

General Principles of Contingency Management for Smoking Cessation

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Contingency management (CM) is a psychological treatment based on operant conditioning. It consists of providing incentives in exchange for achieving a target behaviour such as abstinence or other treatment-related variables (e.g. session attendance, adherence to medication). The objective of this article was to introduce the rationale of CM for substance use and, more specifically, for smoking cessation. A growing body of empirical literature supports CM as an effective treatment for quitting smoking both in the general population and among other hard-to-treat smokers (e.g. pregnant women or substance users). Despite this, CM remains the treatment least implemented in clinical settings, fundamentally because of its perceived costs in terms of both economic and non-economic resources. In this review article we describe the general principles of CM, the most recent evidence of its effectiveness for achieving tobacco abstinence, the specific characteristics of tobacco use assessment, and the limitations relative to its implementation, as well as possible solutions to these challenges.

Keywords | Contingency Management – Vouchers – Prize – Smoking Cessation – Substance Use – Behaviour Change

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1 INTRODUCTION

At the end of the 1970s, in the light of the limited results of psychological treatment for substance use the principles of operant conditioning began to be applied in the field of drugs, with substance use being understood as a behaviour maintained by its antecedents (i.e. a discriminative stimulus) and consequences (i.e. reinforcement and punishment), thus emerging as contingency management (CM). Nowadays, there are more than a dozen meta-analyses and systematic reviews that support the effectiveness of CM for the treatment of substance use (Ainscough et al., 2017; Benishek et al., 2014; Davis et al., 2016; Getty et al., 2019; Ginley et al., 2021; Griffith et al., 2000; Hartzler et al., 2012; Lussier et al., 2006; McPherson et al., 2018; Prendergast et al., 2006; Sayegh et al., 2017), including tobacco use (Cahill et al., 2015; Notley et al., 2019; Sigmon & Patrick, 2012).

As mentioned above, CM understands substance use as an operant behaviour which is maintained, and therefore can be modified, through its consequences (Higgins et al., 2008). Specifically, CM consists of providing positive reinforcement contingent on the desired target behaviour, in order to thus reinforce competition with the positive effects related to substance use (e.g. euphoria; Ginley et al., 2021).

There are two CM procedures, each based on the reinforcement programme used. Prize-based CM, also called fishbowl, reinforces the target behaviours with prize draws (i.e. variable-ratio reinforcement), using a low magnitude of reinforcement which does indeed reduce the cost while retaining efficacy. Specifically, reinforcers range from positive messages (e.g. “good job”) to monetary reinforcers (e.g. \$100; Benishek et al., 2014). On the other hand, the procedure that has received more attention is voucher-based CM, which provides tangible incentives such as vouchers, money, gift cards, employment, or clinical privileges, among others (Rash et al., 2020). One of the advantages of vouchers is the possibility of choosing natural reinforcers based on the patient’s preferences (e.g. tickets to the cinema, outdoor activities).

2 GENERAL PRINCIPLES OF CONTINGENCY MANAGEMENT

The general principles of the application of CM are the following: 1) select the target behaviour; 2) monitor the target behaviour frequently; 3) provide the reinforcer contingently and immediately upon the delivery of the target behaviour; and 4) increase the value of the incentive to reinforce continued abstinence and reset the magnitude of the incentives to their initial values after non-compliance with the target behaviour (Higgins et al., 2007; Lussier et al., 2006; Pfund et al., 2021; Rash & DePhilippis, 2019). Each of these general principles is introduced in more detail below.

2.1 Selecting the target behaviour

It is crucial that the behaviour that we want to modify is observable and quantifiable. The target behaviour could be smoking abstinence, tobacco use reduction, or other treatment-related variables, such as session attendance, treatment retention, medication adherence, or the completion of required tasks. Although reinforcing treatment attendance has evidenced a positive impact on abstinence, the most effective way to achieve abstinence is to directly reinforce smoking abstinence or reduction (Pfund et al., 2022).

2.2 Monitoring the target behaviour

Monitoring the target behaviour, either consumption or other relevant variables, is essential in CM programmes, given that the therapists should guarantee that the behaviour has taken place. The monitoring is conducted through biochemical analysis or supporting documents.

In the case of tobacco, there are several specific characteristics related to monitoring smoking that must be taken into account. Tobacco use could be biochemically assessed through carbon monoxide by a smokerlyzer, and cotinine (i.e. the main metabolite of nicotine) in different fluids (i.e. blood, urine, saliva).

The most widespread measure is through testing for carbon monoxide, since the smokerlyzer is portable, is a non-invasive measure, and its cost is relatively low. However, the half-life of carbon monoxide in expired air is relatively short (i.e. eight hours), so tobacco use needs to be evaluated very frequently. Further, there is no agreement on the cut-off level to consider abstinence as having been achieved; while some studies recommend 4 ppm (Benowitz et al., 2020), many clinical trials use 8 or 10 ppm. Another important limitation of carbon monoxide is the incapability of detecting electronic cigarette use or other smokeless tobacco (e.g. snus or nicotine pouches). In order to overcome this limitation, more and more studies also include the evaluation of cotinine, whose half-life is around 48 hours. However, the costs related to biochemical cotinine analysis are very elevated, especially when it is evaluated quantitatively. The scientific literature recommends the combination of these two measures, given that cotinine presents better sensitivity and specificity values and carbon monoxide is very sensitive to tobacco-related variables (e.g. when the last cigarette was smoked, how many cigarettes have been smoked today).

2.3 Providing the reinforcers

Following the operant conditioning principles, incentives should be provided contingently and immediately upon the delivery of the target behaviour, given that the more immediately after the delivery of the target behaviour the application of a reinforcer takes place, the greater the effect that it has. This points out the importance of providing incentives for as long as tobacco use is evaluated (Rash et al., 2020).

Additionally, incentives should have sufficient magnitude to be able to compete with the positive consequences of tobacco use. Reinforcement magnitude refers to the total amount that the person could obtain. Previous studies have concluded that a higher magnitude yields a greater likelihood of tobacco abstinence (Higgins et al., 2007; Packer et al., 2012). However, recent studies have pointed out that there is a ceiling effect, that is, amounts higher than \$300 are similar to providing \$900 (Breen et al., 2020; Petry et al., 2015).

2.4 Increasing and resetting the value of the incentives

In addition to the magnitude of the reinforcers, it is also important to increase the value of the vouchers in order to reinforce continuous abstinence. For instance, if a person receives \$10 for the first negative analysis, for the next negative analysis the value increases by \$5, so that they receive a total of \$25, and thus consecutively. Adding extra bonuses for maintaining continued abstinence (e.g. \$10 for every two negative tests) has been shown to have a positive impact on abstinence (Businelle et al., 2009).

It should be noted that when the target behaviour is not achieved, the reinforcer must be withdrawn. Also, for the next negative result, instead of the person receiving the amount corresponding to the session, the value of the incentive is reset. *Table 1* displays an example of voucher-based CM.

Table 1 | Example of voucher-based contingency management

| Sessions | Biochemical analysis results | Value of incentives in \$ |
|--------------|------------------------------|---------------------------|
| 1 | Abstinent | 20 |
| 2 | Abstinent | 25 |
| 3 | Abstinent | 30 |
| 4 | Smoker | 0 |
| 5 | Abstinent | 20 |
| 6 | Abstinent | 25 |
| Total | | 120 |

3 EFFECTIVENESS OF CONTINGENCY MANAGEMENT FOR SMOKING CESSATION

CM has shown promising results in terms of abstinence and reduction of tobacco use, as well as session attendance, treatment completion, and adherence to guidelines (Cahill et al., 2015; López-Núñez et al., 2016; Notley et al., 2019; Sigmon & Patrick, 2012). Reinforcing successive approaches to abstinence, that is, a reduction of cotinine levels (known as shaping), has shown the same results as reinforcing abstinence (Secades-Villa et al., 2019).

Concerning the general population, tobacco abstinence rates at a six-month follow-up were set at 10.5%–51.2%, compared to 7.13%–28.6% in the comparison groups (Notley et al., 2019; Secades-Villa et al., 2014), similar to those found with pharmacological treatments (18%–36%; Cahill et al., 2013; Hughes et al., 2014; Stead et al., 2012; U.S. Public Health Service, 2008).

Recently, CM has been implemented in hard-to-treat smokers, such as individuals with depression (González-Roz et al., 2021), people with substance use disorders (Secades-Villa et al., 2020), people with obesity (García-Fernández et al., 2022), and pregnant women (Boyd et al., 2016; Sigmon & Patrick, 2012), among others. Notwithstanding, future large-scale trials are needed to elucidate the long-term effect of CM in these subpopulations, as well as the specific components maintaining the effects (e.g. the magnitude of the incentives, incentives at follow-ups).

4 LIMITATIONS OF CONTINGENCY MANAGEMENT

One of the main reasons why MC is the least implemented treatment in clinical settings is its high perceived cost, although it has been shown to be highly cost-effective (González-Roz et al., 2021; López-Núñez et al., 2016). Notwithstanding this, there are several alternatives for reducing the costs related to CM. One of the strategies is considering non-monetary reinforcement, such as clinical privileges in residential treatment (e.g. choosing the free-time activity, more time for calling), or employment-based reinforcement (Dunn et al., 2015). Other alternatives are the use of a prize-based CM procedure or deposit contracts (Jarvis & Dallery, 2017).

One of the debates that CM has aroused is the maintenance of its effects at follow-ups, once incentives are withdrawn. The findings relative to long-term effects are diverse: whereas some studies point out that the addictive effect is diminished (Benishek et al., 2014; Prendergast et al., 2006; Sayegh et al., 2017), others indicate that the effectiveness is maintained in the long term (Davis et al., 2016; Ginley et al., 2021). This could be accounted for by differences in the CM procedure (i.e. prize-based vs. vouchers), how abstinence has been assessed (e.g. self-report vs. biochemically verified), or by the CM parameters (e.g. reinforcement magnitude).

An additional difficulty is the need to monitor tobacco use frequently. E-health interventions (such as ecological momentary assessment) have tried to solve this issue by providing patients with a personal carbon monoxide measuring device which is directly connected to a personal mobile phone. In this line, tobacco use assessment is not required every day, and furthermore, incentives could be provided to patients immediately (Beckham et al., 2018; Getty et al., 2019; Harvanko et al., 2020).

5 CONCLUSION

The objective of this article was to provide the rationale of using CM for smoking cessation. CM is one of the most cost-effective treatments for smoking cessation, especially when it is combined with other standard treatment methods for smoking cessation, either pharmacological or psychological. However, it remains the smoking cessation treatment that is least implemented in clinical settings, fundamentally because of its perceived costs. There are several sets of guidelines for clinicians that facilitate the implementation of CM in clinical contexts and solve the main doubts relative to its application (Oluwoye et al., 2019; Petry, 2000; Pfund et al., 2021). On the other hand, large-scale studies should be conducted with internet-based CM interventions (such as using a smartphone, wearable devices, or web-based applications) in order to examine the differences compared to other forms of CM (e.g. face-to-face interventions).

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