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Perceptions of Adulteration and Quality Assurance Practices Reported by People who Use Drugs:

A Review of the Literature

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Executive Summary

Assessing drug quality can be difficult within an unregulated drug market. A brief literature review was conducted to examine the perceptions of people who use drugs on adulteration practices and drug quality assessment techniques. Searches of Web of Science, PubMed, PsycINFO, and CINAHL databases included literature published from the January 2000 to July 2015. After all exclusions, a total of 19 studies were identified. Two themes were derived from these studies. The first theme identified perceptions of drug adulteration and quality assessment practices. The second theme delved deeper into the main source of drug quality assessment source – social networks – and identified how relationships with friends and dealers influence drug consumption, risk communication, and usage patterns. Overall, people who use drugs employ a variety of non-evidence-based practices in an attempt to reduce risks associated with drug content and adulteration. The most significant influences of drug use behaviour, knowledge and perceived harms were peers, friends and dealer relationships.

Introduction

Illicit drug use is a complex public health issue and one of the main drivers of HIV and hepatitis C transmission, and premature death globally (1,2). In response, public health initiatives have been introduced to reduce associated harms at strategic points along the continuum of substance use (3). The majority of these harm reduction initiatives focus on minimizing risks associated with the administration of drugs and are aimed to reduce disease transmission. Such initiatives include needle syringe programs and education surrounding safer drug use(4).

Among people who use drugs (PWUD) in Canada, drug overdose is the leading cause of death, particularly for those using opioids (5). There are direct and indirect costs associated with both illegal drug activity and drug overdose in Canada. In 2002, the total estimated cost attributable to illicit drug use in Canada was $8.2 billion (6). Most recent data suggest approximately $500,000 is spent annually on ambulance response to drug overdose in Vancouver alone(7).

One of the main drivers of these high overdose rates comes from the variability in drug quality and purity in an unregulated, informal drug market (8,9). Substances may be added intentionally to enhance the effects of the psychoactive ingredient, a practice known as drug adulteration(10,11). Cocaine, heroin and methylenedioxyphenethylamine (MDMA) or “ecstasy” are examples of drugs that are often adulterated with substances such as levamisole, acetaminophen, and methamphetamine, respectively (12). Alternatively, diluents – usually referred to as “cutting” agents – describes substances added to bulk a drug thereby diminishing its psychoactive effects (11,12). Cutting substances added during manufacturing or transporting of drugs include agents such as mannitol, chalk, rat poison, ground glass, and household cleaning products such as Vim (12,13).

Harm reduction strategies used to respond to increasing drug overdose morbidity and mortality rates include issuing local, national or international information bulletins regarding adulterated drugs. Locally, health organizations in British Columbia (BC) issue drug alerts to the media when health risks, such as increased illicit drug deaths, overdoses or other harms associated with drug quality, are identified. BC’s Drug Overdose and Alert Partnership is a network of organizations that share data and expertise to make timely decisions to inform the public about unusual adverse events associated with illicit drugs. This data is obtained from a number of member organizations, including the BC Coroners Service and the BC Ambulance Service; and collated, analyzed and disseminated by the BC Centre for Disease Control(14).

In addition to local surveillance, some countries have implemented national surveillance programs and early warning systems for "new" or "changed" substances when they are first detected on the street. In the Netherlands, for instance, the Ministry of Health provides surveillance of adulterated drugs through the Drug Information and Monitoring System (DIMS) for the past two decades(15). Substance users are able to submit a sample of their drug for analysis of its contents; in cases when the substance is not found on file, further information is sought from the donor. Through this system, individuals can be assured their samples have been assessed with high standard quantitative analysis(15). Like the DIMS system, the European Monitoring Centre for Drug and Drug Addiction (EMCDDA) also have weekly updates thus allowing for early detection of new substances emerging in the street drug market(16). The United Nations Office on Drugs and Crime (UNODC) also conducts International Collaborative Exercises that allow laboratories to assess performance in participating countries around the world enabling the detection of new drug combinations(17).

Despite the use of these drug-monitoring systems, morbidity and mortality related to drug adulterants within informal drug markets persist. One illuminating example of the dangers this unregulated economy can be found in the spike in rates of overdose related to fentanyl, a synthetic opioid that is far more potent than morphine, commonly used as an adulterant in street heroin(18). In 2005-2006, Chicago, USA experienced an outbreak of opioid related deaths (4). In this time period, 342 deaths were attributed to fentanyl adulteration of opioids or fentanyl alone(19). More recently, there has been an increase in deaths in Pennsylvania, Maryland and Rhode Island, USA related to fentanyl-adulterated heroin(20). Similarly, BC has experienced an increase in fentanyl-detected deaths from 5% of all illicit drug deaths in 2012 to 25% in 2014(18). BC has also experienced recent deaths related to drug adulterants including substances involved in ecstasy(21) and cocaine(22).

A brief narrative literature review was conducted to explore the perceptions of people who use drugs (PWUD) regarding drug adulteration across a variety of drug classes, to explore the current state of knowledge regarding drug adulterants. Additionally, we identified a range of personal or shared quality assessment and harm reduction strategies that are in current use by PWUD to reduce the risk of overdose mortality and morbidity.

Methods

Search methods

The databases accessed in this review were PubMed, CINAHL, Web of Science, PsychINFO, and Medline. The search was limited to studies published from January 2000 to July 2015 according to inclusion criteria described below. Back referencing of included articles and gray literature was also conducted to identify any additional relevant articles.

Keywords employed in conducting the search were: “illicit drug use*”, “harm”, “drug quality”, “attitudes”, “patterns of drug use”, “knowledge exchange”, “drug user perceptions”, “consumer attitudes”, “opinions”, “social networks”, “drug use perceptions”, “drug use behaviours”, “injection drug use*”, “opioid use*”, “high risk behaviour”, ”quality assessment practices”, “drug testing,” “drug adulterants”, “trusted sources”, “drug potency and purity” “illicit drug user support”.

Inclusion Criteria

Studies were limited to those published in English involving the major topics of quality assessment practices related to drug adulterants or knowledge sharing practices among PWUD and dealers. A total of 1,396 articles were identified through the database search and 46 additional records were found through online searches of grey literature and two additional article through back referencing. After removing 22 duplicates, the combined records total was 1,421 (Figure 1). Titles and abstracts of all articles were then reviewed; studies were excluded if they did not conform to the major topics noted above. The remaining 36 articles were read through in full. This resulted in 19 articles included in this review (Table 1). Content analysis was performed and the following results are based on the major themes that emerged.

Results

Study Characteristics

The majority of studies were qualitative although a few employed mixed methods design. Given the challenges in reaching PWUD, most studies used purposive sampling, snowball sampling or a combination of both to recruit participants. Qualitative data collection was gathered predominantly by observation, semi-structured and in-depth interviews, which facilitated information gathering from participants in a comfortable setting. Qualitative approaches employed ethnography, grounded theory or case study analysis; study design was generally well articulated and reproducible.

While gender was generally representative of the target populations, ethnicity was not, particularly in the United States where most study samples were predominantly Caucasian ethnicity and to a lesser extent African American. Only one study contained a majority sample of African Americans (23) and another Canadian aboriginal (24). American Indians/Alaskan Natives were not well represented nor were other minority groups among samples.

Themes

From the 19 articles reviewed, two themes emerged. The primary theme, **Adulterants and Quality Assessment**, encompassed ideas of drug quality and adulterants, peer beliefs surrounding adulterants as well as how to identify and test for adulterants. A secondary theme, **Relationships, Social Network and Drug use**, included ideas of how the social network and the dealer relationship influences drug consumption, beliefs and harm reduction practices, as well as how social networks were used to communicate drug information. Overall, these relationships were in and of themselves a primary way to assess drug quality; therefore, can be seen as a sub-theme of Adulterants and Quality Assessment.

Adulterants and Quality Assessment

DRUG QUALITY BELIEFS AND KNOWLEDGE AMONG PWUD

Overall, a range of beliefs and a low level of understanding regarding the widespread harms of adulterated drugs were identified. From the perspective of PWUD, there are conflicting reports on the topic of adulteration. Among cocaine users in Antwerp, Belgium, the majority did not test cocaine for purity, and lacked an understanding of the underlying rationale and significance of drug quality testing (25). Similarly, PWUD in Australia did not believe that spikes of overdoses in their region were attributable to changes in purity or adulterants (26). On the other hand, 94.8% of heroin users in the United Kingdom believed that a wide range of cutting agents was involved when overdoses were occurring, although only 31.9% inquired about heroin quality at the time of purchase (27). In London, drug dealers interviewed downplayed dangerous cutting practices with only a few admitting to adulteration (13). Interestingly, this study examined forensic and anecdotal evidence which found far less adulteration occurred than perceived and rather used stories of cutting agents to explain overdose and death among the community (13). The type of drug used may be predictive of drug quality and testing beliefs. People who use ecstasy appear to be more knowledgeable about adulteration and express an interest in quality assessment. Johnston et al, investigated regular ecstasy use in Australia and found that approximately 84% of users attempted to determine drug purity at least some of the time, citing dealers and websites as potential sources of information to appraise drug quality (28).

DRUG QUALITY ASSESSMENT TECHNIQUES

PWUD who are concerned about drug adulterants use a wide range of 'tests' to evaluate drug quality. The majority of drug quality appraisal appears to rely on sensory tests. Individuals that use heroin rely on sensory tests such as taste, color, smell, and behaviour of substances under specific circumstances (11,24,25,27,29). For instance, a bitter taste or numbness was thought indicative of higher quality of heroin (11) and the same can be said of cocaine, though lidocaine, a common adulterant, can also mimic this effect (25). Scent when cooking is assumed to be indicative of good quality heroin (27) and when prepared for intravenous administration, a sweet sour odour is preferred (11). An observed dark red color of vapours when smoked is reportedly indicative of uncut heroin (11) as well as a light crystalline texture (24,27). Heroin cut with sugars tend to turn foils black and leave more residue (11). Admittedly, some PWUD also admit that these sensory assessment techniques can fall short, and for some the only way to know if they are adulterated is by using (29).

Multiple routes of administration and variable methods of preparation further complicate assessment techniques. Powdered drugs must be dissolved prior to injection, and this can serve as the basis for additional assessment techniques (24). Additional assessments of heroin quality include "testing" the behaviour of the substance under conditions such as heating (11,24,29). How a substance 'runs' or behaves when heated (e.g. running clear indicates better quality heroin) or what residue is left is considered grounds to determine the presence of adulterants (11,24,27,29). Getting a 'taste' or taking a 'hit' is another drug quality assessment technique where users will test a little of their drug to assess the effect before using a large amount (24). The quality of the 'hit,' its duration (11,27) and absence of unpleasant sensations are also used to judge drug quality (11,29).

Some consumers employ tests of greater specificity to evaluate purity through adding a test solution or evaluating the melting point of the substance; however, these require access to special equipment (25). Several scientific techniques measure drug composition more precisely than sensory tests and are accessible to PWUD internationally. Some test kits can be purchased globally and are affordable depending on relative socio-economic status. Test kits cost under $50 and have been shown to be precise. As such, there has been significant interest expressed in using kits (28). There was expressed interest among people who use ecstasy demonstrates a mutual motivation among users and health service providers to reduce drug related harms of use through testing kits. One such tool is Gas Chromatography Nitrogen Phosphorous Detection (GC-NPD) used elsewhere, is a reliable, effective service made freely available to PWUD in the Netherlands through the Ministry of Health's Drug Information and Monitoring System (DIMS) (15). These testing techniques

generally only identify a presence or absence of a specific substance but do not test broadly nor give the concentration of a substance.

Although drug testing equipment is becoming increasingly available worldwide, the majority of users do not have access to such equipment or test kits due to financial constraints, the lack of knowledge to operate tests, or lack storage space due to homelessness or unstable housing. Johnston et al. demonstrated that among 810 regular ecstasy users, only 22% of the sample used test kits to assess drug quality(28). However, over half of those who used test kits were aware of their inherent limitations. Among the studies reviewed, ecstasy users tend to be more knowledgeable regarding the harms of ecstasy use and demonstrate pro-active measures through the adoption of a range of harm reduction strategies, prior, during and post-ecstasy use(28,30).

DRUG PREFERENCES & ADDITIONAL RISKS

Issues of drug quality and availability may lead PWUD to alter their drug choices. A study conducted in Toronto to investigate the preference of using of prescription opioids among street-based PWUD (31). This study revealed an increase in preference of prescription opioids was due to ease in crushing pills and reduced side effects from inconsistent and poor quality heroin (31). However, understanding the risk associated with a drug does not always lead to a change in drug preference. Firestone et al. found that PWUD understood the overdose risk associated with injecting fentanyl; however, they were unwilling to change their drug preference because of the desired for such a high potency drug (32). Similarly, during a heroin shortage in the United Kingdom in 2010, Harris et al. found perceptions of low purity and heavy adulteration only deterred some participants from purchase (29). For those that did reduce or cease heroin use, some viewed it as a temporary measure (29). Interestingly, the participants in this study who moved away from heroin use transitioned to more crack cocaine, benzodiazepine, and alcohol use.

Relationships, Social Network and Drug Use

CONSUMPTION AND SOCIAL NETWORK

A common theme across all studies was the pivotal role relationships had on drug use patterns and behaviors. Ecstasy appears to be largely consumed in social settings with significant emphasis placed upon ongoing peer relationships (28,30). Jacinto et al found external impersonal sources, such as the media or educational campaigns, did not match the value placed on relationships of friends, acquaintances, dealers, and experienced users (30).

Social settings may also influence the choice of drug consumed as well as strategies employed by PWUD to reduce harms. Ecstasy tends to be used in the presence of others and may be more

conducive to social situations such as a party or rave. A qualitative study investigating harm reduction and the decision-making process of recreational ecstasy users in Australia found that harm reduction practices were often a group process with pre-planning to ensure all peers enjoyed their experiences. PWUD were aware of the negative consequences of use but made attempts to mitigate these together. Some experienced injection heroin users on the other hand may prefer to use alone to avoid the pressure to share with friends (33). Using alone reduces the opportunity to intervene in the event of an overdose and makes it difficult for harm reduction messages to reach the person. Socio-economic status, life course and personal preferences are factors that may also influence the context or social situation in which drugs are used (28).

SOCIAL NETWORKS AND OTHER STRATEGIES TO REDUCE HARMS

The structural and societal divide between illicit drug use and mainstream society, partially due to the illegality of psychoactive substances and stigma, may hinder the transfer of drug adulterant information between PWUD and service providers. As a result, PWUD rely on their friends and social networks to glean information regarding the risks of, and practices for, using psychoactive substances. In a prospective cohort study, AIDS Link to Intravenous Experiences (ALIVE), Pollini et al. investigated responses to overdose among 924 injection drug users (23). Almost three quarters (73.2 %) relied on information received from friends or acquaintances regarding overdose prevention or responses. Those that received information from medical and social service providers were more likely to contact emergency services in a timely manner. However, due to poor communication between health service providers and PWUD, there has been growth in peer involvement in designing harm reduction services (23).

PWUD use other harm reduction strategies to mitigate the harms associated with using adulterated drugs. Studies have described “testing” for adulteration by “heating a small sample [of heroin] on foil” to detect adulterants, although PWUD admit these techniques can fall short (29). Other harm reduction strategies include finding alternative routes of administration, such as smoking instead of injecting(29). As Harris points out, this is an interesting strategy to use with low-purity heroin, as injecting is a more efficient mode of administration (29).

A number of online resources have emerged to provide PWUD information to reduce harms associated with substance use. Tackett-Gibson evaluated discussion threads from a reputable harm reduction website for ketamine users and found that forum members were well acquainted with scientific literature and knowledgeable about the risks of ketamine use (34). Interpretations of the threads revealed that scientific studies were questioned and lay knowledge from “experts” or experienced users tended to be valued over scientific evidence. Some research has examined drug

assessment techniques for drugs including ecstasy and several hallucinogens in online drug markets, or "cryptomarkets", or in drug use forums (35). PWUD who turn to cryptomarkets to purchase illicit drugs tended to place high value and trust in the review sections, which hold the opinions of hundreds of other PWUD in this online market (36). Another source of purity information has also come with the rise of the well-known harm reduction organization, *Dance Safe*, have explored the use of drug testing kits among recreational ecstasy users at music festivals (37,38).

Aside from testing kits, recreational "party drug" users tend to rely on peer-to-peer transmission or word of mouth as the primary means of generating knowledge related to drug use and the adoption of harm reduction strategies to mitigate risk (30,34). In gathering information about drug quality or purity, studies have found the majority of emphasis is placed upon drug dealer or peer relationships (25,39). Tackett-Gibson cautions the competing views of risk offered with "official" sources of authority and the danger of incomplete or inaccurate knowledge translation on a global scale. With lack of regulation, the challenge is ensuring sound evidence is disseminated (34).

Kerr et al. investigated the effectiveness of a public health warning in Vancouver that communicated the risk of circulating higher potency heroin (33). This study found that rather than demonstrating greater caution, people who injected heroin reported that the "higher potency" heroin was instead sought after. Feedback included scepticism of warnings, belief drug strength was irrelevant and cultural logic that low quality heroin might give rise to withdrawal (33). Similarly, Miller conducted 60 in-depth interviews with injection drug users in an Australian regional city some seven years prior, demonstrating that media reporting of "killer batches of heroin" may not actually deter drug use, but increase motivation to use it(26). More recent research in BC found user-informed messaging using words that imply harm such as "toxic" may be more effective in impacting high-risk drug seeking behaviour (24).

BELIEFS ABOUT THE DEALER AND DRUG QUALITY

A number of studies affirm the belief that drug quality is deeply embedded in the dealer-consumer relationship, although perceptions of these relationships vary considerably. When probed about the characteristics a reliable cocaine dealer might possess, 111 cocaine users from a metropolitan area of Antwerp, Belgium shared the following characteristics: unobtrusive, honest, not a cocaine consumer themselves, and highly selective of clientele (25). Tied to these perceptions, 41.6% believed that a reliable dealer would not adulterate cocaine (25). The trust established with a dealer appeared to transfer to trust in product quality. Purchasing illicit street drugs such as heroin

or cocaine from a trusted dealer has been considered a harm reduction strategy (24). Jacinto et al. conducted a four-year study between 2003-2006 with a sample of 120 ecstasy users and dealers to qualitatively investigate harm reduction strategies and found trust between the dealer and consumer was a key factor governing the perception of drug quality (30). This study like others found negative effects of the drug were attributed to adulterants and strategies to mitigate risk were again to purchase from a trusted source. Similarly, Baljak et al. found PWUD placed a high level of trust in their dealer despite admitting the drugs they purchased may have been adulterated and their dealer may not know its contents (24). Interestingly, the trust established between a dealer and PWUD can diminish when overall purity in the marketplace becomes low. In one study of the 2010 "great heroin shortage" in Australia, relationships eroded between PWUD and previously trusted dealers (29). Studies of two high-profile street markets in Sydney, Australia show that dealers downplay dangerous adulterant practices (11). Although it is in the best interest of the dealer to maintain the health of their client (11), there is limited evidence supporting the notion that trust between the dealer and user results in better drug quality.

For PWUD that may be new to a drug or street market, the trust between dealers and users may not be established. One study found PWUD would often refer people new to town to reputable dealers who have the "good [stuff]" (24). Purchasing from a new dealer was not recommended. For new users, many are turning to cryptomarkets. Crypomarkets offer a unique forum for PWUD in that they offer feedback on dealers' reputations and history of drug quality through the use of reviews and forums (40). One study on cryptomarkets in the United States as well as one in Australia found participants, new and experienced, viewed online cryptomarkets as more reliable and better quality source of illicit drugs than on the street (40,36,41). One study found dealers would report testing products with kits as well as using the products on themselves to assess the quality (41). "Trip reporting" by other PWUD on the site was perceived as a reliable source of drug quality assessment (36). Van Hout and Bingham explain many cryptomarkets "harm reduction ethos appeared centred on informed consumerism and responsible vending by availability of high quality products with low risk for contamination, vendor tested products, trip reporting, and feedback on the vending infrastructure" (41). The majority of studies found PWUD viewed online drug markets as a way to reduce harms associated with adulterated drugs, and described very positive experiences with products purchased on websites (36,40,41). Dealers describe a personal interest in harm reduction as a motivation to sell within cryptomarkets, with a personal interest in the "intelligent and responsible use of drugs" (41). In one study using an online questionnaire of over 9,400 respondents, participants reported the most common reasons for purchasing online were better quality (77%) and the use of vendor rating systems (65%)(40).

Discussion

The purpose of this brief literature review was to look at the perceptions and beliefs surrounding drug adulteration as well as methods used with PWUD to reduce harms from illicit drug in an informal, unregulated market. Overall, there is limited published peer-reviewed and grey literature evaluating behaviors and beliefs surrounding adulterants and related harm reduction practices. From the 19 studies identified, two themes evolved: Adulterants and Quality Assessment, and Relationships, Social Networks and Drug Use.

The first theme – Adulterants and Quality Assessment – was rooted in beliefs around drug adulteration and various quality assessment techniques. We found PWUD tend to rely on observational cues to assess product quality. One challenge with this strategy is that it reinforces the emphasis placed on trust between the buyer and seller. Neither this relationship nor sensory cues can guarantee drug potency or purity (11); such techniques are not always accurate or based on scientific methods. Overall, scientific testing through test kits were not a viable or accessible for PWUD internationally and limited information has been published on the prevalence or perceptions about drug testing available, other than a two publications on the DIMS in the Netherlands (15,42). Unlike Europe, in Canada it is challenging to get samples analyzed in laboratories other than through law enforcement. Grassroots harm reduction organizations such as DanceSafe have increased access to drug testing kits in specific contexts with “party drug” users, and may be limited to primarily ecstasy users (36). Effective drug surveillance methods to monitor can be tied with appropriate communication to PWUD of the presence of harmful substances – an area of potential growth where health service providers, researchers and partnerships with health agencies specialized in the field of harm reduction can contribute and play a valuable role in communicating drug alerts.

The literature also highlighted quality assessment practices. The literature further gave no indication as to what point drugs become adulterated; they may exchange hands a number of times prior to reaching the consumer. Being able to follow up with PWUD after a negative reaction, such as an overdose, may aid our ability to understand how harmful drug adulterants enter the final street-level product. However, follow up may be challenging due to the mental state at time, as well as the reluctance to share information about illicit drugs (43). Future research could explore the conditions or factors that influence illicit drug market, as well as strategies to intervene before adulterated drugs are made available.

The second major theme, Relationships, Social Networks and Drug use, shows that the most trusted communication about drug safety comes from current relationships with other PWUD and

their social network. It is concerning to see participants in many studies placed a high level of trust in their dealer despite admitting the drugs they purchased may have been adulterated and their dealer may not know its contents. Understanding the knowledge shared between PWUD might assist in harm reduction strategies aimed to reduce consumption of a particular adulterated drug. Although it is in the best interest of the dealer to maintain the health of their client (11), there is limited evidence supporting the notion that trust between the dealer and user results in better drug quality. Therefore, emphasis should be placed on alternate harm reduction practices, such as using in the company of others, planning what to do if things go wrong, and tasting the drug (i.e. using a small amount first).

Not all interventions to communicate adulterated drug harms are effective. Drug alerts may not achieve the intended effect of promoting the health and safety of this marginalized population, but rather cause harms such as drug seeking behaviour (24,33,26). Only one study to our knowledge offered user-informed suggestions of content, language and mode of communication of drug alerts (24). Without understanding the perceptions of adulterated drugs among PWUD makes designing public health interventions difficult. It is clear that involving the PWUD community in the reporting and disseminating information is essential to effectively communicate information about adulterated drugs (24).

There are several limitations of this brief literature review. First, many of the study samples of the reviewed articles were not representative of general PWUD populations. Understanding perceptions of adulterants and risk-reducing strategies between PWUD may differ by drug class. It is imperative to emphasize that there is no attempt to assume that one shared drug culture exists across all drug classes and drug using populations. Much of the literature evaluated particular drug classes such as heroin and cocaine therefore not all illicit drugs were equally represented in this review.

Second, this review was initiated as part of a larger project and does not represent a systematic or exhaustive review of the literature. The larger study performed focus groups to identify how to communicate drug alerts with PWUD in Vancouver, Canada. The results of those focus groups have been considered and included (Soukup-Baljak, 2015)(24). Despite this, due to the number of references in our initial search and limited resources available in this project, it was not feasible for us to conduct a thorough systematic review. Rather, this review attempts to briefly scan and summarize broad themes, which may encourage further research or reviews on these topics. Because of the vastness of this area of research, we urge future research to expand the search

terms, inclusion criteria, and strategy to systematically review gray sources to elicit a more comprehensive examination of the literature.

Conclusion

Due to the risky nature of illicit drug use, PWUD employ a variety of techniques to reduce and communicate harms. Nonetheless, the most significant influences of drug use behaviour, knowledge and perceived harms are peers, friends and dealer relationships. Secondary sources tend to be drug testing kits, surveillance systems and public health drug alerts, and cryptomarkets. Further research assessing the knowledge level and current understanding of drug adulterants in Canada and elsewhere are warranted. Presently, no evidence-based standard exists to assess drug quality that is universally accessible to PWUD. As a result, PWUD rely on subjective assessments and unscientific means to evaluate drug quality. Raising a basic standard of awareness of the risks associated with varying drug quality and how to reduce risk based on evidence should be further explored to reduce the risk of overdose in this vulnerable population. Bridging research with practice requires further exploration in order to tailor harm reduction strategies to illicit drug users that will be valuable and effective.

Table 1: Documents included in the literature review

Authors	Date	Country	Study designs	Sample	Key results
Best (27)	2004	England	Semi structured interviews	114 drug users	Almost 94% of the sample believed a wide range of cutting agents was involved, although only 31.9% inquired about heroin quality at the time of purchase. The sample felt that indications of adulterants included: higher level of residue, not running clear, smell, being darker in color, and how crystalline the compound was.
Brunt (15)	2011	The Netherlands	Descriptive	Over 10,000 samples from 1992-2010	The Ministry of Health in the Netherlands has made illicit drug testing for drug users possible since the 1990s, in order to prevent serious health hazards associated with unexpected dangerous substances with a system of drug testing called the Drug Information and Monitoring System (DIMS). The DIMS results were used for national and international risk assessments and major warning and prevention activities.
Coomber (11)	2006	Australia	Semi structured interviews	32 heroin dealers	Factors that indicate high quality heroin include: burning a dark red fume, when the drug runs clear when heated, a strong or pungent sweet-sour smell, a bitter taste, and leaving little residue. Others will assess the quality of the hit.
Decorte	2001	Belgium	Ethnography	111 heroin	Most users did not test their cocaine for adulterants. Users

(25)				users	often relied on 'user lore' to decide what cocaine to buy and from what dealer however, this 'lore' may be incomplete or false. For example, user lore or types of reliable dealers included: sellers who are not using cocaine themselves, older dealers, and unobtrusive dealers. Judgment on purity of cocaine was found to be poor.
Evrard (44)	2010	France	Face to face interviews	373 cocaine users	Seventy five percent of cocaine samples contained at least one adulterant of which phenacetin, caffeine and paracetamol were the most common. The median cocaine content was 22% Users had poor discrimination in being able to detect adulterants
Firestone (31)	2008	Canada	In depth interviews	25 prescription opioid users	Respondents were more likely to use prescription opioids because they are dependable and consistently generate the same experience compared to the poor quality high price of heroin.
Firestone (32)	2009	Canada	In depth interviews	25 prescription opioid users	Fentanyl is a highly desired drug and users accept the risks of this drug due to the highly desired effects compared to other opioids available.
Jacinto (30)	2008	United Stated	In depth interviews	120 drug distributors	Most ecstasy sales occurred in private settings to friends. Most of those who sold at raves and clubs sold to friends. Buying ecstasy from a trusted dealer was a common strategy to avoid unexpected effects as well as adulterants. Adulterants were thought to cause negative outcomes.
Johnston (28)	2006	Australia	Interviews	810 ecstasy users	Over half the sample attempted to find out about the content and purity of the ecstasy always or most of the time. Asking friends and dealers was the most common way of getting information about content and quality. Many indicated using testing kits. Over half of those that used test kits were aware of their limitations.
Kerr (33)	2013	Canada	Semi structured interviews	18 active heroin injectors	Most participants were aware of the warning for high potency heroin but reported seeking the potency heroin and reported no change in their overdose risk behavior. Barriers to the adoption of overdose prevention strategies include: poverty and wanting to use alone to save money, opiate withdrawal preventing them from using small amounts first, and the perception that it is ok to purchase from a trusted dealer.
Panagopolous (39)	2005	Australia	Semi structured interviews	40 ecstasy users	Many harm reduction strategies were identified including: buying from a known dealing, pace dosage, use test kit, having a cell phone for emergencies. A variety of peer based strategies were also identified including: having a sober member of the group and using with peers. There is also peer group etiquette such as watching out for each other, never leaving members alone, newcomers being provided with extra support and supervision.
Pollini (23)	2006	United States	Cross sectional survey	924 injection drug users	Most injection drug users have received information on how to prevent or respond to an overdose but most received this information from friends or other drug users. Those who received information solely from lay sources were less likely to call 911 while those who received information from

					medical or social services were less likely to delay calling 911.
Miller (26)	2007	Australia	Qualitative interviews	60 heroin injection drug users	Interviewees did not believe overdoses were caused by changes in purity or adulterants, and when they heard about overdoses, participants would try to gain access to the drug in question.
Soukup-Baljak (24)	2015	Canada	Qualitative interviews	32 people who use drugs	The most effective and trusted information about drug quality was primarily from: a) trusted, reputable dealers or b) peer-based social networks. Quality assessment techniques were primarily sensory. A number of concrete guidelines were suggested to improve the effectiveness of drug alert modes and methods of communication in the community.
Harris (29)	2015	United Kingdom	Qualitative interviews	37 injection drug users	The majority of participants reported decline in purity and increased adulteration, and the use of other drugs during a heroin shortage in London. Participants used harm reduction strategies to manage changes in purity and availability.
Van Hout (36)	2013		Online posts and qualitative interviews	4 threads, 1249 posts and 20 completed interviews	Reasons for utilizing cryptomarkets for seeking illicit drugs included concerns for street drug quality and personal safety. Vendor selection was based off of quality of product. Forums provided user advice, trip reports, and product reviews. Overall, consumers described using these markets for harm reduction purposes and their experiences were very positive with the products.
Tackett-Gibson(34)	2008	United States	Discussions gathered from a drug information website	59 discussions from harm reduction website	Website users appeared to have a lot of knowledge about ketamine's risks and harms and were able to discuss these using scientific terms. Website members put a lot of confidence in the experience of other website members. The website's users used technology and access to scientific information to understand the risks of ketamine and promoted safe use practices.
Van Hout (41)	2014		Qualitative interviews online	10 Vendors	Vendors described a personal interest in harm reduction, claiming responsible and informed use as a motivation to selling online. Reviews, personal use, and trip reports, were seen as ways to ensure high quality products sold in the marketplace.
Barratt (40)	2013	United Kingdom, United States, and Australia	Online questionnaire	9470 users of Silk Road	The most common reasons for purchasing drugs online was better quality (77%) and the use of vendor rating systems (65%).

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