Brief cognitive-behavioural intervention for cannabis use disorders

Introduction

There is now compelling evidence that frequent cannabis use can lead to dependence syndrome [1]. *Cannabis dependence* is formally defined in the Diagnostic and Statistical Manual (DSM-IV) of the American Psychiatric Association [2] and the International Classification of Diseases (ICD-10) by the World Health Organisation [3]. In addition to dependence, both diagnostic systems provide recognition for problematic cannabis users who do not fulfil the criteria of dependence. These individuals are identified as having *cannabis abuse* (DSM-IV) or *harmful use* (ICD-10). Collectively, cannabis dependence and cannabis abuse are known as *cannabis use disorders*.

These definitions have been applied in population studies to quantify the prevalence of cannabis use disorders [4, 5]. For example, based on DSM-IV criteria, 31.7% (95% CI: 27.7, 35.7) of the Australian adults in 1997 who had used cannabis in the past 12 months fulfilled the criteria of cannabis use disorders [4]. A large proportion of these individuals (66%) had symptoms consistent with a diagnosis of cannabis dependence [4]. Overall, cannabis use disorders afflicted 2.2% (95% CI: 1.8, 2.6) of the general adult Australian population [4].

In recent years, there has been an increase in demand for the treatment services of cannabis use disorders in Australia [6]. Factors that effect this demand include widespread use of cannabis [4, 7, 8] as well as increasing recognition of cannabis use disorders by cannabis users, clinicians and government jurisdictions. To date, psychotherapeutic treatments remain the most commonly used approach to treat cannabis use disorders [9, 10]. Of these, cognitive-behavioural therapy (CBT), delivered either individually or in group, is one of the most frequently employed techniques [9, 10].

A brief, 6-session CBT for cannabis use disorders was proposed and tested for efficacy in a randomised controlled trial (RCT) conducted in Australia by Copeland and colleagues [11]. As part of the “Assessing Cost-Effectiveness in Preventing Non-communicable Disease” (ACE-Prevention) project, an economic evaluation based on the treatment model and efficacy as observed in this trial [11] was conducted.

Method

Using a Markov model that was developed to evaluate the public health consequences of cannabis use [12], this evaluation assessed the cost-effectiveness of a 6-session CBT intervention if it were made available nationally across Australia to individuals afflicted with cannabis use disorders. The costs and benefit were evaluated primarily from a health sector perspective. The method section firstly describes the intervention and then the method for the cost-effectiveness analysis.

Intervention

Recruitment and screening

The RCT conducted by Copeland and colleagues [11] recruited participants by advertisements in newspapers and radio interviews in the state of New South Wales, Australia. A preliminary screening for eligibility was conducted when receiving telephone enquiries. From the 1,075 telephone enquiries received, 510 interested individuals were deemed eligible. Fifty-six percent (285) proceeded to making an appointment. Of these, 229 individuals attended and were confirmed as eligible when assessed against the inclusion/exclusion criteria in a structured clinical interview by a clinical psychologist. The eligibility criteria are listed in Figure 1. Note that meeting DSM-IV criteria for cannabis abuse or dependence was *not* a prerequisite for participation in this trial. Nevertheless, most of the participants recruited in the trial were daily or near-daily users, with 96.4% receiving a DSM-IV diagnosis [11]. All participants received assessment feedback which was summarised in a handout called “Your cannabis use in Profile”.

Description

Eligible participants were randomly allocated to the following groups in the RCT:

(I) an intervention package comprising six, weekly 1-hour individual sessions of motivational interview and standard relapse prevention intervention (6CBT);

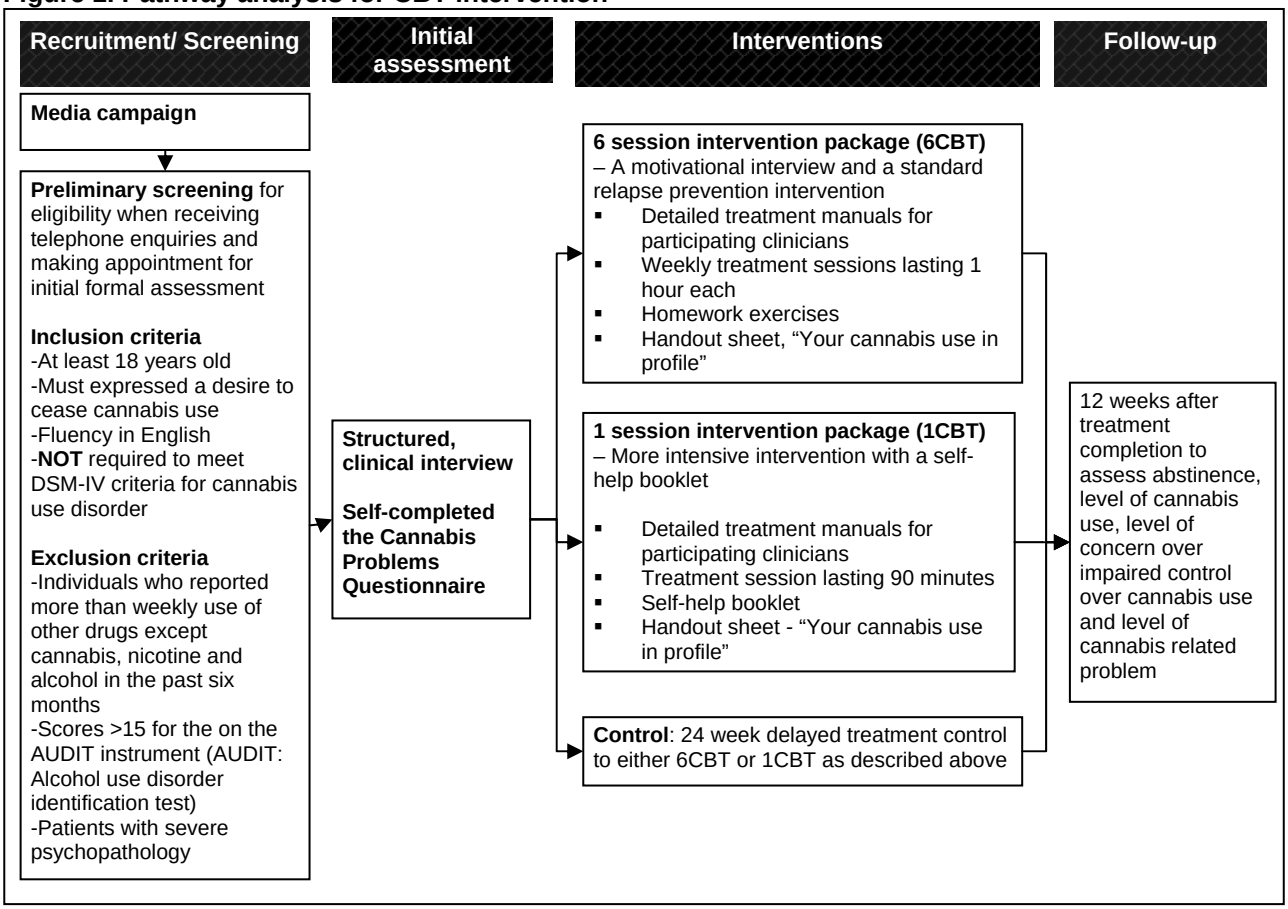
(II) a 90-minute individual session of intensive therapy (1CBT) with a self-help booklet; and

(III) 24-week delayed treatment control group (DTC).

All treatments were provided by registered clinical psychologists who were familiar with CBT techniques. Nonetheless, all participating clinicians in the trial were trained in the intervention, presumably as part of the trial protocol to ensure treatment fidelity. All psychologists received information from a detailed treatment manual.

Participants who received CBT intervention were assisted to develop a set of strategies to manage cannabis withdrawal and to prevent relapse. For the participants allocated to the 6CBT group, homework exercises with accompanying handouts were assigned weekly and were reviewed at the beginning of the next session. The same worksheets were provided for participants receiving 1CBT. Further details on the technical treatment content of the interventions can be obtained elsewhere [11]. It is noteworthy that one literature review regarded the 1CBT group in this RCT as insufficient to be effective [10]. The authors of this review argued that the research findings could only infer that “any engagement with treatment is superior to no engagement, rather than the relative efficacies of varying durations of CBT treatments” (p.336) [10].

Figure 1. Pathway analysis for CBT intervention



Intervention effects

During the follow-up period (median: 237 days, range: 102-553 days), the observed number of participants who achieved continuous abstinence in each allocated group is listed in Table 1.

Table 1. Patterns of continuous abstinence

	6CBT	1CBT	DTC
Continuous abstinence	8	3	0
Remaining as a user	70	79	69
Total	**78**	**82**	**69**

Given the reasoning that 1CBT was too time-limited to be effective [10] and there is no statistical difference between 1CBT and DTC group (p=0.25), this evaluation combined 1CBT with DTC as one control group. Reanalysing using STATA statistical software (version 10.0, StataCorp), the RR of achieving complete abstinence between 6CBT and the control groups was found to be 5.16 (95% CI: 1.614; 16.5, p=0.009).

In the trial, linear regression also found that participants in the 6CBT group had more significant reduction in daily cannabis consumption (Table 2, p.4) than the DTC group (beta=-0.2, t=-2.3, p=0.02). No difference was detected between DTC and 1CBT (p=0.2) [11].

Table 2. Comparison of daily amount of cannabis use in the last month at baseline and follow-up [11]

Treatment group	Baseline mean (SD)*	Follow-up mean (SD)
6CBT	2.2 (0.9)	1.8 (1.0)
1CBT	2.0 (0.8)	1.5 (1.2)
DTC	2.1 (0.8)	1.3 (0.9)

*expressed as a transformation of the raw score: ln(1+ number of water-pipes smoked per day)

Comparator

The incremental cost-effectiveness was calculated by comparing the intervention against 'current practice'. In the reference year of 2003 for this evaluation, there was no systematic delivery of CBT for individuals meeting the criteria for cannabis use disorders. Therefore, the comparator is considered as 'do-nothing', that is, there is no cost or benefit attributed to 'current practice'.

It is noteworthy that in the year 2007, the Commonwealth Department of Health and Ageing established the National Cannabis Prevention and Information Centre (NCPIC) in New South Wales. Many thousands of client booklets and around 100 training workshops on CBT have been delivered from NCPIC [Personal communication with Prof. Jan Copeland]. However, there is currently no published information about whether the delivery of materials and training workshops has led to systematic implementation of the intervention to individuals meeting the criteria.

National implementation

Recruitment and screening

This evaluation assumed that patients are recruited via the same mechanism – paid advertisements and radio interviews. It is anticipated that a total of 16 paid advertisements will be posted for the 8 states and territories in Australia. When estimating the total number of individuals with cannabis use disorders recruited, the same recruitment rates and percentage interested/eligible as observed in the trial were applied as the median rates. The estimate was based on the 2003 adult Australian population aged between 18-64 years of 12,538,200 persons [13] and that 2.2% of the adult population has cannabis use disorders [4].

It was also assumed that interested individuals would call a national toll-free number where trained receptionists applied a preset questionnaire to assess eligibility and refer interested individuals to participating psychologists.

Implementation

Although all three participating psychologists from the original trial were trained in the treatment approach, this evaluation assumed that all registered psychologists would be able to deliver the

intervention according to the treatment manuals provided without receiving further training. This is because CBT technique is one of the core skills learnt during professional training of a clinical psychologist.

Although individuals with drug use disorders can access Medicare subsidy via the Better Access Initiative [14], subsidised psychological service was not available in 2003 – the reference year for this evaluation. Therefore, the intervention was assumed to be delivered through private psychologists. This means that most of the costs are incurred by individuals rather than the government sector.

Analysis

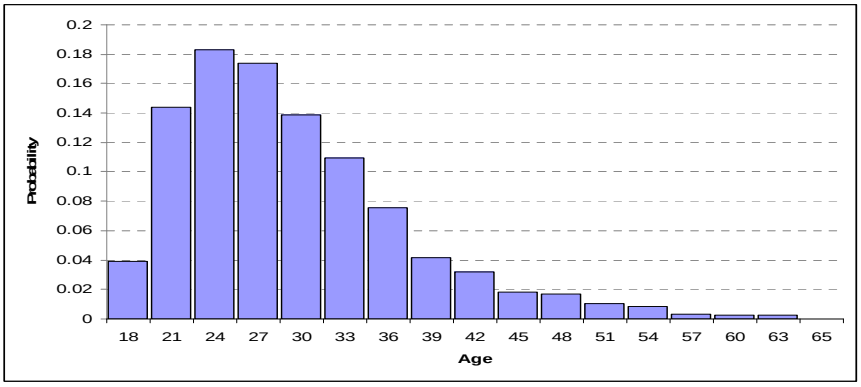
Health benefit

A Markov model was constructed in TreeAge Pro [15] with links to Microsoft Excel to estimate the potential health gain resulting from providing 6 sessions of CBT to individuals with cannabis use disorders across Australia in the 2003 reference year. The structure, input data and the validation of output data for this model were described in another paper [12].

Briefly, a 17-state Markov model was constructed to simulate the initiation of cannabis use, progression in use, reduction and complete remission by annual cycles. The complete matrix of annual transition probabilities between the Markov-states were derived from observations made in a Victorian adolescent cohort [16] and three well-recognised patterns of cannabis use in the population. These observations are that: (I) cannabis use initiation typically occurs after 10 years of age; (II) cannabis use peaks in young adulthood; and (III) cannabis use declines to a negligible level after 65 years of age. Using the derived transition probabilities, the model follows the experience of a simulated cohort, categorizing cannabis use at four levels – non-use, light use, weekly use and daily use. By applying the relative risks according to the extent of cannabis use, the incidence of schizophrenia [17], heroin and poly-drug use (HPU) [18] and road traffic accidents (RTAs) [19] were modelled. Most of the epidemiological inputs for the model were obtained from the Australian Burden of Disease and Injury Study (AusBoD) 2003 [20].

In this evaluation, the model follows the experience of individuals aged between 18 to 64 years, who enter the model as daily cannabis users, until their death or reaching 100 years of age. The age of the daily cannabis users was determined by random selection according to an age probability distribution for daily users (Figure 2). This distribution was constructed based on data from the 2004 National Drug Strategy Household Survey [7]. As observed in the RCT by Copeland and colleagues [11], it was assumed that most daily cannabis users recruited to the intervention have cannabis use disorders.

Figure 2. Age probability distribution for daily cannabis users



The impact of CBT intervention was evaluated by applying a relative risk of 5.16 (95% CI: 1.6; 16.5) to the base-case probability of remission for daily cannabis users. This increased 'risk' in remission was applied for 1 year at the age when they enter the model. The comparator was the scenario under current practice where the relative risk of remission in daily cannabis users was assigned a value of 1. The intervention effect was applied for only 1 year, after which the probability of remission was set to return to that observed in the base case (i.e. RR=1).

The potential health gain was calculated using Disability Adjusted Life-Years (DALYs). The DALY is a composite population health measure that sums the years of life lost due to premature mortality (YLL) and the equivalent 'healthy' years lost due to disability (YLD) [20]. The DALY was selected as the common metric to evaluate health gains in the ACE-Prevention project.

Each Markov state in the model was assigned a disability weight (DW) that estimates the level of disability associated with the specified 'health' characteristics of that Markov state. The YLD was calculated in this model by accruing, cycle by cycle, the disability whenever the simulated individuals 'spent time' in a particular Markov state. The DW used in this model were based on the Dutch weighting system [21]. Where co-morbidities were present in a health state (e.g. health states with schizophrenia and HPU), a validated multiplicative method was used to adjust the DWs [22]. A list of the DWs used can be found in Appendix A. The model also tracked the YLD associated with incidence of non-fatal RTAs. Given that the level of disability of injury resulting from a RTA varies considerably, this evaluation did not estimate the YLDs by applying an average DW value as described above. Instead, age-specific 'incident YLD' due to RTA derived from the AusBoD study was applied to each incident RTA case.

The YLL component of a DALY was calculated in the model by assessing the number of death in each cycle and using the following formula:

$$\text{YLL} = \frac{1 - e^{-D*L}}{D}$$

where D is the annual discount rate (3%) and L is the health-adjusted life expectancy in the Australian population of 2003 at the age of death

Although the RCT found that 6CBT group had a more significant reduction in daily dose of cannabis consumed than the control group, this change did not correspond to a change in the Markov state in the current model i.e. individuals still remained as daily users despite using cannabis at a lesser daily dose. While this reduction may be important clinically in terms of the well-being for individual cannabis users, the corresponding reduction in health risks associated with this level of reduction is currently unknown. Therefore, this evaluation did not account for this observed effect.

Costs

Pathway analysis was conducted based on Figure 1 (p.3) to identify resource use. Table 3 specifies the cost items, unit costs, sources and assumptions for costing. Where applicable, costs were adjusted to real prices in the 2003 reference year using health price index.

Table 3. summary of unit cost information, data sources and assumptions

Costing parameter (Costing unit)	Cost to Government	Cost to individuals	Unit cost sources	Assumption
Paid advertisements in local newspaper	$1250		Nominal cost for ONE paid advertisement	Based on total trial budget of $2500 for advertisement
Time cost for attending a radio interview (hour)	$ 41.38		Australian Public Service Commission (July 2003) www.apsc.gov.au	APSC 6 level 1 salary ($50430 pa.)+ 60% on-costs
Receptionists – screening for eligibility and general administration	$34,971*		http://content.mycareer.com.au/salary-centre/administration-office-support/reception	One full-time administrative officer attributing half-time to this intervention with 60% oncost (based at a National call centre)
Treatment manuals for participating clinicians	$50.00		Nominal cost	-
Initial psychological assessment (hour)		$90.10	Manual of resource items and their associated costs [23]	Initial consultation for 60 minutes
Cost of psychological service - 60 minute session		$ 63.05	Manual of resource items and their associated costs [23]	Subsequent consultation 60 minutes
Time cost for participating subject (hour)		$17.17	Wage rate, gender ratio and workforce statistics from ABS [Ref]	Calculated using method of Jacobs & Fassbender (1998) [24]
Travel cost to access psychological services		$7.05	Vehicle operating costs obtained from RACV [Ref]	Calculated based on $0.55/KM and weighted by approximated travel distance in urban, regional and rural areas
Time cost – Homework exercise (0.5 Hour)		$8.59	Wage rate, gender ratio and workforce statistics from ABS [Ref]	Calculated using method of Jacobs & Fassbender (1998) [24]
Self-help booklet		$15.00	Nominal cost	-
Handout sheets including "Your cannabis use in profile"		$5.00	Nominal cost	-

*Deflated

- Costs included

All costs to the government and individuals seeking treatment were accounted for. These included: (I) the cost of recruitment and preliminary screening for participants; (II) the cost of private psychological services; (III) the cost of CBT manuals for psychologists; (IV) the patient travel cost to attend the treatment session; (V) the cost of booklets and handouts; and (VI) patient time cost to complete the homework exercises and attending the treatment sessions.

- Costs excluded

According to the ACE-Prevention methodology, the intervention was evaluated as operating at a 'steady state' where trained personnel, infrastructure and other resources were assumed to be available for the program implementation. Given this, the evaluation excluded the costs associated with the initial set-up and the development of the treatment manuals and handouts.

- Cost offsets

Cost offsets refer to the anticipated economic costs that would have incurred in the absence of intervention. Consistent with a health sector perspective, this study incorporated the costs of disease treatment when estimating cost-offsets. The figures were derived from the Disease Costs and Impacts Study data by the Australian Institute of Health and Welfare (AIHW) which has been adjusted for 2003 by AIHW. The average cost per prevalent case was derived for each of the modelled consequences (Schizophrenia, RTA and HPU).

In addition, the cost-offsets were also calculated with or without the inclusion of the estimated cost for cannabis and heroin consumption that would have incurred to individual users if the intervention was not implemented. The consumption cost was estimated from the street prices of cannabis and heroin as reported by the Australian Crime Commission [25]. Since the price of cannabis varies by the parts of the cannabis plant and by the total quantity in a single transaction, an average cost of $28 per gram were used to estimate the annual costs of cannabis use. Table 4 outlines the steps in estimating the annual cost of cannabis use.

Table 4. Estimated Annual cost of cannabis consumption for cannabis users

Parameter	Light users	Weekly users	Daily users	Source/assumption
Use frequency (week)	0.1	2	7	Estimated
Nº joint per use	1	2	2	[26]
Nº Joints per year	5	208	728	Calculated
Gram/joint	0.25	0.25	0.25	Estimated
Cost (pa) per cannabis user	**$37**	**$1467**	**$5135**	**Calculated**

For individuals using heroin and poly-drugs, annual per user cost of $26,700 was estimated. The calculation was based on a median price of $54 ($30 to $150) per 150 milligram (one hit) [25] of

heroin, using 1.9 hits per use [8]. This cost was adjusted according to age in order to reflect the different proportions of heroin users in different categories of use frequency at different age [7]. Cost-offsets per case for each health state are listed in Appendix B.

Cost-effectiveness

An incremental cost-effectiveness ratio (ICER) was calculated. This ratio represents the additional cost per additional DALY averted comparing 6CBT to a 'do nothing' alternative. The analysis presented the ICER in three forms: **(I)** without considering the cost-offsets; **(II)** considering the cost-offsets, but *without* the costs of drug consumption by users (CO1) and; **(III)** considering the cost-offsets *with* the costs of drug consumption (CO2).

Uncertainty

Ninety-five percent uncertainty intervals were determined by Monte Carlo simulation with 3000 iterations. Table 5 shows the distributions of uncertainty around input parameters. Based on the result of the uncertainty analysis, an 'acceptability curve' was plotted to evaluate the intervention's probability of being cost-effective against different willingness-to-pay thresholds.

Table 5. Distributions of uncertainty around input parameters

Parameter	Distribution	Median (Uncertainty Range)	Sources
% Dependent cannabis users aged 18 – 64 years in the general population	Normal	0.022, s.e =0.002	Swift and colleagues [4]
N^{o} Paid advertisements in local newspaper	Triangular*	16 (8,24)	Estimated
% Respond to recruitment campaign	Uniform[§]	0.036 (0.036, 0.18)	Calculated based on estimated total daily cannabis users in NSW
% Eligible persons following preliminary screening	Triangular	0.474 ± 0.2	Trial based point estimate [11]
% Attended first appointment	Triangular	0.467± 0.2	Trial based point estimate [11]
% Eligible for the intervention	Triangular	0.962 ± 0.2	Trial based point estimate [11]
N^{o} CBT session attended patient for 6CBT arm	Discreet	0 session: 9.0% 1 session: 7.6% 2 sessions: 9.0% 3 sessions: 7.7% 4 sessions: 7.7% 5 sessions: 9.0% 6 sessions: 50%	Copeland and colleagues [11]
Paid advertisement rate	Triangular	$1250 ± 20%	Estimated based on total budget for advertisement in the trial
Receptionists salary	Triangular	$34,971 ± 20%	[Ref] Estimated
Treatment manuals	Triangular	$50 ($40, $60)	Estimated
Cost of Initial psychological assessment (hour)	Triangular	$63.05 ± 20%	[23] and Protocol
Cost of psychological service - 60 minute session	Triangular	$90.10 ± 20%	[23] and Protocol

*In a triangular distribution, the greatest probability of being chosen is the value representing the top of the triangle (i.e. the most likely value), while the probability of other values being chosen tapers off towards the extremes of the base of the triangle between the minimum and maximum values; [§]Uniform distribution is used equal probability between two values

Results

Based on the estimated recruitment rates, it is anticipated that about 1,970 cannabis users who used cannabis daily will access the CBT service through private psychologists in one year. When compared against a 'do nothing' alternative, the intervention averted 71 DALYs at a total costs of $1.04 million (Table 6). The median health sector cost offsets (CO1) was found to be $0.43M. This estimate increases substantially when consumption costs (CO2) were incorporated ($8.00M).

Despite having a low impact in terms of the number of DALY averted, the intervention is found to be cost-effective because of its relatively low costs. The incremental cost-effectiveness ratio (ICER) was found to be $15,400. When CO1 was incorporated, the ICER reduced to $8,800 per DALY averted. The intervention is a dominant intervention to a 'do nothing' alternative when CO2 was incorporated.

Table 6 Cost-effectiveness results for the Gatehouse intervention in Australia

	Median	**95% uncertainty range**
Number of participants recruited	1,970	670; 4,260
Total DALY averted	**71**	**4; 194**
Total Intervention cost	**$1.04M**	**$0.3M; $2.63M**
Total cost-offsets (without consumption cost) (CO1*)	$0.43M	$0.09M; $1.51M
Total cost-offsets (with consumption cost) (CO2§)	$8.00M	$2.82M; $18.2M
Cost/DALY averted (no CO)	**$15,400**	**$3,300; $63,700**
Cost/DALY averted (with CO1)	$8,800	Dominant; $45,916
Cost/DALY averted (with CO2)	Dominant	Dominant

*CO1 includes medical cost estimates for cases of schizophrenia, road traffic accident and heroin and poly-drug use;
§CO2 includes CO1 and consumption costs of cannabis and heroin

The result of uncertainty analysis is illustrated in Figure 3. Monte Carlo simulation has generated point estimates that are mostly located in the North-East (more costly but more effective) and South-East (less costly and more effective) quadrants of the cost-effectiveness plane. There is a very small probability (1.7%) that the intervention is less effective than the current practice. The main factor influencing the uncertainty range was the large 95% confidence interval for the estimated effectiveness. Incorporation of CO2 also introduced considerable uncertainty.

The probability of being cost-effective was determined by assessing the uncertainty estimates against various "willingness-to-pay" thresholds (Figure 4). When assessed against a threshold of $50,000 per DALY averted, approximately 94% of the estimates fall below the threshold. When CO1 and CO2 were incorporated, about 96% and 98% falls below the $50,000 threshold.

Figure 3. Cost-effectiveness of uncertainty analysis

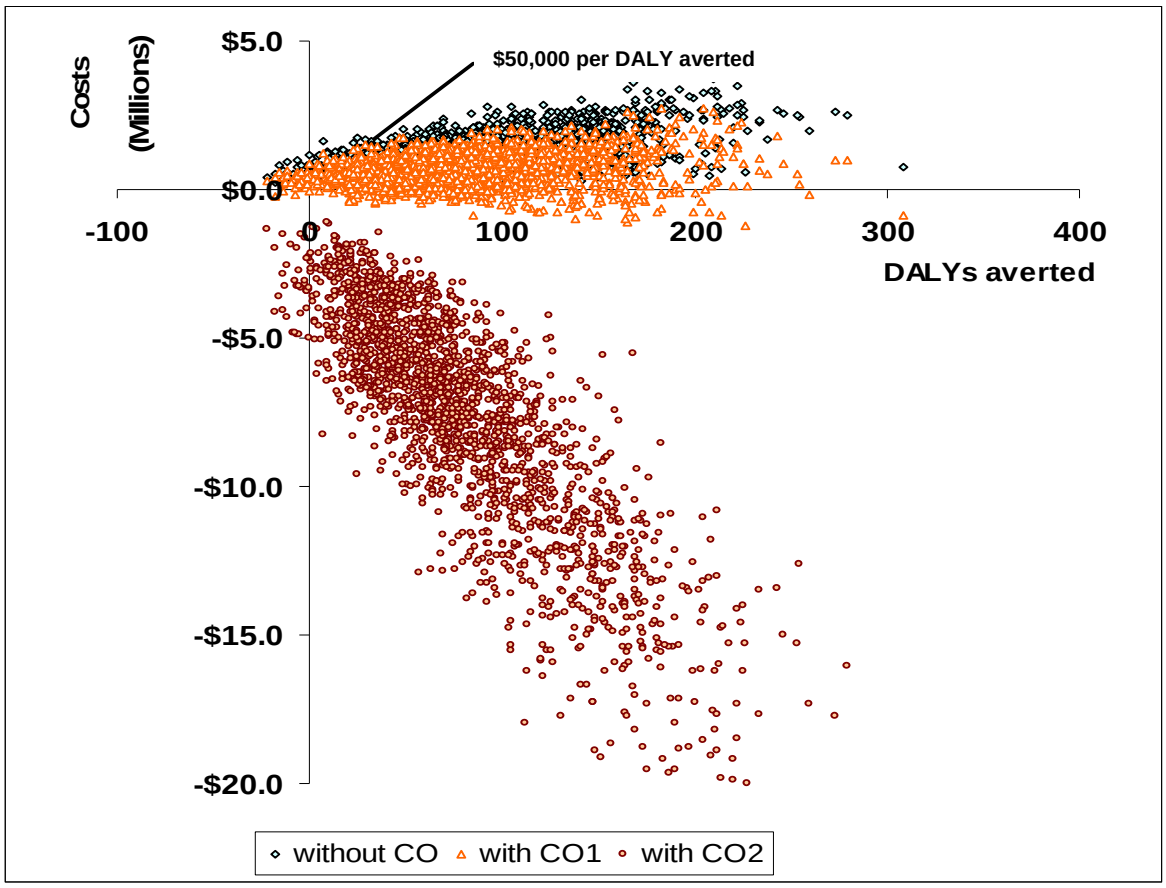
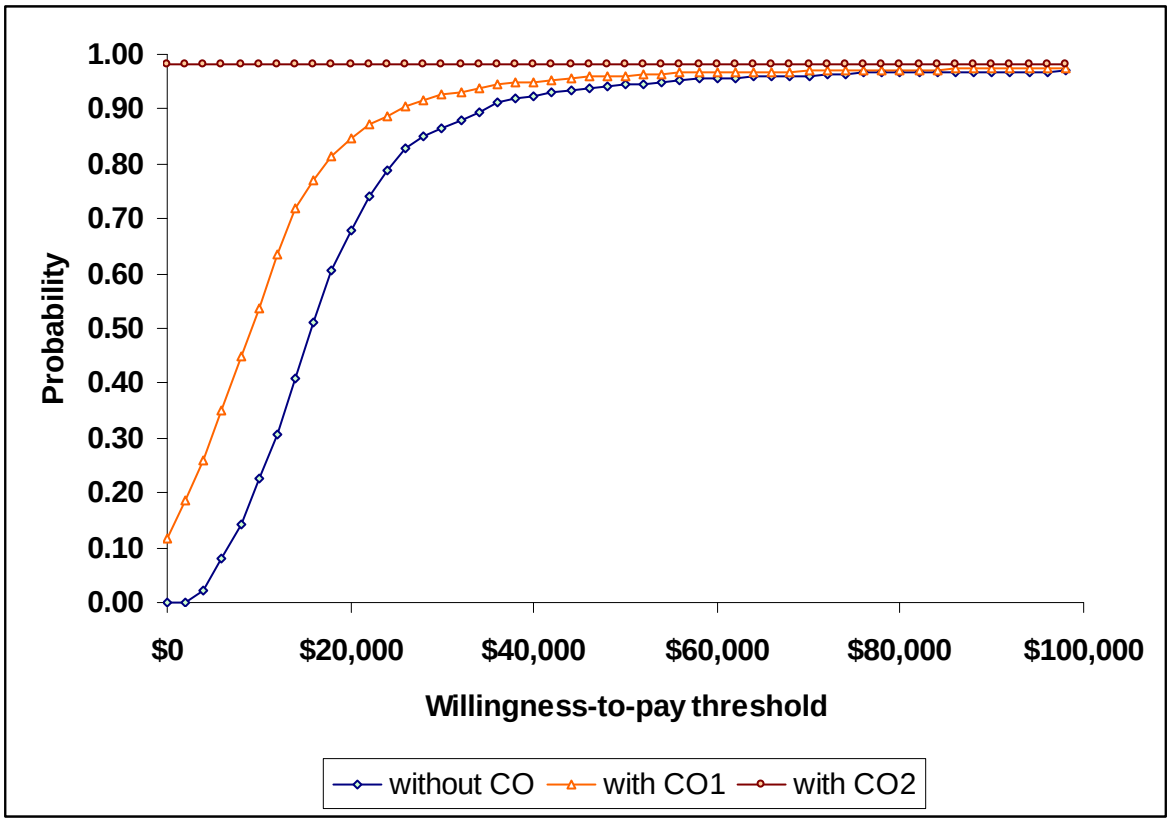


Figure 4. Acceptability curve for CBT intervention



Discussion

This evaluation found that providing 6 sessions of CBT by psychologists to recruited individuals with cannabis use disorders offers, at a population level, a small benefit in terms of DALYs averted. Nevertheless, at relatively low costs, the intervention was found to be cost-effective with more than 94% of the uncertainty estimates falling below a $50,000 per DALY averted willingness-to-pay threshold.

One reason for the relatively low impact of this intervention is because of the small estimated number of participants recruited. In this evaluation, the number of participants was estimated using the same recruitment rates as those observed in the trial i.e. recruiting via paid advertisements and self-referral. Using the same recruitment rates in this evaluation is reasonable because these rates take into account the effectiveness of the recruitment method, as well as individuals' motivational factors when self-referring and attending the treatment service. Given the low budget for advertisements ($2,500) in the trial, it may be speculated that increasing the expenditure in advertising may increase the awareness of treatment availability, and subsequently improves the overall impacts of this intervention. However, a low participation rate may still remain due to the lack of motivation in eligible individuals in seeking treatment.

It is important to note that the recruited trial participants were a group of severely dependent cannabis users for whom a brief CBT treatment is not usually considered as appropriate [11]. It is therefore probable that alternative treatment targets of a younger and less dependent group of cannabis users may offer higher impact from a population perspective.

A limitation of this evaluation is the lack of consideration for those who remain as daily users despite using cannabis at lesser daily dose. Analysis in the original trial indicated a statistically significant effect in daily cannabis consumption and a lower likelihood of self-reported cannabis-related problems in those who received the 6CBT intervention [11]. The evaluation excluded this consideration because it is not known how this reduction may impact on the overall 'disability' of individuals. Indeed, although the trial observed that the intervention group had a significant reduction in scores using the *Severity of Dependence Scale*, the mean score at follow-up for all groups remained above the threshold for dependence [11]. Nevertheless, it is important to recognise that any reduction in use may be an important benefit to *individual users* from both health and economic perspectives.

Another important issue for consideration when implementing this intervention is related to service delivery. It has been noted in the field of alcohol and tobacco secondary prevention that the use of brief interventions has "largely failed" (p. 11) despite a substantial body of research evidence demonstrating their efficacy [27]. Roche and Freeman argued in this article that the key influencing factors hindering the success of brief interventions were the unwillingness of

professionals in up-taking the intervention and the ineffectiveness of service delivery model through general practice [27]. Although the CBT intervention in this evaluation involves psychologists rather than the highly demanded medical service through general practice, ensuring the availability and effective access to treatment service to all clients remains pertinent for the realisation of effectiveness and cost-effectiveness.

In summary, offering effective treatments for individuals with cannabis use disorders is an important policy option. Although the findings indicate that 6 sessions of CBT intervention has a low level of population impact in terms of DALYs averted, this economic evaluation provides evidence for its cost-effectiveness. Benefits to individuals such as reduction in daily cannabis consumption should be considered by clinicians on an individual basis. The CBT intervention may have a greater impact at the population level if effectiveness can be demonstrated amongst younger and less dependent individuals with cannabis use disorders.

References

1. Dennis, M., Babor, T. F., Roebuck, M. C. & Donaldson, J. (2002) Changing the focus: the case for recognizing and treating cannabis use disorders, *Addiction*, 97 Suppl 1, 4-15.

2. American Psychiatric Association (1994) *Diagnostic and Statistical Manual of Mental Disorders, 4th Edition* (Washington, DC., American Psychiatric Association).

3. World Health Organisation (1999) *The International Statistical Classification of Diseases and related Helath Problems. Tenth revisioin (ICD-10)* (Geneva, Switzerland, World Health Organisation).

4. Swift, W., Hall, W. & Teesson, M. (2001) Cannabis use and dependence among Australian adults: results from the National Survey of Mental Health and Wellbeing, *Addiction*, 96, 737-48.

5. Office of Applied Studies (2000) National Household Survey on Drug Abuse: Main Findings 1998 (Rockville, Substance Abuse and Mental Health Administration).

6. Australian Institute of Health and Welfare (2007) Alcohol and other drug treatment services in Australia 2005–06: report on the National Minimum Data Set. *Drug Treatment Series no.7. Cat. no. HSE 53.* (Canberra, AIHW).

7. Australian Institute of Health and Welfare (2005) 2004 National Drug Strategy Household Survey: Detailed Findings. *Drug Statistics Series No.16. AIHW cat. no. PHE 66* (Canberra, AIHW).

8. Australian Institute of Health and Welfare (2008) 2007 National Drug Strategy Household Survey: first results *Drug Statistics Series number 20.Cat. no. PHE 98* (Canberra, AIHW).

9. Denis, C., Lavie, E., Fatseas, M. & Auriacombe, M. (2006) Psychotherapeutic interventions for cannabis abuse and/or dependence in outpatient settings, *Cochrane Database Syst Rev*, 3, CD005336.

10. Nordstrom, B. R. & Levin, F. R. (2007) Treatment of cannabis use disorders: a review of the literature, *Am J Addict*, 16, 331-42.

11. Copeland, J., Swift, W., Roffman, R. & Stephens, R. (2001) A randomized controlled trial of brief cognitive-behavioral interventions for cannabis use disorder, *J Subst Abuse Treat*, 21, 55-64; discussion 65-6.

12. Tay-Teo, K. S., Bulfone, L., Doran, C. & Hall, W. (2008) Modelling the public health consequences of cannabis use in Australia (Working Paper).

13. Australian Bureau of Statistics (2003) 3201.0 - Population by Age and Sex, Australian States and Territories (Canberra, Australian Bureau of Statistics).

14. The Australian Department of Health and Ageing (1 November 2007) Medicare Benefits Schedule Allied Health Services (Canberra, Commonwealth of Australia).

15. Treeage Software (2008) TreeAge Pro 2008 (Williamstown, MA).

16. Coffey, C., Lynskey, M., Wolfe, R. & Patton, G. C. (2000) Initiation and progression of cannabis use in a population-based Australian adolescent longitudinal study, *Addiction*, 95, 1679-90.

17. Semple, D. M., Mcintosh, A. M. & Lawrie, S. M. (2005) Cannabis as a risk factor for psychosis: systematic review, *Journal of Psychopharmacology*, 19, 187-94.

18. Degenhardt, L., Hall, W. & Lynskey, M. (2001) The relationship between cannabis use and other substance use in the general population, *Drug Alcohol Depend*, 64, 319-27.

19. Drummer, O. H., Gerostamoulos, J., Batziris, H., Chu, M., Caplehorn, J., Robertson, M. D. *et al.* (2004) The involvement of drugs in drivers of motor vehicles killed in Australian road traffic crashes, *Accident Analysis & Prevention*, 36, 239-48.

20. Begg, S., Vos, T., Barker, B., Stevenson, C., Stanley, L. & Lopez, A. (2007) The burden of disease and injury in Australia 2003. (PHE 82. Canberra: AIHW).

21. Stouthard, M., Essink-Bot, M., Bonsel, G. & Group., D. D. W. (2000) Disability weights for diseases - A modified protocol and results for a Western European region, *European Journal of Public Health*, 10, 24.

22. Flanagan, W., Mcintosh, C. N., Le Petit, C. & Berthelot, J. M. (2006) Deriving utility scores for co-morbid conditions: a test of the multiplicative model for combining individual condition scores, *Popul Health Metr*, 4, 13.

23. Commonwealth Department of Health and Ageing (2002) Manual of resource items and their associated costs (Canberra, Commonwealth Department of Health and Ageing).

24. Jacobs, P. & Fassbender, K. (1998) The measurement of indirect costs in the health economics evaluation literature. A review, *Int J Technol Assess Health Care*, 14, 799-808.

25. Australian Crime Commission (2005) Illicit Drug Data Report 2003 - 2004 (Canberra, Australian Crime Commission).

26. Reilly, D., Didcott, P., Swift, W. & Hall, W. (1998) Long-term cannabis use: characteristics of users in an Australian rural area, *Addiction*, 93, 837-46.

27. Roche, A. M. & Freeman, T. (2004) Brief interventions: good in theory but weak in practice, *Drug Alcohol Rev*, 23, 11-8.

Appendices

Appendix A – Disability weights for health-states in the cannabis model

Cannabis use level	Non-users				Light users				Weekly users				Daily users				
Comorbidity / Age	Nil^	SZP*	HPU§	SZP + HPU	nil	SZP	HPU	SZP + HPU	nil	SZP	SZP + HPU	SZP + HPU	nil	SZP	HPU	SZP + HPU	Dead
10	0.025	0.423	0.263	0.597	0.025	0.448	0.288	0.597	0.045	0.459	0.303	0.605	0.045	0.459	0.303	0.605	1.000
15	0.032	0.420	0.261	0.600	0.032	0.452	0.293	0.600	0.057	0.466	0.312	0.610	0.057	0.466	0.312	0.610	1.000
20	0.040	0.416	0.259	0.603	0.040	0.456	0.299	0.603	0.065	0.471	0.318	0.614	0.065	0.471	0.318	0.614	1.000
25	0.049	0.413	0.257	0.607	0.049	0.461	0.306	0.607	0.068	0.473	0.320	0.615	0.068	0.473	0.320	0.615	1.000
30	0.053	0.411	0.256	0.609	0.053	0.464	0.309	0.609	0.073	0.475	0.323	0.617	0.073	0.475	0.323	0.617	1.000
35	0.057	0.409	0.255	0.610	0.057	0.466	0.312	0.610	0.070	0.473	0.321	0.615	0.070	0.473	0.321	0.615	1.000
40	0.061	0.407	0.254	0.612	0.061	0.468	0.314	0.612	0.073	0.475	0.323	0.617	0.073	0.475	0.323	0.617	1.000
45	0.074	0.402	0.250	0.617	0.074	0.476	0.324	0.617	0.082	0.480	0.330	0.621	0.082	0.480	0.330	0.621	1.000
50	0.083	0.398	0.248	0.621	0.083	0.481	0.331	0.621	0.091	0.486	0.337	0.624	0.091	0.486	0.337	0.624	1.000
55	0.098	0.391	0.243	0.627	0.098	0.489	0.342	0.627	0.098	0.489	0.342	0.627	0.098	0.489	0.342	0.627	1.000
60	0.117	0.383	0.238	0.635	0.117	0.500	0.356	0.635	0.117	0.500	0.356	0.635	0.117	0.500	0.356	0.635	1.000
65	0.143	0.372	0.231	0.646	0.143	0.515	0.374	0.646	0.143	0.515	0.374	0.646	0.143	0.515	0.374	0.646	1.000
70	0.178	0.356	0.222	0.660	0.178	0.535	0.400	0.660	0.178	0.535	0.400	0.660	0.178	0.535	0.400	0.660	1.000
75	0.231	0.334	0.208	0.682	0.231	0.564	0.438	0.682	0.231	0.564	0.438	0.682	0.231	0.564	0.438	0.682	1.000
80	0.285	0.310	0.193	0.704	0.285	0.595	0.478	0.704	0.285	0.595	0.478	0.704	0.285	0.595	0.478	0.704	1.000
85	0.349	0.282	0.176	0.731	0.349	0.632	0.525	0.731	0.349	0.632	0.525	0.731	0.349	0.632	0.525	0.731	1.000
90	0.393	0.264	0.164	0.749	0.393	0.656	0.557	0.749	0.393	0.656	0.557	0.749	0.393	0.656	0.557	0.749	1.000
95	0.415	0.254	0.158	0.758	0.415	0.669	0.573	0.758	0.415	0.669	0.573	0.758	0.415	0.669	0.573	0.758	1.000
100	0.409	0.257	0.160	0.756	0.409	0.665	0.568	0.756	0.409	0.665	0.568	0.756	0.409	0.665	0.568	0.756	1.000

^ Background disability; *SZP: Schizophrenia; §HPU: Heroin and poly-drug use

Appendix B – Cost-offset estimate (in AUD 2003) for health-states in the cannabis model

Cannabis use level	Non-users				Light users				Weekly users				Daily users			
Comorbidity / Age	Nil	SZP*	HPU§	SZP + HPU	nil	SZP	HPU	SZP + HPU	nil	SZP	SZP + HPU	SZP + HPU	nil	SZP	HPU	SZP + HPU
10	-	17,917	1,172	19,089	37	17,954	1,209	19,126	1,467	19,384	2,639	20,556	5,135	23,052	6,307	24,224
15	-	22,647	2,352	24,999	37	22,683	2,389	25,035	1,467	24,114	3,819	26,466	5,135	27,782	7,487	30,134
20	-	22,647	20,547	43,194	37	22,683	20,584	43,230	1,467	24,114	22,014	44,661	5,135	27,782	25,682	48,329
25	-	14,276	19,660	33,936	37	14,313	19,696	33,972	1,467	15,743	21,127	35,403	5,135	19,411	24,795	39,071
30	-	14,276	21,176	35,452	37	14,313	21,213	35,489	1,467	15,743	22,643	36,919	5,135	19,411	26,311	40,587
35	-	9,928	20,804	30,731	37	9,964	20,840	30,768	1,467	11,395	22,271	32,198	5,135	15,063	25,939	35,866
40	-	9,928	14,384	24,311	37	9,964	14,420	24,348	1,467	11,395	15,851	25,778	5,135	15,063	19,519	29,446
45	-	7,944	13,936	21,880	37	7,980	13,973	21,917	1,467	9,411	15,404	23,347	5,135	13,079	19,071	27,015
50	-	7,944	13,936	21,880	37	7,980	13,973	21,917	1,467	9,411	15,404	23,347	5,135	13,079	19,071	27,015
55	-	6,409	13,807	20,216	37	6,446	13,843	20,253	1,467	7,876	15,274	21,683	5,135	11,544	18,942	25,351
60	-	6,409	13,807	20,216	37	6,446	13,843	20,253	1,467	7,876	15,274	21,683	5,135	11,544	18,942	25,351
65	-	10,124	13,765	23,889	37	10,160	13,802	23,926	1,467	11,591	15,233	25,356	5,135	15,259	18,900	29,024
70	-	10,124	13,765	23,889	37	10,160	13,802	23,926	1,467	11,591	15,233	25,356	5,135	15,259	18,900	29,024
75	-	12,008	14,376	26,385	37	12,045	14,413	26,421	1,467	13,476	15,843	27,852	5,135	17,143	19,511	31,520
80	-	12,008	14,376	26,385	37	12,045	14,413	26,421	1,467	13,476	15,843	27,852	5,135	17,143	19,511	31,520
85	-	19,956	15,209	35,165	37	19,992	15,246	35,201	1,467	21,423	16,676	36,632	5,135	25,091	20,344	40,300
90	-	19,956	15,209	35,165	37	19,992	15,246	35,201	1,467	21,423	16,676	36,632	5,135	25,091	20,344	40,300
95	-	19,956	15,209	35,165	37	19,992	15,246	35,201	1,467	21,423	16,676	36,632	5,135	25,091	20,344	40,300
100	-	19,956	15,209	35,165	37	19,992	15,246	35,201	1,467	21,423	16,676	36,632	5,135	25,091	20,344	40,300

*SZP: Schizophrenia; §HPU: Heroin and poly-drug use

Appendix C – Second stage filter criteria – (DRAFT ONLY)

Cost per DALY averted	**Strength of evidence**	**Equity**	**Acceptability**	**Feasibility**	**Sustainability**	**Relevance to indigenous population**	**'Other effects' (not captured in modelling)**
No cost offsets: $15,400 **+ cost offsets CO1*:** $8,800 **+ cost offsets CO2§:** Dominant	"Limited evidence of effectiveness" – The effect is unlikely to be due to chance but the effectiveness was estimated from only one good quality level II study. However, there were several studies with similar but different treatment modalities that have demonstrated the efficacy [9, 10].	Potential to increase inequities if access to intervention is limited by the availability of psychologists in regional and rural areas	Consistent with the national drug strategy – Acceptable to the Government. CBT is a commonly used psychological intervention – Acceptable to the users	Availability of psychologists in regional and rural areas may be a potential issue	Likely to be sustainable once established and implemented	Relevance – high rate of cannabis use in indigenous population. **However**, there is lower availability of services in regional and rural areas	**Positive:** Reduction in cannabis consumption in those who those who remains as daily users May potentially benefit social outcomes such as employment and crime **Negative:**
Decision point: Cost-effective	Appropriate evaluation alongside program implementation	May be an issue if access to the intervention is not evenly distributed	Not likely to be an issue	Workforce may be an issue	Sustainable if implemented	May be an issues in reaching intervention targets in indigenous population	Potentially having positive benefits at individual and social level

Policy Considerations: The implementation of a CBT intervention based on the model proposed by Copeland and colleagues is very likely to be cost-effective even though the overall impact of the intervention is low from a population perspective. However, the effectiveness was estimated from only one good quality level II study. The availability of psychological service in regional and rural area may be an issue in term of feasibility and equity. The intervention may not reach intervention targets in indigenous population.

*CO1 includes medical estimates for cases of schizophrenia, road traffic accident and heroin and poly-drug use;
§CO2 includes CO1 and consumption costs of cannabis and heroin