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Contingency Management Interventions for HIV, Tuberculosis, and Hepatitis Control Among Individuals With Substance Use Disorders: A Systematized Review

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Abstract

Hepatitis, HIV and tuberculosis are significant and costly public health problems that disproportionately affect individuals with substance use disorders (SUDs). Incentive-based treatment approaches (i.e., contingency management; CM) are highly effective at reducing drug use. The primary aim of this report is to review the extant literature that examines the efficacy of CM interventions for the prevention, diagnosis and treatment of hepatitis, HIV and tuberculosis among individuals with SUDs. A literature search identified 23 controlled studies on this topic. In approximately 85% of the studies, CM produced significantly better adherence to prevention, diagnosis and treatment-related medical services, with adherence rates averaging almost 35% higher among patients receiving incentives vs. control condition participants. Findings from these studies parallel the results of a meta-analysis of CM interventions for the treatment of SUDs. The results also suggest that the principles that underlie the efficacy of CM generalize across infectious disease and substance abuse treatment behaviors. The application of additional principles from the literature on CM for treatment of SUDs to interventions targeting infectious disease control would be beneficial. Further development and dissemination of these interventions has the potential to greatly impact public health.

Keywords

HIV; Contingency management intervention; Substance abuse disorder; Tuberculosis; Hepatitis; Incentives

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1. Introduction

Infectious diseases are among the most costly public health problems globally. Although many infectious conditions disproportionately affect developing nations, hepatitis B, hepatitis C, human immunodeficiency virus (HIV) and tuberculosis (TB) persist in developed countries at levels that pose serious threats to the public health. Collectively, almost 100,000 new cases of these diseases are diagnosed annually in the U.S. alone (CDC, 2014b, 2015b; CDC, 2014a, 2015a). These conditions pose a considerable burden; as one example, HIV accounts for almost 14,000 deaths (CDC, 2015c) and costs over $36 billion annually (Hutchinson et al., 2006). These conditions persist despite being relatively easy to prevent (e.g., through vaccination or behavioral precautions to prevent transmission; Alter, 2003; Moses, Vlahov, & Normand, 1995), diagnose, and treat using pharmacological agents (CDC, 2011). Although considerable medical progress has been made, these conditions continue to negatively affect public health, largely because of poor adherence to medical recommendations. Thus, the development of new methods to improve adherence is a public health priority.

Individuals with substance use disorders (SUDs) are disproportionately affected by hepatitis, HIV, and TB. The National Institute of Drug Abuse (NIDA) considers drug abuse and HIV “intertwined epidemics” (NIDA, 2012), and emphasizes the close links between substance abuse and hepatitis (NIDA, 2013) and TB infection (NIDA, 1998). Individuals with SUDs are more likely to become infected because they engage in risky sexual and drug taking behaviors that transmit HIV and hepatitis, and because socioeconomic disadvantage often places them in crowded conditions in which TB is more easily transmitted (Getahun, Gunneberg, Sculier, Verster, & Raviglione, 2012; Kral et al., 2001; Paul et al., 1993). As a result, the prevalence of hepatitis, HIV and TB infections are considerably higher among individuals with SUDs (Befrits et al., 1995; Booth, Kwiatkowski, & Chitwood, 2000; Des Jarlais et al., 2007; Durante, Selwyn, & O’Connor, 1998; Hagen et al., 2001; Howard, Klein, Schoenbaum, & Gourevitch, 2002; Nelson et al., 2011; Petry, 1999; Rehm et al., 2009) than in the general U.S. population (CDC, 2015a, 2015b, 2015c). Individuals with SUDs also are more likely to be co-infected with two or more of these conditions and/or to acquire drug-resistant strains of HIV and TB (e.g., Atkinson, Paul, Sloan, Curtis, & Miller, 2009; McCance-Katz et al., 2002; Manosuthi et al., 2006; Perri et al., 2011). Co-infection and drug resistance leads to accelerated morbidity and mortality and overall greater threats to public health.

The elevated prevalence of hepatitis, HIV, and TB among individuals with SUDs underscores the limited success of widely disseminated efforts to reduce transmission within this vulnerable population. For example, the hepatitis B vaccination series provides long-term protection from infection to greater than 90% of those who complete it (CDC, 2006). Although population-wide vaccination began in 1982, many injection drug users remain unvaccinated (CDC, 2015a, 2015b, 2015c; Ladak, Gjelsvik, Feller, Rosenthal, & Montague, 2012), in part because many who are offered the vaccine never start or fail to complete all three doses of the series (e.g., Hwang et al., 2010). Efforts to diagnose these conditions among individuals with SUDs have frequently met with limited success. Screening for TB involves a simple skin test that requires patients to return 48–72 hours later to have the test

site read, followed by chest x-rays if the skin test is positive. Unfortunately, less than half of individuals with SUDs return to have skin tests read (FitzGerald et al., 1999) and only one third of those who do return and test positive follow through with chest x-ray referrals (Perlman et al., 2003). Likewise, hepatitis, HIV and TB can be effectively treated with pharmacotherapy, but individuals with SUDs often begin treatment late and are unable to achieve the high rates of medication adherence required for successful treatment outcomes (Arnsten et al., 2001; Batki, Gruber, Bradley, Bradley, & Delucchi, 2002; Chaisson et al., 2001).

Behavioral economics may help us understand why rates of infection remain high and treatment outcomes are generally poor among individuals with SUDs. Prevention (e.g., completing the hepatitis B vaccination series), diagnosis (e.g., completing diagnostic testing for TB) and treatment (e.g., taking antiretroviral medication to suppress HIV) requires individuals to engage in an immediate and effortful behavior (e.g., go to a vaccine clinic, pick up medications from a pharmacy) in order to prevent or improve outcomes that are delayed and probabilistic (e.g., greater likelihood of premature morbidity or mortality). Delay discounting describes the tendency to devalue future outcomes; the longer outcomes are delayed, the less influence they exert over present behavior. A substantial body of literature demonstrates that individuals with SUDs discount delayed outcomes more steeply than non-substance using individuals (cf. Reynolds, 2006), including greater discounting of future health (Petry, 2003). Steeper discounting may partially explain why individuals with SUDs have particular difficulty adhering to medical recommendations: the positive consequences are far too delayed to have much control over immediate actions. Thus, behavioral economic theory suggests that interventions that involve immediate positive consequences for engaging in desired medical behaviors may be particularly effective for infectious disease control among individuals with SUDs.

Incentive-based interventions, such as contingency management (CM), are among the most reliable and efficacious means to promote behavior change among individuals with SUDs. These interventions offer incentives for engaging in positive health behaviors. There is an extensive literature on incentive-based treatments to promote abstinence from alcohol and drugs. In CM interventions, patients receive incentives, often vouchers with monetary value that can be exchanged for retail items, contingent upon satisfying a predetermined therapeutic goal (Higgins, Silverman, & Heil, 2008). Many studies have demonstrated that CM effectively promotes drug abstinence and other therapeutic changes (e.g., clinic attendance, participation in vocational training, adherence to addiction pharmacotherapy) among individuals in treatment for SUDs. Several reviews have been published on CM for the treatment for SUDs, synthesizing this literature as it has grown (e.g., Hartzler, Lash, & Roll, 2012; Stitzer & Petry, 2006). A comprehensive meta-analysis of 40 studies of CM interventions for the treatment of SUDs found consistent evidence of a positive treatment effect across drug classes and treatment behaviors (Lussier, Heil, Mongeon, Badger, & Higgins, 2006). This meta-analysis also investigated how various incentive parameters moderate intervention efficacy, demonstrating that higher magnitude incentives and incentives delivered after shorter delays are associated with larger treatment effect sizes. Individual laboratory studies have also identified other potential moderators. For example, incentive schedules in which payments escalate in magnitude with each successful

completion of a target behavior are more effective than schedules where payment magnitude is fixed (Roll & Higgins, 2000; Roll, Higgins, & Badger, 1996) and cash incentives are more effective than non-cash incentives of equivalent monetary value (Festinger, Marlowe, Dugosh, Croft, & Arabia, 2008; Vandrey, Bigelow, & Stitzer, 2007).

We are aware of only two reviews of CM interventions for infectious disease specifically among individuals with SUDs: one summarized only the HIV literature (3 studies; Haug & Sorensen, 2006) and the other only the TB literature (11 studies; Lutge, Wiysonge, Knight, & Volmink, 2012). The low rates of adherence among individuals with SUDs are not unique to HIV and TB, but also apply to the prevention of hepatitis B and treatment of hepatitis C. Therefore, the primary aim of this review is to provide a comprehensive analysis of the literature on CM interventions targeting the prevention, diagnosis and treatment of hepatitis, HIV and TB among individuals with SUDs. This review examines overall efficacy of these interventions and begins to explore the incentive characteristics that moderate efficacy. The discussion aims to synthesize the findings and underscore where they may inform future development of improved interventions for the control of hepatitis, HIV and TB.

2. Methods

2.1. Literature search and study selection

The present report describes the results of a systematized review, which incorporates many, but not all, of the elements of a systematic review while stopping short of a full systematic review of the literature. Systematized reviews are often conducted when many elements of a systematic review can be incorporated, but resource constraints do not allow for a full systematic review, as was the case here. Literature searches were conducted using PubMed, MEDLINE and Google Scholar using the terms: ““incentives,” “payments” and “monetary” combined with terms relevant to infectious disease and SUDs generally (“adherence,” “alcohol,” “diagnosis,” “disease,” “drug users,” “substance abuse,” “infectious,” “methadone,” “prevention,” “treatment” and “virus”) and terms specific to infectious disease (“AIDS,” “hepatitis,” “HBV,” “HCV,” “HIV,” “HTLV-1,” “Mtb,” “TB” and “tuberculosis”) using the Boolean operator AND. The reference sections of published articles that met inclusion criteria were reviewed to ensure that all relevant articles were identified. Searches were limited to articles that were written in English, published in peer-reviewed journals and were available in full-text (either in print or electronically) as of June 2015, when the final search was run. The abstracts of relevant search results were initially identified by ESH, reviewed by ESH and SHH and, if deemed relevant, proceeded to full-text review.

Full-text review and data extraction were performed by three authors (ESH, AKM and SHH) and disagreements regarding inclusion/exclusion were resolved through discussion. Identified studies were included in this review if they met six criteria: (1) the intervention(s) directly targeted medical prevention, diagnosis or treatment of hepatitis B, hepatitis C, HIV or tuberculosis; (2) the incentive(s) offered were of quantifiable monetary value; studies that delivered incentives of non-quantifiable value (e.g., methadone doses contingent on TB medication adherence) were excluded; (3) the incentive(s) were delivered contingent upon objectively verified occurrence of the desired target behavior; (4) studies targeted individuals with SUDs or another high-risk population with a substantial percentage (≥33%) of the

study sample had an SUD, allowing us to include additional studies with findings that are likely generalizable to individuals with SUDs; (5) studies were either randomized controlled trials, within-subject studies, or included appropriately matched historical control cohorts as comparison conditions; (6) study designs allowed for the effects of incentives to be isolated.

Detailed data on participant characteristics, study design, methods, and outcomes for included studies are presented in Tables 1–3. Although multiple outcomes were often reported, the outcomes column in the tables selectively reports data regarding the specific behavior(s) targeted by the CM intervention (e.g., incentives for receiving second and third hepatitis B vaccinations), the broader medical target (e.g., completing the three-dose hepatitis B vaccination series) or both.

3. Results

3.1. Characteristics of included studies

Twenty-three studies met inclusion criteria. These studies targeted prevention of hepatitis B (5 studies; Table 1), diagnosis of TB (6 studies; Table 2), treatment of TB (8 studies; Table 3) and treatment of HIV (4 studies, Table 3). The majority (16; 70%) of these studies were randomized controlled trials, 6 used historic control patients for comparison, and 1 used a within-subject design. Almost all (19; 83%) were conducted in the United States. Participants were recruited via street outreach, infectious disease specialty clinics, substance use treatment centers, syringe exchanges, jail, and Veterans Affairs and community hospitals. Target behaviors ranged from one-time completion of a single target behavior (e.g., returning to have a TB skin test read) to completion of a target behavior multiple times a day (e.g., adherence to antiretroviral therapy). In several studies, multiple behaviors were reinforced (e.g., incentives provided for on-time dosing and completion of clinic visits). Incentives offered included cash, non-cash vouchers (e.g., gift cards, meal or grocery coupons, phone cards, or transportation tokens) and prizes (e.g., toiletries or household items). Incentives ranged in value from $0.50 to $100 for completion of the target behavior, and total possible study earnings ranged from $4 to $1237.

3.2. Studies targeting prevention

Five studies focused on prevention offered incentives to individuals with SUDs for receiving hepatitis B vaccinations (Table 1). The first two of these studies found that offering $10–20 in cash significantly increased the percentage of individuals who received the first dose of a three-vaccination series (Trubatch, Fisher, Cagle, & Fenaughty, 2000) and series completion rates among individuals who received the first dose prior to being offered incentives (Seal et al., 2003). Improvements in adherence were large, with initiation and completion rates several fold higher in the incentive conditions as compared to the no-incentive control conditions. In a related study, Stitzer, Polk, Bowles, and Kosten (2010) compared an incentive condition in which participants received $10 to cover transportation costs to an incentive package that consisted of $10 to cover transportation costs plus lottery-style incentives for weekly clinic attendance and cash bonuses ($20–$50) for attending monthly visits where vaccinations were administered. Despite noticeable differences favoring the experimental condition on the number of injections received and percentage of participants

completing the vaccination series, results did not reach statistical significance. However, this may be a function of the small sample size of this study; only 13 participants were randomized to each condition.

The studies reviewed above administered the hepatitis B vaccine on a traditional schedule, in which the second and third doses were given one and six months after the first dose, respectively. Recent evidence demonstrates that offering individuals with SUDs the hepatitis B vaccine on an accelerated schedule (i.e., second and third doses administered at 7 and 21 days after the first dose,) may improve vaccination series completion rates (e.g., Hwang et al., 2010). Two studies examined whether the addition of incentives to an accelerated hepatitis B vaccine schedule further improved completion rates (Topp et al., 2013; Weaver et al., 2014). Both studies observed significantly higher rates of completion among patients offered incentives relative to control patients. One of these studies (Weaver et al., 2014) also compared incentives offered on a fixed schedule (£10/dose) to an escalating schedule (£5, £10 and £15 for the first, second and third doses, respectively). Completion rates were marginally higher among those randomized to the escalating schedule, but differences were not statistically significant. The fact that there were only three opportunities to earn incentives (and therefore only two escalations in incentive value) likely contributed to the lack of differences between groups.

3.3. Studies targeting diagnosis

Four studies examined the effect of incentives on rates of return for TB skin test readings (Table 2). These studies found that offering incentives (e.g., cash, grocery store coupons, fast food vouchers, bus tokens, ranging in value from $4 to $10) produced superior rates of return relative to control interventions that did not include incentives (Chaisson, Keruly, McAvinue, Gallant, & Moore, 1996; FitzGerald et al., 1999; Malotte, Hollingshead, & Rhodes, 1999; Malotte, Rhodes, & Mais, 1998). Return rates were especially impressive among patients offered $10 cash (>90% returned) compared to no-incentive controls from the same studies (<50% returned; Malotte et al., 1998; Malotte et al., 1999). Although not tested statistically, two studies had multiple incentive arms that provide some information about whether incentive magnitude or incentive type influenced return rate. In the first (Malotte et al., 1998), higher magnitude cash incentives ($10) produced greater rates of return than lower magnitude ($5) incentives, and in the second (Malotte et al., 1999), cash incentives ($10) produced greater rates of return compared to grocery store coupons and fast food tokens/bus tokens of equivalent value. Taken together, incentive conditions in these two studies produced high rates of return (>80%) and differences in return rates between incentive conditions were minor relative to differences between incentive conditions and no-incentive control conditions.

Two additional studies targeted adherence with referrals to offsite clinics for more extensive diagnostic testing among patients who screened positive for TB (Perlman et al., 2003; Pilote et al., 1996). Both studies found significantly better adherence rates among patients offered incentives. While both studies achieved high rates of adherence, it is worth noting that differences in return rates between incentive conditions and no-incentive controls appear to be larger in the study reported on by Perlman et al. (2003), which offered $25 incentives to

adhere within one week, than those observed by Pilote et al. (1996), which offered $5 incentives to adhere within three weeks. Since these studies enrolled patients with similar sociodemograpic and substance use characteristics, the larger differences observed by Perlman et al. (2003) suggest that larger magnitude incentives may be more effective.

3.4. Studies targeting treatment

3.4.1. Tuberculosis—Eight studies targeted medication adherence among TB patients (Table 3). Three studies examined CM to promote adherence to isoniazid therapy for TB, which consists of twice weekly observed dosing for 6 months. Patients were offered incentives (e.g., cash, grocery store gift cards) for taking each dose of isoniazid and treatment completion rates were compared to patients not offered incentives (Bock, Sales, Rogers, & DeVoe, 2001; Malotte, Hollingshead, & Larro, 2001; Tulsky et al., 2000). Patients offered incentives had superior treatment outcomes in all three studies, although only the first two studies reported statistically significant differences.

Two additional studies (White et al., 1998; White et al., 2002) examined incentives to encourage inmates receiving isoniazid pharmacotherapy while in jail to visit an outpatient TB clinic to continue treatment after release. These studies offered inmates either $5 cash or $25 in food or transportation vouchers for attendance at the initial visit as compared to no-incentive control groups. Although $25 vouchers significantly improved adherence relative to control participants, overall, attendance was relatively poor in all conditions (24–37%). These results suggest that recently released inmates may be a particularly recalcitrant population who may require larger magnitude and/or more reinforcing incentives to promote adherence.

Three studies compared the efficacy of two different incentive conditions. Davidson et al. (2000) demonstrated that patients offered a higher magnitude incentive package were almost three-fold more likely to reach the levels of isoniazid adherence necessary for successful treatment compared to those offered a lower magnitude package. Chaisson et al. (2001) found generally higher rates of adherence among patients who received incentives immediately, but these differences did not reach statistical significance. The delays examined (one month vs. six months) are unusually long and likely made it difficult to detect an effect of delay. Finally, Tulsky et al. (2004) reported generally higher rates of adherence among patients who received cash, rather than non-cash, incentives, but these results were not statistically significant.

3.4.2. HIV—Four studies targeted HIV treatment (Table 3). Two of these were randomized controlled trial that targeted adherence to antiretroviral pharmacotherapy using medication events monitoring system (MEMS) caps to record medication bottle openings and delivering incentives contingent upon patients opening pill bottles at predetermined times (Rigsby et al., 2000; Sorensen et al., 2007). In addition, both provided cash incentives on an escalating schedule and employed a reset contingency, whereby missed bottle openings resulted in a reset of incentives to their initial low value. As mentioned earlier, these schedule characteristics have been shown to produce the highest rates of continuous abstinence with regard to CM treatments for SUDs (Roll & Higgins, 2000; Roll et al., 1996). Both studies

demonstrated significantly better adherence outcomes among patients offered incentives as compared to participants in the control condition.

Two recent studies evaluated CM to target improvements in HIV viral load directly to improve patient outcomes (Farber et al., 2013; Solomon et al., 2014). Farber et al. (2013) demonstrated that patients who received cash incentives ($100) for either having undetectable viral load or having a viral load significantly lower than the prior lowest viral load in the past year had a significantly higher percentage of tests with undetectable viral load. Solomon et al. (2014) recruited antiretroviral therapy-naïve patients and offered them incentives for several treatment-related behaviors (a $4 voucher for initiating antiretroviral therapy, $4 vouchers for attending monthly refill visits, and $8 vouchers for viral suppression at biannual study visits). Participants offered vouchers were more likely to initiate antiretroviral therapy and completed more monthly medication refills than participants in a control condition not offered incentives; however, the effect of the incentive intervention on viral load was not significant.

4. Discussion

We identified 23 studies of CM interventions for the prevention, diagnosis and treatment of hepatitis, HIV and TB among individuals with SUDs. In approximately 85% of the studies, CM produced significantly better adherence to prevention, diagnosis and treatment-related medical services, with adherence rates averaging almost 35% higher among patients receiving incentives vs. control condition participants. Results were generally consistent across behaviors: 80% of studies targeting prevention, 100% of studies targeting diagnosis, and 66% of studies targeting treatment adherence showed a significant advantage for incentive-based treatments over control conditions. Adherence rates averaged 45% higher for prevention behaviors, 54% higher for diagnosis-related behaviors, and 20% higher for treatment adherence. Thus, CM consistently produced positive effects across a variety of substance-using populations and behaviors, providing evidence that basic behavioral economic principles can be applied to the development of effective clinical interventions. By providing immediate reinforcement for adherence to prevention, diagnosis and treatment protocols, these interventions promote higher rates of success within a population shown to be less sensitive to the naturalistic delayed consequences of these health conditions.

Only a handful of studies to date have expressly examined incentive characteristics that could moderate treatment efficacy. Results of one of the two studies that included incentives of different magnitudes (Davidson et al., 2000) indicated that larger incentives produce superior effects, while the return rates in the other study (Malotte et al., 1998) were extremely high in both magnitude conditions, suggesting that for less effortful behaviors, lower magnitude incentives may be adequate. The one study examining incentive delay (Chaisson et al., 2001) reported that participants who were offered more immediate incentives trended toward higher rates of treatment completion than those offered delayed incentives. The lack of statistically significant effect of delay may at first appear to contradict the results of Lussier et al. (2006); however, the delays examined in this study (one month vs. six months) are unusually long, likely making any effect of delay difficult to detect. Similarly, the results of the one study that examined different incentive schedules

(Weaver et al., 2014) suggested minor, and not statistically significant, differences favoring an escalating schedule over a fixed schedule for hepatitis B vaccination adherence. While these results appear to be at odds with human laboratory studies (Roll & Higgins, 2000; Roll et al., 1996), it seems likely that these differences did not meet statistical significance because there were only three opportunities to earn incentives, leaving little room for the substantial escalations in value across multiple opportunities to earn as in prior studies documenting the efficacy of this approach. The two studies that compared different incentive types found relatively small differences between cash and non-cash incentives, although all incentive conditions outperformed non-incentive conditions (Malotte et al., 1999; Tulsky et al., 2004). This parallels findings from CM studies comparing cash and vouchers for the treatment of SUDs (e.g., Festinger et al., 2008; Vandrey et al., 2007). Results from studies that explicitly examined this issue suggest that cash incentives do not lead to additional drug use (e.g., Festinger et al., 2005, 2008), so in instances where cash incentives are acceptable to all involved, offering cash in favor of non-cash incentives may be a useful way to maximize efficacy when cost-effectiveness is critical.

Although the vast majority of these studies demonstrated that contingent incentives improve adherence to prevention, diagnosis and treatment-related behaviors, in many cases a substantial number of patients in incentive conditions still had poor outcomes during the intervention period. Variability in treatment outcomes for CM targeting drug users is not unique (e.g., Downey, Helmus, & Schuster, 2000; Petry et al., 2004). Silverman, Chutuape, Bigelow, and Stitzer (1999) recruited participants from a study of CM to promote cocaine abstinence among methadone patients who had poor treatment outcomes during a 12-week treatment period (maximum earnings = $1155). These patients were subsequently randomly assigned to zero, low and high magnitude incentive conditions for 9 additional weeks of treatment. Almost half (45%) of participants randomized to the high magnitude condition (maximum earnings = $3480) achieved sustained abstinence, even though they did not do so during the initial 12-week intervention. These findings suggest that patients who are unable to achieve high rates of medication adherence with incentive magnitudes offered by the studies reviewed here could likely benefit from higher magnitude interventions.

The interventions reviewed here successfully targeted a variety of subpopulations of individuals with SUDs (e.g., injection drug users, cocaine users, homeless adults) and many different adherence-related behaviors, suggesting that there exist opportunities to adapt these interventions to prevention, diagnosis, and treatment behaviors not yet addressed. Regarding prevention, adherence to HIV pre-exposure prophylaxis (PrEP) is a prime target. Tenofovir (Truvada®) has been shown to be effective at preventing HIV infection among individuals with SUDs when taken daily, but suboptimal adherence often undermines potential benefits (Martin et al., 2015). Adapting the CM interventions that increase adherence to antiviral therapy reviewed here to target adherence to PrEP among individuals with SUDs could prevent new HIV infections. HIV diagnosis among injection drug users is also a leading target for CM since fewer than half are tested for HIV each year (CDC, 2014c), and they often seek out services that provide optimal contexts for HIV testing (e.g., syringe exchange). Hepatitis C is a prime treatment target because poor adherence among individuals with SUDs often leads to suboptimal treatment outcomes (Almasio et al., 2011; Bruggmann et al., 2008; Roca, Gómez, & Arnedo, 1999). High rates of treatment failure and

concerns over psychiatric side effects of treatments available at the time led the National Institutes of Health to recommend in 1997 that individuals actively using drugs not be offered treatment for hepatitis C until they are abstinent for six months (NIH, 1997). However, a number of newer medications have fewer side effects and some show cure rates of nearly 100% in clinical trials (e.g., Afdhal et al., 2014; Kowdley et al., 2014). Incentive interventions could be a powerful tool to promote adherence to these new, highly effective treatments. As a final example, CM interventions could be adapted to target combined adherence to anti-TB medications and antivirals among individuals being treated for HIV/TB co-infection, reducing morbidity and mortality in this severely affected population.

Although this review focuses on CM interventions for infectious disease control in individuals with SUDs, these types of interventions are effective with other socioeconomically-disadvantaged populations that tend to discount delayed rewards steeply. For example, Thornton (2008) demonstrated that offering individuals in rural Malawi, a country in Sub-Saharan Africa, modest incentives (~ $1 U.S) for returning to learn HIV test results significantly increased rates of return. Large-scale incentive interventions like Thornton (2008) are often referred to as conditional cash transfer (CCT) programs. A recent review of 13 CCT programs concluded that they are effective at increasing use of preventive medical services and improving immunization coverage (Ranganathan & Lagarde, 2012). The efficacy of CCT programs demonstrates that infectious disease interventions based on behavioral economic principles can be effective across a variety of disadvantaged populations, and also suggest some of the interventions reviewed here could be scaled up to produce population-level improvements in infectious disease control.

These conclusions and recommendations must be considered in light of four noteworthy limitations. First, this is not a systematic review; although we included most elements of the systematic review process, we cannot with absolute confidence be sure that the search was exhaustive and comprehensive and our conclusions are necessarily more qualitative than quantitative. Second, six of the studies included in this review utilized historical control cohorts as comparison conditions, which may complicate interpretation of the results because of the potential for imbalance between groups. However, these studies utilized control cohorts that were sociodemographically and clinically similar to patients that were provided incentives, and the results were consistent with those of the more rigorous randomized controlled trials included in this review. Third, this review was limited to studies published in peer-reviewed journals, which is susceptible to publication bias. Fourth, some of these studies did not report statistical results for relevant comparisons, limiting our ability to draw conclusions about some of the moderator variables examined here. In this regard, performing a meta-analytic review of this growing literature may be an important next step. Although the results of this review suggest that the findings of Lussier et al. (2006) generalize to CM interventions targeting infectious disease-related behaviors among individuals with SUDs, the additional quantitative data provided by a meta-analysis would allow for more definitive conclusions about the efficacy of these interventions.

In summary, the present review demonstrates that there is compelling evidence that incentive-based interventions improve adherence to vaccinations, diagnostic tests and pharmacotherapies critical for the control of hepatitis, HIV and TB among individuals with

SUDs. The parameters that moderate the efficacy of these interventions appear consistent with those shown to influence outcomes of CM for the treatment of SUDs. Incentives are a valuable tool that can be used to improve public health outcomes related to infectious disease.

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References

Afdhal N, Zeuzem S, Kwo P, Chojkier M, Gitlin N, Puoti M, … Foster GR. Ledipasvir and sofosbuvir for untreated HCV genotype 1 infection. New England Journal of Medicine. 2014; 370:1889–1898. [PubMed: 24725239]

Almasio PL, Babudieri S, Barbarini G, Brunetto M, Conte D, Dentico P, … Starnini G. Recommendations for the prevention, diagnosis, and treatment of chronic hepatitis B and C in special population groups (migrants, intravenous drug users and prison inmates). Digestive and Liver Disease. 2011; 43:589–595. [PubMed: 21256097]

Alter MJ. Epidemiology and prevention of hepatitis B. Seminars in liver disease. 2003; 23(1):39–46. [PubMed: 12616449]

Arnsten JH, Demas PA, Farzadegan H, Grant RW, Gourevitch MN, Chang CJ, … Schoenbaum EE. Antiretroviral therapy adherence and viral suppression in HIV-infected drug users: Comparison of self-report and electronic monitoring. Clinical Infectious Diseases. 2001; 33:1417–1423. [PubMed: 11550118]

Atkinson SR, Paul J, Sloan E, Curtis S, Miller R. The emergence of meticillin-resistant *Staphylococcus aureus* among injecting drug users. Journal of Infection. 2009; 58:339–345. [PubMed: 19344954]

Batki SL, Gruber VA, Bradley JM, Bradley M, Delucchi K. A controlled trial of methadone treatment combined with directly observed isoniazid for tuberculosis prevention in injection drug users. Drug and Alcohol Dependence. 2002; 66:283–293. [PubMed: 12062463]

Befrits R, Hedman M, Blomquist L, Allander T, Grillner L, Kinnman N, … Hultcrantz R. Chronic hepatitis C in alcoholic patients: Prevalence, genotypes, and correlation to liver disease. Scandinavian Journal of Gastroenterology. 1995; 30:1113–1118. [PubMed: 8578173]

Bock NN, Sales RM, Rogers T, DeVoe B. A spoonful of sugar...: improving adherence to tuberculosis treatment using financial incentives [notes from the field. The International Journal of Tuberculosis and Lung Disease. 2001; 5:96–98. [PubMed: 11263524]

Booth RE, Kwiatkowski CF, Chitwood DD. Sex related HIV risk behaviors: differential risks among injection drug users, crack smokers, and injection drug users who smoke crack. Drug and Alcohol Dependence. 2000; 58:219–226. [PubMed: 10759032]

Bruggmann P, Falcato L, Dober S, Helbling B, Keiser O, Negro F, Meili D. Active intravenous drug use during chronic hepatitis C therapy does not reduce sustained virological response rates in adherent patients. Journal of Viral Hepatitis. 2008; 15:747–752. [PubMed: 18637072]

Centers for Disease Control and Prevention. A comprehensive immunization strategy to eliminate transmission of hepatitis B virus infection in the United States. 2006. http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5516a1.htm

Centers for Disease Control and Prevention. Recommendations for use of an isoniazid-rifapentine regimen with direct observation to treat latent mycobacterium tuberculosis infection. Morbidity and Mortality Weekly Report. 2011; 48:1650–1653.

Centers for Disease Control and Prevention. Monitoring selected national HIV prevention and care objectives by using HIV surveillance data—United States and 6 dependent areas—2012. HIV surveillance supplemental report 2014. 2014a; 19(3) Published November 2014.

Centers for Disease Control and Prevention. Tuberculosis. 2014b. http://www.cdc.gov/tb/statistics/

Centers for Disease Control and Prevention. HIV infection and risk, prevention, and testing behaviors among injecting drug users: National HIV behavioral surveillance system, 20 U.S. cities, 2009. Morbidity and Mortality Weekly Reports. 2014c; 63(ss-6):1–51.

Centers for Disease Control and Prevention. Surveillance for viral hepatitis –United States, 2013. 2015a. http://www.cdc.gov/hepatitis/Statistics/2013Surveillance/Commentary.htm#hepB

Centers for Disease Control and Prevention. Hepatitis C FAQs for the public. 2015b. http://www.cdc.gov/hepatitis/C/cFAQ.htm

Centers for Disease Control and Prevention. HIV in the United States: At a glance. 2015c. http://www.cdc.gov/hiv/statistics/basics/ataglance.html

Chaisson RE, Keruly JC, McAvinue S, Gallant JE, Moore RD. Effects of an incentive and education program on return rates for PPD test reading in patients with HIV infection. JAIDS Journal of Acquired Immune Deficiency Syndromes. 1996; 11:455–459.

Chaisson RE, Barnes GL, Hackman J, Watkinson L, LPN LK, Metha S, … Moore RD. A randomized, controlled trial of interventions to improve adherence to isoniazid therapy to prevent tuberculosis in injection drug users. The American Journal of Medicine. 2001; 110:610–615. [PubMed: 11382368]

Davidson H, Schluger NW, Feldman PH, Valentine DP, Telzak EE, Laufer FN. The effects of increasing incentives on adherence to tuberculosis directly observed therapy. The International Journal of Tuberculosis and Lung Disease. 2000; 4:860–865. [PubMed: 10985655]

Des Jarlais DC, Arasteh K, Perlis T, Hagan H, Abdul-Quader A, Heckathorn DD, … Friedman SR. Convergence of HIV seroprevalence among injecting and non-injecting drug users in New York City. AIDS. 2007; 21:231–235. [PubMed: 17197815]

Downey KK, Helmus TC, Schuster CR. Treatment of heroin-dependent poly-drug abusers with contingency management and buprenorphine maintenance. Experimental and Clinical Psychopharmacology. 2000; 8:176. [PubMed: 10843300]

Durante AJ, Selwyn PA, O'Connor PG. Risk factors for and knowledge of mycobacterium tuberculosis infection among drug users in substance abuse treatment. Addiction. 1998; 93:1393–1401. [PubMed: 9926545]

Farber S, Tate J, Frank C, Ardito D, Kozal M, Justice AC, Braithwaite RS. A study of financial incentives to reduce plasma HIV RNA among patients in care. AIDS and Behavior. 2013; 17:2293–2300. [PubMed: 23404097]

Festinger DS, Marlowe DB, Croft JR, Dugosh KL, Mastro NK, Lee PA, … Patapis NS. Do research payments precipitate drug use or coerce participation? Drug and Alcohol Dependence. 2005; 78:275–281. [PubMed: 15893158]

Festinger DS, Marlowe DB, Dugosh KL, Croft JR, Arabia PL. Higher magnitude cash payments improve research follow-up rates without increasing drug use or perceived coercion. Drug and Alcohol Dependence. 2008; 96:128–135. [PubMed: 18395365]

FitzGerald JM, Patrick DM, Strathdee S, Rekart M, Elwood RK, Schecter MT. … Vancouver Injection Drug Use Study Group. Use of incentives to increase compliance for TB screening in a population of intravenous drug users. The International Journal of Tuberculosis and Lung Disease. 1999; 3:153–155. [PubMed: 10091882]

Getahun H, Gunneberg C, Sculier D, Verster A, Raviglione M. Tuberculosis and HIV in people who inject drugs: Evidence for action for tuberculosis, HIV, prison and harm reduction services. Current Opinion in HIV and AIDS. 2012; 7:345–353. [PubMed: 22678489]

Hagen H, Thiede H, Weiss NS, Hopkins SG, Duchin JS, Alexander ER. Sharing of drug preparation equipment as a risk factor for hepatitis C. American Journal of Public Health. 2001; 91:42–46. [PubMed: 11189822]

Hartzler B, Lash SJ, Roll JM. Contingency management in substance abuse treatment: A structured review of the evidence for its transportability. Drug and Alcohol Dependence. 2012; 122:1–10. [PubMed: 22153943]

Haug NA, Sorensen JL. Contingency management interventions for HIV-related behaviors. Current HIV/AIDS Reports. 2006; 3:154–159. [PubMed: 17032574]

Higgins, ST.Silverman, K., Heil, SH., editors. Contingency Management in Substance Abuse Treatment. New York: Guilford Press; 2008.

Howard AA, Klein RS, Schoenbaum EE, Gourevitch MN. Crack cocaine use and other risk factors for tuberculin positivity in drug users. Clinical Infectious Diseases. 2002; 35:1183–1190. [PubMed: 12410478]

Hutchinson AB, Farnham PG, Dean HD, Ekwueme DU, Del Rio C, Kamimoto L, Kellerman SE. The economic burden of HIV in the United States in the era of highly active antiretroviral therapy: Evidence of continuing racial and ethnic differences. JAIDS Journal of Acquired Immune Deficiency Syndromes. 2006; 43:451–457. [PubMed: 16980906]

Hwang LY, Grimes CZ, Tran TQ, Clark A, Xia P, Lai D, … Williams M. Accelerated hepatitis B vaccination schedule among drug users: A randomized controlled trial. Journal of Infectious Diseases. 2010; 202:1500–1509. [PubMed: 20936979]

Kowdley KV, Lawitz E, Poordad F, Cohen DE, Nelson DR, Zeuzem S, … Xie W. Phase 2b trial of interferon-free therapy for hepatitis C virus genotype 1. New England Journal of Medicine. 2014; 370:222–232. [PubMed: 24428468]

Kral AH, Bluthenthal RN, Lorvick J, Gee L, Bacchetti P, Edlin BR. Sexual transmission of HIV-1 among injection drug users in San Francisco, USA: Risk-factor analysis. The Lancet. 2001; 357:1397–1401.

Ladak F, Gjelsvik A, Feller E, Rosenthal S, Montague BT. Hepatitis B in the United States: ongoing missed opportunities for hepatitis B vaccination, evidence from the behavioral risk factor surveillance survey, 2007. Infection. 2012; 40:405–413. [PubMed: 22237474]

Lussier JP, Heil SH, Mongeon JA, Badger GJ, Higgins ST. A meta-analysis of voucher-based reinforcement therapy for substance use disorders. Addiction. 2006; 101:192–203. [PubMed: 16445548]

Lutge EE, Wiysonge CS, Knight SE, Volmink J. Material incentives and enablers in the management of tuberculosis. Cochrane Database of Systematic Reviews. 2012; 1

Malotte CK, Rhodes F, Mais KE. Tuberculosis screening and compliance with return for skin test reading among active drug users. American Journal of Public Health. 1998; 88:792–796. [PubMed: 9585747]

Malotte CK, Hollingshead JR, Rhodes F. Monetary versus nonmonetary incentives for TB skin test reading among drug users. American Journal of Preventive Medicine. 1999; 16:182–188. [PubMed: 10198656]

Malotte CK, Hollingshead JR, Larro M. Incentives vs outreach workers for latent tuberculosis treatment in drug users. American Journal of Preventive Medicine. 2001; 20:103–107. [PubMed: 11165450]

Management of Hepatitis C. NIH Consens. Statement Online 1997 Mar 24–26. 1997; 15(3):1–41.

Manosuthi W, Chottanapand S, Thongyen S, Chaovavanich A, Sungkanuparph S. Survival rate and risk factors of mortality among HIV/tuberculosis-coinfected patients with and without antiretroviral therapy. JAIDS Journal of Acquired Immune Deficiency Syndromes. 2006; 43(1):42–46. [PubMed: 16885778]

Martin M, Vanichseni S, Suntharasamai P, Sangkum U, Mock PA, Leethochawalit M, … Kittimunkong S. The impact of adherence to preexposure prophylaxis on the risk of HIV infection among people who inject drugs. AIDS. 2015; 29:819–824. [PubMed: 25985403]

McCance-Katz EF, Gourevitch MN, Arnsten J, Sarlo J, Rainey P, Jatlow P. Modified directly observed therapy (MDOT) for injection drug users with HIV disease. The American Journal on Addictions. 2002; 11:271–278. [PubMed: 12584870]

Moses, LE.Vlahov, D., Normand, J., editors. Preventing HIV transmission: The role of sterile needles and bleach. National Academies Press; 1995.

National Institute on Drug Abuse. NIDA notes: The rise and fall of TB in the United States. 1998. https://archives.drugabuse.gov/NIDA_Notes/NNVol13N3/USTB.html

National Institute on Drug Abuse. DrugFacts: HIV/AIDS and drug abuse: Intertwined epidemics. 2012. http://www.drugabuse.gov/publications/drugfacts/hivaids-drug-abuse-intertwined-epidemics

National Institute on Drug Abuse. Viral hepatitis – A very real consequence of substance abuse. 2013. https://www.drugabuse.gov/related-topics/viral-hepatitis-very-real-consequence-substance-use

Nelson PK, Mathers BM, Cowie B, Hagan H, Des Jarlais D, Horyniak D, Degenhardt L. Global epidemiology of hepatitis B and hepatitis C in people who inject drugs: results of systematic reviews. The Lancet. 2011; 378(9791):571–583.

Paul EA, Lebowitz SM, Moore RE, Hoven CW, Bennett BA, Chen A. Nemesis revisited: Tuberculosis infection in a New York City men's shelter. American Journal of Public Health. 1993; 83:1743–1745. [PubMed: 8259807]

Perlman DC, Friedmann MP, Horn ML, Nugent MA, Schoeb MV, Carey J, … Des Jarlais DC. Impact of monetary incentives on adherence to referral for screening chest X-rays after syringe exchange-based tuberculin skin testing. Journal of Urban Health. 2003; 80:428–437. [PubMed: 12930881]

Perri BR, Proops D, Moonan PK, Munsiff SS, Kreiswirth BN, Kurepina N, … Ahuja SD. Mycobacterium tuberculosis cluster with developing drug resistance, New York, New York, USA, 2003–2009. Emerging Infectious Diseases. 2011; 17:372. [PubMed: 21392426]

Petry NM. Alcohol use in HIV patients: What we don't know may hurt us. International Journal of STD & AIDS. 1999; 10:561–570. [PubMed: 10492422]

Petry NM. Discounting of money, health, and freedom in substance abusers and controls. Drug and Alcohol Dependence. 2003; 71:133–141. [PubMed: 12927651]

Petry NM, Tedford J, Austin M, Nich C, Carroll KM, Rounsaville BJ. Prize reinforcement contingency management for treating cocaine users: how low can we go, and with whom? Addiction. 2004; 99(3):349–360. [PubMed: 14982548]

Pilote L, Tulsky JP, Zolopa AR, Hahn JA, Schecter GF, Moss AR. Tuberculosis prophylaxis in the homeless: A trial to improve adherence to referral. Archives of Internal Medicine. 1996; 156:161–165. [PubMed: 8546549]

Ranganathan M, Lagarde M. Promoting healthy behaviours and improving health outcomes in low and middle income countries: A review of the impact of conditional cash transfer programmes. Preventive Medicine. 2012; 55:S95–S105. [PubMed: 22178043]

Rehm J, Samokhvalov AV, Neuman MG, Room R, Parry C, Lönnroth K, … Popova S. The association between alcohol use, alcohol use disorders and tuberculosis (TB). A systematic review. BMC public health. 2009; 9:450. [PubMed: 19961618]

Reynolds B. A review of delay-discounting research with humans: Relations to drug use and gambling. Behavioural Pharmacology. 2006; 17:651–667. [PubMed: 17110792]

Rigsby MO, Rosen MI, Beauvais JE, Cramer JA, Rainey PM, O'Malley SS, … Rounsaville BJ. Cue-dose training with monetary reinforcement: Pilot study of an antiretro-viral adherence intervention. Journal of General Internal Medicine. 2000; 15:841–847. [PubMed: 11119180]

Roca B, Gómez CJ, Arnedo A. Stavudine, lamivudine and indinavir in drug abusing and non-drug abusing HIV-infected patients: Adherence, side effects and efficacy. Journal of Infection. 1999; 39:141–145. [PubMed: 10609532]

Roll JM, Higgins ST. A within-subject comparison of three different schedules of reinforcement of drug abstinence using cigarette smoking as an exemplar. Drug and Alcohol Dependence. 2000; 58:103–109. [PubMed: 10669060]

Roll JM, Higgins ST, Badger GJ. An experimental comparison of three different schedules of reinforcement of drug abstinence using cigarette smoking as an exemplar. Journal of Applied Behavior Analysis. 1996; 29:495. [PubMed: 8995832]

Seal KH, Kral AH, Lorvick J, McNees A, Gee L, Edlin BR. A randomized controlled trial of monetary incentives vs. outreach to enhance adherence to the hepatitis B vaccine series among injection drug users. Drug and Alcohol Dependence. 2003; 71:127–131. [PubMed: 12927650]

Silverman K, Chutuape MA, Bigelow GE, Stitzer ML. Voucher-based reinforcement of cocaine abstinence in treatment-resistant methadone patients: Effects of reinforcement magnitude. Psychopharmacology. 1999; 146:128–138. [PubMed: 10525747]

Solomon SS, Srikrishnan AK, Vasudevan CK, Anand S, Kumar MS, Balakrishnan P, … Lucas GM. Voucher incentives improve linkage to and retention in care among HIV-infected drugs users in Chennai, India. Clinical Infectious Diseases. 2014 [ciu324].

Sorensen JL, Haug NA, Delucchi KL, Gruber V, Kletter E, Batki SL, … Hall S. Voucher reinforcement improves medication adherence in HIV-positive methadone patients: A randomized trial. Drug and Alcohol Dependence. 2007; 88:54–63. [PubMed: 17056206]

Stitzer M, Petry N. Contingency management for treatment of substance abuse. Annual Review Clinical Psychology. 2006; 2:411–434.

Stitzer ML, Polk T, Bowles S, Kosten T. Drug users' adherence to a 6-month vaccination protocol: Effects of motivational incentives. Drug and Alcohol Dependence. 2010; 107:76–79. [PubMed: 19828264]

Thornton RL. The demand for, and impact of, learning HIV status. The American Economic Review. 2008; 98:1829. [PubMed: 21687831]

Topp L, Day CA, Wand H, Deacon RM, van Beek I, Haber PS. … Group V. I. T. H. S. A randomised controlled trial of financial incentives to increase hepatitis B vaccination completion among people who inject drugs in Australia. Preventive Medicine. 2013; 57:297–303. [PubMed: 23639625]

Trubatch BN, Fisher DG, Cagle HH, Fenaughty AM. Vaccination strategies for targeted and difficult-to-access groups. American Journal of Public Health. 2000; 90:447. [PubMed: 10705870]

Tulsky JP, Pilote L, Hahn JA, Zolopa AJ, Burke M, Chesney M, Moss AR. Adherence to isoniazid prophylaxis in the homeless: A randomized controlled trial. Archives of Internal Medicine. 2000; 160:697–702. [PubMed: 10724056]

Tulsky JP, Hahn JA, Long HL, Chambers DB, Robertson MJ, Chesney MA, Moss AR. Can the poor adhere? Incentives for adherence to TB prevention in homeless adults. The International Journal of Tuberculosis and Lung Disease. 2004; 8:83–91. [PubMed: 14974750]

Vandrey R, Bigelow GE, Stitzer ML. Contingency management in cocaine abusers: A dose-effect comparison of goods-based versus cash-based incentives. Experimental and Clinical Psychopharmacology. 2007; 15:338. [PubMed: 17696680]

Weaver T, Metrebian N, Hellier J, Pilling S, Charles V, Little N, … Strang J. Use of contingency management incentives to improve completion of hepatitis B vaccination in people undergoing treatment for heroin dependence: A cluster randomised trial. The Lancet. 2014; 384:153–163.

White MC, Tulsky JP, Reilly P, McIntosh HW, Hoynes TM, Goldenson J. A clinical trial of a financial incentive to go to the tuberculosis clinic for isoniazid after release from jail. The International Journal of Tuberculosis and Lung Disease. 1998; 2:506–512. [PubMed: 9626609]

White MC, Tulsky JP, Goldenson J, Portillo CJ, Kawamura M, Menendez E. Randomized controlled trial of interventions to improve follow-up for latent tuberculosis infection after release from jail. Archives of Internal Medicine. 2002; 162:1044–1050. [PubMed: 11996616]

Table 1

Studies targeting prevention.

Study	Condition	Population	Recruitment	*N*	Design	Medical target	Incentive group(s)	Control group	Outcomes
Trubatch et al. (2000)	Hepatitis B	IDUs	Community outreach	312	HC	Receipt of 1st vaccine	$10 for proof of vaccination from provider	Referrals only	48% of participants in incentive group received first vaccine vs. 7% of participants in control group
Seal et al. (2003)	Hepatitis B	IDUs	Street outreach	96	RCT	Completion of series of 3 vaccinations	$20 for returning to field site monthly for 6 months (2nd and 3rd vaccinations given at months 1 and 6)	Weekly outreach with reminders of upcoming vaccine appointments	69% of participants in incentive group completed vaccination series vs. 23% of participants in control group
Stitzer et al. (2010)	Hepatitis B	Cocaine users	Veterans administration hospital, community hospital, community outreach	26	RCT	Completion of series of 3 vaccinations	$20 for completing questionnaires and receiving first vaccination and $10 for transportation costs + lottery-style incentives worth $0–80 for weekly visit attendance and $20–$50 bonuses for monthly injections (2nd and 3rd vaccinations given at months 1 and 6; placebo injections given months 2–5)	$20 for completing questionnaires and receiving first vaccination and $10 for transportation costs	Participants in incentive group received 91% of injections vs. 78% among participants in the control group (p = .22) 77% of participants in incentive group completed the 7-vaccination series vs. 46% of participants in control group (p = .11)
Topp et al. (2013)	Hepatitis B	IDUs	Syringe exchange, community outreach	139	RCT	Completion of series of 3 vaccinations	$30 (AUD) per dose for receiving 2nd and 3rd doses of vaccine series on-time (7 and 21 days post-1st dose)	Usual encouragement to return for 2nd and 3rd doses	87% of participants in incentive group completed vaccination series vs. 66% of participants in the control group
Weaver et al. (2014)	Hepatitis B	Opioid- maintained patients	Opioid maintenance clinic	210	RCT	Completion of series of 3 vaccinations	Two incentive groups: (1) fixed value (£10) or (2) escalating value (£5, £10, £15) for receiving doses on-time at 1,14 and 21 days	Treatment as usual	45% of participants in fixed value incentive group and 49% of participants in escalating value incentive group

Study	Condition	Population	Recruitment	*N*	Design	Medical target	Incentive group(s)	Control group	Outcomes
									completed vaccination series vs. 9% of participants in control group

Note. Study = reference to primary report. Condition = infectious condition targeted. Population = characteristics of individuals included in the study sample (injection drug users abbreviated as “IDUs”). Recruitment = settings(s) in which participants were recruited for the study. N = sample size, all groups combined. Design = experimental design used (randomized controlled trial abbreviated as “RCT” and historical control abbreviated as “HC”). Medical target = medical behavior targeted by the incentive intervention. Incentives group(s) = characteristics of incentives offered contingent upon completion of target behavior(s) in one or more of the incentive conditions examined: Incentive values are in U.S. cash unless otherwise specified (Australian dollar abbreviated “AUD”). Control group = control arm or cohort that did not receive incentives used as comparison condition. Outcomes = effect of incentives on target behavior(s) relative to comparison condition. Differences between experimental and control conditions are significant at a level of $p < .05$ unless otherwise specified.

Table 2

Studies targeting diagnosis.

Study	Condition	Population	Recruitment	*N*	Design	Medical target	Incentive group(s)	Control group	Outcomes
Chaisson et al. (1996)	TB	People with HIV (50% IDUs)	HIV clinic	659	HC	Return for skin test reading	$4 fast food voucher for returning in 2–3 days	Instructions to return in 2–3 days	48% return rate among participants in incentive group vs. 35% of participants in control group
Pilote et al. (1996)	TB	Homeless adults with a positive TB skin test (42% IDU, 64% crack cocaine)	Street outreach	244	RCT	Attend appointment at TB clinic	Referral slips and bus tokens for transport to clinic + $5 for attending appointment within 3 weeks	Referral slips and bus tokens for transport to clinic	84% attendance among participants in incentive group vs. 53% of participants in control group
Malotte et al. (1998)	TB	Active drug users	Street outreach	1004	RCT	Return for skin test reading	Two incentive groups: (1) $10 or (2) $5 for returning as scheduled	Instructions to return in 2–3 days	93% return rate among participants offered $10 and 86% of participants offered $5 vs. 33% of participants in the control group
Malotte et al. (1999)	TB	Active drug users	Street outreach	1078	RCT	Return for skin test reading	Three incentive groups: (1) $10, (2) $10 grocery store coupons or (3) $10 fast food coupons/bus tokens for returning as scheduled	Instructions to return in 2–3 days	95% return rate among participants offered cash and 86% among participants offered grocery store coupons and 83% among participants offered fast food coupons/bus tokens vs. 49% among participants in the control group
FitzGerald et al. (1999)	TB	IDUs	Syringe exchange	1107	HC	Return for skin test reading	$5 (CAN) for returning in 2–3 days	Instructions to return in 2–3 days	78% return rate among participants in incentive group vs. 43% among participants in control group
Perlman et al. (2003)	TB	IDUs with a positive TB skin test	Syringe exchange	177	HC	Have chest x-ray at off-site clinic	Referral slips, $5 in transportation tokens for travel to clinic + $25 for having chest x-ray within 7 days of referral	Referral slips and $5 in transportation tokens for travel to clinic	83% adherence among participants in the incentive group vs. 34% among participants in the control group

Note. Study = reference to primary report. Condition = Infectious condition targeted (tuberculosis abbreviated as “TB”). Population = characteristics of individuals included in the study sample (human immunodeficiency virus abbreviated as “HIV”, injection drug users abbreviated as “IDUs.”) Recruitment = settings(s) in which participants were recruited for the study (randomized controlled trial abbreviated as “RCT” and historical control abbreviated as “HC”). N = sample size, all groups combined. Design = experimental design used (randomized controlled trial abbreviated as “RCT” and historical control abbreviated as “HC”). Medical target = medical behavior targeted by the incentive intervention. Incentive group(s) = characteristics of incentives offered contingent upon completion of target behavior(s) in one or more of the incentive conditions examined. Incentives are in U.S. cash unless otherwise specified (Canadian dollar abbreviated as “CAN”). Control group = control arm or cohort that did not receive incentives used as comparison condition. Outcomes = effect of incentives on target behavior(s) relative to comparison condition. Differences between experimental and control conditions are significant at a level of $p < .05$.

Table 3

Studies targeting treatment adherence.

Study	Condition	Population	Recruitment	*N*	Design	Medical target	Incentive group(s)	Control group	Outcomes
White et al. (1998)	TB	Inmates who initiated INH while incarcerated and were released during study period (79% with alcohol/ drug abuse)	Jail	61	RCT	INH completion	TB education + $5 for attending first clinic visit at TB clinic	TB education	26% attendance among participants in incentive group vs. 23% among participants in control group (p = .82)
Tulsky et al. (2000)	TB	Homeless adults with a positive TB skin test (36% crack cocaine user, 11% IDUs)	Street outreach	118	RCT	INH completion	$5/observed dose (doses given 2×/week for 6 months)	Self-administered daily dosing and attendance at monthly refill visits	44% treatment completion among participants in incentive group vs. 26% among participants in the control group (p = . 11)
Davidson et al. (2000)	TB	Patients receiving treatment for TB (42% drug users)	TB clinics	365	HC	Treatment completion	Two incentive groups: (1) $15 in subway tokens/week for ingesting all doses or (2) $15 in subway tokens/week for ingesting all doses and monthly bonuses of $30–60 in subway tokens for ingesting ≥80% of doses in that month	Not applicable	Participants offered higher magnitude incentive package were 2.7 times more likely to take ≥80% of doses than patients offered lower magnitude package
Rigsby et al. (2000)	HIV	HIV+ patients on ART (80% drug users)	Veterans administration hospital, infectious disease center	55	RCT	ART adherence	Cue dose training + cash payments for attending study visits ($280 maximum) + escalating incentive schedule from $2–$10 for on-time medication cap opening (4 weeks)	Cue dose training + cash payments for attending study visits	On-time MEMS cap openings increased among patients in incentive condition (70% to ~90%) but not among participants in control group (68% to ~75%)
Chaisson et al. (2001)	TB	IDUs with a positive TB skin test	TB clinic	300	RCT	INH completion	Two incentive group: $10/ month for adhering to study procedures, paid out (1) each month for 6 months or (2) in a lump sum at end of 6 months; incentive arms sometimes combined with self-administered treatment, self-administered treatment + peer support or supervised dosing	Not applicable	83% completion among participants offered incentives each month vs. 75% among participants offered incentives in a lump sum (p = .09)

Study	Condition	Population	Recruitment	*N*	Design	Medical target	Incentive group(s)	Control group	Outcomes
Malotte et al. (2001)	TB	IDUs and crack cocaine users with a positive TB skin test	Street outreach	163	RCT	INH completion	Directly observed therapy provided by an outreach worker + $5 dose (doses given 2×/week for 6–12 months)	Directly observed therapy provided by an outreach worker	53% treatment completion among participants in incentive group vs. 4% in control group
Bock et al. (2001)	TB	Adults (56% alcohol/drug abusers) and children with a history of TB medication non-adherence	TB clinic	107	HC	Treatment completion	$5 grocery coupon/observed dose or physician visit	Directly observed therapy	Participants in incentive group were 5.7 times more likely to successfully complete treatment within 32 weeks than participants in control group (60% vs. 19%)
White et al. (2002)	TB	Inmates with latent TB who initiated INH while incarcerated and were released during study period (55% alcohol/drug problem)	Jail	325	RCT	INH completion	Informational session + $25 food/transportation vouchers for attending first visit at TB clinic within 1 month of release	Informational session	37% attendance among participants in incentive group vs. 37% among participants in control group (significance data not reported) 12% treatment completion in the incentive group vs. 23% in control group (significance data not reported)
Tulsky et al. (2004)	TB	Homeless adults with a positive TB skin test (51% crack cocaine users, 42% IDUs)	Street outreach	119	RCT	Treatment completion	Two incentive groups: (1) $5/observed dose or (2) $5 non-cash incentive/observed dose (doses given 2×/week for 4–6 months)	Not applicable	89% treatment completion among participants in cash incentive group vs. 81% among participants in the non-cash group (p = . 23)
Sorensen et al. (2007)	HIV	HIV+ methadone patients <80% ART-adherent	Methadone clinics	66	RCT	ART adherence	Cash payments for completing various tasks ($256 maximum) + escalating vouchers, starting at $1/day, for each on-time medication cap opening (daily for 12 weeks)	Cash payments for completing various tasks + lottery-style incentives worth $0–$80 for attendance at study visits	78% on-time MEMS cap openings among participants in the incentive group vs. 56% among participants in the control group
Farber et al. (2013)	HIV	HIV+ patients on ART and with detectable viral load (52% IDU)	HIV clinic	77	W-S	Reduced viral load	$100 for blood test with undetectable viral load or viral load ≤1-log10 lower than prior lowest viral load in past year (1×/quarter for 1 year)	Viral load in year prior to incentive implementation	Proportion of tests with undetectable viral load increased from 57% to 69% after introduction of incentive
Solomon et al. (2014)	HIV	ART-naive HIV + drug users	Substance abuse research clinic, street outreach	120	RCT	Linkage and retention in care, viral suppression	$4 (U.S. equivalent) voucher for initiating medication and $4 voucher for attending	Lottery-style incentives worth $0–$8 for quarterly study visit attendance	45% initiation among participants in incentive group vs.

Study	Condition	Population	Recruitment	*N*	Design	Medical target	Incentive group(s)	Control group	Outcomes
							each monthly medication refill visit (delivered quarterly) and $8 voucher for viral suppression at 6- and 12-months		27% among participants in control group Median of 8 monthly refill visits among participants in incentive group vs. 3.5 among participants in control group 32% viral suppression among participants in incentive group vs. 33% in control group (significance data not reported)

Note. Study = reference to primary report. Condition = infectious condition targeted (tuberculosis abbreviated as “TB” and human immunodeficiency virus abbreviated as “HIV”). Population = characteristics of individuals included in the study sample (isoniazid abbreviated as “INH”, injection drug user abbreviated as “IDUs,” and antiretroviral therapy abbreviated as “ART”). Recruitment = setting(s) in which participants were recruited for the study. N = sample size, all groups combined. Design = experimental design used (randomized controlled trial abbreviated as “RCT,” historical control abbreviated as “HC,” and within-subjects design abbreviated as “W-S”). Medical target = medical behavior targeted by the incentive intervention. Incentive group(s) = characteristics of incentives offered contingent upon completion of target behavior(s) in one or more of the incentive conditions examined; incentives are in U.S. cash. Control group = control arm or cohort that did not receive incentives used as comparison condition. Outcomes = effect of incentives on target behavior(s) relative to comparison condition. Differences between incentive and control conditions are significant at a level of $p < .05$ unless otherwise specified.