a responsibility to understand and learn about substances of abuse; their psychoactive, toxic, and withdrawal effects; and how they interact with human emotions and behavior. Practicing psychiatrists must routinely obtain drug and alcohol histories, focusing not only on duration, amounts, and patterns of use but also on the effects that patients seek and obtain from the drugs they choose. Similarly, family histories of drug use and misuse patterns also should be obtained routinely. Psychiatrists should routinely consider whether their patients with psychiatric conditions suffer from concomitant substance abuse disorders and whether patients presenting with substance abuse disorders also might be suffering from coexistent treatable psychiatric problems. Psychiatrists should be cognizant of the life-threatening aspects of substance abuse as background for emphasizing the importance and necessity of obtaining control and abstinence at the onset of treatment. Accordingly, psychiatrists must learn how to use appropriate hospital and other residential treatment, support groups (e.g., Alcoholics Anonymous and Narcotics Anonymous), pharmacological treatment, and psychotherapeutic modalities (33).

Psychiatrists involved in the treatment of children and youth presenting with behavioral and emotional problems should be alert to the possibility that drug use may be a contributing factor. Close cooperation between psychiatrists, primary care providers, parents, and educators is needed to overcome the serious problems of alcohol and other drug abuse among our youth.

Finally, psychiatric practitioners are well suited to work with primary care providers in assessing and managing substance abuse patients in both outpatient and inpatient settings. They also are able to work with and interface with nonmedical caregivers, especially in consulting with self-help programs and drug counselors and helping them appreciate the mental health needs and psychiatric disabilities of their clients. The psychiatrist has a substantial contribution to offer in the management of the substance abuser. The psychiatrist can provide a dynamic understanding of the patient and can plan individualized multidisciplinary treatment and its implementation. It is the responsibility of the psychiatrist to emphasize the danger of drug use. To adopt a more neutral stance toward drug use by youth and refrain from warning of the dangers to mental health is to fail to fulfill an important public health responsibility of our profession.

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