Published in final edited form as:

AIDS Behav. 2013 September ; 17(7): 2283–2292. doi:10.1007/s10461-013-0415-2.

Conditional economic incentives to improve HIV treatment adherence: literature review and theoretical considerations

Omar Galárraga^{a,*}, Becky L. Genberg^a, Rosemarie A. Martin^b, M. Barton Laws^a, and Ira B. Wilson^{a,c}

^aDepartment of Health Services, Policy & Practice; Brown University, Providence, RI 02912, USA

^bDepartment of Behavioral and Social Sciences; Brown University, Providence, RI 02912, USA

^cThe Warren Alpert Medical School; Brown University, Providence, RI 02912, USA

Abstract

We present selected theoretical issues regarding conditional economic incentives (CEI) for HIV treatment adherence. High HIV treatment adherence is essential not only to improve individual health for persons living with HIV, but also to reduce transmission. The incentives literature spans several decades and various disciplines, thus we selectively point out useful concepts from economics, psychology and HIV clinical practice to elucidate the complex interaction between socio-economic issues, psychological perspectives and optimal treatment adherence. Appropriately-implemented CEI can help patients improve their adherence to HIV treatment in the short-term, while the incentives are in place. However, more research is needed to uncover mechanisms that can increase habit formation or maintenance effects in the longer-term. We suggest some potentially fruitful avenues for future research in this area, including the use of concepts from self-determination theory. This general framework may have implications for related research among disadvantaged communities with high rates of HIV/AIDS infection.

Keywords

antiretroviral HIV treatment; adherence to medication; economic incentives; contingency management; conditional cash transfers

Introduction

Adherence broadly refers to the level of agreement between medical advice and patient behavior. High and consistent levels of adherence are essential for achieving the full therapeutic effect of a pharmaceutical treatment. Few cases may be more dramatic than the protection against further HIV replication offered by antiretroviral therapy (ART) (1–3). Adherence to ART is required to maintain a healthy immune system (as measured by increased CD4 cell counts) and concurrently for viral suppression (4). However, how to support patients to achieve *sustained* high levels of adherence, particularly among the most vulnerable, is a subject of considerable debate.

Studies have shown that adherence levels tend to decrease over time and that maintaining high levels of adherence is uncommon: Behavioral interventions for ART adherence center around several approaches including patient education, case management, modified directly

*Corresponding author: Box G-S121-7, 121 South Main Street, Brown University, Providence, RI 02912, USA, Tel. +401-863-2331, omar_galarraga@brown.edu.

observed therapy (mDOT), and conditional economic incentives (CEI) (5). Various incentive methods for ART adherence have been studied including voucher reinforcement, prize systems, and cash payments (6–9). Often, behavioral interventions have paired more than one strategy in attempt to maximize the impact on adherence. However little is known about which components are most effective in improving outcomes for given populations. Many ART adherence interventions have limited or no explicit theoretical basis. Two recent general reviews of economic incentives and adherence (10,11) summarize the main findings from the HIV treatment trials, but do not attempt to provide the theoretical basis for why the effects may be occurring.

The goal of this paper is to summarize the theoretical foundations potentially underlying CEI for medication adherence. These concepts have been developed in economics and psychology over the last several decades. However, no attempt has been made to synthesize this body of cross-disciplinary work particularly as it pertains to ART adherence. The specific objectives of this article are: (1) to offer a theoretical basis for ongoing research on using CEI to promote adherence; (2) to inform a critical discussion of the limitations of CEI and to offer a preliminary synthesized conceptual model to promote sustained adherence; (3) to critically review randomized controlled trials of CEI for ART adherence in the US, and (4) to *broadly* consider under what specific conditions CEI approaches may be most successful and when complementary approaches may be useful in promoting adherence. Several strands of literature from different disciplines are merged to offer insights into the potential mechanisms that may enhance or inhibit the success of CEI for sustained ART adherence. Finally, we offer recommendations for future multidisciplinary research on the use of CEI to promote ART adherence among vulnerable populations.

Micro- and behavioral-economics framework for conditional economic incentives

CEI are a method originally developed in psychology, under the name of contingency management, to improve patients' outcomes and are used predominantly in the treatment of substance use disorders (12–15). The objective is to provide financial or other rewards to patients who accomplish specific tasks or behaviors that can be objectively monitored; reinforcements are seen as the most important means of shaping healthier behaviors and strengthening the likelihood of their reoccurrence (16,17). Beyond substance use disorders, financial incentives have also been shown to be successful at improving patients' adherence to medical treatments (10,11,18).

One way of conceptualizing incentives for adherence is through the lens of general economic theory (19). Economic theory assumes that people maximize their utility (happiness or satisfaction). Therefore, people may not adhere because they perceive a reduction in utility due to out-of-pocket costs, side effects, perceived risks, delayed benefits, or other idiosyncratic reasons. The idea of using CEI is to increase income when adherent (through a contingent payment), which in turn increases utility. Under this framework, economically "rational" consumers would increase adherence up to the point where their disutility from the medication is at least equal to the utility gain from the additional income.

The fundamental theory question is: "Why would we as patients not take a medicine that is ostensibly good for us?" Traditional economics models where the consumer is supposed to maximize his or her utility fail to provide satisfactory answers to this question (20). A new branch of inquiry called "behavioral economics" which incorporates insights from psychology may help improve understanding (21,22). Suboptimal adherence to ART may be related to status quo inertia and also to time discounting and time preferences (23). People taking treatment for HIV may discount the future and prefer current utility of not adhering,

over future benefits of controlled viral load; or may have a preference for immediate rewards connected to non-adherence over long term utility associated with high adherence. Furthermore, people may exhibit “myopic” preferences (24) where events further in the future may be discounted more heavily than those more imminent. A related concept in the psychological literature is the temporal perspective (25,26), which captures whether a person is more oriented towards the present (hedonism), the past (negative and positive memories), or the future. Theoretically, higher adherence should be negatively correlated with present (hedonistic) orientation and positively correlated with future orientation. While people may know that if they stop taking ART they may risk treatment failure, opportunistic infections, etc., these events may occur far into the future. Hence, CEI help to bring the benefits much closer to the present, and make specific costs (i.e., losing incentives) more salient (27).

Based on the general economic law of demand, consumers purchase more of any given good or service when the price is lower, other things being equal (28). Under this basic premise, financial incentives effectively decrease the actual cost of adhering to treatment (or alternatively increase the cost of non-adherence) which should be accompanied by an increase in the demand for adherence. This works as a “price effect”: people acquire more of a less costly good (less of a more expensive one). On the other hand, there can be an “income effect” if the incentives are large enough. For people for whom lack of resources is a barrier, additional income may facilitate increased adherence. Other goods (complements and substitutes) can also influence demand. If, for example, patients tend to miss their doses more often when they drink alcohol, tying CEI to medication adherence effectively increases the costs of drinking. So, there might be a decrease in activities complementary to non-adherence, such as drinking. Under this theoretical framework, the underlying notion is to encourage behaviors consistent with full adherence, while discouraging and making more expensive behaviors associated or complementary to non-adherence.

Social and behavioral theoretical perspectives to inform CEI approaches

In this section we introduce relevant theoretical perspectives from the social and behavioral sciences to formulate a critical discussion of the potential limitations of CEI approaches and provide insight into why CEI alone may fail to sustain adherence after the removal of the incentives. Figure 1 presents a comprehensive depiction of multilevel determinants of medication adherence. Highlighted (in white background) are the components reviewed here in greatest depth, namely the economic and psychological influences. The other factors presented are meant to provide a more complete picture of how multilevel forces can impact adherence behaviors and offer insights to extend the analysis beyond the psychological and economic realms.

CEI may be most useful for initially increasing adherence. CEI provide an immediate, perceptible benefit to consistent medication-taking. However, this does not necessarily create a lasting effect after the incentives are removed. CEI essentially ignore the motivational structure underlying choices about taking medications, and artificially overlay an external reward. A theory of health behavior and motivation is required in order to understand how a behavior can become habitual and sustained. Why we as patients would not take a medication that is beneficial to our health seems puzzling also in the context of the health belief model (29), which asserts that taking a health-related action is a function of the perceived threat of the underlying condition, and the perceived benefit of the therapy. Given that untreated HIV is a fatal condition, and that ART is highly effective if used properly, it would seem illogical not to adhere to therapy. Other models of health-related behavior suggest that this highly cognitive and rational approach to decision-making is not what happens in practice.

Self determination theory (SDT) posits that internalized motivation, rather than external incentives, is essential to long-term behavioral regulation (30–32). SDT proposes that people have intrinsic motivation to achieve competence, autonomy and relatedness. Social contexts that support satisfaction of basic needs facilitate growth processes, including internally-motivated behaviors, along with integration of extrinsic factors. If the contexts hinder autonomy, competence, or relatedness they may be linked to poorer motivation, performance, and well-being (33,34). While autonomous extrinsic motivation is based on processes of internalization and integration, intrinsic motivation and integrated internalization may be facilitated by autonomy and supportive social contexts which can promote learning (35). SDT explicitly predicts that contingent incentives may be counterproductive in the long run by undermining internal motivation (33). There are dissenting opinions, however, about this general claim (36–38), and the hypothesis has not been directly tested in the context of ART adherence.

Motivational interviewing (MI) is a counseling method that is conceptualized and informed by SDT. MI represents a general and practical approach for changing behaviors by enhancing and facilitating a client's own internally motivated change process (39). Responsibility for changing a behavior is assumed to lie within the individual, and ambivalence is recognized as a natural part of this change process. MI is designed to assist clients in working through ambivalence and in moving toward change. MI utilizes specific techniques for providing feedback based on an individual's risk, and self-efficacy using a non-confrontational and empathic therapist style with emphasis on facilitating the individual's consideration of the effects of their behavior on other life areas, and allowance for multiple options for change. MI helps to modify behaviors through a process of internalizing the motivation for change. Long-term adherence in adults has been linked strongly to internal motivation (40,41), and the efficacy of MI in improving short-term ART adherence has also been demonstrated (42). The introduction of MI either contingent with or subsequent to CEI may improve the maintenance of longer-term adherence.

More generally, CEI are weakly associated with social learning theory (43), the theory of reasoned action (44), and the trans-theoretical model of behavior change (45,46). These theories suggest that the assumption in the health belief model, that health-related behavior is a function of an explicit valuation of health outcomes weighed against manifest costs such as out-of-pocket expenses or side effects, is at best an oversimplification. They posit more complex influences such as social group norms, self-image, perceptions by others, and the competing demands of other priorities. CEI approaches, on the other hand, are generally focused on changing individual behaviors apart from the social and economic contexts that shape health behaviors, but they need not be. The community reinforcement approach (CRA) incorporates the social context into operant conditioning models. For example, the CRA has been combined with CEI for the treatment of addictions, particularly cocaine (47). With this approach, substance-free social activities and interactions are used as reinforcements for cessation of substance use. CEI may also include vouchers for social activities, to further use the social context to reinforce high-adherence behavior. Integration of the social context along with CEI may also improve the longevity of adherence behaviors following the removal of incentives.

Many argue that social and economic factors, rather than individual motivation or cognition, are the fundamental determinants of health behaviors (48). This perspective suggests that individuals living in conditions of deprivation have limited agency to adhere due to the constraints of their environment (49). The social environment has also been shown to bolster adherence (50–54) and in conditions of chronic poverty, patients adhered to ART in order to maintain family and friendship roles as sources of social capital (55). The mechanisms for how CEI impacts adherence among people living in conditions of financial poverty are

unknown, but this research suggests that additional financial resources from CEI may increase adherence through improved material conditions and enhanced social capital. This perspective would advocate for long-term use of (at least modest) financial assistance in order to sustain adherence over time.

Several other sociological and psychological theories highlight the mechanisms underlying CEI. Self-efficacy (56) is a psychological construct that may be important to how CEI relate to adherence. Treatment self-efficacy is the patients' perception or belief that they have the skills and ability to adhere to a treatment plan. The information-motivation-behavioral skills (IMB) model incorporates self-efficacy and assumes that well-informed HIV-infected patients with self-efficacy to act and the behavioral skills to adhere will be more likely to do so (57,58). It is unknown how CEI may impact treatment self-efficacy. For some, CEI might be just what is needed for them to experience success taking ART and the associated health benefits such as quick weight gain, reductions in fatigue, and a return to normal life activities. For others who may experience financial gains without concomitant health gains, such as someone who is asymptomatic with high CD4 counts, self-efficacy could remain unchanged. Additional research is needed to understand how CEI impacts self-efficacy of treatment adherence.

Identity theory is another potentially important approach to how people cope with chronic diseases. Sociological studies of how identity is affected by and reformulated in the course of chronic illness emerged, beginning in the early 1980s (59,60), and continued expanding the concept of patient empowerment (61), and identity incorporation in HIV/AIDS (62). In the language of identity theory, the "self" is composed of many identities (63), which correspond to various roles and relationships, (e.g., student, athlete, son, African-American). Some identities are more salient than others, and are more likely to present in various contexts. Within this framework the "self" is relatively stable, but must abandon some identities and incorporate new ones over time. Diagnosis with a chronic disease presents several challenges to identity. It requires new behaviors and activities such as regularly taking medications and seeing specialist physicians. It forces changes in work and life expectancy (64) or other established roles, including sexual and romantic relationships. The diagnosis of HIV-infection also carries stigma and presents problems of concealment or disclosure. Changes in expectation for longevity and future health also may strike at the very heart of the self-system. For many people with HIV, there are additional layers of complexity related to identity, such as substance abuse, criminal justice involvement, mental illness, and sexuality, all of which may need to be confronted in order to successfully manage living with HIV. The interaction of identity and CEI has not been thoroughly studied in the context of ART adherence.

Randomized controlled trials of CEI for ART adherence

We identified four randomized controlled trials of CEI to promote ART adherence, summarized in Table 1. Rigsby et al. (2000) assessed two interventions for improving ART adherence at a Veterans Affairs HIV clinic and a community-based HIV clinical trials site (65). The 55 participants were on stable ART regimens; they were predominantly male (89%) and African American (69%), and had a history of heroin or cocaine use (80%). The intervention consisted of four weekly sessions of either: general guidelines for adherence (control group); cue-dose training consisting of personalized cues for remembering particular dose times and feedback about medication taking using Medication Event Monitoring System (MEMS) pill bottle caps that record time of bottle opening (CD); or cue-dose training combined with cash reinforcement for correctly timed bottle opening (CD +CEI). Potential maximum total earnings were \$280. Medication adherence, according to MEMS, increased significantly during the 4-week training period in the CD+CEI group

compared to the controls, but not in the CD group. In the 8-week follow-up after training and reinforcement were discontinued, adherence in the CD+CEI group returned to baseline levels. The authors concluded that cue-dose training with CEI led to transient improvement in ART adherence, but not to sustained improvement beyond the active intervention period.

Javanbakht et al. (2006) evaluated a program designed to improve ART adherence among patients with poor adherence (66). Ninety HIV-infected patients experiencing treatment failure because of poor adherence were randomly assigned to either: control, or to an adherence case management intervention with contingency management/conditional economic incentives (CEI), which included individualized adherence support. After 48 weeks, more of those in CEI achieved at least a one log-10 drop in viral load compared to those in control (55% vs. 28%). Those in CEI were almost 2.5 times more likely to have a reduction in viral load compared with the control group (odds ratio=2.49). Also, CD4 cell counts were higher in CEI compared to control (209 cells/mm³ vs .150 cells/mm³). The authors conclude that individualized adherence intervention with CEI is feasible and effective in reducing viral loads and improving immune function. However, there is no report of what happened after the incentives were removed.

Rosen et al. (2007) studied 56 participants with a history of illicit substance use with suboptimal ART adherence (8). Participants were randomly assigned to 16 weeks of either: weekly CEI-based counseling, or supportive counseling. The CEI intervention reviewed MEMS data to electronically check when pill bottles were opened, and included brief substance abuse counseling. CEI participants received incentives based on MEMS-measured adherence with prize drawings from a fishbowl, and bonus drawings for consecutive weeks of perfect adherence. The mean MEMS-measured adherence rate (doses taken/total possible doses) in the CEI group increased significantly from 61% at baseline to 76% during the 16-week treatment phase; while in the control group adherence decreased from 59% to 44%. In addition, the mean log-transformed viral load was significantly lower in the CEI group (2.9 vs. 3.3 in the control group). Nevertheless, in the 16-week follow-up phase, the differences in adherence and viral load were no longer significant.

Sorensen et al. (2007) evaluate a CEI intervention to improve medication adherence among HIV-positive methadone maintenance patients (9). After a 4-week baseline observation phase, 66 participants were randomly assigned to either: medication coaching sessions every other week to assist with adherence strategies (control); medication coaching plus vouchers conditional on opening MEMS caps on time (CEI). At baseline, the adherence rate was 51% using MEMS, 75% using self-report and 75% using pill count. After the 12-week intervention, the mean adherence differences between CEI and control groups were significant using MEMS (78% versus 56%), pill count (86% versus 75%), and self-report (87% versus 69%). However, the differences between the groups faded after CEI were discontinued.

Discussion

The evidence presented in the literature, largely from clinical trials with relatively small sample sizes and short intervention periods, suggests that CEI methods significantly increase ART adherence while incentives are in place, but adherence returns to pre-intervention levels once the incentives are removed. Thus, the major challenge for CEI interventions seems to be how to combine it with approaches that internalize adherence behaviors and promote “maintenance effects” (in psychology) or “habit formation” (in economics). In this review we focused on CEI for the promotion of adopting a new health behavior. CEI are often used to reinforce the cessation of a harmful behavior, such as smoking or alcohol use. One exception in the economics literature is CEI to promote exercise, a behavior which was

actually sustained after CEI were removed (67). The mechanisms for incentives appear to work differently depending on whether they are reinforcing the removal of a detrimental health behavior or the promotion of a healthy behavior; addictions spur complex physiological forces.

A few principles seem to underlie the relatively success of CEI interventions for adherence (7) in the studies reviewed. First, reinforcement seems to work better, at least initially, if it is based on objective measures and is delivered as soon as possible after the target behavior was achieved; thus, for HIV medication adherence, weekly or bi-weekly visits where electronic caps results are reinforced appear ideal, at least in the short run. Second, the appropriate behavior for reinforcement must be targeted. Opening an electronic cap bottle is but one (imperfect) measure of adherence. Taking ART as prescribed is a desirable intermediate step in the ladder of possible outcomes which may include increased CD4 cell counts and suppressed virus. Clinical markers of disease progression, such as viral load, were measured in the studies reviewed but only two of the four studies showed improvements (8,66). On the one hand, this result is troublesome if the reinforced (“intermediate”) behavior changes, but final outcomes do not change. This type of result may point to participants “gaming the system,” inappropriate measurements of final outcomes, or other factors on the pathway between adherence and viral suppression (e.g., resistance) having an unmeasured impact. On the other hand, incentivizing viral suppression may be the ideal ultimate goal, but it may occur at the expense of rapidly linking reinforced behaviors (taking the pills) with results: clinical practices may be able to carry out only quarterly viral load testing or monthly at the most. In addition, other factors such as viral resistance may block the impact of ART adherence on viral load measures.

Third, escalating incentive schedules with resets can be effectively implemented for ART adherence (8,9,65); that is, participants receive increasingly greater rewards for achieving the target behavior on a sustained basis. This method rewards those with sustained behavior change, and makes the costs of relapse higher (68). This type of intensive intervention, however, may prove difficult to sustain over longer periods of time. Similarly, vouchers or a token economy system may work as well as cash incentives. To lower programmatic costs, a “fishbowl” lottery system can also be implemented with similar results as more costly reinforcement. Of note, previous studies to incentivize clinic attendance for HIV prevention sessions found that cash worked better than vouchers (69), and similar results were found for STI treatment (70). These results point to the potential usefulness of CEI to help achieve the entire spectrum of activities required in the cascade from HIV testing, to linkage to care and treatment, and then to viral suppression, where “partial credit” is not enough. Nevertheless, CEI alone do not seem sufficient to help individuals internalize the reinforcement for optimal adherence. In the trials reviewed, other strategies were implemented with CEI to decrease barriers to medication adherence, but were not based on any clearly articulated theoretical approach. The additional interventions included: medication counseling or coaching (66), pagers and pill organizers (66), and cue-dose training (65) (Table 1). Case management and substance abuse counseling were employed when barriers to adherence included substance abuse and mental health problems (8). It is then difficult to disentangle the effects of the additional components versus CEI and their impact on adherence, and it is not clear what the standard practice in the clinical management of HIV should include in order to maximize the effectiveness of CEI (71). Hence, a clear articulation of what is the additional treatment administered in conjunction with CEI is necessary in future studies. Only one of the studies reviewed, Rigsby et al. 2000 (65), included the additional components as a separate arm in the randomized controlled trial (72).

None of the trials fully answered the more fundamental questions: “Why do the incentives work?” and “Why do they stop working?” The lack of maintained effects suggests CEI

alone are not sufficient, even with some combination of other interventions to address barriers to adherence (Table 1). Additionally, the length of the reinforcement trials may have been too short (though the trial reported by Javanbakht et al. (2006) lasted one year). Certainly, a graduated approach where CEI are phased out over time, while complementary interventions are increased and also phased out as individuals “graduate” to appropriate sustained adherence may prove useful in future implementation research. Other hypothesis-driven and theory-based approaches are required to test whether coupling CEI with motivational interviewing and comprehensive wrap-around services, or other population-specific interventions, is more effective and longer-lasting than CEI alone. The review of other theoretical approaches and the conceptual framework presented here (Figure 1) suggest that psychosocial interventions that focus on internal motivations for ART adherence may be successful at promoting maintenance of medication-taking over time. Additionally interventions that also incorporate elements of the multilevel influences on behaviors may be most successful at promoting long-term adherence.

A related question is: “For whom do the incentives work best?” The trials reviewed here were conducted among mostly minority populations (e.g., African American and/or Hispanic) with a previous history of illicit drug use, relatively low socio-economic status or outright poverty, and a history of treatment failure or poor adherence. It is perhaps not surprising that these populations did not maintain optimal adherence levels when incentives were removed, as many participants may have other more pressing needs (e.g., housing, food security, mental health co-morbidities, etc.). From this perspective, we also posit a continuum of the motivation to adhere, where on one end are externally motivating factors (“I take my pills because they are paying me to do so”), and on the other there is introjected motivation (“I take my pills because I want to live and be healthy”). Under this continuum, an ideal CEI intervention would initially boost adherence in the externally motivated patients. That is, CEI become an emergency means of saving the most vulnerable, and then other approaches become necessary over time within this group, in order to internalize the need to adhere to ART. This type of psychological classification and highly targeted approach would require improved coordination at the clinical level between mental health/psychological counselors and HIV specialists; a menu approach to individualized services, and the creation of stronger patient-provider bonds.

Given that CEI seem to work effectively for short-term ART adherence, there may still be cases where CEI should be used with caution in selected key populations. The risk of internal motivation being thwarted by external incentives, as posited in self-determination theory, needs to be tested (31), and a sorting mechanism to improve outcomes may be achievable (31,73). The heterogeneity may be explained based on measurable markers: e.g., highly functioning participants of higher socio-economic status may be more likely to be “internally motivated.” So far, no studies have focused on the locus of control and the autonomous treatment regulation characteristics for HIV patients who are less advantaged, and who thus may be more likely to benefit from external incentives. More generally, none of the studies reviewed addressed any of the economic and psychological constructs either as covariates or as moderators of the main CEI effect.

Depending on the levels of HIV prevalence and incidence, and the baseline levels of community viral load and medical treatment compliance, CEI for optimal treatment adherence may be more or less cost effective in comparison to the status quo and when taking into account the potential for HIV infections and treatment costs averted from secondary prevention. The main parameter from the extant literature would be the elasticity of treatment adherence with respect to the CEI; that is, how adherence responds as the CEI changes. A “break even” point may exist within a closed-system, such as Medicaid, where

the initial investments in CEI could in theory be offset by future savings in avoided treatment costs from secondary preventions (74).

Finally, the literature to date has focused on CEI approaches to enhance HIV treatment adherence among people living with HIV in the United States; further research is required to test the feasibility and acceptability of CEI approaches in other settings, particularly in low and middle-income countries.

Conclusion

While CEI are often effective in achieving improvements in HIV treatment adherence, their effects are usually short-lived. In this review, we have summarized various theories from micro- and behavioral-economics to social and clinical psychology that may help us understand how CEI work, and how they might be integrated with theories of health behavior that focus more on internal motivation. Our broader goal is to suggest how economic and behavioral interventions might be optimally combined so that we are better able to predict who needs and will benefit from CEI, and what must be done to increase the chances that beneficial health behaviors do not stop when CEI stop. More research is needed to realize these goals, and to weigh the possibility that for some patients CEI may need to be considered as a long-term solution to achieve the ultimate goal of sustained HIV suppression. In theory, CEI would seem most justified for patients with severe or life-threatening illness, particularly when combined with poverty and/or the lack of social resources and support. CEI might be particularly effective if it were used to engage patients in regular clinical care and link them to other wrap-around services such as counseling and social workers. Theory-driven approaches testing complements to CEI such as motivational interviewing or mediator concepts from self-determination theory may be fruitful avenues of future research that may produce longer-lasting results.

Acknowledgments

We thank Don Operario and Caroline Kuo for helpful discussions; and Gary Rose for comments on an earlier draft. This work was supported in part by the National Institutes of Health/Fogarty International Center (K01-TW008016-04) that provided support for Dr. Galárraga; and also by a training grant from the Agency for Healthcare Research and Quality (1T32HS019657-01) that provided support for Dr. Genberg.

References

1. Hogg RS, Heath KV, Yip B, et al. Improved survival among HIV-infected individuals following initiation of antiretroviral therapy. *JAMA*. 1998; 279(6):450–454. [PubMed: 9466638]
2. Hammer SM, Squires KE, Hughes MD, et al. A controlled trial of two nucleoside analogues plus didanosine in persons with human immunodeficiency virus infection and CD4 cell counts of 200 per cubic millimeter or less. AIDS Clinical Trials Group 320 Study Team. *N Engl J Med*. 1997; 337(11):725–733. [PubMed: 9287227]
3. Hirsch M, Steigbigel R, Staszewski S, et al. A randomized, controlled trial of didanosine, zidovudine, and lamivudine in adults with advanced human immunodeficiency virus type 1 infection and prior antiretroviral therapy. *J Infect Dis*. 1999; 180(3):659–665. [PubMed: 10438352]
4. Bangsberg DR, Perry S, Charlebois ED, et al. Non-adherence to highly active antiretroviral therapy predicts progression to AIDS. *AIDS*. 2001; 15(9):1181–1183. [PubMed: 11416722]
5. Simoni JM, Amico KR, Pearson CR, Malow R. Strategies for promoting adherence to antiretroviral therapy: a review of the literature. *Curr Infect Dis Rep*. 2008; 10(6):515–521. [PubMed: 18945394]
6. Haug NA, Sorensen JL, Gruber VA, Lollo N, Roth G. HAART adherence strategies for methadone clients who are HIV-positive: a treatment manual for implementing contingency management and medication coaching. *Behav Modif*. 2006; 30(6):752–781. [PubMed: 17050764]

7. Haug NA, Sorensen JL. Contingency management interventions for HIV-related behaviors. *Curr HIV/AIDS Rep.* 2006; 3(4):154–159. [PubMed: 17032574]
8. Rosen MI, Dieckhaus K, McMahon TJ, et al. Improved adherence with contingency management. *AIDS Patient Care and STDs.* 2007; 21(1):30–40. [PubMed: 17263651]
9. Sorensen JL, Haug NA, Delucchi KL, et al. Voucher reinforcement improves medication adherence in HIV-positive methadone patients: a randomized trial. *Drug Alcohol Depend.* 2007; 88(1):54–63. [PubMed: 17056206]
10. Petry NM, Rash CJ, Byrne S, Ashraf S, White WB. Financial reinforcers for improving medication adherence: Findings from a meta-analysis. *Am J Med.* 2012; 125(9):888–896. [PubMed: 22800876]
11. Defulio A, Silverman K. The use of incentives to reinforce medication adherence. *Prev Med.* 2012 Epub ahead of print.
12. Griffith JD, Rowan-Szal GA, Roark RR, Simpson DD. Contingency management in outpatient methadone treatment: a meta-analysis. *Drug Alcohol Depend.* 2000; 58(2-Jan):55–66. [PubMed: 10669055]
13. 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(2):192–203. [PubMed: 16445548]
14. Prendergast M, Podus D, Finney J, Greenwell L, Roll J. Contingency management for treatment of substance use disorders: a meta-analysis. *J Subst Abuse Treat.* 2006; 101(11):1546–1560.
15. Dutra L, Stathopoulou G, Basden SL, Leyro TM, Powers MB, Otto MW. A meta-analytic review of psychosocial interventions for substance use disorders. *Am J Psychiatry.* 2008; 165(2):179–187. [PubMed: 18198270]
16. Contingency management in substance abuse treatment. 1st ed.. New York, Ny: Guilford Press; 2008.
17. Dallery, J.; Meredith, SE.; Budney, AJ. Contingency Management in Substance Abuse Treatment. In: Walters, ST.; Rotgers, F., editors. *Treating Substance Abuse: Theory and technique.* 3rd ed.. New York, NY: Guilford Press; 2012.
18. Giuffrida A, Torgerson DJ. Should we pay the patient? Review of financial incentives to enhance patient compliance. *BMJ.* 1997; 315(7110):703–707. [PubMed: 9314754]
19. Fiszbein, A.; Schady, N.; Ferreira, FHG. Conditional cash transfers: reducing present and future poverty. Washington D.C.: World Bank; 2009. [Chapter 2: Economic Rationale].
20. Loewenstein G, Brennan T, Volpp KG. Asymmetric paternalism to improve health behaviors. *JAMA.* 2007; 298(20):2415–2417. [PubMed: 18042920]
21. Rabin M. Psychology and Economics. *J Economic Literature.* 1998; 36(1):11–46.
22. DellaVigna S. Psychology and Economics: Evidence from the Field. *J Economic Literature.* 2009; 47(2):315–372.
23. Frederick S, Loewenstein G, O'Donoghue T. Time discounting and time preference: A critical review. *J Economic Literature.* 2002; 40(2):351–401.
24. Laibson D. Golden Eggs and Hyperbolic Discounting. *Quarterly J Economics.* 1997; 112(2):443–477.
25. Zimbardo PG, Boyd JN. Putting time in perspective: A valid, reliable individual-differences metric. *Journal of Personality and Social Psychology.* 1999; 77(6):1271–1288.
26. Boyd, JN.; Zimbardo, PG.; Strathman, A.; Joireman, J. Understanding behavior in the context of time: Theory, research, and application. Mahwah, NJ US: Lawrence Erlbaum Associates Publishers; 2005. *Time Perspective, Health, and Risk Taking.*
27. Murphy, JG.; MacKillop, J.; Vuchinich, RE.; Tucker, JA. The behavioral economics of substance abuse. In: Walters, ST.; Rotgers, F., editors. *Treating substance abuse: theory and technique.* 3rd ed.. New York, NY: Guilford Press; 2012.
28. Marshall, A. Principles of economics. London and New York: Macmillan and co; 1890.
29. Strecher, VJ.; Rosenstock, IM. The Health Belief Model. In: Glanz, K.; Lewis, FM., editors. *Health Behavior and Health Education: Theory, Research and Practice.* San Francisco, CA: Jossey-Bass Publishers; 1997.

30. Deci EL, Ryan RM. A motivational approach to self: integration in personality. *Nebr Symp Motiv.* 1990; 38:237–288. [PubMed: 2130258]
31. Deci EL, Koestner R, Ryan RM. A meta-analytic review of experiments examining the effects of extrinsic rewards on intrinsic motivation. *Psychol Bull.* 1999; 125(6):627–668. discussion 692–700. [PubMed: 10589297]
32. Ryan RM, Deci EL. Intrinsic and Extrinsic Motivations: Classic Definitions and New Directions. *Contemp Educ Psychol.* 2000; 25(1):54–67. [PubMed: 10620381]
33. Deci EL, Ryan RM. The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry.* 2000; 11(4):227–268.
34. Deci EL, Ryan RM. Self-Determination Theory: A Macrotheory of Human Motivation, Development, and Health. *Canadian Psychology.* 2008; 49(3):182–185.
35. Rigby CS, Deci EL, Patrick BC, Ryan RM. Beyond the Intrinsic Extrinsic Dichotomy - Self-Determination in Motivation and Learning. *Motivation and Emotion.* 1992; 16(3):165–185.
36. Cameron J. Negative effects of reward on intrinsic motivation - A limited phenomenon: Comment on Deci, Koestner, and Ryan (2001). *Review of Educational Research.* 2001; 71(1):29–42.
37. Cameron J, Banko KM, Pierce WD. Pervasive negative effects of rewards on intrinsic motivation: The myth continues. *Behavior Analyst.* 2001; 24(1):1–44. [PubMed: 22478353]
38. Pierce WD, Cameron J, Banko KM, So S. Positive effects of rewards and performance standards on intrinsic motivation. *The Psychological Record.* 2003; 53:561–579.
39. Miller WR, Rose GS. Toward a theory of motivational interviewing. *American Psychologist.* 2009; 64(6):527–537. [PubMed: 19739882]
40. Williams GC, Rodin GC, Ryan RM, Grolnick WS, Deci EL. Autonomous regulation and long-term medication adherence in adult outpatients. *Health Psychol.* 1998; 17(3):269–276. [PubMed: 9619477]
41. Ryan RM, Deci EL. Self-regulation and the problem of human autonomy: does psychology need choice, self-determination, and will? *Journal of Personality.* 2006; 74(6):1557–1585. [PubMed: 17083658]
42. DiIorio C, McCarty F, Resnicow K, et al. Using motivational interviewing to promote adherence to antiretroviral medications: a randomized controlled study. *AIDS Care.* 2008; 20(3):273–283. [PubMed: 18351473]
43. Bandura, A. *Social learning theory.* Englewood Cliffs, N.J.: Prentice Hall; 1977.
44. Azjen, I.; Fishbein, M. *Understanding attitudes and predicting social behavior.* Englewood Cliffs, NJ: Prentice-Hall; 1980.
45. Prochaska, JO.; Norcross, JC.; DiClemente, CC. *Changing for good: the revolutionary program that explains the six stages of change and teaches you how to free yourself from bad habits.* New York: W. Morrow; 1994.
46. Prochaska, JO.; DiClemente, CC. *The transtheoretical approach: crossing traditional boundaries of therapy.* Homewood, Ill.: Dow Jones-Irwin; 1984.
47. Roozen HG, Boulogne JJ, van Tulder MW, van den Brink W, De Jong CA, Kerkhof AJ. A systematic review of the effectiveness of the community reinforcement approach in alcohol, cocaine and opioid addiction. *Drug Alcohol Depend.* 2004; 74(1):1–13. [PubMed: 15072802]
48. Link BG, Phelan J. Social conditions as fundamental causes of disease. *J Health Soc Behav.* 1995; (Spec No):80–94. [PubMed: 7560851]
49. Farmer P. Social scientists and the new tuberculosis. *Soc Sci Med.* 1997; 44:347–358. [PubMed: 9004369]
50. Simoni JM, Huh D, Frick PA, et al. Peer support and pager messaging to promote antiretroviral modifying therapy in Seattle: a randomized controlled trial. *J Acquir Immune Defic Syndr.* 2009; 52(4):465–473. [PubMed: 19911481]
51. Simoni JM, Frick PA, Huang B. A longitudinal evaluation of a social support model of medication adherence among HIV-positive men and women on antiretroviral therapy. *Health Psychol.* 2006; 25(1):74–81. [PubMed: 16448300]

52. Koenig LJ, Pals SL, Bush T, Pratt Palmore M, Stratford D, Ellerbrock TV. Randomized controlled trial of an intervention to prevent adherence failure among HIV-infected patients initiating antiretroviral therapy. *Health Psychol.* 2008; 27(2):159–169. [PubMed: 18377134]
53. Deering KN, Shannon K, Sinclair H, Parsad D, Gilbert E, Tyndall MW. Piloting a peer-driven intervention model to increase access and adherence to antiretroviral therapy and HIV care among street-entrenched HIV-positive women in Vancouver. *AIDS Patient Care and STDs.* 2009; 23(8): 603–609. [PubMed: 19591602]
54. DiMatteo MR. Social support and patient adherence to medical treatment: a meta-analysis. *Health Psychol.* 2004; 23(2):207–218. [PubMed: 15008666]
55. Ware NC, Idoko J, Kaaya S, et al. Explaining adherence success in sub-Saharan Africa: an ethnographic study. *PLoS Med.* 2009; 6(1):e11. [PubMed: 19175285]
56. Bandura A. Human agency in social cognitive theory. *Am Psychol.* 1989; 44(9):1175–1184. [PubMed: 2782727]
57. Fisher JD, Amico KR, Fisher WA, Harman JJ. The information-motivation-behavioral skills model of antiretroviral adherence and its applications. *Curr HIV/AIDS Rep.* 2008; 5(4):193–203. [PubMed: 18838059]
58. Fisher JD, Fisher WA, Amico KR, Harman JJ. An information-motivation-behavioral skills model of adherence to antiretroviral therapy. *Health Psychol.* 2006; 25(4):462–473. [PubMed: 16846321]
59. Bury M. Chronic illness as biographical disruption. *Sociol Health Illn.* 1982; 4:167–182. [PubMed: 10260456]
60. Charmaz K. Loss of self: a fundamental form of suffering in the chronically ill. *Sociol Health Illn.* 1983; 5:168–195. [PubMed: 10261981]
61. Aujoulat I, Marcolongo R, Bonadiman L, Deccache A. Reconsidering patient empowerment in chronic illness: a critique of models of self-efficacy and bodily control. *Soc Sci Med.* 2008; 66:1228–1239. [PubMed: 18155338]
62. Baumgartner LM. The incorporation of the HIV/AIDS identity into the self over time. *Qual Health Res.* 2007; 17:919–931. [PubMed: 17724104]
63. Serpe RT. Stability and change in self: a structural symbolic interactionist explanation. *Soc Psychol Q.* 1987; 50:44–55.
64. Auld MC. Disentangling the effects of morbidity and life expectancy on labor market outcomes. *Health Econ.* 2002; 11(6):471–483. [PubMed: 12203751]
65. Rigsby MO, Rosen MI, Beauvais JE. Cue-dose training with monetary reinforcement: pilot study of an antiretroviral adherence intervention. *Journal of General Internal Medicine.* 2000; 15(12): 841–847. [PubMed: 11119180]
66. Javanbakht M, Prosser P, Grimes T, Weinstein M, Farthing C. Efficacy of an individualized adherence support program with contingent reinforcement among nonadherent HIV-positive patients: results from a randomized trial. *J Int Phys AIDS Care.* 2006; 5(4):143–150.
67. Charness G, Gneezy U. Incentives to Exercise. *Econometrica.* 2009; 77(3):909–931.
68. Roll JM, Higgins ST, Badger GJ. An experimental comparison of three different schedules of reinforcement of drug abstinence using cigarette smoking as an exemplar. *J Appl Behav Anal.* 1996; 29(4):495–504. quiz 504-5. [PubMed: 8995832]
69. Deren S, Stephens R, Davis WR, Feucht TE, Tortu S. The impact of providing incentives for attendance at AIDS prevention sessions. *Public Health Rep.* 1994; 109(4):548–554. [PubMed: 8041855]
70. Kamb ML, Rhodes F, Hoxworth T, et al. What about money? Effect of small monetary incentives on enrollment, retention, and motivation to change behaviour in an HIV/STD prevention counselling intervention. The Project RESPECT Study Group. *Sex Transm Infect.* 1998; 74(4): 253–255. [PubMed: 9924463]
71. Simoni JM, Amico KR, Smith L, Nelson K. Antiretroviral adherence interventions: translating research findings to the real world clinic. *Curr HIV/AIDS Rep.* 2010; 7(1):44–51. [PubMed: 20425057]
72. McNairy ML, El-Sadr WM. The HIV care continuum: no partial credit given. *AIDS.* 2012; 26(14): 1735–1738. [PubMed: 22614888]

73. Benabou R, Tirole J. Intrinsic and extrinsic motivation. *Review of Economic Studies*. 2003; 70(3): 489–520.
74. Cohen MS, Chen YQ, McCauley M, et al. Prevention of HIV-1 infection with early antiretroviral therapy. *N Engl J Med*. 2011; 365(6):493–505. [PubMed: 21767103]
75. Higgins ST. Comments on contingency management and conditional cash transfers. *Health Econ*. 2010; 19(10):1255–1258. [PubMed: 19670269]

Figure 1. Multilevel conceptual model of the determinants of ART adherence in the context of conditional economic incentives.

Table 1

Summary of reviewed randomized controlled trials of conditional economic incentives to promote ART adherence

Author, Year	Rigsby et al. 2000	Javanbakht et al. 2006	Rosen et al. 2007	Sorensen et al. 2007
Reference	(65)	(66)	(8)	(9)
Population & Setting	N=55 HIV-infected patients from VA HIV clinic and community HIV Clinical trials site in West Haven and Hartford, CT	N=90 HIV-infected patients experiencing treatment failure due to poor adherence, at AIDS Health Care Foundation, Los Angeles, CA	N=56 HIV-infected patients with history of substance use from HIV Clinics in Hartford, CT	N=66 HIV-infected patients enrolled in methadone (MMT) at 2 urban clinics in San Francisco, CA
Eligibility criteria	Prescribed ART, capable of using/understanding MEMS, >22 on Mini-Mental Status exam	Stable ART, HIV-RNA>5000 copies/mL, CD4<200, with no evidence of genotypic drug resistance, repeated noncompliance; attending clinic	Prescribed ART, willing/able to use MEMS, had ever used illicit drug weekly for 1 year, >23 on Mini-Mental Status exam, <80% adherence from BL to 4 wks	Prescribed ART for at least 1 month, enrolled in outpatient MMT, not living in controlled environment, <80% adherence from BL to 4 wks
Study design	1 wk BL, 4 wk randomized intervention, 8 wk F/U	Weekly meetings (intensive) for 3 months, then every 2 wks for 3 months, and once/month for 6 months	4 wk BL, 16 wk randomized intervention, 16 wk F/U	4 wk BL, 12 wk randomized intervention, 4 wk F/U
CEI Incentive	Cash - \$2/dose-\$10/day, plus inconvenience fee	Cash - \$20, plus \$10 inconvenience payment/visit	Voucher - variable (from \$1–100), plus up to \$325 in inconvenience payments	Voucher - starting at \$0.50/opening with increases
CEI Target	Correct dose (+/- 2 hours from agreed upon time)	Decreased (by one log-10) or undetectable HIV-RNA	Correct dose (+/- 3 hours from agreed-upon time)	Correct dose (+/- 2 hours from scheduled time)
CEI other components	Cue-dose training (CD)	Case management; medication boxes and pagers; counseling and education	Weekly counseling w/ MEMS review; MEMS print-out sent to provider; urine toxicology	Medication-coaching at BL/every 2 wks w/ MEMS print-out
Max. potential earning	\$280	\$240	\$800	\$1,172.40
Control group	<u>Control</u> General counseling <u>Cue-dose</u> (CD): same as Control, plus cue-dose training, but without reinforcement	Adherence support, including counseling and educational sessions, medication boxes and pagers.	"Attention control" with same weekly counseling as intervention group; discussion of substance use with referral; MEMS print-out sent to providers	Medication counseling every 2 wks. Fishbowl prize to promote retention in study assessments after initial assessments.
Outcome measured	Adherence: MEMS (% "correct" doses/all doses prescribed)	% w/10-fold (1 log-10) decrease in HIV-RNA	Adherence: MEMS (% doses taken/all doses prescribed)	Adherence: MEMS (% on-time doses/all doses prescribed and longest number of continually adherent days)
Outcome post-intervention	Increased in CD+CEI group (p<0.001). No difference between control & CD group (p=0.79)	Decreased @ 24 (p=0.06) and 48 weeks (p=0.01)	Increased adherence (p=0.01) and reduced HIV-RNA (p=0.02)	On-time doses increased (p<0.05) and longest number of adherent days increased (p<0.05)
Outcome at F/U	Decreased in CD+CEI group from weeks 5–12	N/A	No differences at week 32	No difference at week 16