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Longitudinal Trajectories of Ketamine Use among Young Injection Drug Users

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Abstract

Background—Ketamine is a dissociative anesthetic that became increasingly popular in the club and rave scene in the 1980s and 1990s. Reports surfaced in the late 1990s indicating that ketamine was being injected in several U.S. cities by young injection drug users (IDUs). Since all studies on ketamine injection were cross-sectional, a longitudinal study was undertaken in 2005 to determine: characteristics of young IDUs who continue to inject ketamine; frequency of ketamine injection over an extended time period; risks associated with ongoing ketamine injection; and environmental factors that impact patterns of ketamine use.

Methods—Young IDUs aged 16 to 29 with a history of injecting ketamine (n=101) were recruited from public locations in Los Angeles and followed during a two-year longitudinal study. A semi-structured instrument captured quantitative and qualitative data on patterns of ketamine injection and other drug use. A statistical model sorted IDUs who completed three or more interviews (n=66) into three groups based upon patterns of ketamine injection at baseline and follow-up. Qualitative analysis focused on detailed case studies within each group.

Results—IDUs recruited at baseline were typically in their early 20s, male, heterosexual, white, and homeless. Longitudinal injection trajectories included: “Moderates,” who injected ketamine several times per year (n=5); “Occasionals,” who injected ketamine approximately once per year (n=21); and “Abstainers,” who did not inject any ketamine during follow-up (n=40). Findings suggest that ketamine is infrequently injected compared to other drugs such as heroin, cocaine, and methamphetamine. Most IDUs who begin injecting ketamine will stop or curb use due to: negative or ambivalent experiences associated with ketamine; an inability to find the drug due to declining supply; or maturing out of injecting drugs more generally.

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Conflict of Interests

None of the authors have a financial or personal relationship with other people or organizations that could inappropriately bias the research or study findings.

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Conclusion—Reducing ketamine injection among young IDUs may best be accomplished by targeting particular groups of IDUs identified in this study, such as homeless youth and homeless travelers.

Keywords

Ketamine; Injection Drug Use; High-Risk Youth

Introduction

Ketamine is a dissociative anesthetic that became increasingly popular in the club and rave scene in the 1980s and 1990s (Dotson, Ackerman, & West, 1995; Jansen, 2001), though the non-medical use of ketamine extends back to the mid-1960s soon after the drug was developed (Lilly, 1978; Siegel, 1978). Ketamine users, which commonly included young people and gay men, typically sniffed a powdered form of the drug to enhance sensory experiences within the club environs (Jansen, 2001; Dillon, Copeland & Jansen, 2003). In the late 1990s, reports indicated that liquid forms of ketamine were being injected in several U.S. cities by young injection drug users (IDUs) (CEWG, 1999).

Subsequent research by Lankenau and Clatts (2002) revealed that young IDUs who injected ketamine were of two general types: experienced IDUs who injected ketamine in addition to other drugs, such as heroin, cocaine, and methamphetamine; and new IDUs who initiated injection drug use with ketamine but injected few other drugs. Additional analyses by Lankenau and Sanders (2007) indicated that young IDUs who frequently injected ketamine typically initiated injection drug use with ketamine, enjoyed the effects of ketamine, were stably housed, and associated with others who injected ketamine. Significantly, these studies revealed that the practice of ketamine injection was associated with particular high-risk behaviors, such as sharing injection drug paraphernalia (Lankenau & Clatts, 2002; Lankenau & Clatts, 2004) and polydrug use (Lankenau & Clatts, 2005; Lankenau & Sanders, 2007). Furthermore, case study reports of recreational users identified several negative health outcomes associated with injecting ketamine, including dependence, overdose, and physical injuries following acute intoxication (Jansen, 2001).

A review of studies on recreational ketamine use recommended additional research on the harms associated with ketamine injection (Copeland & Dillon, 2005). Since existing studies of ketamine injectors were largely cross-sectional (Lankenau & Clatts, 2002; Lankenau & Clatts, 2004) or based upon limited case studies (Jansen, 2001), certain prospective questions could not be addressed, such as: What are the characteristics of IDUs who continue to inject ketamine compared to those who abstain? How frequently do IDUs inject ketamine over an extended time period? How often do users experience negative health outcomes, such as dependence, overdose, or exposure to infectious disease, as a consequence of injecting ketamine? What are the structural or environmental factors that impact patterns of ketamine injection? To address these questions, a longitudinal study of young IDUs with a history of injecting ketamine was initiated.

Methods

During this Los Angeles-based longitudinal study on ketamine injection, 101 IDUs were recruited for a baseline interview during 2005, and invited to participate in a series of five follow-up interviews between 2005 and 2007. Subsequent follow-up interviews resulted in an additional 284 interviews.

Baseline Sampling

Data collection began with a Community Assessment Process (CAP; Clatts et al., 1995) by two trained ethnographers. The goals of the CAP were to record local knowledge of the practice of ketamine injection, and to determine the locations of groups of young people who injected ketamine. Towards this end, ethnographers interviewed key informants who might have direct or indirect contact with young ketamine injectors, such as directors of homeless shelters, needle exchange coordinators, and outreach workers. Subsequent ethnographic field work in a range of settings located ketamine sniffers in clubs and bars but only found ketamine injectors in street-based, public venues. Ethnographers recruited young ketamine injectors using a combination of both targeted sampling (Watters & Biernacki, 1989), which focuses sampling on specific neighborhoods and venues known to contain the desired population, and chain referral sampling (Biernacki & Waldorf, 1981; Penrod et al., 2003), which utilizes the networks of recruited subjects to enroll more subjects. Both are non-random yet effective methods for sampling hidden populations of drug users.

Baseline Recruitment Sites

Young IDUs were recruited from public locations in three areas of Los Angeles: Santa Monica and Venice -- contiguous beach communities located on the west side of Los Angeles, and Hollywood -- situated about a dozen miles to the east. Similar types of businesses, physical spaces, and illicit activities were found within each recruitment area: bars, tattoo shops, retail stores, parks, panhandling, sex work, and drug selling. Additionally, each neighborhood attracted similar kinds of young people, including both local homeless youth and "traveler" or "nomadic" homeless youth, who move from city to city on a frequent basis in search of new adventures, work opportunities, drugs, or to avoid law enforcement (Des Jarlais et al., 2005; Hyde, 2005).

Baseline Enrollment

Young people were eligible for study enrollment if they were between the ages of 16 and 29, and had injected ketamine at least once within the past two years. These criteria were selected to enroll a sample of young IDUs who could describe relatively recent ketamine injection events. A series of screening questions focusing on health behaviors, recent drug use, and history of homelessness were asked in order to mask the true enrollment criteria. Before beginning an interview, individuals signed informed consent documents approved by the Institutional Review Board at Childrens Hospital Los Angeles. During the consent process, subjects agreed to be contacted for a series of five follow-up interviews over the next two years. At the conclusion of the interview, which lasted approximately one hour, subjects received a \$20 cash payment, and risk-reduction referral information.

Follow-Up Interviews

The 101 IDUs enrolled at baseline were eligible for five follow-up interviews occurring approximately every three to four months over a two-year period. Five primary strategies were employed to retain IDUs for follow-up interviews (Lankenau et al., forthcoming a): First, locator information, such as a telephone number, email address, or home address, was collected during the baseline interview to facilitate follow-up tracking. Since most subjects were homeless and/or travelers, an email address was often the most useful locator information (internet access is available at many drop-in centers and public libraries around the country). Second, a toll-free telephone number connecting directly to an ethnographer's project cell phone was provided at baseline, which allowed participants to call for follow-up interviews from anywhere in the U.S., including payphones. Third, participants who completed follow-up interviews over the telephone were wired interview incentives via Western Union. Fourth, cash incentives progressively increased for each interview by \$5, so that participants received

\$20 at baseline, \$25 for Follow-up One, \$30 for Follow-up Two, and so on. Last, ongoing fieldwork in the primary recruitment areas of Venice, Santa Monica, and Hollywood, allowed ethnographers to encounter enrolled participants, engage them in informal conversations, remind them of follow-up interview dates, and provide some with new cards containing the toll-free number.

While many follow-up interviews took place in Los Angeles, most occurred via telephone from other cities, such as Portland, Seattle, New Orleans, Miami, Chicago, and New York as well as smaller towns and rural areas (Lankenau et al., 2008a). Response rates were as follows: 77.2% of subjects were retained at Follow-up One, 68% at Follow-up Two, 64% at Follow-up Three, 58.2% at Follow-up Four, and 47.9% at Follow-up Five. Respondents who were retained through Follow-up Five were significantly younger (1.3 years) than those who were lost to attrition. However, there were no statistical differences in other key demographic indicators such as gender, race, education, or sexual preference. Notably, an attrition analysis showed that respondents who were homeless at baseline were not any more likely to be lost to follow-up than housed respondents.

Measures

The baseline interview consisted of a series of structured and semi-structured questions within eight modules that were programmed using Questionnaire Development Software. Data for this analysis are based upon questions from four modules: Ketamine Injection Initiation; Current Drug Use; Methods of Acquiring Ketamine; and Demographics (See Table 1). The follow-up interview began with an Introductory module that started with a general question: "Tell me what has been happening in your life since we last spoke?" Participants responded by describing a range of events, such as entering into drug treatment, periods of incarceration, experimentation with new drugs, traveling to new locations, and changes in housing status. Additionally, the Introductory module of the follow-up interview contained several questions concerning recent ketamine use (see Table 1). If the subject had injected ketamine since the previous interview, they were administered two modules: Methods of Acquiring Ketamine and the Most Recent Ketamine Injection Event. Similarly, if the subject had sniffed ketamine since the previous interview, they were administered two modules: Methods of Acquiring Ketamine and the Most Recent Ketamine Sniffing Event. To reduce the likelihood of response bias, participants were reminded before starting each follow-up interview that reporting ketamine use since the previous interview either an injection or sniffing event - was not necessary to remain in the study. All baseline and follow-up interviews were digitally recorded and transcribed.

Analysis

A mixed methods approach was chosen to maximize description of temporal trends in the data. Due to the large volume of follow-up interviews ($n=284$), it would have been impractical to conduct a rich qualitative analysis that also respected the temporal structure of the data. Additionally, given that the distribution of ketamine injection over the follow up period was skewed towards infrequent use, a simple random sampling of cases may have overlooked the highest risk individuals. Instead, a statistical model was created to describe the distribution of ketamine injection trajectories among the sample; this model was then used to select individuals for case studies. It is important to note that the statistical model presented is not intended as an inferential model, but rather as a tool for identifying cases for qualitative analysis and for contextualizing those cases relative to the sample as a whole.

To distinguish subpopulations of IDUs with distinct ketamine use patterns over the length of the study period, SAS Proc Traj, a group based mixture modeling approach, was used to identify unobserved subpopulations of IDUs based on their ketamine injection behavior as reported at

each follow up interview (ketamine sniffing behavior during follow-up was not used in this model). Modeling was limited to respondents who had completed the baseline assessment and at least two follow up interviews since trajectories could not be logically estimated for IDUs who completed fewer than three total interviews. To control for time differences due to variability in follow up intervals between respondents, the reported number of ketamine injection events at each follow up was converted to an annual rate. Among the mixture models available in Proc Traj, the censored normal trajectory model was selected since it is the most appropriate for continuous data with clustering at the minimum.

To determine the optimal number of trajectories or groups in the model, quadratic growth parameter models were created with 1 to 5 different trajectory groups. Using the Bayesian model selection criteria outlined by Jones, Nagin, & Roeder (2001)¹, the data favored a 3 group model. This model also best represented empirical heterogeneity in the data and groups exhibited statistically significant differences (at the .05 level of significance) in rates of ketamine injection during follow up.

Respondents were assigned to one of three trajectory groups based on posterior probabilities greater than .66 as follows: Class 1 - moderate to high use at baseline and moderate use during follow-up (n=5; 7.6%); Class 2 - low to moderate use baseline and low use during follow-up (n=21; 31.8%); and Class 3 - no ketamine injection during follow-up (n=40; 60.6%). Two respondents could not be assigned to a class due to a high likelihood of belonging to more than one class (i.e. respondents had no class in which posterior probabilities were greater than 66%) and were excluded from further analysis. For ease of identification during the subsequent analysis, Class 1 IDUs are referred to as “Moderates,” Class 2 IDUs as “Occasionals,” and Class 3 IDUs as “Abstainers.”

Qualitative analysis – deployed to understand variability within and between the three trajectory groups -- was accomplished during a multi-stage process. First, baseline and follow-up interview transcripts were organized by groups – Moderates, Occasionals, and Abstainers - and general longitudinal trends within each group were described in analytical memos (Lofland & Lofland, 1995). During this stage, it was revealed that IDUs who did not complete all follow-up interviews provided only a partial picture of ketamine injection trajectories during the study period and were excluded from the next stage of analysis. Second, IDUs who had completed all five follow-up interviews (n=34) were chosen for additional qualitative analysis. Two cases were selected from each group that exhibited contrasting recent use of ketamine at baseline to depict movement towards increased, decreased, or sustained ketamine injection during follow-up. For instance, the two cases selected from the Moderate group consist of an IDU who had injected once in the previous year (low) and another who had injected 16 times in the previous year (high). Third, paper copies of all six interviews (baseline and five follow-ups) for each of the six selected cases were printed. The primary drug-using and life events occurring during follow-up as well as relevant data from baseline interviews were coded using a “two-level” coding scheme (Miles & Huberman). A “first level” set of *a priori* codes centered on existing research questions, such as chronic misuse of ketamine, while a “second level” set of codes focused on emergent themes within the data, such as “maturing out” of ketamine use.

Based upon this two-level coding scheme and previous analyses of injection events (Lankenau & Sanders, 2007; Lankenau et al. forthcoming b), brief narratives of each case were developed that integrated baseline and follow-up data. The narratives, designed to elucidate ketamine

¹This approach to testing the number of components in a model uses the log of the Bayes factor (B_{10}) to estimate the degree of evidence in favor of the alternative over the null model. Following Kass & Raftery (1995) the log Bayes factor is approximated as follows: $2\log_e(B_{10}) \approx 2(\Delta BIC)$. Practically speaking, this is estimated by tabulating the BIC for each model, and calculating two times the differences between the alternative (n+1 groups) model and null (n groups) models.

using trajectories during the follow-up period, contained the following elements: baseline ketamine injection history including injection events within the past year; first experience injecting ketamine including polydrug use at initiation; and total number of injection events during follow-up. Summaries of follow-up interviews included: number of injection events; location of events; forms of ketamine injected; cost of ketamine; context of injection event; other drug use; and details pertaining to other important life events, such as jails, jobs, relationships, and housing. Subsequent analyses of individuals and group trajectories were based upon comparing key descriptive features found in each brief narrative.

Results

Overall, IDUs at baseline were typically in their early 20s, male, heterosexual, white, and homeless (see Table 2). Approximately one-third reported being HCV positive. Moderates more commonly identified as heterosexual, graduated from high school, reported some form of employment, and had histories of drug treatment. Occasionals were more typically male, white, homeless travelers, and reported being HCV positive. Abstainers were evenly divided between men and women, had a higher proportion of minority youth, and a higher proportion of youth identifying as gay, lesbian, bisexual, or other.

Baseline patterns of ketamine use differed between categories in several respects (see Table 3). The average age of ketamine injection initiation was two and one half years lower among Moderates compared to Abstainers, and all Moderates initiated injection drug use with a drug other than ketamine. Also, Moderates reported more ketamine injection events and fewer ketamine sniffing events at baseline, and largely preferred intravenous rather than intramuscular injection as the primary mode of administering ketamine. Abstainers reported the fewest ketamine injection events, the most sniffing events, and were relatively evenly divided among preferred modes of administering ketamine. A small percentage of Abstainers reported ketamine as their drug of choice. Occasionals were consistently positioned between Moderates and Abstainers on nearly all indicators. In sum, baseline data indicate that Moderates had longer histories of injection drug use, greater familiarity with injecting ketamine, and were more inclined to inject ketamine intravenously than either Occasionals or Abstainers.

The mean annual rates of ketamine use during follow-up indicate distinct differences among the three groups (see Table 4). Moderates reported moderate rates of injection during follow-up – between 6 and 11 injections annually – or approximately 8 times per year. Moderates reported the lowest rates of sniffing ketamine during follow-up – less than once per year. Occasionals reported low rates of injection during follow-up (and similarly low rates of sniffing) – less than once per year. Abstainers did not inject ketamine during follow-up, but did report the highest rates of sniffing ketamine during follow-up – a little more than once per year.

Case Studies of Moderate Ketamine IDUs

Jerry, a 21 year-old homeless traveler, reported injecting ketamine 17 times at baseline including once in the previous year. He described his first experience injecting ketamine, which occurred after injecting some heroin and cocaine, as follows:

“I felt kind of spaced out. Then I got really light-headed feeling – not that energized. I was just really out of it – spacey.”

Jerry injected ketamine 34 times during the follow-up period. At the first follow-up, he had traveled to Detroit where he injected ketamine once that he received for free after using crack and injecting heroin earlier in the day. At the second follow-up, he had traveled to Toronto where he met up with various groups of IDUs. He reported injecting ketamine every day for a

week or more, while also injecting heroin, OxyContin, Dilaudid, PCP, and methamphetamine during this period. While frequently obtaining ketamine for free, he also had purchased vials of liquid ketamine in a Toronto park for \$20. In total, he reported injecting ketamine 20 times while in Toronto. At the third follow-up, he had traveled to Minnesota, Wisconsin, Alabama, and Austin, Texas, where he had been in jail for two months. While not injecting any ketamine during this period, he reported injecting heroin and methamphetamine, which he described as his drug of choice. At the fourth interview, while still in Austin, he discovered a source of ketamine while looking to buy other drugs, and reported injecting ketamine during three consecutive days. During this period in Austin, he both paid for ketamine and received it for free, and reported injecting ketamine a total of 13 times. Following Austin, he traveled to Colorado and Michigan where he did not inject any ketamine but worked several jobs. During the fifth interview, he did not report injecting any ketamine nor had he bought or used any other drugs during the past month, except for marijuana. At that interview, described himself as “domesticated” as he was living in Michigan with family, working a full-time job, and using no drugs aside from marijuana and alcohol.

Bob, a 23 year-old homeless local living in Los Angeles, reported injecting ketamine 25 times at baseline including 16 times in the previous year. He described his first ketamine injection, which occurred after injecting some methamphetamine, as follows:

“I got suck – just like froze for 45 minutes. I couldn’t move. I saw colors in my head. I liked it.”

Bob lived in Los Angeles across the five follow-up periods and injected a total of 41 times. At the first follow-up, he bought ketamine from a drug seller and also acquired ketamine for free from friends at clubs. During that period, he reported injecting ketamine 15 times. At the second follow-up, he was living in an apartment building that housed a drug seller:

There was actually a ketamine hookup that lived in the apartments we were living in. He just happened to sell ketamine and crystal too...I paid like 80 bucks for a vial [of liquid ketamine].

He reported injecting 15 times during that period – primarily combining methamphetamine with liquid ketamine. At the third follow-up, he indicated receiving ketamine for free from a friend and injecting nine times. He combined ketamine with methamphetamine during each of these injections. At the fourth follow-up, he reported injecting ketamine two times, which he acquired for free and both times mixed ketamine with methamphetamine. He also reported using fewer drugs overall with the exception of marijuana, which he smoked daily. By the fifth interview, he reported no ketamine injections and less use of methamphetamine. He described obtaining a medical marijuana card that enabled him to legally purchase marijuana in Los Angeles, which resulted in increased marijuana use but less hard drug use. He also stated that he was no longer homeless – he was living in a house and growing marijuana.

Comparing Trajectories among Moderates

Several notable features characterize these two trajectories. First, both injectors described neutral or positive ketamine injection initiation experiences, suggesting openness toward injecting ketamine in the future given the right opportunities. Second, both initiated ketamine injection while using other drugs, which foreshadowed polydrug using injection patterns during follow-up interviews. Both remained active injection drug users of a variety of substances in addition to ketamine, such as heroin, methamphetamine, and prescription opioids. Third, both reported ongoing access to ketamine in a variety of urban locations – Los Angeles, Detroit, Toronto, and Austin – where ketamine was purchased or received for free from friends who were also using ketamine. Hence, both remained within networks where ketamine was regularly available -- sometimes in large quantities -- in one or more locations. Fourth, neither

expressed an interest in curbing their drug use until the fifth interview, at which time both intimated the start of a “maturing out” trajectory whereby they were primarily using marijuana, had reduced hard drug use, including ketamine, and had established stable housing.

Case Studies of Occasional Ketamine IDUs

Phil, a 22 year-old homeless traveler, reported injecting ketamine five times at baseline and no ketamine injections in the previous year. He described his first ketamine injection experience in unpleasant terms:

“The hallucinations - it was weird. It was actually really bad. I don’t know why I ever did it again.”

Phil injected ketamine three times during the follow-up period. At the first follow-up, he traveled with a friend to Phoenix, where he stopped using heroin for a period of time. He reported injecting Klonopin while trying to reduce his heroin use, but eventually resumed injecting heroin. He did not use any ketamine in Phoenix, which he attributed to limited access:

“You can’t find ketamine in Arizona. You’d think being so close to the Mexican border, it should be everywhere.”

At the second follow-up, however, he reported eventually injecting ketamine twice that he received for free while in Phoenix. He mixed the injection with heroin and cocaine. He indicated later entering a drug treatment program in Phoenix. He eventually left Phoenix for Portland, Oregon, and said that his “clean time got really destroyed when I came to Portland.” At the third follow-up, he was still in Portland and had been to jail. He did not use ketamine, but was using heroin and cocaine every day. At the fourth interview, he reported injecting powder ketamine once that he received for free from friends while in Portland, but was primarily using heroin and cocaine. He tried to enter another drug treatment program but was unsuccessful. At the fifth interview, he returned to Southern California. He did not report any ketamine use and indicated quitting heroin and cocaine. Though, he said he increased his non-medical use of prescription drugs.

Mickey, a 26 year-old homeless traveler, reported injecting ketamine 30 times at baseline including five times in the previous year. He initiated ketamine after using some cocaine, methamphetamine, and marijuana:

“It was a whole different experience. I felt lost – like I was in a cartoon.”

During follow-up, Mickey reported injecting ketamine once, sniffing ketamine three times, and selling ketamine once. At first follow-up, he reported sniffing ketamine three times and selling it once while in Los Angeles, and indicated that he mainly obtained ketamine for free from friends or acquaintances. He then left for Berkeley where he injected ketamine once, which he exchanged for some methamphetamine. Subsequently, he had gotten a new girlfriend, who encouraged him to stop injecting drugs, though he continued to sniff methamphetamine. At the second follow-up, he had broken up with his girlfriend and headed to San Francisco, where he began injecting heroin and went on a two week binge: “I got strung out for the first time in my life and hated myself for it.” During that time, he had reported using a gram of methamphetamine per day, but no ketamine. Following this period of heavy heroin and methamphetamine use, he reported stopping drug use for a month. At the third interview, he was in Mountain View, California, and reported relapsing shortly after the last interview. He was subsequently jailed in Santa Cruz for a previous drug possession charge. He had not used any ketamine, but was using methamphetamine and drinking heavily to the point of blacking out. At the fourth interview, he was in San Francisco and reported being jailed in Santa Cruz for a second time for 100 days for possession of methamphetamine. He reported injecting OxyContin for the first time, but was primarily injecting methamphetamine. He did not inject

any ketamine and was not in contact with any ketamine injectors. At the fifth interview, he was in Minneapolis following a time in Madison, Wisconsin, where he was arrested. He did not use ketamine, and reported reducing his heroin, methamphetamine, and cocaine use: “Everything has gone down except alcohol.”

Comparing Trajectories among Occasionals

Several characteristics of these two trajectories are notable. First, both described their ketamine injection initiation experience in more negative or ambiguous terms, which foreshadowed limited interest in future ketamine injection events. Second, access to ketamine was limited and availability arose primarily due to chance during follow-up. In particular, neither appeared to be within networks of active ketamine users since no large sources of ketamine were described. Third, in the midst of limited ketamine use, both were actively injecting other substances, such as heroin, cocaine or methamphetamine, and prescription drugs. Fourth, each reported attempting to quit heroin during the follow-up period, including entering into detoxification programs. Relatedly, both spent periods of time in jail, which limited drug use during incarceration. Hence, periods of sobriety were mixed with periods of active use of several illegal drugs and limited ketamine use.

Case Studies of Abstaining Ketamine IDUs

Bill, a 19 year-old homeless local, reported injecting ketamine once at baseline. He described his initiation experience in unpleasant terms:

“It was really weird – like hallucinations and stuff. I really don’t like being in that state of mind.”

Bill did not use any ketamine during follow-up, but came across it once. At the first follow-up, he had moved south from Los Angeles to Orange County, and indicated trying to reduce his injection drug use:

“I kind of left L.A. to go towards O.C. [Orange County] - to stay away from drugs. I used to use needles almost on a daily basis and now I just do it like once every two weeks with a needle. I just use like pipes or sniffing.”

He primarily reported using marijuana and methamphetamine, but no ketamine. At the second follow-up, he remained in Orange County, and was injecting drugs, but had not used ketamine. He reported using ecstasy, methamphetamine, and marijuana. At the third follow-up, he had been recently released from jail. He did not report using ketamine, but used heroin and mushrooms in addition to other drugs previously reported. Methamphetamine was his drug of choice. At the fourth follow-up, he reported access to liquid ketamine but did not use it: “Someone had it in liquid form but didn’t know how to change it to powder.” At the fifth interview, he reported using the same assortment of drugs in both Los Angeles and Orange County, but no ketamine.

Donna, a 24 year-old homeless traveler, had injected ketamine 35 times at baseline including 15 times in the previous year. She described her first injection as more potent than sniffing ketamine:

“It was a lot more powerful than before [sniffing]. Everything got all wobbly. I tried walking across the room and it was kind of tough. We were laughing, kind of giddy.”

Donna reported selling ketamine and sniffing it once during follow-up but no ketamine injections. At the first follow-up, she was looking for a job in Athens, Georgia, and planning to stay for an extended period. She reported selling ketamine, sniffed it once, but did not inject it. Additionally, she was smoking crack and in a methadone program with her husband, whom she had just married. At the second follow-up, she was still in Athens where she was working

at a telemarketing job but quit after one month. She did not use any ketamine, but was using cocaine occasionally. At the third interview, she and her husband returned to Los Angeles after losing their home in Athens. She had been using heroin on a daily basis in addition to cocaine and crack but no ketamine. At the fourth interview, she and her husband returned to Georgia where she became pregnant. They subsequently moved to Virginia Beach, enrolled in another methadone program, but did not use any ketamine. At the fifth follow-up, she remained in Virginia Beach, where she had given birth to a son, was working part-time at a bookstore, was on methadone, but had not used any ketamine.

Comparing Trajectories among Abstainers

These two cases reflect different ketamine using trajectories. Bill never particularly enjoyed the effects of ketamine as suggested by his ketamine initiation description and limited use at baseline. The fact that he had an opportunity to inject liquid ketamine during follow-up but chose not to further demonstrates his ambivalence towards the drug. He also shared other attributes of Occasionals who reported limited ketamine use: ongoing injection of heroin or methamphetamine, attempts to curb drug use overall, and periods of incarceration. Donna is more clearly an instance of an IDU “maturing out” (Winick, 1962) of ketamine use in particular and drug use more generally. At baseline, she described a positive initial ketamine experience and reported 35 lifetime injections including recent use, which suggested an affinity for injecting ketamine. However, she was recruited into the study prior to the start of several significant life changes: getting married; finding stable housing; beginning new employment; entering a methadone program; and giving birth to a child. The fact that she sold ketamine and sniffed it once during follow-up highlighted the transition between old and new patterns of drug use. While her movements in-and-out of housing and drug treatment indicate ongoing struggles with drugs, the overall trajectory is towards increased stability and less drug use, including little or no ketamine use.

Discussion

This is the first study to longitudinally analyze patterns of ketamine injection among young IDUs. Findings indicate that a majority (61%) reported either no ketamine injection or only sniffing ketamine during follow-up, while a minority (39%) reported occasional or moderate patterns of ketamine injection. Factors inhibiting ketamine use during follow-up included: assuming greater life responsibilities, such as housing, parenting, or work; losing contact with networks of ketamine injectors; traveling to locations where drug use was limited and/or supplies of ketamine were scant; increasing use of a particular drug, such as heroin or methamphetamine; reducing drug use overall including entering into drug treatment programs; and being incarcerated. Factors contributing to continued ketamine use during follow-up included: maintaining ongoing contacts with networks of ketamine injectors; developing new contacts with networks of drug users who use or sell a wide assortment of substances; traveling to border states or other locations where diverted supplies of ketamine were more plentiful; and maintaining an active interest in the experiences associated with ketamine use.

Baseline data of history of ketamine sniffing, injection, and preferred mode of administration were good indicators of ketamine use during follow-up: subjects with a more extensive history of injection, more limited history of sniffing, and who preferred injection were more likely to inject ketamine during follow-up (Moderates and Occasionals) whereas those with a limited history of injecting ketamine and more extensive history of sniffing ketamine at baseline were more likely to not inject or only sniff ketamine during follow-up (Abstainers). IDUs who initiated injection drug use with ketamine were less likely to inject ketamine during follow-up, which contrasts with preliminary data on injection trajectories (Lankenau & Sanders, 2007).

The case studies, which assembled data from baseline and follow-up interviews, described three general trajectories. The Abstainer trajectory, as exemplified by Bill, was the most typical among all IDUs in the study. It is characterized by injecting ketamine once or a few times at baseline, not enjoying the effects, having few connections to supplies of ketamine or other users during follow-up, and preferring to inject other drugs. IDUs adhering this trajectory in combination with an “experimental” orientation towards injecting ketamine (Lankenau & Sanders, 2007) are unlikely to inject ketamine in the future. Donna represented a variation on this trajectory since her lack of ketamine injection could be more clearly ascribed to a “maturing out” process, which involves assuming new, non drug-related roles that are plausible and reinforcing (Winick, 1962). Also, maturing out is characterized by a stop-start pattern that occurs over time as the individual becomes comfortable in a nonuser role. Similarly, these IDUs were active ketamine users at one time, but their declining use was fundamentally associated with assuming other important roles and life responsibilities. As such, the maturing out trajectory is likely to manifest itself among other current ketamine users overtime. The Occasional trajectory, as represented by Phil and Mickey, was the second most common. These IDUs were largely concerned with injecting other drugs but periodically encountered supplies of ketamine or other ketamine users depending upon location. For them, ketamine served to diversify or supplement their injection drug using patterns. The Moderate trajectory, as represented by Jerry and Bob, was the least common trajectory. IDUs within this trajectory enjoyed injecting ketamine, were within networks of active ketamine users, and were willing to pay for ketamine when it was available. Follow-up data suggests that these users will continue to inject ketamine as long as it is available, but that a maturing out process is likely at some point upon securing stable housing and/or employment. Overall, the case studies indicate that initiating ketamine injection is unlikely to result in chronic ketamine use or dependence among young IDUs, which corroborates findings from other reports (Copeland & Dillon, 2005).

Additionally, the case studies also reveal a general trend of declining use of ketamine, which mirrors other study findings indicating that IDUs viewed ketamine as increasingly difficult to buy between January 2005 and December 2007 – the span of the study period (Lankenau, Jackson Bloom, & Shin, 2008). The declining patterns of use exhibited by these IDUs may be partially explained by a declining supply of ketamine during the study period due to Drug Enforcement Agency (DEA) interdiction efforts at the national level. Based upon ketamine seizure data collected between 2001 and 2006, the DEA concluded that overall ketamine availability has decreased (DEA, 2007). For instance, in April 2005, the DEA disrupted an organization that had been smuggling ketamine from India into the United States, resulting in the seizure of 108 kilograms of ketamine with an estimated street value of \$1.62 million (DEA, 2005). In November 2005, the DEA dismantled a large organization that had been smuggling ketamine from Mexico into Southern California: approximately 35,000 dose units of ketamine were seized at that time (DEA, 2007). These large seizures most likely reduced the overall availability and quality of ketamine in parts of the U.S. during 2005 and 2006 – the primary periods of data collection.

Lastly, the case studies also revealed much about the ongoing difficulties of substance abuse, homelessness, and their interconnections. The desire to stop using drugs and seek treatment was commonly reported. However, IDUs were typically unable to sustain periods of abstinence across follow-up interviews. These findings mirror other longitudinal research on young IDUs indicating that relapses into injection drug use typically follow periods of cessation, and that sustained periods of cessation are uncommon (Evans et al. 2009). Similarly, almost none were able to sustain two consecutive periods of stable housing. In fact, being homeless also meant being linked to a diverse network of drug users who had access to ketamine and a variety of other illicit substances, such as heroin, cocaine, methamphetamine, and marijuana. Additionally, most were also homeless travelers, who moved about the country and accessed

drug markets in multiple areas (Lankenau et al., 2008b). Nearly all found themselves in the midst of an ongoing cycle – homelessness leading to increased substance use, or substance use resulting in persistent homelessness – but frequently without the means to end either one for a sustained period. Maturing out of ketamine injection, however, was a characteristic of some IDUs who were attempting the broader process of injection cessation, which has been associated with reduced frequency of injecting heroin and cocaine prior to cessation (Evans et al. 2009).

Limitations

There are several limitations that should be noted in this longitudinal study of ketamine injection among young IDUs. First, approximately one-third of subjects enrolled at baseline were not included in the trajectory analysis. These IDUs did not complete the minimum number of follow-up interviews to establish a ketamine injection trajectory that could be statistically analyzed. Additionally, another third of subjects selected for the trajectory analysis did not complete all five follow-up interviews: most were lost to follow-up while others had not been enrolled in the study early enough to complete all five interviews (Lankenau et al., forthcoming a). Attrition analysis indicated that IDUs retained in the study through the final interview were one year younger on average than those lost to follow-up, but similar on other demographic indicators and levels of reported lifetime ketamine use. Consequently, study findings may be impacted by a selection bias towards subjects completing more follow-up interviews; in this case, younger respondents who are presumably earlier in their drug using trajectories. Second, reported ketamine use during follow-up interviews may be subject to response or recall bias: IDUs may have over reported or overestimated the number of times injecting ketamine between interviews. However, since the majority of IDUs reported no or limited ketamine injection events during follow-up, overestimates of use by these participants are likely to be minimal. Among Moderates who reported up to 20 ketamine events, ethnographers probed the contexts of these events to minimize over reporting. To reduce the likelihood of over reporting more generally, all subjects were instructed at the start of each interview that they could report no ketamine use and remain in the longitudinal study. Finally, the small sample limits the generalizability of findings to a broader population of young ketamine injectors. In particular, the study largely captured homeless, polydrug IDUs who injected ketamine along with a variety of other drugs (Lankenau et al forthcoming b). A study that recruited primarily IDUs who injected ketamine (a subgroup that was targeted but not found during sampling) may have uncovered different trajectories, including more consistent injectors. However, the cases studies are broadly representative of the three trajectories of IDUs identified within this sample and describe several key longitudinal patterns of ketamine injection.

Conclusion

This longitudinal study suggests that ketamine is infrequently injected compared to other drugs such as heroin, cocaine, and methamphetamine. Rather than a drug of choice, ketamine is injected when it is available. The type of IDU who continues to regularly inject ketamine has had an extensive polydrug using injection career. Furthermore, these findings suggest that most IDUs who begin injecting ketamine often stop or curb use due to: negative or ambivalent experiences associated with ketamine; an inability to find the drug due to declining supply; or maturing out of injecting drugs more generally, which may be facilitated by other factors such as incarceration, drug treatment, or increased stability in one's life.

Reducing ketamine injection among IDUs may best be accomplished by focusing on particular groups of IDUs identified in this study, such as young homeless IDUs and homeless travelers. As the case studies indicate, these IDUs face a range of challenges, such as securing housing, employment, and health care, which may require interventions and assistance beyond those

focused on substance abuse alone. Additionally, since particular risk behaviors are associated with ketamine injection, such as sharing vials of liquid ketamine, multiple injections, and polydrug use (Lankenau et al., 2007), interventions aimed at curbing ketamine use more broadly should also focus on risk reduction, such as injection paraphernalia sharing, overdose prevention, and drug treatment.

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Table 1

Baseline and Follow-Up Interview Questions

Interview	Module	Question
Baseline	Ketamine Injection Initiation	How old were you the first time you ever injected ketamine?
		Were you using any other drugs before that first injection of ketamine?
		How did that first injection of ketamine make you feel?
	Current Drug Use	How many times have you injected ketamine in your lifetime?
		How many times have you sniffed ketamine in your lifetime?
		What is your preferred way to use ketamine?
		Out of all the drugs that were discussed, including ketamine, what is your “drug of choice”?
	Methods of Acquiring Ketamine	How difficult is it to buy powder ketamine right now?
		How difficult is it to buy liquid ketamine right now?
	Demographics	What is the highest grade of school you’ve completed?
		Tell me about your current living situation. Do you consider yourself homeless?
Follow-Up	Introductory	Tell me what has been happening in your life since we last spoke?
		How many times have you injected ketamine since we last spoke?
		Was there a time when you shot ketamine everyday or at least once a week since we last spoke?
		Have you mixed ketamine with any other drugs since we last spoke?
	Most Recent Ketamine Injection Event	Tell me about the most recent time you injected ketamine.
		Did you pay or exchange anything for the ketamine?
		What town or city were you in the last time you injected K?
	Most Recent Ketamine Sniffing Event	Tell me about the most recent time you sniffed ketamine.
		Did you pay or exchange anything for the ketamine?
		What town or city were you in the last time you sniffed K?

Table 2

Demographic Characteristics at Baseline (n=66)

	Total n=66	Moderates n=5	Occasionals n=21	Abstainers n=40
Mean Age at Enrollment	21.76	21.20	21.86	21.78
Male Gender	59.1%	60%	76.2%	50%
Race and Ethnicity				
White/Caucasian	78.8%	80%	90.5%	72.5%
Black/African American	1.5%	0%	0%	2.5%
Hispanic/Latino	7.6%	0%	0%	12.5%
Asian or Pacific Islander	1.5%	0%	0%	2.5%
Native American	0%	0%	0%	0%
Multiracial Background	10.6%	20%	9.5%	10%
Sexual Identity				
Heterosexual	75.8%	100%	81.0%	70%
Gay/Lesbian	1.5%	0%	0%	2.5%
Bisexual	21.2%	0%	19%	25%
Other/Undecided	3%	0%	0%	5%
High School Graduate or GED	60.6%	80%	71.4%	52.5%
Homeless	97%	100%	90.5%	100%
Homeless Traveler	71.2%	60%	85.7%	65%
Employed Full or Part Time	12.1%	40%	9.5%	10%
History of Drug Treatment	57.6%	80%	66.7%	50%
History of Mental Health Care	44.9%	66.7%	31.3%	50%
Ever Arrested	98.5%	80%	100%	100%
Ever in Jail	89.4%	80%	100%	85%
Ever in Prison	12.1%	20%	9.5%	12.5%
Tested for HIV	90.9%	80%	95.2%	90%
Tested for HCV	84.8%	80%	85.7%	85%
HCV Positive	30.4%	25%	38.9%	26.5%

Table 3**Ketamine Injection History at Baseline (n=66)**

	Total n=66	Moderates n=5	Occasionals n=21	Abstainers n=40
Mean Age of 1 st Ketamine Injection	18.9	16.8	18.5	19.3
Median Lifetime Ketamine Injection Events	4.5	17.5	5.5	3
Median Lifetime Ketamine Sniffing Events	3	1	2	4
Initiated Injection Drug Use with Ketamine	13.6%	0%	9.5%	17.5%
Preferred Way to Use Ketamine				
Intravenous (IV)	45.5%	80%	47.6%	40%
Intramuscular (IM)	25.8%	0%	23.8%	30%
Intranasal (sniffed)	31.8%	20%	33.3%	32.5%
Drug of Choice is Ketamine	4.5%	0%	0%	7.5%

Table 4**Ketamine Use during Follow-Up (N=66)**

	Total n=66	Moderates n=5	Occasionals n=21	Abstainers n=40
Ketamine Injected During Follow-Up *				
Mean Annual Rate	2.25	8.25	.82	0
Standard Deviation	3.24	2.54	.81	-
Range	.19 – 11.35	5.51 – 11.35	.19 – 3.76	-
Ketamine Sniffed During Follow-Up **				
Mean Annual Rate	.92	.66	.84	1.11
Standard Deviation	.95	.37	.63	1.40
Range	.18 – 3.98	.20 – 1.02	.19 – 1.99	.18 – 3.98

* Among those who injected K during follow-up (n=26).

** Among those who sniffed K during follow-up (n=27).