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DISCUSSION

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Evolution of the substance use landscape: Implications for contingency management

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Abstract

Contingency management (CM), which involves the delivery of incentives upon meeting behavioral goals, has the potential to improve substance use treatment outcomes. The intervention allows for flexibility through numerous modifiable components including changes to incentive magnitude and schedule, target behavior, and intervention structure. Unfortunately, numerous changes in the substance use landscape have occurred in the past 10 to 15 years: Substances are more potent, overdose risk has increased, new substances and methods of use have been introduced, and substance classes are increasingly being intentionally and unintentionally mixed. These developments potentially undermine CM outcomes. We explored recent substance use changes due to legislative, regulatory, social, and economic factors for four substance classes: stimulants, opioids, tobacco, and cannabis. We discuss potential adjustments to the modifiable components of CM for future research in response to these changes. By continually adapting to the shifting substance use landscape, CM can maintain optimal efficacy.

KEYWORDS
contingency management, potency, substance abuse, treatment, trend

Problematic substance use, defined as substance use that results in fuctional and health-related problems, is a notable threat to human health and well-being that devastates the lives of millions of Americans each year (Center for Behavioral Health Statistics, 2022). Evidence-based treatments have the potential to aid people in recovery, but changes in substance use patterns make maintaining treatment efficacy difficult. Legislative, regulatory, social, and economic factors have altered drug potency, risk for overdose, the availability of new substances, drug combinations, and methods of use (hereafter referred to as substance use landscape). To adequately reduce problematic substance use and to improve people's lives, treatment development must consider changes in substance use landscape.

CONTINGENCY MANAGEMENT

Contingency management (CM) is one such evidence-based intervention that has the potential to be adapted to the changing landscape of substance use. Based on positive reinforcement in operant conditioning, CM requires the use of tangible rewards for engaging in explicitly defined and objectively verified target behaviors. If the reward results in an increase in the target behavior, this reward would be considered a reinforcer (Higgins et al., 2007; Skinner, 1938). In the treatment context, reinforcement is delivered for achieving intermediate treatment steps (e.g., urine drug tests showing reductions or abstinence) before longer term outcomes (i.e., natural reinforcers) can take over to maintain the behavior (e.g., improved health, job stability, stronger interpersonal relationships; Hooker et al., 2022).

A wealth of evidence supports CM as a viable intervention to be broadly disseminated (Bolívar et al., 2021; Getty et al., 2019; McPherson et al., 2018). In fact, in 2011, the United States Department of Veterans Affairs implemented CM for stimulant use disorder. Additionally, three states recently developed CM pilot programs that were viewed as acceptable and beneficial by providers (DePhilippis et al., 2018; Green et al., 2023; Parent et al., 2023; State of California Health and Human Services Agency, 2022). Although CM has a promising evidence base, it is underused in clinical practice due to criticisms such as cost, clinic staff training and burden, and provider attitudes of CM efficacy (Oluwoye et al., 2020; Rash et al., 2017). Efforts are being made to optimize implementation within the constraints of real-world systems to ensure that benefits are maximized for more people (Becker et al., 2023; Ginley et al., 2021).

Contingency management modifications

Contingency management has several components that can be manipulated to address substance use across a range of presenting problems and environments while maintaining the scientific integrity of the intervention. These include changes to reinforcer magnitude (i.e., monetary value), frequency, type (e.g., vouchers, cash, items, virtual), and schedule (e.g., continuous or intermittent, fixed or escalating schedules; Getty et al., 2019; Jhanjee, 2014; Kidorf et al., 2013; Preston et al., 2008). Other modifiable components include the target behavior such as abstinence from one or more substances, treatment visit attendance, biological sample submission, medication adherence, or some combination of these targets (McPherson et al., 2018; Rash et al., 2020). Finally, the structure of CM is malleable including the duration of the intervention, the potential for an individual to receive repeated exposures to CM, and the administration of CM either alone or in conjunction with other treatments such as medications for opioid use disorder or other behavioral therapies (e.g., motivational interviewing, community reinforcement approach; McPherson et al., 2018; Rash et al., 2020).

Changes in the substance use landscape

The range of CM components allows interventionists to address different substance use disorders, and it also allows for flexibility due to changes in substance use patterns. In the past 10 to 15 years, changes to the landscape have included the following: Substances have grown in potency, risk for overdose has increased, new substances and methods of use have been introduced, and substance classes are increasingly being intentionally and unintentionally mixed (Churchill et al., 2023; Drug Enforcement Administration, 2021a; National Institute on Drug Abuse, 2023). These changes have implications for the reinforcing aspects maintaining substance use and the potential for CM to differentially reinforce abstinence. Using operant theory to understand how the changing drug landscape might influence the modifiable variables in CM, such as incentive amount, delay, schedule, and frequency, will improve implementation (Rash et al., 2020). In this manuscript, we discuss recent changes in four classes of substances (stimulants, opioids, tobacco, and cannabis) and subsequent substance use disorder risk due to legislative, regulatory, social, or economic factors. Specific changes include prevalence and potency, new substances, contamination, adulteration, or substance co-use, implications for non-CM treatment options, route of administration, and legalization. We then discuss the implications of these changes for CM design, research, and implementation to adapt to a continually shifting substance use landscape.

CHANGES IN STIMULANTS

Changes in prevalence and potency

In recent years, stimulant use prevalence and overdose rates have increased and stimulants have increased in potency. Methamphetamine use increased 43% among American adults between 2015 and 2019, prescription stimulant misuse increased 40% among adults aged 35 to 49 between 2015 and 2019, and cocaine use increased 24% among American adults between 2011 and 2019 (Han et al., 2021; Mustaquim et al., 2021; Schepis et al., 2022). Although stimulant use spans the United States, the relative prevalence of each type of stimulant is regional. For example, methamphetamine use is particularly prevalent in the West and Midwest regions of the United States (Hedegaard et al., 2019; Kim et al., 2014). However, methamphetamine use has surged among all regions of the United States, including areas that have had historically low levels of methamphetamine use, driven by consistently low prices and an increase in supply (Artigiani et al., 2020; Drug Enforcement Administration, 2021a). As manufacturing shifted from the United States to Mexico and as transnational criminal organizations have improved manufacturing efficiency, methamphetamine potency has increased (Drug Enforcement Administration, 2021a; United Nations Office on Drugs and Crime, 2022).

Although some people report using stimulants because they are afraid of the overdose risk from the synthetic opioid fentanyl, overdose rates from cocaine and methamphetamine have more than tripled since 1999. This change can only be partially accounted for by concomitant opioid use. Notably, overdose rates involving stimulants and other drug classes like opioids, as well as overdoses from stimulants alone, have increased (Ahmed et al., 2022; Ellis et al., 2018; Hedegaard et al., 2020; Vivolo-Kantor et al., 2020). Nationally, overdose deaths involving stimulants have increased from 12,122 in 2015 to 53,495 in 2021 (National Institute on Drug Abuse, 2023).

New substances

In addition to greater use of "conventional" stimulants such as methamphetamine and cocaine, newer stimulants have also increased in popularity. These include synthetic cathinones, the most reported of which was eutylone in 2019, and other novel psychoactive substances (Drug Enforcement Administration, 2021a). These drugs are designed to mimic the characteristics of existing stimulants such as cocaine, 3,4-methylenedioxymethamphetamine (MDMA), and methamphetamine, but as a group they are highly diverse and often combined with other substance classes. Therefore, they vary widely with respect to composition, subjective effect, and withdrawal symptoms. The increased use of novel psychoactive substances, especially among younger adults, makes monitoring them, predicting their effects, and addressing their use difficult (Canning et al., 2021; Miliano et al., 2016; Peacock et al., 2019; Tracy et al., 2017). Treatment providers may be less confident in addressing the use of such a diverse, ever-changing group of substances (Wood et al., 2016).

Contamination

Within the stimulants themselves, contaminants have been increasingly detected and are often present without user detection. These unknowingly incorporated contaminants include fentanyl, which started growing in prevalence in 2014 and surged between 2018 and 2021 (Ciccarone et al., 2017; Palamar et al., 2022). The United States Drug Enforcement Administration seized 20,000,000 pills containing stimulants and fentanyl in 2021 alone, more than the two previous years combined (Drug Enforcement Administration, 2021b). Powder-based stimulants are notably vulnerable to contamination; a study of voluntarily mailed drug samples to a public drug-checking service from 77 harm-reduction and health-related programs found fentanyl in 12.5% of powder methamphetamine and 14.8% of powder cocaine samples, but the presence of fentanyl in crystalline stimulants was negligible (Wagner et al., 2023). Drug trafficking organizations can also inadvertently mix substances when they process and distribute many classes of drugs at the same time; fentanyl's potency makes it a frequently detected accidental contaminant because a relatively small amount of the substance can produce a noticeable effect (Drug Enforcement Administration, 2021a; Rosenblum et al., 2020).

In addition to accidental contamination, drugs are often mislabeled as other substances. For example, methamphetamine in pill form has been increasingly seized by the United States Drug Enforcement Administration over time. Due to the sporadic (but increasing) nature of these seizures, along with the pills often being labeled as other stimulants (e.g., Adderall), the Drug Enforcement Administration has reason to believe that methamphetamine is being manufactured in pill form exclusively to be disguised as other substances (Drug Enforcement Administration, 2021b). Criminal organizations may be labeling their methamphetamine as prescription medications in an effort to market their product as safer or its effects as more predictable, thus increasing its appeal. Additionally, novel psychoactive substances, such as synthetic cathinones, can be marketed as substitutes for existing stimulants or falsely marketed as the substances themselves (MDMA in particular). Because synthetic cathinones are often distributed and sold under generic names, it is unclear what is in the substance itself and when the substance has been contaminated (Drug Enforcement Administration, 2021a).

CHANGES IN OPIOIDS

Changes in prevalence and potency

The prevalence of opioid use disorder in the United States, determined using adjusted estimates to better capture rates, remained fairly stable between 2010 and 2014, reaching peak prevalence in 2015 at 4.04%. Between 2010 and 2019, the percentage of opioid use disorder steadily declined to 2.77% in 2019, or approximately 7.63 million people aged 12 or older (Keyes et al., 2022). However, given the risks for overdose and effects on physical and mental health, particularly concerning the surge of synthetic opioids and opioid potency (described below), the burden of disease remains high.

New substances

One of the most marked recent changes in the illict opioid supply is the increase of synthetic opioids. Fentanyl, an opioid that is 30 to 50 times more powerful than heroin, emerged in 2014 in response to restrictions on medical opioid prescribing practices. Since 2014, fentanyl production and fentanyl use have increased sharply (Ciccarone, 2019; Ciccarone et al., 2017; Fischer et al., 2020). Between 2018 and 2021, there was a large increase in both pill and powder seizures containing fentanyl (Palamar et al., 2022). Isotonitazene, or nitazene, is another synthetic opioid similar to fentanyl that emerged in 2019 (Drug Enforcement Administration Public Information Office, 2022). Together, manufacturing and illicit use of these synthetic opioids has increased considerably in recent years, and, due to their potency, they carry notable risk for overdose (Rosenblum et al., 2020). In 2019, 51.5% of drug overdose deaths in the United States included synthetic opioids, with the highest percentages in the Northeast at 71% (Mattson et al., 2021). Overdose deaths involving fentanyl have even increased dramatically since 2019, greatly surpassing deaths from heroin (Ciccarone, 2019; National Institute on Drug Abuse, 2023).

Adulteration

Fentanyl, along with other opioids, has been increasingly mixed with adulterants (i.e., substances that have been purposefully added in the manufacturing process to increase the duration of subjective effects). As opposed to contaminants, which are accidentally added, the addition of adulterants is intentional, often without the knowledge of the person using it (Friedman et al., 2022; Singh et al., 2020). Xylazine, a veterinary anesthetic and sedative, was first seen as an opioid adulterant in 2001 in Puerto Rico and has been rapidly increasing in prevalence in the United States since 2018, particularly in the northeast (Alexander et al., 2022; Johnson et al., 2021; Torruella, 2011). Xylazine is not a controlled substance and is not regulated by the United States Drug Enforcement Administration, but it compounds risk for overdose death due in part to added respiratory depression (Johnson et al., 2021; Ruiz-Colón et al., 2014). Additionally, xylazine carries risk for skin lesions that result from injections but are seen across the body, not just at the injection site (Reyes et al., 2012). Opioids with adulterants such as xylazine may be sought out explicitly by a person who uses the opioid because xylazine prolongs the opioids's subjective effects, or adulterants may be present in opioids without the user's awareness or desire (Spadaro et al., 2023). Not much is known about xylazine withdrawal, but some patients and providers describe a unique set of prolonged withdrawal symptoms that include restlessness and irritability (D'Orazio et al., 2023). Comfort medications can be prescribed to offset withdrawal symptoms but are not prescribed uniformly by medical providers; no medication has been developed specifically for xylazine withdrawal (D'Orazio et al., 2023; Ehrman-Dupre et al., 2022). Further complicating care is the potential for open wounds due to xylazine, which can interfere with admission to shelters and inpatient care (D'Orazio et al., 2023).

Substance co-use

In addition to an increase in opioid-contaminated methamphetamine, there has been an increase in people who intentionally use methamphetamines and opioids concurrently and nonconcurrently. Among a national sample of individuals entering opioid treatment, methamphetamine use grew by 85% between 2011 and 2018, whereas nicotine, alcohol, marijuana, and cocaine co-use remained stable (Cicero et al., 2020). Another study found a similar increase in opioid and methamphetamine co-use among people entering treatment between 1992 and 2017, whereas co-use of opioids and alcohol as well as opioids and cocaine decreased during the same period (Ford et al., 2021). In a national sample of new patients who were being treated for opioid use disorder across the United States between 2012 and 2019, methamphetamine use increased from 23.1% to 36.5% in urban areas and from 24.5% to 46.1% in rural areas (Ellis et al., 2021). Although cocaine co-use has remained stable, overdose deaths involving opioids and stimulants (either cocaine or methamphetamine) have increased from 6,594 in 2015 to 37,682 in 2021, a 5.7-fold change (National Institute on Drug Abuse, 2023). Purportedly, this increase of stimulants in fentanyl-involved overdose deaths across the United States has largely driven what is being considered the "fourth wave" of the opioid crisis (Friedman & Shover, 2023).

Among individuals with opioid use disorder, those engaging in co-occurring substance use are less likely to initiate buprenorphine treatment (discussed more below) than are those who use opioids alone (Xu et al., 2022). Individuals who use both opioids and methamphetamine, specifically, are less likely to be abstinent and more likely to drop out of treatment. Methamphetamines deliver powerful, immediate subjective effects that can lower inhibitions, increase the likelihood of returning to opioid use, and carry their own set of withdrawal symptoms (Frost et al., 2021).

Implications for non-CM treatment options

The diversity and availability of opioid treatment options has changed greatly over the 21st century, particularly for medications for opioid use disorder. Methadone was first introduced as a daily treatment in the 1960s, and buprenorphine was first offered in 2002 as a daily sublingual tablet and then in 2010 as a daily sublingual film. More administration options are available for buprenorphine than for methadone, which is primarily oral, including a weekly injection (approved in May 2023), a monthly injection (approved in 2017), and a subdermal implant every 6 months (approved in 2018; Heidbreder et al., 2023; National Institute on Drug Abuse, 2021; United States Food and Drug Administration, 2023b).

Methadone and buprenorphine have historically differed in their treatment structure and patient requirements. As a full opioid agonist, methadone has greater potential for diversion, meaning that individuals could use it for purposes other than prescribed such as selling or recreation (Hoffman et al., 2019). Therefore, methadone typically requires daily visits to a specialized clinic where dosing is supervised (Samet et al., 2018). Conversely, buprenorphine is a partial agonist with a lower risk of overdose, intoxication, and diversion (Shulman et al., 2019). The better safety profile means that buprenorphine can be prescribed by a range of health care providers for a week or more at a time (Kampman & Jarvis, 2015).

Methadone has been steadily available since its introduction, but its availability has increased particularly in recent years. Between 2017 and 2019, methadone prescriptions among treatment programs increased by 12.3%

across the United States, with the greatest growth found in North Dakota and Mississippi. Contributors to this growth include an overall increase in opioid treatment programs, Medicare and Medicaid shifting to include methadone treatment in their policies as of 2020, emergency department methadone initiation, and loosened restrictions on take-home doses (Costello, 2020; Furst et al., 2022; Huo et al., 2023; Kessler et al., 2022; Substance Abuse and Mental Health Services Administration, 2023b; Taylor et al., 2023). Efforts are being made to research and expand methadone prescription practices, including the possibility of prescribing methadone in settings beyond the specialized clinics (Joudrey et al., 2021; McCarty et al., 2021).

Similarly, buprenorphine prescription practices have increased substantially. Between 2016 and 2019, buprenorphine prescriptions increased by 92% in the United States, and in 2019, buprenorphine accounted for 87% of Medicaid prescriptions for opioid use disorder (Kennalley et al., 2023; Williams & Saunders, 2023). As mentioned previously, buprenorphine can be prescribed by a wide range of providers in diverse contexts. In 2022, the United States Drug Enforcement Administration removed the previously held requirement for providers to apply for special authorization, called an "X-waiver," to prescribe buprenorphine. Without the extensive process to acquire an X-wavier, providers now have fewer barriers to prescribing buprenorphine than ever before (American Association of Physician Associates, 2023; Milgram, 2023; Substance Abuse and Mental Health Services Administration, 2023c, Volpe, 2023).

The increase of synthetic opioids and adulterants has complicated induction and sustained treatment with medications for opioid use disorder. Precipitated withdrawal is a risk with buprenorphine and occurs when the medication is given while opioids are still bound to their receptors (Rosen et al., 2014). Precipitated withdrawal is more likely with fentanyl due to its notably slow excretion, which makes treatment continuation less likely (Silverstein et al., 2019). Fentanyl has been directly linked to lower abstinence and engagement in buprenorphine treatment overall, even beyond experiences of precipitated withdrawal (Volkow, 2021). The United States Food and Drug Administration's recommendations for buprenorphine dosage were determined by 2014, before the increase in fentanyl use. In light of the greater ubiquity of highly potent fentanyl in the opioid supply and lower dose buprenorphine being less effective, attempts to change induction strategies are underway and researchers have recommended higher target doses of buprenorphine (Ahmed et al., 2021; Chambers et al., 2023). Although methadone does not carry risk for precipitated withdrawal, recommendations for dosage were also established by 1995, long before fentanyl became prevalent around 2014. Efforts are being made to adjust dosage protocols to maintain induction efficacy (Buresh et al., 2022; Yarmolinsky & Rettig, 1995). Although treatment retention is similar for buprenorphine and methadone, recent interest in methadone has increased (Bromley et al., 2021; Klimas et al., 2021) because it does not require opioid withdrawal symptoms for induction and opioid tolerance is maintained during treatment, which reduces overdose risk if a person abruptly uses fentanyl. Similarly complicating medication for treating opioid use disorder is the increase in xylazine as an opioid adulterant. Xylazine is not an opioid, so buprenorphine and other medications for opioid use disorder cannot address withdrawal and craving. Therefore, people can take medications for opioid use disorder exactly as prescribed and still experience withdrawal, resulting in the perception that these medications are ineffective (Spadaro et al., 2023).

CHANGES IN TOBACCO

Changes in prevalence

In recent years, the overall use of combustible tobacco products, such as cigarettes, has declined for all age groups. Between 2019 and 2021, the proportion of American adults who regularly used combustible tobacco products dropped from 16.7% to 14.5%, continuing the trend of decreasing use of combustible products since 2005 (Cornelius et al., 2022, 2023). Between 2019 and 2020, among daily cigarette smokers, the prevalence of individuals smoking 20 or more cigarettes per day decreased but the prevalence of individuals smoking between 1 and 19 cigarettes per day increased (Cornelius et al., 2022). Similarly, adolescents' use of combustible tobacco has decreased since 1997 (Meza et al., 2020). Conversely, from 2002 to 2018, the proportion of those who initiated smoking in early adulthood (ages 18 to 23) and the proportion of individuals who became daily smokers in early adulthood increased relative to other age groups (Barrington-Trimis et al., 2020). Although the decreases in combustible tobacco use are welcome news, smoking remains the number one cause of premature death and disease, accounting for approximately 480,000 deaths per year (Centers for Disease Control and Prevention, 2020). The increase in prevalence of light smoking (i.e., 1 to 19 cigarettes per day) is notable, as these individuals may not see their smoking as requiring treatment.

The continuous decrease in the prevalence of cigarette smoking has also yielded an increase in cigarette quit attempts and cessation rates among existing smokers (Creamer et al., 2019). From 2002 to 2014, younger adults (ages 18 to 24) were more likely to make a quit attempt than were cigarette smokers above the age of 55 (Arancini et al., 2021). Between 2006 and 2016, daily cigarette smokers were less likely to make a quit attempt than were occasional smokers (Johnson et al., 2019).

Routes of administration

In stark contrast to the decline in combustable tobacco use, electronic nicotine delivery systems, also known as electronic cigarettes, e-cigarettes, or vapes, have become more prevalent in recent years. Sales of e-cigarettes started in 2007 in the United States and increased by 122.2% between 2014 and 2020 (Ali et al., 2020; United States Department of Health and Human Services, 2016). Among adults, e-cigarette use followed a quadratic function from 2014 to 2018 (beginning at 3.7% of adults using e-cigarettes in 2014, reaching a low of 2.8% in 2017, and ending at 3.2% in 2018), increased in 2019 to 4.5%, decreased between 2019 and 2020 to 3.7%, and increased in 2021 again to 4.5% (Cornelius et al., 2022, 2023; Dai & Leventhal, 2019). Among adolescents, vaping increased from 2017 to 2019 (East et al., 2021).

Electronic cigarettes boast an ever-expanding range of products and flavors such as fruit, spices, and desserts. These flavors have been popular, and although tobacco- and menthol-flavored sales decreased, sales of other flavors increased between 2014 and 2020 (Ali et al., 2020). In an effort to curb youth e-cigarette use, the United States Food and Drug Administration banned the sale of all cartridge or pod-based vape products other than tobacco- or menthol-flavored products (United States Food and Drug Administration, 2020). However, e-cigarettes are still being sold without approval due to uneven enforcement of this ban. Furthermore, manufacturers are exploiting a loophole by creating flavored disposable vape products as opposed to refillable cartridge or pod-based products. In 2022, 14% of high school students endorsed past-month e-cigarette use and 85% of these students used non-tobacco-flavored e-cigarettes, suggesting that federal bans have not deterred youth e-cigarette use (Bridges, 2023; United States Department of Health and Human Services, 2022).

The first e-cigarettes were designed to mimic combustible cigarettes, but more recent generations have diversified their models and include prefilled cartridges and disposable products (Ali et al., 2020; Sargent et al., 2022; Tackett et al., 2021; United States Department of Health and Human Services, 2016). In addition to premade products, modification and customization have grown in popularity. Customizations include battery life enhancements, increased vapor, temperature control, and e-liquid concentration. Adding cannabis has also become increasingly popular among youth since 2013, whereas adding cocaine or synthetic cannabinoids has been less common (Choi et al., 2021; Churchill et al., 2023; Harrell et al., 2022). Among these enhancements is the capacity to add higher concentrations of nicotine to the liquid, increasing the potential for nicotine toxicity and even greater nicotine dependence (Bendel et al., 2022). The larger variety of products may create different patterns of use to assess and address, and device modifications could produce higher nicotine levels and the co-use of other substances. The consistently high percentages of adolescents and adults who vape indicate that support for vaping cessation is of considerable importance.

CHANGES IN CANNABIS

Legalization

Although cannabis is still classified as a Schedule I drug and is illegal at the federal level at the time of this writing, the United States Drug Enforcement Administration has proposed to reclassify cannabis as a Schedule III drug to loosen restrictions (United States Department of Justice, 2024). California was the first state to legalize it for medical purposes in 1996, and Colorado and Washington legalized it for recreational (i.e., nonmedical) purposes in 2012 (Patton, 2020). As of 2023, 38 states and Washington, D.C. have approved medical cannabis and 24 states and Washington, D.C. have approved recreational use (National Conference of State Legislatures, 2023). The increase in legalization has been positively associated with perceptions of cannabis as being safe. Between 2002 and 2014, the percentge of individuals who believed using cannabis weekly put them at risk for adverse outcomes dropped from 50.4% to 33.3% (Compton et al., 2016). Efforts are being made to communicate risks for cannabis use, including electronic or vaping product-use-associated lung injury, unintentional overdose, vehicle collisions due to driving under the influence, low fetal birth weight after use during pregnancy, and cannabis use disorder (Gabrhelík et al., 2020; Hinckley et al., 2022).

Changes in prevalence and potency

The prevalence of cannabis use increased considerably both before and after states legalized its use. Past-year nonmedical use among American adults increased from 11.0% in 2002 to 13.2% in 2015. For adults 18 to 25 and adults over 26, past-year nonmedical use increased from 29.8% to 31.9% and 7.0% to 10.1%, respectively, whereas nonmedical cannabis use among individuals younger than 12 decreased (15.8% to 13.1%; Azofeifa et al., 2016). Another study found, among adults aged 18 or older, past-year use increased to 15.3% in 2017, with an increase in daily cannabis use from 1.9% in 2002 to 4.2% in 2017 (Compton et al., 2019). In 2021, the prevalence of past-year use increased further to 18.7% (adults 18 to 25 at 35.4%, adults over 26 at 17.2%, and adolescents at 10.5%; Substance Abuse and Mental Health Services Administration, 2023a). Notably, past-year cannabis use among adults 65 and older also increased from 2.4% in 2015 to 4.2% in 2018, driven both by positive feelings for recreational use and perceived medical benefits such as pain relief (Han & Palamar, 2020; Staton et al., 2022). The prevalence of

past-year cannabis use disorder was stable between 2002 and 2017 (1.5% to 1.4%) but increased to 5.8% by 2021 (Compton et al., 2019; Substance Abuse and Mental Health Services Administration, 2023a).

Recreational legalization has played a considerable role in the increase in cannabis use. In areas with recreational legalization between 2008 and 2016, cannabis use and cannabis use disorder were compared before and after legalization. Past-year cannabis use disorder among adolescents aged 12 to 17 increased from 2.18% to 2.72%, 25% higher than the observed increases in areas that did not legalize recreational use, but there was no change in past-month cannabis use. Young adults aged 18 to 25 evidenced no changes in cannabis use disorder or cannabis use. Finally, adults aged 26 or older demonstrated both increases in past-year cannabis use disorder (0.90% to 1.23%) and past-month cannabis use (5.65% to 7.10%; Cerdá et al., 2020).

In recent years, cannabis has become increasingly available and advertised. In 2022, there were 5,142 medical cannabis dispensaries in the United States, which represents a 1.7% increase from 2021 (IBIS World, 2023). Marketing for cannabis products includes social media, print media, and billboards. Moreover, although some states have imposed limits to advertising that may reach adolescents, research has shown that youth are still exposed (Trangenstein et al., 2021; Whitehill et al., 2020). Dispensaries and retail locations for cannabis employ marketing tactics to entice customers including sales and promotions, curbside delivery and pickup, online ordering, shipping, and flexibility payment methods like cash and debit cards (Berg et al., 2023).

The potency of cannabis, specifically in terms of tetrahydrocannabinol (THC), has increased dramatically from below 5% in the 1990s to 17.1% in 2017 in illicit markets (Chandra et al., 2019; Mehmedic et al., 2010). For recreational markets, the THC content averages 15 to 21%, but dispensaries can carry high-potency products that are up to seven times as potent as what is available on the black market (Cash et al., 2020; ElSohly et al., 2021; Hinckley et al., 2022). Similar THC content has been observed for medical and recreational cannabis, and, although some evidence suggests that advertised THC values overestimate the actual THC value, the claim of the average THC content of 15% is well above what is considered necessary for medical use. Medical THC has reduced pain at concentrations around 5 to 10% (Cash et al., 2020; Pennypacker et al., 2022; Schwabe et al., 2023; Wallace et al., 2015; Wilsey et al., 2013). Cannabis concentrates have even higher potency than flower products and can boast over 60% THC (Davenport, 2021). The market share of these products increased 145.8% in Washington State between 2014 and 2016, and cannabis concentrates are far more likely to be used in states that have legalized recreational use (Chandra et al., 2019; Hasin et al., 2023; Smart et al., 2017).

This increased potency has occurred often unknowingly to consumers and unchecked from a regulatory perspective. Even in places where cannabis use is legal, most users are unaware of the THC levels in their products (Hammond & Goodman, 2022). Only Vermont and Connecticut have limits on THC potency for flower and concentrates, with all other states imposing no limits (Pacula et al., 2022). There is no consensus regarding recommended THC doses for consumers, due in part to the difficulty in determining dose from the range of products and methods of use (Volkow & Sharpless, 2021). Last, the United States Food and Drug Administration has not approved a single cannabis product that is available for recreational use. The United States Food and Drug Administration has approved four products (cannabidiol and three synthetic drugs) for medical use; however, these are available by prescription only (United States Food and Drug Administration, 2023a).

Routes of administration

The variety in cannabis products and routes of administration has surged in recent years. Although the dried herb remains the most popular form of cannabis across both areas of legality and illegality, particularly for daily use, other forms of cannabis have become popular. These include concentrates (solid or tinctures), oils, edibles, drinks, hash, topicals, and lozenges or tablets (i.e., troches); these products are all more common where recreational cannabis is legal than in areas where it is not (Goodman et al., 2020; Hammond et al., 2022; Rossi, 2023). The use of edibles, oils, drinks, and topical ointments increased notably between 2018 and 2020 (Hammond et al., 2022; Hammond & Goodman, 2022). Methods of cannabis use include smoking, eating, drinking, vaping, and dabbing (the inhalation of high-concentrate cannabis). These methods can carry additional risk. Vaping often invovles concentrates and can carry considerably higher THC levels than other modes of delivery. Edible cannabis often has a delayed onset of subjective effects and carries the risk of individuals consuming a larger quantity than intended (Schauer et al., 2020).

IMPLICATIONS FOR CONTINGENCY MANAGEMENT

The following discussion outlines the potential influence of these recent changes to the substance abuse landscape on the delivery of effective CM. Operant theory is used to discuss the potential adjustments to some of the modifiable components of CM (e.g., reinforcer magnitude and schedule, target behaviors, and structure) that are most suited to adapting to the current substance use landscape and supporting flexibility with respect to future changes in substance use while maintaining the scientific integrity

of the intervention. If a relevant establishing operation is in place, a target behavior is most likely to occur when the reinforcer is large in magnitude, delivered at a high rate in relation to the behavior, delivered immediately following the behavior of interest, and is high quality (Koehler et al., 2005; Neef et al., 1992; Reichle & Wacker, 1993; Trosclair-Lasserre et al., 2008). These principles can inform the optimization of reinforcement in CM to accommodate substance use changes.

Reinforcers

Reinforcer magnitude

The increased potency of stimulants, opioids, nicotine content in electronic nicotine delivery systems, and cannabis results in a larger subjective substance effect (Bendel et al., 2022; Ciccarone, 2019; Drug Enforcement Administration, 2021a). Greater potency makes these substances more reinforcing through both positive reinforcement with enhanced substance effects and negative reinforcement because of more severe withdrawal symptoms. A study of 22 individuals using opioids found that, after cessation, those who had been using higher doses of heroin evidenced more severe withdrawal than did those who had been using lower doses (Siciliano & Jones, 2017; Smolka & Schmidt, 1999). With greater substance-related reinforcement, it may be more difficult to effectively compete by providing reinforcers for treatment engagement or reduced substance use, which are often targeted in CM. Studies on CM have consistently shown that higher magnitude incentives are more effective than lower magnitude incentives (Dallery et al., 2001; Packer et al., 2012; Romanowich & Lamb, 2010), and in the face of increasing drug potency and overdose, higher magnitude incentives are more likely to be needed (National Institute on Drug Abuse, 2023). More research is needed to explicitly elucidate effective magnitudes for the current state of the drug landscape as well as for individuals using a range of substances. Notably, individuals who vacillate between opioid use and abstinence during treatment are at an even higher risk of overdose due to the loss of tolerance, making sustained abstinence vital (Malta et al., 2019; Strang, 2003).

High-magnitude incentives increase CM expense. Although CM has demonstrated cost effectiveness with respect to medical outcomes, cost is still an oft-cited barrier to implementing CM, an objection that is not extended to other treatments like medications for opioid use disorder (Fairley et al., 2021; Proctor, 2022; United States Department of Health and Human Services, 2023). The cost of CM could in theory be supported through insurance, employers, and government entities, but the uptake of CM lags behind its evidence base (DeFulio, 2023). One driving force behind this concern is the federal antikickback statute and other laws designed to prevent fraud that may target providers who use federal funding (e.g., Medicare, Medicaid) and who also provide CM-based incentives. The antikickback statute, called United States Code Title 42, specifically prohibits profit from medical referral or services funded through federal means (Criminal Penalities for Acts Involving Federal Health Care Programs, 2024). Lawful implementation practices must be considered for each program as clarified by the Office of Inspector General Final Rule, but the intervention is not inherently illegal (Clark & Davis, 2023; United States Department of Health and Human Services, 2023; United States Department of Health and Human Services, Office of Inspector General, 2020). In fact, in 2021, the Biden administration requested that the Office on Drug Control Policy examine and address barriers to the dissemination of CM (Office of National Drug Control Policy, 2021).

In addition to Medicare expansion, federal grants are considered some of the most viable mechanisms for funding, but there is currently a $75 annual cap on per-person per-year incentives through the Department of Health and Human Services that limits evidence-based implementation (however, there has been a call from the Contingency Management Policy Group asking the Substance Abuse and Mental Health Services Administration to rescind the $75 cap; Knopf, 2024; Oluwoye et al., 2020; Proctor, 2022; State of California Health and Human Services Agency, 2022). To combat this, 40 states have thus far requested increasing this cap to a value (e.g., $599 because it is under the threshold for reporting income to the Internal Revenue Services) that better aligns with effective, evidence-based incentive magnitudes (United States Department of Health and Human Services, 2023).

Perhaps the strongest objection to cost can be attributed to stigma. Providers and stakeholders alike worry that incentives undermine intrinsic motivation and enable individuals to spend the money on substances, despite the lack of evidence to support such misappropriation of funds (Festinger et al., 2014; Ledgerwood & Petry, 2006; Sinclair et al., 2011). In these cases, substance use disorders are viewed not as health conditions needing adequately funded treatment but rather as personal failures deserving punishment (Proctor, 2022). The increase in substance potency may require higher doses of medications such as buprenorphine and may similarly warrant higher "doses" of incentives. Although cost can be seen as prohibitive for the dissemination of CM (Rash et al., 2017), it is possible that CM will lose efficacy if "standard" reinforcement magnitudes do not adjust to, and better compete with, the more robust reinforcing effects of higher potency substances.

Increased incentive magnitude may also be necessary to decrease nicotine consumption for those who use electronic nicotine delivery systems. Compared with cigarette smoking, people engage in a greater number of "vaping" events, spend more time vaping, and require more effort

to stop (Parks et al., 2022). Vaping incurs more opportunities for "Pavlovian pairing." Many newer vape devices are small, easily concealed, and produce little to no vapor (also known as "stealth vaping"), so individuals can discreetly incorporate vaping into more of their existing activities than in the past (Yang et al., 2023). In other words, a greater number of environmental contexts are being associated with vaping and are thus likely to be established as conditioned stimuli for vaping (Piper et al., 2022). When it comes to CM, the possibility of more conditioned stimuli triggering nicotine craving and more time spent vaping throughout a person's day may require larger and more frequently delivered incentives to effectively compete. The same may also be true for cannabis, particularly when it is vaped, also creating a greater variety of conditioned stimuli (Hammond et al., 2022; Schauer et al., 2020).

Reinforcer frequency

In addition to higher magnitude incentives overall, increasing incentive magnitude and the frequency of incentive delivery may be warranted, specifically during early abstinence to better compete with the aversive aspects of severe withdrawal. As noted earlier, withdrawal symptoms have increased in severity because of increases in drug potency, the presence of adulterants such as xylazine in opioids, and contaminants like fentanyl found in other substance classes (D'Orazio et al., 2023; Siciliano & Jones, 2017; Silverstein et al., 2019). Contaminants may lead individuals to experience unexpected withdrawal symptoms, which may make treatment engagement seem especially unpleasant. Even pharmacological treatments such as medications for opioid use disorder, designed specifically to mitigate withdrawal symptoms, are less effective when individuals continue to experience withdrawal (Hoffman et al., 2019). Although providers are attempting to best meet their patients' needs, changes to recommended prescriptive practices are often slower than changes in the drug landscape. Therefore, CM has to offset a greater initial barrier to treatment induction and early abstinence. Previous research has supported the efficacy of "start-up bonuses," which may be more efficacious given these recent changes (Katz et al., 2002; Robles et al., 2000). Delivering incentives more frequently during this period will also allow for more immediate reinforcers in the context of treatment behavior, especially when those treatment-related behaviors are otherwise punishing (Griffith et al., 2000; Pfund et al., 2022).

Reinforcer type and schedule

The increase in substance potency and the threat of withdrawal also has implications for incentive type and schedule of reinforcement. The need for CM incentives to be more reinforcing to compete with drug use warrants prioritizing monetary incentives over vouchers or other items. Monetary incentives are perceived as more valuable than vouchers because they can be immediately delivered onto a reloadable debit card for ease of implementation and privacy, and as a generalized reinforcer they can be exchanged for a wide array of backup reinforcers (DeFulio et al., 2021; Festinger et al., 2014; Madden & Bickel, 2009; Rosado et al., 2005; Slowiak et al., 2011). It should be noted that the provision of monetary-based incentives has not been linked with increased cravings, drug use, or risky behaviors such as gambling, meaning that it is a relatively safe option for reinforcement (Festinger et al., 2014). However, interventionists should maintain awareness of regulatory barriers when determining a feasible form of incentive. These include the current annual cap of $75 on per-person per-year incentives (discussed earlier) through the Department of Health and Human Services and the requirement of the Office of Inspector General to consider cash or cash-equivalent CM of any amount on a case-by-case basis (Clark & Davis, 2023; United States Department of Health and Human Services, 2023).

Additionally, guaranteed and continuous schedules of incentives should be prioritized over probability-based "fishbowl draws," where the incentive is not guaranteed, particularly in the beginning stages of treatment. Although prior CM research has found little difference in the efficacy of continuous versus intermittent schedules of reinforcement as well as vouchers versus item-based incentives, these findings should be considered with caution given the changes in the substance use landscape (Chudzynski et al., 2015; Ginley et al., 2021; Petry et al., 2005). It is possible that a continuous schedule may emerge as necessary because doing so ensures early and frequent contact with the relation between behavior (e.g., abstinence) and consequence (e.g., monetary incentive), producing a more rapid acquisition of behavior change according to operant theory (Tryon, 2014). However, more research is needed to examine the comparative efficacy of reinforcement schedules in the context of the shifting drug landscape.

Target behavior

Objective measurement

Characterizing target behaviors, such as the use of electronic nicotine delivery systems and cannabis, has become increasingly challenging because of the wide variety of doses and delivery systems that are now available. Objective measurements are preferred in CM but may prove challenging to obtain. Nicotine abstinence can be verified using biomarkers such as cotinine, but these tests can be costly, and the effort to complete them may result in attrition (Marsot & Simon, 2016; Palmer et al., 2022 Patrick et al., 2023; Raiff et al., 2022). An alternative

nicotine biomarker may be resting heart rate, which yields changes that are similar to those seen for combustible cigarettes, but heart rate has not been studied as a method for objectively verifying vape use (Chaumont et al., 2020; Mueller et al., 2021). Historically, CM interventions for cannabis use have used saliva (in person or on video) or urine tests for verifying outcomes (Beckham et al., 2018; Litt et al., 2020; Schuster et al., 2016; Stanger et al., 2015). Unfortunately, these tests produce either dichotomous outcomes based on a predefined cutoff or quantitative levels of THC. Tests with dichtomous outcomes may result in false positives, as a person engaging in heavy use can take 1–8 weeks to test negative for THC. Tests with quantitative levels can be prohibitively expensive, and the results can be delayed (Lorenzetti et al., 2022).

Prioritizing objective measurement is important because the changes in electronic nicotine delivery systems and cannabis use make the collection of accurate self-report data particularly challenging. In some cases, individuals may not even be aware of their patterns (Sanchez et al., 2021). As mentioned previously, individuals engage in a higher number of individual vaping events than those who smoke cigarettes, which may be difficult to estimate (Parks et al., 2022). Electronic nicotine delivery systems come in a variety of doses and the amount of nicotine ingested from a single "puff" is highly variable (Yamaguchi et al., 2022). Similarly, cannabis products vary widely in THC concentration and mode of delivery (e.g., flower, edibles, tinctures, vapes), making it difficult to reliably quantify frequency and dose (Goodman et al., 2020; Schauer et al., 2020).

Despite these challenges, CM is still promising to address vaping and cannabis use. It has been successfully applied to vaping and cannabis cessation for adolescent, young adult, and adult populations (Beckham et al., 2018; Cooke et al., 2024; Harvanko et al., 2020; Morean et al., 2015; Palmer et al., 2022). The ability to change nicotine concentration in electronic nicotine delivery systems may be measured and altered in support of cessation by incentivizing incrementally lowered concentrations. However, weaker nicotine levels in the liquid solution could increase the frequency of vaping that may be difficult to measure, consistent with research findings of more frequent smoking of low-nicotine cigarettes than of higher nicotine cigarettes (Dallery et al., 2003; Goldenson et al., 2017). Contingency management implementation should weigh available resources for verifying abstinence, measuring vaping, and identifying what behaviors can be feasibly and effectively targeted for contingent rewards.

Selection of substance outcomes

The selection and measurement of target behavior for illicit substances is also difficult. Substance co-use may be purposeful or unintentional due to adulterants, contaminants, and mislabeling, and distinguishing purposeful from unintentional use may not be possible. The vast array of new stimulants means that it is unlikely that providers can test for all potential substances through drug screens (Miliano et al., 2016). Xylazine is similarly not uniformly included in routine toxicology screening across the United States, forcing a reliance on self-report that is insufficiently objective to be a CM-based target behavior (Drug Enforcement Administration, 2022). Even among biologically verified samples, discrepancies between these results and self-report may be due to purposeful concealment, lapses in memory, or the use of contaminated substances. Not all substances may be appropriate for abstinence-based incentives because of prolonged metabolism and limitations in technology to detect changes in the levels of the substance, with fentanyl being a notable example due to its long half-life: Fentanyl has been detected in the urine for up to 28 days after use (United States Department of Health and Human Services, 2023). Withholding incentives due to positive results from contaminated substances may unintentionally punish an individual's genuine efforts toward abstinence. In this case, the target substance can be determined through patient preference and tracked through collaborations with the addiction-based medical provider's interpretation of biological measures (Cunningham et al., 2017). It is also important to notify people of their drug screen results to ensure that they are knowledgeable about the composition of their substance use in the event that there were unintentional contaminants detected.

Even among substances that are purposefully co-used, such as opioids and methamphetamine, delineating one or more target behaviors can be challenging. Prior research has successfully used CM to reinforce simultaneous abstinence from multiple substances such as opioids and stimulants (Christensen et al., 2014; DeFulio & Silverman, 2011). However, for some abstinence from all substances may be prohibitive to sustain and may result in an individual abandoning treatment (Rash & DePhilippis, 2019). In determining the substance(s) targeted for abstinence, interventionists should consider patient preference, level of health risk such as overdose, level of relative impairment, likelihood of drug substitution, and frequency of simultaneous co-use.

Alternatives to abstinence

Because abstinence can be difficult to achieve in light of these changes in the drug landscape, it may be beneficial to consider other standards for "success." For example, alternative target behaviors such as treatment attendance, biological sample submission, and medication adherence could be considered as exclusive target behaviors or in

conjunction with abstinence. These alternatives are viewed as acceptable target behaviors by patients (Getty, Weaver, & Metrbian, 2022; Getty, Weaver, Lynskey, et al., 2022) and are associated with both increased treatment engagement and abstinence, although effect sizes tend to be smaller for attendance alone than for abstinence (Bolívar et al., 2021; Petry et al., 2012; Pfund et al., 2022). Intermediate, more achievable steps in recovery can be reinforced, such as attending a treatment session. This may support increased chances of later abstinence, which could then also be incentivized once achieved (e.g., added bonuses contingent on abstinence).

Shaping behavior

If abstinence is prioritized as the primary target behavior, interventionists could consider shaping abstinence by incentivizing successively lower substance levels, a technique used effectively for individuals having difficulty with smoking cessation (Lamb et al., 2010). Shaping could allow for reductions in substance use while mitigating prolonged withdrawal symptoms, aligning with a harm-reduction approach (Paquette et al., 2022). This process could also be used to address the population of treatment-resistant individuals who are still smoking cigarettes despite overall decreases in prevalence of cigarette smoking (Cornelius et al., 2023). Last, measures that examine the quantity of a substance should be prioritized over binary results, as some substances such as fentanyl have a long half-life that can result in a positive drug test long after drug taking has ceased (United States Department of Health and Human Services, 2023). However, obtaining objective measures of the quantity of a substance may be cost and time prohibitive and not always feasible for all substance classes. When planning CM, interventionists must consider whether their resources support more fine-grained target behaviors.

Structure of CM

Duration and repetition

Substance use disorder is a condition that is characterized by chronic relapsing for most individuals (Goodwin & Sias, 2014). For many individuals, their first several attempts at abstinence are unlikely to create lifelong abstinence (Körkel, 2021). Therefore, people should be given the opportunity to use CM as many times as necessary, particularly in light of the newer difficulties associated with more potent substances (increasing their reinforcing value), more severe withdrawal, and the integration of more substance classes (Friedman et al., 2022; Friedman & Shover, 2023; Siciliano & Jones, 2017; Smolka & Schmidt, 1999).

Integration with other treatments

Contingency management has been successfully used as a standalone treatment, but CM can also be used in conjunction with complementary treatments (McPherson et al., 2018; Ray et al., 2020). For example, efforts may need to be made to increase quit intentions among low-quantity smokers who do not view their behavior as problematic. Because younger adults are more likely to make a quit attempt than older adults (Arancini et al., 2021), CM for younger adults could focus on maintaining abstinence, whereas CM for older adults may focus on increasing the odds of initiating a quit attempt (Martner & Dallery, 2019). Contingency mangagement could also be delivered alongside pharmacological or brief behavioral interventions such as motivational interviewing or tailored letters (Asfar et al., 2011; Heckman et al., 2010; Meyer et al., 2016). Contingency management has also been successfully combined with cognitive behavioral therapy, episodic future thinking (vividly imagining personal, non-substance-related future events), and community reinforcement approaches for a range of substances (Aonso-Diego et al., 2021; Meyers et al., 2011; Petitjean et al., 2014). In the community reinforcement approach, patients use problem solving, skill building, and other strategies to improve areas of their life that are unfulfilling, replacing substance-related behaviors with more reinforcing, non-substance-related behaviors such as gainful employment, hobbies, and family activities (Higgins & Rogers, 2009; Hunt & Azrin, 1973; Petry & Barry, 2010).

Contingency management must be carefully structured when combined with other treatments, particularly for medications for opioid use disorder. Buprenorphine is distinct from methadone in terms of the topography of treatment-related behavior required of the patient and thus should be approached distinctly in terms of planning the CM intervention. Although attempts have been made to reduce burden, methadone typically demands more effort to maintain engagement (e.g., daily use, often completed at a specialty clinic). However, this higher demand also allows for more frequent drug testing at around two or three times per week, more frequent opportunities for socially mediated positive reinforcement such as verbal praise, and more immediate incentive delivery (Petry et al., 2015; Toegel et al., 2020). Medication adherence can be directly reinforced because methadone consumption is typically supervised at every visit (as is also the case for injectable buprenorphine and naltrexone).

Comparatively, oral buprenorphine is typically self-administered two to three times a day in a person's natural environment, making treatment attendance a separate event from medication adherence. Incentives can typically be given at appointments with evidence of drug screen results (often weekly, but less often as treatment stability is achieved), thereby indirectly reinforcing treatment adherence rather than directly reinforcing each instance of medication taking (McPherson et al., 2018;

Tkacz et al., 2012). This schedule carries a risk of treatment drop out between appointments, especially if there is difficulty with buprenorphine induction such as experiencing precipitated withdrawal, as discussed earlier (Varshneya et al., 2022). As previously mentioned, this likely warrants more frequent, larger magnitude incentives, especially early in the treatment attempt (Griffith et al., 2000; Pfund et al., 2022). Oral naltrexone must also be self-administered and compels comparable considerations for CM. In contrast, injectable buprenorphine and naltrexone demand fewer treatment visits but require a greater commitment at the outset because of the effects of the injections; once taken they cannot be removed and the medication must be slowly metabolized (Morgan et al., 2018). It may be necessary to substantially reinforce treatment engagement for these injectable medications, particularly at the early stages, and the incentives should be of a suitable magnitude to compete with the aversive aspects of withdrawal and fewer opportunities for reinforcement.

DISCUSSION

Contingency management is an effective substance use intervention with great promise for widespread dissemination, but it requires careful implementation, informed by operant theory and research, to ensure that outcomes maintain in the context of a dynamic substance use landscape. Adapting CM to recent changes in the drug use landscape will create procedures that are better suited to effectively addressing more potent and diverse substance use. Increasing versatility in CM procedures now will prepare institutions for accommodating potential changes to substance potency and diversity in the future.

Updating CM interventions must occur at the design stage to ensure fidelity to theory and research in the creation of CM programs and during the implementation stage to ensure fidelity to the design and standardization of procedures. Without substantial training in the science of behavior change and the elements of robust CM as determined by the research (e.g., immediately delivered reinforcers, incentives on escalating schedules), any modification made for practical purposes can potentially undermine efficacy (Rash et al., 2020). Collaboration and education must occur on multiple levels; involve behavior analysts, stakeholders, and clinic staff with ample opportunities for didactics; and include resources and fidelity checks to keep practices aligned with the science (Kirby et al., 2021; Oluwoye et al., 2020). These resources must likewise incorporate new research findings and changes in the substance use landscape.

Although these decisions must be carefully weighed in the presence of increased cost and institutional constraints, these adaptations can increase the likelihood of treatment optimization. Further research is needed to examine whether the proposed changes to CM translate to improved treatment outcomes, and implementation efforts must determine what changes can be feasibly adopted now, given current regulatory and resource limitations. Interventionists could monitor changes in composition, potency, and method of use in real time, and they could pivot their approach (e.g., incentive magnitude, target behaviors, measurement techniques, and adjunctive treatments) according to local trends. Flexibly delivered CM will increase the likelihood of effectiveness in the face of changing substance use, both at present and in the future.

CONFLICT OF INTEREST STATEMENT

The authors do not have any conflicts of interest to declare.

DATA AVAILABILITY STATEMENT

No data were collected or analyzed to produce this article.

ETHICS APPROVAL

No human or animal subjects were used to produce this article.

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