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Comparing the dynamic course of heroin, cocaine, and methamphetamine use over 10 years

Yih-Ing Hser*, **Elizabeth Evans**, **David Huang**, **Mary-Lynn Brecht**, and **Libo Li**
UCLA Integrated Substance Abuse Programs, Semel Institute for Neuroscience and Human Behavior, University of California, Los Angeles, 1640 S. Sepulveda Blvd., 200, Los Angeles, CA 90025, USA

Abstract

To examine dynamic changes in drug-use trajectories over time we analyzed episode types and predictors of quitting use over the 10 years following drug-use initiation for 1797 heroin, cocaine, and methamphetamine (meth) users. Most episodes reflected high use and incarceration, however these events occurred more frequently among heroin and meth users. Quitting was predicted by current treatment and self-help participation among meth (RR 2.57, 1.79–3.70; 2.57, 1.80–3.67) and cocaine (RR 2.00, 1.42–2.81; 2.10, 1.63–2.72) users, and by a history of quitting for meth users (RR 1.11, 1.06–1.17). Quitting was less likely among all users under legal supervision (RR 0.55–0.69) and among heroin (RR 0.66, 0.45–0.97) and meth users (RR 0.73, 0.60–0.89) with an early drug-use onset. Relative to cocaine or meth use, heroin use was characterized by persistent use at a high-level which was often only interrupted by incarceration. While quitting drug use can be facilitated by treatment and/or self-help participation, few people had these experiences in the 10 years following first use.

Keywords

Substance use; Trajectories; Longitudinal; Quitting

1. Introduction

Both the scientific and medical communities now increasingly acknowledge that drug dependence can be a chronic disorder that requires long-term care or management (Anglin, Hser, & Grella, 1997; Hser, Hoffman, Grella, & Anglin, 2001; Hser, Longshore, & Anglin, 2007; Hser, Huang, Brecht, Li, & Evans, 2008). However, the extant literature is limited in that it mainly focuses on studies of heroin users or on studies with short-term observation periods. Along with heroin, cocaine and methamphetamine (meth) are considered “major” illicit drugs that are often associated with severe consequences including mortality, morbidity, and criminality. In our own prior work on drug-dependent users, we found that for all three drug types, use trajectories since initiation were persistent over 10 years of observation; however, average use levels were highest for heroin (13 to 18 days per month), lowest for cocaine (8 to 11 days), and in between for meth (around 12 days per month) (Hser, Huang, et al., 2008). Furthermore, consistent with earlier research demonstrating associations of early drug-use onset with more frequent drug use, a quicker escalation to higher levels of use, and

*Corresponding author. UCLA Integrated Substance Abuse Programs, 1640 S. Sepulveda Blvd., Suite 200, Los Angeles, CA 90025, USA. Tel.: +1 310 267 5388; fax: +1 310 473 7885. yhser@ucla.edu (Y.-I Hser)..
laevans@ucla.edu (E. Evans), yhuang@ucla.edu (D. Huang), lbrecht@ucla.edu (M.-L. Brecht), lilibo@ucla.edu (L. Li).

greater persistence in using (Anthony & Petronis, 1995; Office of the National Drug Control Policy, 2004; van Ours, 2006; Yu & Williford, 1992), we also found associations between early onset and persistent high use of heroin, cocaine, and meth (Hser, Huang, et al., 2008).

However, notwithstanding our own earlier work, no studies have investigated if long-term patterns of cocaine or meth use are similar to that of heroin. Furthermore, it is not clear what similarities and differences may exist in predictors of and pathways to quitting among users of these different drugs. Lastly, although risk and protective factors have been shown to predict drug abuse outcomes at subsequent time points and the high frequency of life transitions that often accompany long-term use has been documented (Scott, Foss, & Dennis, 2005), few studies have tested the flow of such processes over time or determined how variables operate so as to "push" individual trajectories toward or away from adverse outcomes (Wills, Walker, & Resko, 2005).

In this article we further examine dynamic patterns of heroin, cocaine, and meth use over the first 10 years following their initiation, focusing on similarities and differences in the frequency and duration of use patterns, service system (treatment and self-help, criminal justice) exposure, and predictors of quitting. Applying a life course perspective, we conceptualize the progression of drug use as involving onset, maintenance of use, no use, and relapse, and we examine relationships between these events that, over time, can be characterized as drug-use acceleration or deceleration.

A systematic mapping of drug-use patterns over time by drug type and user characteristics can have important policy and service implications. Identifying factors associated with distinctive life course drug-use patterns, with an emphasis on phenomena associated with drug-use deceleration and desistance, will assist in developing more targeted treatment services and policies. Below we briefly examine aspects of change processes pertinent to our current examination of drug-use patterns over the life course.

1.1. Acceleration and maintenance of use

While initial involvement with drugs may originate with external factors, e.g., peer pressure, drug availability, or other environmental risk factors (Day, Degenhardt, & Hall, 2006; Guo, Hill, Hawkins, Catalano, & Abbott, 2002), and vulnerability may be inherited in the form of heightened susceptibility to a certain drug type, subsequent escalation to and maintenance of higher levels of drug use are likely the result of a combination of biological, environmental, and, particularly, psychological or psychiatric characteristics (Kaplan, Martin, & Robbins, 1985; Lynskey et al., 2003). Many studies have focused on the progression from initiation to dependence among adolescents (Bolognini et al., 2005; Manning et al., 2001; White, Jarrett, Valencia, Loeber, & Wei, 2007; Zapert, Snow, &Tebes,2002), and time to dependence has been found to be fastest among users of opiates and cocaine (Ridenour, Lanza, Donny, & Clark, 2006; Tsuang et al., 1999; Wagner & Anthony, 2002). Differences in acceleration rates have been reported by race (Ellickson, Hays, & Bell, 1992; Hyman, Garcia, & Sinha, 2006; Reardon & Buka, 2002; White et al., 2007) and gender (Hyman et al, 2006; Liu & Kaplan, 1996; O'Brien, Wu, & Anthony, 2005). Fewer studies have analyzed the onset and course of methamphetamine use (Brecht, Greenwell, & Anglin, 2007) and none, to our knowledge, have compared the incidence and duration of acceleration episodes for heroin, cocaine, and meth over long periods of time.

1.2. Relapse

Even among those who cease use due to their own efforts or treatment, with some exceptions (Price, Risk, & Spitznagel, 2001), high rates of relapse (60%–78%) are typical (Butzin, Martin, & Inciardi, 2005; Chung & Maisto, 2006; Davstad et al., 2007; Gossop, Stewart, Browne, &

Marsden, 2002; Hser, Joshi, Anglin, & Fletcher, 1999; Simpson, Joe, Fletcher, Hubbard, & Anglin, 1999; Termorshuizen, Krol, Prins, & van Ameijden, 2005). Relapse research has examined the course of use by discrete drug types, notably heroin and cocaine, and findings have generally shown that severe or dependent users tend to persist in their drug use, often for substantial periods of their lifespan. Dennis, Scott, Funk, and Foss (2005) documented the 27-year use careers of primarily cocaine, heroin, and alcohol users, noting that treatment episodes typically first occur later in the use career. Over 33 years, Hser et al. (2001) found that even among heroin users abstinent for as long as 15 years, a quarter eventually relapsed. Similarly, Falck, Wang, and Carlson (2006) and Scott et al. (2005) reported persistent use or high relapse rates among cocaine alcohol, opioid, and cannabis users in their long-term follow-up studies. Low socioeconomic status, comorbid psychiatric conditions, and lack of family and social supports are among the most important predictors of relapse (Hasin et al., 2002; Hser, 2007; McLellan, Lewis, O'Brien, & Kleber, 2000; Termorshuizen et al., 2005; Weisner, Ray, Mertens, Satre, & Moore, 2003). However, few studies have sufficiently lengthy observation periods to adequately characterize the phenomena involved in the long-term processes of dependence, recovery, and relapse and even fewer have investigated differences in these processes by drug type.

1.3. Deceleration and quitting

Relative to onset and relapse, deceleration and quitting are the least studied phenomena in drug abuse research. Despite the theoretical and policy importance of understanding why people reduce or stop their use, we lack robust conceptual models or rich empirical investigations of maintaining abstinence over the long term. We can, however, identify periods of no use and use, as well as predictors of quitting. Studies suggest that quitting drug use is often mediated by critical life events such as treatment entry, incarceration, and psychiatric distress (Bradizza, Stasiewicz, & Paas, 2006; Dennis et al., 2005; Goldstein & Herrera, 1995; Hser et al., 2001; Warner, Alegria, & Canino, 2004). Drug treatment and self-help participation has not always been associated with quitting (Sherman, Hua, & Latkin, 2004); and qualitative analysis of heroin cessation has reported a high incidence of repeated quit attempts and treatments, often following major life events related to family, health, and employment (Mullen & Hammersley, 2006). Quitting has also been related to disassociation with one's drug-using network (Latkin, Knowlton, Hoover, & Mandell, 1999) and social and personal resources, for example self-efficacy (Hser, 2007) and coping strategies (Gossop et al., 2002), can also be instrumental in overcoming dependence.

Taking advantage of several long-term follow-up studies of drug users with different primary drug types, we analyze the first 10 years following initiation of the drug-use life course to address the following research questions:

1. What are the dynamic patterns of drug use (e.g., onset, acceleration, relapse, deceleration, no use) for primary heroin, cocaine, and meth users?
2. How are user characteristics (e.g., gender, race/ethnicity, and socioeconomic status) and service system exposure (e.g., criminal justice involvement, drug treatment and self-help) related to quitting drug use?
3. How do these patterns and relationships compare across primary heroin, cocaine, and meth users?

We hypothesize that compared to cocaine and meth, heroin addiction will present longer periods of regular use that are more persistent over the life course; quitting will be associated with later onset of drug use, more treatment exposure, and less criminal involvement; and, the dynamic course of use will indeed differ by drug type but will be influenced by similar sets of user and service system factors.

2. Methods

2.1. Datasets and samples

To address these research questions, analyses used data from five studies that collected longitudinal information using the Natural History Instrument (described below). All studies were conducted in California. We rely on projects with Natural History Interview data to maximize coverage of the drug-use career, and we select from each study those subjects for whom the primary drug problem reported by the subject was heroin, cocaine (the majority used both crack and/or powder cocaine), or meth. Projects include the 33-year Heroin Follow-up Study (CRC; *n* =472) (Hser et al., 2001), the Cocaine Treatment Evaluation (CTE; *n* =319) (Hser et al., 2006), the Methamphetamine Natural History Study (METH; *n* = 350) (Brecht, O'Brien, Mayrhauser, & Anglin, 2004), the Treatment Process Study (TPROC; *n* =391) (Hser, Huang, Teruya, & Anglin, 2004), and the Treatment Utilization and Effectiveness study (TUE; *n* = 265) (Hser, Huang, Teruya, & Anglin, 2003). The primary drug (i.e., drug for which the subject was in treatment at the baseline assessment) was heroin for the CRC study, cocaine for the CTE Study, and meth for the METH study. The TUE study included subjects recruited from non-treatment settings (emergency rooms, sexually transmitted disease clinics, and jails) and the primary drug type was self-identified. Most of the heroin users in the sample first started using heroin in the 1950s or 1960s (82%), while most cocaine users first used cocaine in the 1970s or 1980s (89%), and most meth users first used meth in the 1980s or 1990s (81%). While many of these subjects reported use of drugs other than their primary drug, a separate analysis showed very little drug switching and that there was relatively low frequencies of use of non-primary heroin, cocaine, and meth and a moderate use of alcohol and marijuana, particularly among primary users of meth (Brecht, Huang, Evans, & Hser, 2008). Each database provides sufficient numbers of cases of primary drug type; when data are pooled (*N* = 1797), the number of subjects was 629 for heroin (35%), 694 for cocaine (39%), and 474 for methamphetamine (26%).

Characteristics for the total sample and by drug type are provided in Table 1. Overall, 72.8% were male, and 34.3% white, 32.1% African American, 29.9% Hispanic, and 3.6% Asian or other racial/ethical groups. At intake assessment, about one-third of subjects had a high school degree, 48% of subjects were working full- or part-time and 46% were not working at all, however fewer cocaine users were not working (45%) than heroin and meth users (56% and 58%, respectively). On average, onset of primary drug use occurred at age 21, regular use began at age 23, and first drug treatment at 29. Criminal involvement (indicated by arrest) started at a mean age of 18 years. Over the first 10 years of addiction careers, the sample spent an average of 4.5 months in drug treatment, and 17 months in prison or jail.

2.2. Instruments/measures

The Natural History Interview (NHI), from which the variables for this analysis were derived, was used in all five studies. The NHI was adapted from instruments designed by Nurco, Bonito, Lerner, and Balter (1975) and has been used with various drug-abusing populations. The NHI was designed to collect retrospective longitudinal quantitative data on drug use and related behaviors. The instrument consists of a set of “static” and a set of “dynamic” forms that permit the capture of longitudinal, sequential data on drug use, employment, criminal involvement, treatment, and other behaviors over the life course of the subjects (see McGlothlin, Anglin, & Wilson, 1977, for detailed description). The static forms collect background information on the subject and are administered once during each interview. The dynamic forms are used to collect retrospective and current data on the drug-use history of the subjects as well as data on events that might have shaped or have been shaped by drug use (e.g., crime, incarceration, employment, and drug treatment). The dynamic part of the interview consists of the repeated administration of these forms for as many life segments (defined by major changes in behaviors

or life events being assessed) as necessary. The procedure requires that the interviewer work closely with the respondent to structure the periods of interest, using corroborative information and memory aids (e.g., major life events, historical events). In this way, drug use, criminal behavior, and periods of legal supervision and treatment participation are anchored to major life events, such as the birth of a child, death of a family member, move to a new location, or loss of a job. The NHI has been shown to have generally high reliability; correlation coefficients of inter-variable relationships, based on 46 variables measured at two interviews 10 years apart, ranged as high as 0.86 and 0.90 (Chou, Hser, & Anglin, 1996; Hser, Anglin, & Chou, 1992).

Natural history data provide a monthly record of drug use and service system exposure since age at first drug use. For the present analyses, monthly observations of drug use, treatment participation, and criminal justice system interaction are based on the NHI. The major outcome is drug use, which is defined as number of days per month using a specified substance. Other measures include user characteristics (e.g., age, gender, race/ethnicity), drug-use history (ages of initiation and regular use), drug treatment history (age of initial treatment, cumulative months of treatment for the entire period), self-help group participation (AA, CA, NA), and criminal history (age at first arrest, months incarcerated). Time-variant covariates include months of incarceration during the year.

2.3. Analytic approach

For each primary drug type, we calculated the numbers of episodes of no use, low use (11 days or less per month), and high use (12 days or more per month) based on the NHI data for each individual and constructed the transition matrix of changes in these statuses over the observational periods. Because the observational periods varied in length across projects, we conducted these analyses for the first 10 years of observation since initial use. Also provided are descriptive statistics (percent, mean duration) for episodes with each of the four types of starting and ending status (no use, low use, high use, incarceration) in the subsequent episode, in which frequency of use between 1 to 11 days per month was classified as low use and 12 or more days of using as high use.

Focusing on change of use, we conducted survival analyses to assess if drug type is associated with time to no use or quitting, with either incarceration or last interview date as censors. These survival analyses were conducted separately for each drug for the first 10 years of the natural history data. We included covariates such as project (source of data) and the sequential number of the episode to control for potential confounds. Predictors include demographics (gender, ethnicity, age at onset of primary drug), and time-varying service exposure including drug treatment, legal supervision status, and self-help participation.

ANOVA tests (for continuous variables) and chi-square tests (for categorical variables) were used to compare group differences.

Unless otherwise indicated, the significance level (two-tailed) was set at $p<.05$.

3. Results

3.1. User characteristics by primary drug type

Background characteristics and onset of primary drug use, drug treatment, and criminality were all significantly different by primary drug type (Table 1). Most primary heroin users in the sample were male (89%), Hispanic (53%) or white (36%), starting their heroin use at about 19 and regular use at about 20, got arrested first at 16, initiated drug treatment at 26, and spent almost 3 years in prison/jail and only 5 months in treatment during the first 10 years of their addiction careers. Similarly, most primary cocaine users were male (71%); but in contrast, the majority were African American (66%), started cocaine use and treatment at much later ages

(23 at first use, 26 at first regular use, and 33 at first treatment), spent slightly shorter duration in treatment (4 months) and had much less criminal involvement (about 6 months of incarceration) during the 10 years. Compared to users of heroin and cocaine, primary meth users were more likely to be women (46%) and to be white (54%); meth users initiated both meth use and crime at around age 19, were first treated at age 28, and spent about 5 months in treatment and less than a year in prison during the first 10 years after initiating use of meth. About 40% of people were injectors and the percentage of injectors was highest among heroin users (more than 90%), followed by meth (44%) and cocaine users (27%) (data not shown).

3.2. Transition among drug-use levels

To assess differences by drug type in changes within individual trajectories, we calculated the number and duration of episodes of no use, low use, high use, and incarceration at the aggregate level (Table 2) and at the individual level (Table 3). The aggregate transition patterns are organized by the beginning and ending status (characterized by level of drug use or incarceration) of each episode. As shown in Table 2, heroin users experienced the greatest number of episode transitions (5711 episodes by 629 individuals, or on average 9 episodes per person), and 37% of their episodes began with use-at-a-high-level (12 or more days per month; 13.4 months per episode), and 36% began with incarceration (10.3 months per episode). Cocaine and meth users had a similar number of episodes per person (7). But for meth users 33% of episodes began with high use (mean duration of 17 months) and 20% with incarceration (mean duration of 7 months), while for cocaine users, 29% of episodes began with high use (mean duration of 16 months) and 12% with incarceration (mean duration of 7 months).

Considering the types of episode end (relapse, recovery, and incarceration), it is notable that 31% of heroin users' episodes started with high use and ended with incarceration, and 21% transitioned from incarceration to high use. These analyses show high frequencies of transition from high use to incarceration across the projects for both heroin and meth users, but less so in the sample of cocaine users. Also notably, for all three drug types, very few incarceration episodes were followed by no use. Finally, patterns of episode frequency and duration rarely paralleled one another (i.e., for most episodes, the duration was longest for the event that was experienced the least). For example, only 5% of heroin high-use episodes ended in no use, but the average duration of this type of event was longest at 20.1 months. More dramatically, only 3% of meth high-use episodes ended in no use, but the average duration was longest at 24.4 months.

Table 3 provides percents of episode types (no use, low use, high use, incarceration) and the mean number and duration of each episode at individuals' level, with statistical comparison by drug type. The mean number of 9 episodes of heroin users over the first 10 years was statistically significantly higher than the mean of 7 episodes of either cocaine or meth users. Additionally, episodes of heroin users were mostly high use (3.3 episodes) or incarceration (3.2), compared to cocaine or meth (2.2 episodes in high use, and 0.9–1.4 incarceration), and although the duration of high-level of heroin use among heroin users (16.5 months) was relatively shorter than for cocaine (22.0 months) or meth (23.2 months), the mean duration of incarceration (9.9 months) of heroin users was much longer than that of cocaine users (2.8 months) or meth users (3.2 months).

Changes in drug use over time can be characterized as increasing use (i.e., acceleration–no use to any use or low use to high use; relapse–no use to any use) or decreasing use (i.e., deceleration–any use to no use, or high use to low use; quitting–any use to no use). In the first 10 years since initiation, significantly fewer heroin users had episodes of deceleration (39.8%) or quitting (32.5%), relative to meth users (82.3%, and 80.4%) or cocaine users (88.0% and 86.6%) (differences between meth and cocaine users were also significant). Most high-use episodes ended with incarceration, with heroin users having the highest rate (88.7%, relative

to 48.7% of cocaine users, and 53.6% of meth users) and numbers of such episodes (2.8, relative to 0.9 to 1.2 among cocaine or meth users).

3.3. Factors related to quitting

The survival analysis on time to quitting use of the primary drug showed significant differences among heroin, cocaine, and meth users during the first 10 years of use (Log-rank test $p<.01$ for overall and pairwise comparisons) (Fig. 1). Predictors of quitting for the three drug types show both similarities and differences (Table 4). Among heroin users, being white (compared to Hispanic) was associated with greater likelihood of quitting, but early onset and legal supervision decreased the likelihood of quitting. Among cocaine users, being male, African American (compared to Hispanics), and under legal supervision decreased the likelihood of quitting, but treatment and self-help participation were positively related to quitting. For meth users, being male, white, under legal supervision, and meth use before age 15 were associated with less likelihood of quitting, but a history of no use or currently involved in treatment or self-help groups increased the likelihood of quitting.

4. Discussion

While we found some similarities in the dynamic patterns of use by drug type and similar sets of user and service system factors influencing use trajectories over time were evident, notable differences by drug type were also revealed. Heroin users exhibited more persistent use and at a higher level relative to cocaine or meth users, but for all three drug types very little drug treatment was received in the 10 years following first use while considerable amounts of time were spent in jails or prisons. Moreover, although there was some variation in predictors of quitting by drug type, a greater likelihood of quitting was associated with current treatment or self-help participation for meth and cocaine users, and a decreased likelihood of quitting was associated with early drug-use onset for heroin and meth users, and by legal supervision for all three drug types. Other predictors of quitting included being white for heroin users, and a history of prior quit episodes for meth users. Being male among meth and cocaine users; being white among meth users; and being African American among cocaine users were all negatively associated with quitting.

Our study was limited by its retrospective survey method. Studies accessed substance users at different points in their substance use histories, resulting in different lengths of observational periods; however, analyses provide a consistent view of the first 10 years since primary substance initiation. Users could have continued to use while incarcerated, although presumably with limited access, but this behavior was not captured in our analyses. Also, the setting from which users were sampled differed somewhat across studies (e.g. treatment or non-treatment venues), resulting in some variation on abuse or dependence experience. However, the majority of the sample had experienced treatment at some point, even if not within the first 10 years since initiation. Thus results are generalizable to a population of problematic users, rather than to a general population.

Our findings suggest that for these cocaine, meth, and especially heroin users, quitting drug use within the first 10 years after initiation is elusive, but not impossible to achieve. Drug-use patterns can be volatile, especially when observed over the long-term, and many individuals frequently transition between no use, varying levels of use, and incarceration. These persistent but fluctuating drug-use patterns suggest that use trajectories can be altered by external and personal events and conditions.

We lack empirical data on the cause or effect impact of drug treatment and incarceration on drug-use trajectories, making it difficult to definitively ascertain if these events accelerate or decelerate drug use and other adverse behaviors. In our analysis legal supervision was

associated with a decreased likelihood of no use for all three drug types, while drug treatment and self-help participation were associated with an increased likelihood of quitting for two of the three drug types. However, self-selection or mutual reinforcement may play a role in these relationships. Evidence suggests that the length of the abstinence episode increases as the number of such episodes increases (Termorshuizen et al., 2005) and that any abstinence is associated with continued maintenance of abstinence (Ribeiro, Dunn, Sesso, Lima, & Laranjeira, 2007), especially if abstinence is achieved early on (DeWit, Offord, & Wong, 1997), is of significant duration (Hser et al., 2001; Vaillant, 1996), and is accompanied by continued self-help participation or aftercare (Kissin, McLeod, & McKay, 2003; McKay, Merikle, Mulvaney, Weiss, & Koppenhaver, 2001; Moos & Moos, 2005; Siegal, Li, & Rapp, 2002) or treatment (Andre, Jaber-Filho, Carvalho, Jullien, & Hoffman, 2003; Darke et al., 2007). These findings indicate that in addition to early intervention efforts to curtail or delay drug use and criminal activity, providing continuing care is likely to enhance the odds of achieving longer-term stable recovery.

One can conjecture how treatment provided earlier after onset and for longer durations might alter drug-use trajectories over the life course. Sampson and Laub's age-graded theory of informal social control and its impact on crime trajectories has only recently been applied to the relationship between drug use and criminal desistance (Schroeder, Giordano, & Cernkovich, 2007), but it seems reasonable to expect that course of crime and drug use are altered by similar life events. This paper represents an initial step in capturing the complexity of describing drug-use patterns over longer time periods. Future analyses might benefit from utilizing more sophisticated statistical models. Also, additional research is needed to identify key life turning points related to the initiation of changes in drug-use patterns. Also of interest is an exploration of racial and ethnic differences in service systems exposure and drug-use trajectories, and how drug-use trajectories are mediated by interactions with other public health service systems like mental health treatment and employment. The timing, frequency, and duration of these and other events, and their interaction with one another to influence drug use over time, remain unexamined. Finally, indicators of sexual orientation were not collected by the studies included in this analysis and so it was not possible to examine whether the trajectories of heterosexual and gay users of particular drugs (especially methamphetamine) were somewhat different, an important topic for future data collection.

In conclusion, our data show that early drug-use histories are associated with a period of acceleration of use, however histories are also characterized by episodes of use at different levels, including some periods of no use and periods of interruption by incarceration. Users of different drugs experience different episodic patterns and exhibit differences in predictors of quitting. These results underscore the need to tailor early intervention, treatment, and continuing care approaches to user characteristics and their social context.

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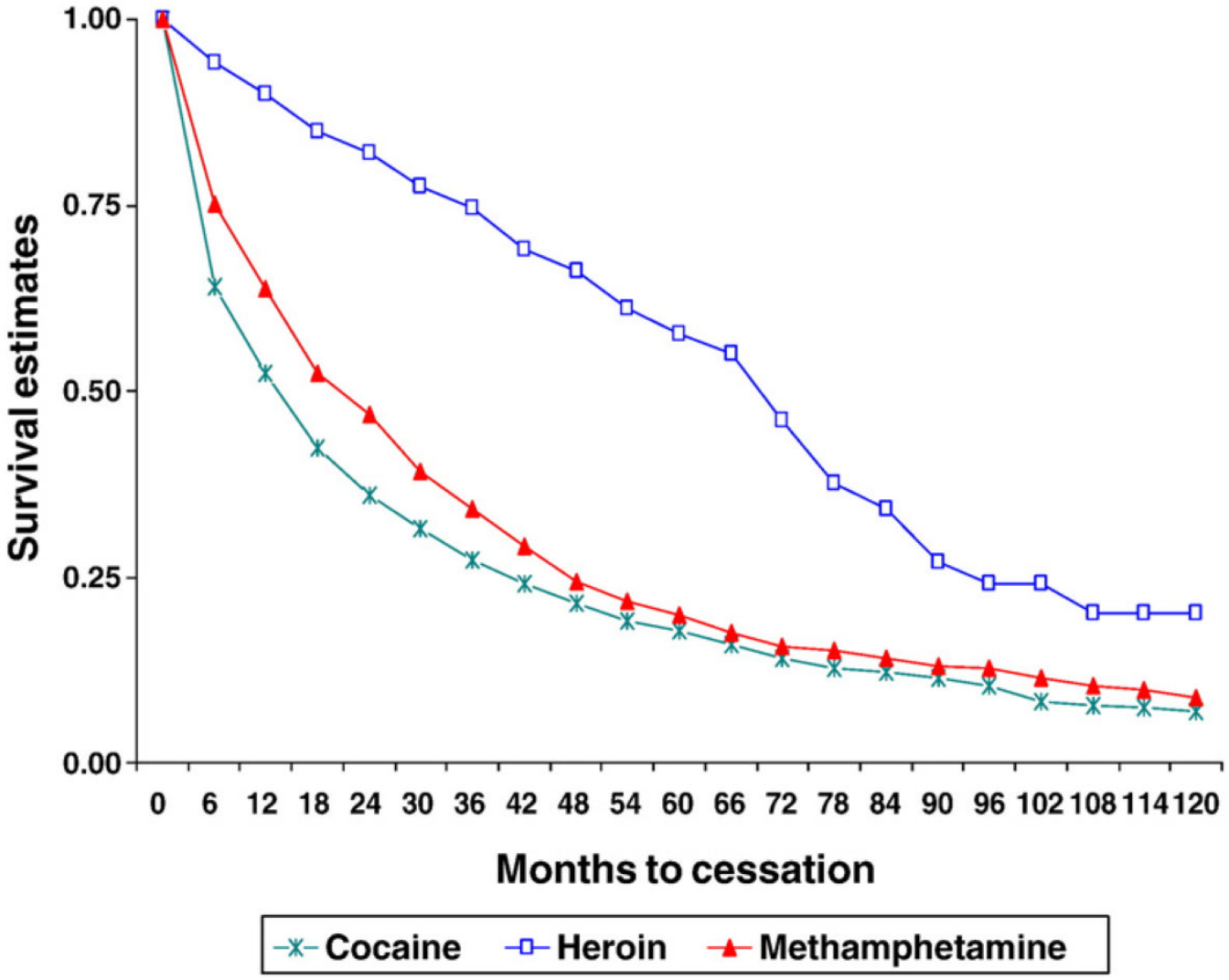

Fig. 1.
Survival estimates on months to quitting use, by drug type (without covariates).

Table 1

Characteristics by primary drug type (N = 1797)

	Heroin (N=629)	Cocaine (N=694)	Methamphetamine (N=474)	Total (N= 1797)
Male (%)**				
Ethnicity (%)**	89.4[a]	70.6[b]	54.2[c]	72.8
White	35.5[a]	19.9[b]	53.8[c]	34.3
Black	9.2	66.0	13.1	32.1
Hispanic	53.4	10.8	26.6	29.9
Asian/other	1.9	3.2	6.5	3.6
Project (%)**				
CRC	75.0	0.0	0.0	26.3
CTE	0.0	46.0	0.0	17.8
METH	0.0	0.0	73.8	19.5
TUE	6.7	27.8	6.3	14.7
TPROC	18.3	26.2	19.8	21.7
Primary drug use+				
Age first use**	18.9 (4.7)[a]	23.0 (6.8)[b]	19.6 (5.5)[a]	20.7 (6.1)
Age first regular use**	20.3 (4.6)[a]	26.3 (7.4)[b]	21.1 (6.3)[a]	22.9 (6.9)
Crime+				
Age first arrest**	15.5 (4.3)[a]	20.2 (7.1)[b]	19.1 (6.8)[b]	18.2 (6.5)
Total months incarcerated over the 10 years**	34.7 (25.9)[a]	6.3 (14.7)[b]	10.5 (19.3)[b]	17.3 (24.1)
Drug treatment+				
Age first treatment*	26.0 (7.0)[a,b]	32.6 (7.2)[a]	27.8 (6.9)[b]	28.9 (7.6)
Total months in treatment over the 10 years**	4.8 (12.2)[a]	3.9 (7.5)[b]	4.9 (6.8)[b]	4.5 (9.3)

+Controlling for project.

[a]indicate a significant difference in pairwise comparisons (p<0.05) after controlling for project.

[b]indicate a significant difference in pairwise comparisons (p<0.05) after controlling for project.

[c]indicate a significant difference in pairwise comparisons (p<0.05) after controlling for project.

**p<0.01

*p<0.05 for overall difference among the three groups.

Table 2

Episodes, aggregated across all subjects during 10 years following first primary drug use

	Heroin (*N*=5711)[a]			Cocaine (*N*=5204)[a]			Methamphetamine (*N*=3477)[a]		
Beginning with…	**No. of episodes**			**No. of episodes**			**No. of episodes**		
Ending with…		**%**	**Mean duration**		**%**	**Mean duration**		**%**	**Mean duration**
No use									
Low use level	86	2	13.4	678	15	13.9	234	8	14.8
High-use level	290	6	11.7	600	13	13.4	387	13	10.2
Incarceration	116	2	13.5	107	2	14.0	170	6	13.2
Total/mean	492	10	12.4	1385	31	13.7	791	26	12.2
Low use level									
No use	94	2	11.1	799	18	8.5	307	10	9.1
High-use level	431	8	15.9	413	9	16.3	229	8	14.0
Incarceration	367	7	11.3	72	2	13.5	73	3	8.1
Total/mean	892	17	13.5	1284	29	11.3	609	20	10.8
High-use level									
No use	240	5	20.1	698	16	17.5	474	16	19.5
Low use level	90	2	13.4	177	4	16.5	86	3	24.4
Incarceration	1554	31	12.2	420	9	14.2	430	14	12.7
Total/mean	1884	37	13.4	1295	29	16.3	990	33	17.0
Incarceration									
No use	284	6	12.2	207	5	8.4	246	8	7.7
Low use level	453	9	11.6	58	1	6.2	65	3	8.2
High-use level	1077	21	9.4	281	6	5.9	302	10	5.7
Total/mean	1814	36	10.3	546	12	6.9	613	20	6.7

[a]Including the last episode (censored by the interview date or the 10 year cut-off date, whichever occurred first).

Table 3

Person-based episodes during 10 years following first primary drug use

	Heroin (*N*=629)			Cocaine (*N*=694)			Methamphetamine (*N*=474)		
	%	No. of episodes	Months of episode	%	No. of episodes	Months of episode	%	No. of episodes	Months of episode
Total episodes[2,3]	100	9.1 (4.2)[a]	17.0 (12.5)[a]	100	7.5 (4.8)[b]	24.2 (21.6)[b]	100	7.3 (5.0)[b]	25.2 (22.9)[b]
No use[1,2,3]	55.5[a]	1.0 (1.3)[a]	10.1 (18.2)[a]	91.6[b]	2.5 (1.9)[b]	22.1 (26.9)[b]	88.4[b]	2.2 (1.7)[c]	22.3 (27.8)[b]
Low use level[1,2]	74.7[a]	1.6 (1.5)[a]	12.3 (17.1)	86.2[b]	2.0 (1.7)[b]	13.1 (19.0)	73.2[a]	1.4 (1.4)[a]	11.4 (20.8)
High-use level[1,2,3]	96.7[a]	3.3 (2.0)[a]	16.5 (15.4)[a]	85.0[b]	2.2 (1.8)[b]	22.0 (26.4)[b]	88.4[b]	2.3 (1.9)[b]	23.2 (24.5)[b]
Incarceration[1,2,3]	87.0[a]	3.2 (2.2)[a]	9.9 (7.3)[a]	35.3[b]	0.9 (1.6)[b]	2.8 (6.7)[b]	46.4[c]	1.4 (2.1)[c]	3.2 (5.5)[b]
Deceleration episodes[1,2,3]	39.8[a]	0.7 (1.1)[a]	7.2 (15.1)[a]	88.0[b]	2.4 (2.0)[b]	15.3 (19.9)[b]	82.3[c]	1.8 (1.5)[c]	16.2 (20.0)[b]
No-use episodes[1,2,3]	32.6[a]	0.5 (1.0)[a]	6.3 (14.5)[a]	86.6[b]	2.2 (1.8)[b]	14.5 (20.0)[b]	80.4[c]	1.6 (1.4)[c]	14.8 (19.8)[b]
Acceleration episodes[1,2,3]	70.0[a]	1.3 (1.4)[a]	12.1 (17.6)[a]	84.3[b]	2.4 (2.1)[b]	16.5 (20.2)[b]	77.0[c]	1.8 (1.7)[c]	12.2 (16.9)[a]
Relapse episodes[1,2,3]	38.8[a]	0.6 (1.0)[a]	5.4 (12.2)[a]	77.2[b]	1.8 (1.8)[b]	14.0 (20.3)[b]	65.4[c]	1.3 (1.4)[c]	9.5 (15.9)[c]
Episodes censored by incarceration with initial status being									
No use[1,2,3]	29.6[a]	0.4 (0.7)[a]	6.9 (17.1)[a]	52.2[b]	0.6 (0.7)[b]	15.3 (27.4)[b]	62.7[c]	0.9 (1.0)[c]	19.3 (29.5)[c]
Low use[1,2]	42.6[a]	0.7 (1.1)[a]	6.4 (13.4)	23.8[b]	0.3 (0.6)[b]	5.4 (17.0)	21.5[b]	0.3 (0.6)[b]	4.4 (17.3)
High use[1,2]	88.7[a]	2.8 (2.0)[a]	14.2 (15.0)	48.7[b]	0.9 (1.4)[b]	13.4 (25.2)	53.6[b]	1.2 (1.7)[c]	13.0 (22.9)

[1] Indicates a significant difference ($p<0.01$) on percentage of subjects with a particular episode type by drug type.

[2] Indicates a significant difference ($p<0.01$) on number of episodes by drug type.

[3] Indicates a significant difference ($p<0.01$) on months of episode by drug type.

[a] indicate a significant difference in pairwise comparisons ($p<0.01$).

[b] indicate a significant difference in pairwise comparisons ($p<0.01$).

[c] indicate a significant difference in pairwise comparisons ($p<0.01$).

Table 4

Survival analysis[a] of months to quitting by primary drug type

	Heroin		Cocaine		Methamphetamine	
	Risk ratio	**95%CI**	**Risk ratio**	**95%CI**	**Risk ratio**	**95%CI**
Male (vs. female)	0.94	(6.68, 1.29)	0.81*	(0.66, 0.99)	0.74**	(0.62, 0.87)
Race/ethnicity (vs. Hispanic)						
White	1.41*	(1.06, 1.86)	0.82	(0.65, 1.02)	0.82*	(0.69, 0.98)
African American	0.71	(0.44, 1.14)	0.81*	(0.67, 0.98)	0.88	(0.66, 1.18)
Other	1.38	(0.69, 2.77)	0.95	(0.67, 1.36)	1.29	(0.94, 1.78)
Sequential order of the episode	0.98	(0.87, 1.10)	1.02	(0.99, 1.06)	1.11**	(1.06, 1.17)
Early onset of drug use (age<15)	0.66*	(0.45, 0.97)	1.01	(0.75, 1.35)	0.73**	(0.60, 0.89)
Time-varying covariates						
Formal treatment	1.52	(0.98, 2.35)	2.00**	(1.42, 2.81)	2.57**	(1.79, 3.70)
Self-help	1.15	(0.27, 4.97)	2.10**	(1.63, 2.72)	2.57**	(1.80, 3.67)
Under legal supervision	0.55**	(0.39, 0.78)	0.65**	(0.52, 0.81)	0.69**	(0.53, 0.90)

** $p<0.01$

* $p<0.05$.

[a] Controlling for project.