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Twelve month outcomes of treatment for heroin dependence: Findings from the Australian Treatment Outcome Study (ATOS)

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TWELVE MONTH OUTCOMES OF TREATMENT FOR HEROIN DEPENDENCE: FINDINGS FROM THE AUSTRALIAN TREATMENT OUTCOME STUDY (ATOS)

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ACRONYMS

ASPD:	Anti-Social Personality Disorder
ATOS:	Australian Treatment Outcome Study
BPD:	Borderline Personality Disorder
CIDI:	Composite International Diagnostic Interview
DASC:	Drug and Alcohol Services Council
DATOS:	Drug Abuse Treatment Outcome Study
DTX:	Detoxification
HRBS:	HIV Risk-taking Behaviour Scale
MT:	Maintenance Therapy
NDARC:	National Drug and Alcohol Research Centre
NTORS:	National Treatment Outcome Research Study
OTI:	Opiate Treatment Index
PTSD:	Post-Traumatic Stress Disorder
RR:	Residential Rehabilitation
SF-12:	Short Form-12

EXECUTIVE SUMMARY

INTRODUCTION

Heroin dependence is remarkably persistent and is, in many cases, a lifelong condition, yet the long term outcome following treatment for heroin dependence is rarely studied and has not yet been systematically studied in Australia. Better understanding of the long term outcomes in terms of mortality, drug use patterns, criminality and psychiatric comorbidity has the potential to guide more effective interventions and public health responses both nationally and internationally.

The Australian Treatment Outcome Study (ATOS) is the first large scale longitudinal treatment outcome study of persons with heroin dependence to be conducted in Australia. ATOS is coordinated by the National Drug and Alcohol Research Centre (NDARC), and is conducted in collaboration with the Drug and Alcohol Services Council (DASC) and Turning Point Alcohol and Drug Centre.

The aims of ATOS are:

To describe the characteristics of people seeking treatment for problems associated with heroin use in Australia;

To describe the treatment received; and

To examine treatment outcomes and costs at 3 and 12 months after commencement of treatment.

The current report presents combined 12 month data from New South Wales, South Australia and Victoria.

METHOD

Thirty eight treatment agencies were randomly selected from within the three main treatment modalities (methadone/buprenorphine maintenance therapy - MT; detoxification - DTX; residential rehabilitation - RR). Seven hundred and forty five individuals entering treatment and 80 heroin users not seeking treatment (NT) were recruited into the study and interviewed by trained research staff using a structured questionnaire. A total of 657 individuals were re-interviewed at 12 months, 80% of the original sample. Data was collected on a variety of

domains including: treatment experiences; heroin and other drug use, mental health and criminal activity.

RESULTS

Comparison of ATOS participants interviewed at 12 months and those lost to follow-up

- There were no differences between those re-interviewed and those lost to follow-up in terms of baseline age, gender, treatment history, heroin use, criminal involvement, Major Depression or personality disorders, suggesting the sample re-interviewed is broadly representative of the original cohort.

Treatment exposure among the NT group

- 74% of the NT group had received some form of intervention for their heroin dependence since baseline. However, the important predictor of positive outcomes at 12 months is the extent of treatment exposure in terms of the cumulative number of days spent in treatment over the 12 month follow-up period. The NT group experienced significantly fewer total treatment days than the index treatment groups groups.

Heroin and other drug use

- There were substantial reductions in heroin and other drug use across all three treatment groups. The majority of those who had entered treatment were abstinent from heroin in the month preceding the 12 month follow-up interview (MT 65%, DTX 52%, RR 63%). While there was also an increase in one month abstinence in the non treatment sample, this was considerably less at 25%.

- The reduction in heroin use in the treatment samples was paralleled by reductions in the use of other drugs, suggesting individuals were not substituting heroin use with other drug use to any significant degree.

Criminality

- There was a notable reduction in the proportion of participants committing crime or obtaining their main source of income through crime across the treatment samples.

Injection-related health and risk-taking

- There were improvements in injection-related health across all treatment modalities, but a less marked improvement among the non treatment group.

- There were reductions in injection-related risk taking behaviours across all treatment modalities.

Major Depression

- The prevalence of Major Depression declined across all treatment modalities. The important treatment factor associated with reduced depression was stability of treatment, with fewer treatment episodes over the follow-up period being associated with less likelihood of having Major Depression at 12 months.

CONCLUSION

The high rate of sample retention at 12 months is of an international standard and lends validity to the findings. The study indicates that heroin users can be successfully engaged in longitudinal studies. There were substantial reductions in drug use, risk-taking, crime and injection-related health problems across all treatment groups and less marked reductions among the NT group. Psychopathology was also dramatically reduced among the treatment modalities, while remaining fairly stable among the NT group, perhaps due to their lower baseline levels. The important treatment factors associated with positive outcomes at 12 months were the cumulative number of treatment days experienced over the 12 month follow-up period ('treatment dose') and the number of treatment episodes undertaken in that time ('treatment stability'). Overall, at 12 months the general functioning of all groups had substantially improved since baseline.

1. INTRODUCTION

The estimated national prevalence of heroin dependence in Australia (6.9 per 1000 population aged 15-54 years) is of the same order of magnitude as in Britain and other European societies[1]. More people are treated in Australia for opioid dependence than for any other illicit drug class, with over 30,000 enrolled in methadone maintenance alone[2]. Despite this, there is a lack of consensus on how treatment services should be delivered and whether they are effective in practice.

Heroin dependence is associated with major health risks, and accounts for a significant proportion of the total burden of disease and injury due to illicit drugs in Australia[3]. The harm associated with heroin use includes fatal and non-fatal heroin overdose, blood borne virus transmission, psychopathology, criminality and the effects of associated polydrug use. Mortality among heroin users is high, with annual rates in the order of 1-3%[4,5]. Clearly, the aim of treatment for heroin dependence needs to be broader than the reduction of heroin use. Consequently, studies evaluating the effectiveness of treatment have tended to examine a range of behavioural and psychological outcomes[6-9].

Studies of psychiatric comorbidity among people seeking treatment for heroin dependence have reported that up to 80 percent of treatment seekers have at least one other psychiatric disorder, most commonly mood disorders, anxiety and Anti-Social Personality Disorder (ASPD)[10-12]. In addition, high rates of Post-Traumatic Stress Disorder (PTSD) and borderline personality disorder (BPD) have been reported among dependent heroin users[13,14]. The high prevalence of psychopathology among heroin users has direct implications for treatment outcome and clinical practice. Psychopathology has consistently emerged as a significant predictor of poor treatment outcome[15], and has been associated with higher levels of HIV risk-taking and HIV infection, greater severity of substance use, and higher levels of psychosocial impairment.

The Drug Abuse Treatment Outcome Study (DATOS)[8,16,17] and the National Treatment Outcome Research Study (NTORS)[9,18,19] are among the most widely published and influential longitudinal cohort studies of treatment outcome to date. While DATOS is the third in a series of prospective cohort studies examining treatment outcomes for substance abuse in the United

States, NTORS is the only such study to have been conducted in the United Kingdom. Both studies involved interviewing adults on entry to four different treatment modalities, and re-assessing them on a range of outcome domains several months post treatment entry. Improvements in drug use, and crime were seen across all treatment types[8,18], with NTORS also reporting significant improvements in physical and mental health across all treatment modalities.

While these studies suggest that existing behavioural, psychosocial, and pharmacological treatments can effectively reduce drug use and dependence, in the context of adequate treatment lengths, it is debatable whether the effects observed in these studies would translate to an Australian setting given differences in government policies and health care delivery systems. The United States system of social service provision is considerably more restrictive than the Australian system, with access to benefits being very limited for dependent heroin and other drug users. Treatment provision in both the United Kingdom and the United States is also markedly different from that provided in Australia. Specifically, the British system of methadone prescription is less tightly regulated than in Australia, with methadone and other opiates (including heroin) being prescribed by General Practitioners, with little or no supervision of drug administration[20]. Conversely, the system in the United States is considerably more restrictive, with access to methadone being very limited[21]. The system in Australia appears to lie somewhere between these models in terms of both access to treatment and restrictions placed on those in treatment. Clearly, a longitudinal treatment outcome study conducted in the Australian context was warranted.

The Australian Treatment Outcome Study (ATOS) is the first large scale, longitudinal study of treatment outcome for heroin dependence to be conducted in Australia, and one of the few to be conducted anywhere in the world. The main purpose of ATOS is to examine the effectiveness of treatment for heroin dependence as it is delivered in everyday practice. Heroin users were recruited on entry to treatment, and were re-interviewed at 3 and 12 months post treatment entry. A comparison group of heroin users who were not in treatment on admission to the study were also recruited in order to allow for more confident attribution of outcomes to treatment. The study commenced in February 2001, and an examination of the baseline characteristics of the sample indicated a high level of polydrug use, criminality and psychopathology among Australian entrants to treatment for heroin dependence[22-24]. The current report presents the 12 month findings of the study.

Specifically, the aims of the study are:

1. To describe the characteristics of participants followed up at 12 months;
2. To describe the treatment received for heroin dependence over the 12 month follow-up period;
3. To examine treatment outcomes (drug use, criminality, physical and mental health) 12 months after commencement of treatment.

2. METHODS

2.1 The ATOS sample

Baseline data were collected between February 2001 and August 2002. Subjects were recruited from 38 agencies treating heroin dependence in Sydney, Adelaide and Melbourne. These agencies were randomly selected from within treatment modality. They comprised 21 methadone/buprenorphine maintenance (MT) agencies, 17 detoxification (DTX) facilities, and 8 residential rehabilitation units (RR). Eight agencies provided both maintenance and detoxification services. In Sydney, a comparison group of heroin users not currently in or seeking treatment (NT) was also recruited from needle and syringe programs within the same regional health areas from which treatment entrants were recruited.

Eligibility criteria were: i) no treatment for heroin dependence in the preceding month, ii) no imprisonment in the preceding month, iii) aged 18 years or over; iv.) had a good understanding of English, and v) agreed to give contact details for follow-up interviews. The sample consisted of 825 current heroin users: 277 entering maintenance therapy, 288 entering detoxification, 180 entering residential rehabilitation and 80 non-treatment subjects. Subjects were interviewed at baseline, 3 months and 12 months. Participants were paid A$20 for completing each interview in Sydney and Melbourne, and $30 in Adelaide. The baseline interview took up to 90 minutes to complete, with follow-up interviews taking approximately 30 minutes. A brief description of the baseline interview is provided below.

The current report examines drug use, criminality, mental and physical health among the cohort at 12 months.

2.2 Treatment modalities

In Australia methadone/buprenorphine is dispensed through maintenance clinics and general practice settings. MT can be either government or privately funded, and is of unlimited duration. After an initial stabilisation period, some clinics/general practitioners (GPs) arrange for clients to be dosed at pharmacies, while the responsibility for case management resides with the clinic/GP. DTX services are also either government or privately funded, are predominantly medicated, and can be provided on either an inpatient or outpatient basis. The average duration of DTX treatment is approximately 5 to 7 days. RR services are drug free,

inpatient and include relatively short-term (e.g. 1 month), or longer term programs (3-12 months). RR services are geared towards abstinence and tend to focus on self-help.

2.3 Baseline interview

Subjects were administered a structured interview (see Ross et al.[22] for details). Sections addressed demographic characteristics, treatment history**,** drug use history, heroin overdose history, injection-related risk-taking behaviour, injection-related health, general health, criminal activity, current Major Depression, Post Traumatic Stress Disorder, Anti-Social Personality Disorder, Borderline Personality Disorder.

In addition, locator information was collected at baseline to facilitate follow-up. The following information was collected: full legal name, nicknames/street names, other surnames that had been used, current address, name of person whose address this was, participant's phone number/s, where they expect to be living in 12 months time, name of a doctor or community health centre that would know how to reach the participant, the first person they would contact if arrested, where they would go if they could no longer stay at their current address, where messages could be left for them, and the contact details of at least two friends, relatives or associates who could be contacted if needed to assist in locating the participant for follow-up.

2.4 Structured interview at 12 month follow-up

Twelve months after the baseline interview extensive efforts were made to recontact and re-interview all individuals who had participated in the baseline interview. If respondents were no longer at the same address as when they were enrolled in the study or interviewed at three months extensive locator information, including the names and addresses of at least three contact persons such as parents, siblings or best friends (see section above) was available. Multiple efforts were made to contact these persons. Once contacted, the purpose of the ongoing study was (re) explained to study participants and they were invited to participate in the follow-up interview at a time and location of their convenience. Participants received up to A$30 to recompense them for costs associated with participating in the interview.

The 12 month interview was an abbreviated form of the baseline interview and included questioning on the following topics:

2.4.1 Treatment history

Participants were asked how many times they had commenced the various treatment options for heroin dependence, how recently they had attended each type of treatment and the duration of that treatment episode. From this data, the cumulative number days in any treatment over the 12 month follow-up period (*treatment dose*), and the total number of treatment episodes (indicating *treatment stability*) was calculated.

2.4.2 Drug use history

Drug use in the preceding month was assessed using the Opiate Treatment Index (OTI)[25].

2.4.3 Heroin overdose history

Questions regarding lifetime history of non-fatal heroin overdose were based on earlier work conducted by the authors[26].

2.4.4 Injection-related risk-taking behaviour

The injecting sub-scale of the HIV Risk-Taking Behaviour Scale (HRBS), a component of the OTI, was used to measure current injection-related risk behaviour[25].

2.4.5 Injection-related health

The injection-related sub-scale of the OTI health scale was used to assess injection-related health problems[25].

2.4.6 General health

The Short Form-12 (SF-12) was administered to provide a general measure of health status[27]. The SF-12 is a standardised, internationally used instrument. The 12 items on the SF-12 are summarised in two weighted summary scales, and generate a mental health and a physical health score. The SF12 is standardised with a mean score of 50 and a standard deviation of 10. Lower scores are indicative of more severe disability.

2.4.7 Criminal activity

Using the criminality scale of the OTI[25], participants were asked how frequently they had committed any property crime, dealing, fraud and/or violent crime in the preceding month.

2.4.8 Current Major Depression

Past month diagnoses of DSM-IV Major Depression were assessed using the version of the Composite International Diagnostic Interview (CIDI) used in the National Survey of Mental Health and Wellbeing[28].

2.4.9 Locator information

To facilitate extended follow-up (at 24 and 36 months) in New South Wales, the locator information was checked for accuracy and, where appropriate, updated.

2.5 Statistical analyses

Where data were highly skewed medians were reported. Highly skewed continuous data were analysed using the Mann-Whitney *U* statistic. Means were reported for non-skewed data. In order to examine change over time in the major domains of drug use, crime, physical and mental health, a series of linear and logistic regressions were conducted using measures obtained at 12 months as the dependent variables. Age, gender, a baseline measure of the dependent variable, the cumulative number of days in any treatment for heroin dependence over the follow-up period and the total number of treatment episodes over the follow-up period were entered into all regression models. Logistic regressions were conducted to determine factors independently associated with dichotomous variables. Independent predictors of continuous variables were determined using linear regression. All analyses were conducted using SPSS for Windows, version 11.0[29].

3. RESULTS

3.1 Sample characteristics

A total of 657 individuals were re-interviewed at 12 month follow-up, representing 80% of the sample of 825 enrolled in the study at baseline. Follow-up rates for the four index groups were: 82% (MT), 82% (DTX), 78% (RR), 66% (NT).

At baseline, the mean age of the 657 participants was 29.5 yrs (SD 7.9, range 18-56), and 64% were male**.** The sample had completed a mean of 10.1 yrs of school education (SD 1.6, range 2-13), 33% had completed a trade/technical course, and 7% a university degree. Thirty seven percent had a prison history. The main sources of income were: social security allowances (50%), criminal activity (20%), wage/salary (18%).

The mean age of first intoxication was 13.5 years (SD 3.2, range 2-34) and 19.6 years (SD 5.2, range 9-43) for first heroin use. The mean length of heroin use career at baseline was 9.9 years (SD 7.6, range <1-35 years). The median OTI heroin use score was 2.0 (range 0.0 -33.3). The sample had used a mean of 9.2 (SD 1.1, range 2-11) drug classes in their lives, and 4.9 (SD 1.7, range 1-10) in the month preceding interview. Eighty nine percent had been enrolled in treatment for opiate dependence prior to ATOS. The median number of previous treatment episodes was 4 (range 0-218), and 76% of participants reported more than one prior episode.

Twenty eight percent met criteria for current Major Depression, and 40% for a lifetime diagnosis of PTSD. A diagnosis of BPD was received by 45% of the sample, and ASPD by 71%.

Table 1: Baseline sample characteristics

	N=657
Age (mean)	29.5
Male (%)	64
Years of school completed (mean)	10.1
Tertiary education:	
None	60
Trade/Technical	33
University/college	7
Prison history (%)	37
Main source of income in past month:	
Gov't benefit	50
Criminal activity	20
Wage/salary	18
Other	12
Age of first intoxication (mean)	13.5
Age of first heroin use (mean)	19.6
Length of heroin use career (mean)	9.9
Heroin OTI score (median)	2.0
Number of drug classes used (mean):	
Ever	9.2
Past month	4.9
Prior treatment for heroin dependence (%)	89
Psychopathology (%):	
Major Depression	28
PTSD	40
BPD	45
ASPD	71

In order to determine factors associated with cohort retention at 12 months, a logistic regression was conducted. Variables entered into the model included having entered treatment at baseline (yes/no), age, gender, previous treatment history (yes/no), criminally active (yes/no), number of heroin use days in the month preceding baseline interview, Major Depression at baseline, and presence/absence of a personality disorder. The overall model was significant (χ^2_{8df} =15.9, p<.05), and had a good fit (Hosmer-Lemeshow χ^2=5.3, df=8, p=0.73). Participants in the non-treatment group were less likely to be retained than those in the treatment groups (81% v 66%, OR 0.45, 95% CI: 0.27-0.75). No other significant differences were observed, suggesting that the sample re-interviewed at 12 month follow-up was broadly representative of the initial sample of 825 enrolled in ATOS.

3.2 Treatment retention

Table 2 shows continuous retention in the index treatment at 12 months and the percentage of each group (including NT) who were in any treatment at 12 month follow-up. Detoxification programs are generally no longer than 7 to 10 days duration, and RR less than one year, thus only individuals receiving MT were retained in the index treatment at 12 months. The retention in the MT group was 44%.

Table 2 also shows whether subjects were in any form of treatment (not just their index treatment) at 12 months. A large number of MT (80%), DTX (49%) and RR (49%) clients were in some form of treatment at 12 months. Approximately half (47%) of the non-treatment group were also in some form of treatment at 12 month follow-up, most commonly MT.

The median cumulative number of treatment days over the follow-up period for the whole sample was 156: MT 334 days, DTX 78 days, RR 137.5 days, and NT 30 days (Table 2). The NT group spent significantly fewer days in treatment over the follow-up period than each of the index treatment groups: MT (*U*=994.5, p<.001), DTX (*U*=4712.0, p<.01), RR (*U*=2040.5, p<.001). The DTX group had less cumulative treatment exposure than the MT (*U*=5224.5, p<.001) and RR (*U*= 11622.0, p<.001) groups, while the RR group had less treatment exposure than the MT group (*U*=4341.0, p<.001).

Table 2: Treatment involvement at 12 months by index group

	MT (N=227)	DTX (N=236)	RR (N=141)	NT (N=53)	TOTAL (N=657)
Still in index treatment (%)	44	0	0	N/A	16 *
Currently in treatment, but not the index treatment (%)	36	49	49	47	44
Current treatment - includes ongoing index treatment (%):					
None	21	51	51	53	41
Methadone maintenance	60	18	5	30	30
Outpatient detoxification	<1	2	0	0	1
Inpatient detoxification	0	3	1	2	2
Residential rehabilitation	1	5	18	0	6
Buprenorphine maintenance	17	14	8	11	13
Outpatient counselling	<1	6	17	4	6
Naltrexone maintenance	1	1	0	0	1
Naltrexone implant	0	<1	0	0	<1
Median cumulative treatment days since baseline interview	334	78	137.5	30	156

* N=604, excludes NT group

3.4 Treatment experiences during the 12 months

While Table 2 shows the percentage of people in each index group who were in some form of treatment at 12 months, it is also the case that a number of people received additional treatment in the intervening 12 months. Details of all treatment experiences since index treatment are summarized in Table 3. The majority (88%) of those who entered DTX at baseline experienced some additional form of treatment in the intervening 12 months, as did 68% of those entering residential rehabilitation and 47% of those entering MT. Seventy four per cent of those in the non-treatment group also entered some form of treatment in the 12 months between baseline and follow-up interviews.

Table 3: Treatment history between baseline and 12 month follow-up by index group

	MT (N=227)	**DTX (N=236)**	**RR (N=141)**	**NT (N=53)**	**TOTAL (N=657)**
Any intervention since baseline interview (excludes index treatment) (%)	47	88	68	74	69
Median treatment episodes since baseline interview (excludes index treatment)	0.0	2.0	1.0	1.0	1.0

Note: *interventions include: Methadone maintenance, Outpatient detoxification, Inpatient detoxification, Residential rehabilitation, Rapid opiate detoxification using naltrexone, Other maintenance therapy (eg. Buprenorphine), Outpatient counselling, Naltrexone maintenance.*

3.5 Changes in heroin use from baseline to 12 months

There were dramatic changes in heroin use between baseline and 12 months (Table 4). The percentage of participants reporting abstinence from heroin in the preceding month increased markedly in all treatment modalities: from 3% to 65% in the MT group, from 0% to 52% in DTX and from 2% to 63% in RR. There were substantial reductions in the number of heroin use days in the last month in all three treatment groups (Table 4). Heroin had been used on a mean of 2.9 days by the MT group, 6.0 days by the DTX group and 4.1 days by the RR group. There was a smaller decline amongst the NT group, who had used on a mean of 10.3 days. None of these subjects reported abstinence in the past month at baseline (a function of the NT inclusion/exclusion criteria in the study), while 25% reported past month abstinence at 12 month follow-up.

Changes in the heroin abstinence rates were paralleled by a reduction in median heroin OTI scores from baseline to 12 month follow-up. Substantial reductions were noted among the MT (1.5 vs 0.0), DTX (2.0 vs 0.0) and RR (1.5 vs 0.0) groups. A less marked reduction in heroin OTI score was evident among the NT group (2.0 vs 0.3).

Participants in NSW and SA were asked about their use of heroin in the 12 month follow-up period (N=570). While the prevalence of heroin use in the preceding month was low among treatment groups, the majority had used heroin within the 12 months: MT (82%), DTX (92%), RR (72%) & NT (100%). Overall, 14% of participants in NSW and SA were abstinent for the entire 12 months, all of whom had entered treatment at baseline.

In order to examine the factors associated with the number of heroin use days in the month preceding the 12 month interview, a linear regression was conducted controlling for age, gender, baseline heroin use, cumulative number of treatment days over the 12 month follow-up period and number of treatment episodes in that time. The model was significant ($F_{5,639}$=12.9, p<.001), and accounted for 9% of the variance. A greater number of baseline heroin use days (β =0.1, t=3.5, p<.001), fewer cumulative number of treatment days (β=-0.2, t=5.7, p<.001) and more treatment episodes over the follow-up period (β=0.1, t=2.7, p<.01) were independently associated with more frequent heroin use at 12 months.

3.6 Changes in other drug use from baseline to 12 months

As shown in Table 4, there were notable reductions in the use of other drugs among all treatment modalities. These changes appeared most evident in the RR treatment group: the use of other opioids by this group declined from 27% at baseline to 9% at follow-up, use of amphetamines fell from 42% to 21%, use of cocaine fell from 28% to 3%; use of benzodiazepines fell from 53% to 18% and use of cannabis fell from 75% to 35%. Among the treatment modalities, the drug classes where there appeared to be little or no changes in levels of use between baseline and 12 months included alcohol and tobacco. While the non-treatment group also showed some reduction in other drug use, this reduction was less marked. In examining the number of drug classes used at 12 months (including heroin), a linear regression was conducted controlling for age, gender, the number of drugs used at baseline, the cumulative number of treatment days and the number of treatment episodes over the 12 month follow-up period. The model was significant ($F_{5,640}$=16.9, p<.001), and accounted for 11% of the variance. A higher level of baseline polydrug use (β=0.3, t=8.0, p<.001), fewer treatment days (β=-0.1, t=2.1, p<.05) and more treatment episodes over the follow-up period

(β=0.1, t=2.3, $p<.05$) were independently associated with using a greater number of drug classes at 12 months. There was no effect of age or gender.

Table 4: Comparison of drug use at baseline and 12 months by index group

	MT (N=227)		DTX (N=236)		RR (N=141)		NT (N=53)		Total (N=657)	
	BL	12 mths	BL	12 mths	BL	12 mths	BL	12 mths	BL	12 mths
Heroin use:										
Median Heroin OTI score	1.5	0	2.0	0	1.5	0	2.0	0.3	2.0	0
Mean number of heroin use days in last month	19.1	2.9	22.8	6.0	17.3	4.1	21.8	10.3	20.3	4.9
Abstinent from heroin in preceding month (%)	3	65	0	52	2	63	0	25	2	57
Other drug use in last month (%):										
Other opiates	37	9	32	16	27	9	36	23	33	13
Amphetamines	27	20	29	20	42	21	43	26	32	21
Cocaine	24	6	34	7	28	3	66	36	32	8
Hallucinogens	4	4	10	7	17	5	19	9	10	6
Benzodiazepines	49	27	55	28	53	18	42	40	51	27
Antidepressants	16	18	12	14	18	18	4	11	14	16
Alcohol	47	52	58	54	57	43	62	55	55	51
Cannabis	71	61	67	48	75	35	70	64	70	51
Inhalants	1	<1	1	1	1	0	4	0	1	1
Tobacco	94	92	94	91	98	94	100	96	95	92
Mean no. of drug classes used last month	4.7	3.2	4.9	3.4	5.1	2.8	5.5	4.4	4.9	3.3

3.7 Heroin overdose

There were notable reductions in rates of non-fatal heroin overdose among treatment modalities (Table 5) with the lowest rate of overdose observed in the MT group. In order to examine overdose experience between the baseline and 12 month interview, a logistic regression was conducted controlling for age, gender, overdose experience in the 12 months preceding baseline interview, cumulative number of treatment days and number of treatment episodes in the 12 month follow-up period. The model was significant (χ^2=125.7, df=5, p<.001), and had a good fit (Hosmer-Lemeshow χ^2=3.5, df=8, p=0.90). The factors associated with overdose at 12 months were having overdosed in the 12 months prior to baseline (OR=6.52, 95% CI: 3.76-11.28), and having more treatment episodes over the follow-up period (OR=1.52, 95% CI: 1.34-1.71).

Table 5: Prevalence of heroin overdose

	MT (N=227)		**DTX (N=236)**		**RR (N=141)**		**NT (N=53)**		**Total (N=657)**	
	BL	12 mth	BL	12 mth	BL	12 mth	BL	12 mth	BL	12 mth
OD past 12 mths (%)	22	4	24	16	38	19	21	15	26	13
OD past mth (%)	5	1	10	2	13	5	4	8	8	3

3.8 General physical health

SF-12 physical health scores had improved slightly across all groups at 12 months, becoming closer to the general population norm than they were at baseline (Table 6). A linear regression examining physical health scores at 12 month follow-up was conducted controlling for age, gender, baseline SF-12 physical health score, cumulative number of treatment days and number of treatment episodes over the 12 month follow-up period. The model was significant ($F_{5,636}$=17.6, p<.001), and accounted for 12% of the variance. Higher baseline SF-12 scores (β=0.3, t=8.1, p<.001) and younger age (β=-0.1, t=2.6, p<.01) were independently associated with higher physical SF-12 score (better health) at 12 month follow-up.

Obvious improvements in injection-related health were seen across all treatment modalities, and to a lesser extent among the NT group. Factors associated with having injection-related health problems in the month preceding the 12 month interview were examined using a logistic regression. The variables entered into the model were age, gender, presence/absence of injection-related health problems at baseline, cumulative number of treatment days and number of treatment episodes over the 12 month follow-up period. The model was significant (χ^2=49.3, df=5, p<.001), and had a good fit (Hosmer-Lemeshow χ^2=3.0, df=8, p=0.93). Injection-related health problems at baseline (OR 2.75, 95% CI: 1.68-4.49), and a greater number of treatment episodes (OR 1.18, 95% CI: 1.09-1.29) were independently associated with injection-related health problems at 12 months.

Table 6: General physical health

	MT (N=227)		**DTX (N=236)**		**RR (N=141)**		**NT (N=53)**		**Total (N=657)**	
	BL	12 mth	BL	12mth	BL	12 mth	BL	12 mth	BL	12 mth
SF-12 Physical health score (mean)	43.6	47.9	42.8	48.3	45.0	51.0	43.8	46.9	43.6	48.7
Injection-related health problems (%)	71	21	74	28	84	28	76	59	75	28

3.9 Risk Taking

All treatment groups showed marked declines in the proportions injecting daily (Table 7). A smaller decline was noted in the NT group, where 36% were still injecting daily at follow-up. There were similar patterns of decline in the borrowing and lending of used needles among the treatment groups.

Factors associated with daily injecting at 12 months were examined using a logistic regression. Variables entered into the model included age, gender, injecting at least daily at baseline (yes/no), the cumulative number of treatment days and the number of treatment episodes over the 12 month follow-up period. The model was significant (χ^2=55.0, df=5, p<.001), and had a good fit (Hosmer-Lemeshow χ^2=8.57, df=8, p=0.38).

Daily or more frequent injecting at baseline (OR 4.3, 95% CI: 1.92-9.62), and more treatment episodes over the follow-up period (OR 1.11, 95% CI: 1.02-1.22) were independently associated with daily or more frequent injecting at 12 months.

Table 7: Needle risk-taking behaviours at baseline and 12 months

	MT (N=227)		DTX (N=236)		RR (N=141)		NT (N=53)		Total (N=657)	
Behaviours/ problems in preceding month	BL %	12mth %	BL %	12mth %	BL %	12mth %	BL %	12mth %	BL %	12 mth
Injecting daily	78	7	84	23	75	15	83	36	80	17
Borrowed needle	14	5	17	5	26	9	21	9	18	6
Lent needle	29	4	27	7	36	8	28	19	30	7

3.10 Mental health

3.10.1 General mental health

All treatment groups showed substantial improvement in mental health between baseline and 12 month follow-up (Table 8). A linear regression examining SF-12 mental health scores at 12 month follow-up was conducted controlling for age, gender, baseline SF-12 mental health score, the cumulative number of treatment days and the number of treatment episodes over the follow-up period. The model was significant ($F_{5,636}$=21.8, p<.001), and accounted for 14% of the variance. Higher baseline SF-12 scores (β=0.3, t=7.0, p<.001), younger age (β=-0.1, t=3.0, p<.005), a greater cumulative number of treatment days (β=0.1, t=2.6, p<.01) and fewer treatment episodes (β=-0.2, t=5.1, p<.001) were independently associated with better mental health at follow-up.

3.10.2 Major Depression

Current Major Depression dropped from 26% to 11% among those entering MT, from 32% to 18% among those entering DTX and from 31% to 13% among those entering RR (Table 8). Current Major Depression remained relatively stable in the non-treatment

group, but it should be acknowledged that they had a lower baseline prevalence (13% at baseline and 15% at 12 months). A similar pattern of results emerged for past month suicidal ideation and attempted suicide. Rates of these behaviours fell dramatically in each of the three treatment groups, but remained relatively stable in the non-treatment group.

Using logistic regression, current Major Depression status at 12 months was examined controlling for age, gender, baseline depression status, cumulative number of treatment days, and number of treatment episodes over the 12 month follow-up period. The model was significant (χ^2=61.0, df=5, p<.001), and had a good fit (Hosmer-Lemeshow (χ^2=3.22, df=8, p=0.92) . Being female (OR 2.37, 95% CI: 1.44-3.90), Major Depression at baseline (OR 3.77, 95% CI: 2.35-6.05), and a greater number of treatment episodes over the follow-up period (OR 1.15, 95% CI: 1.05-1.27) were all independently associated with Major Depression at 12 months.

Table 8: Mental health at baseline and 12 months by index group

	MT (N=227)		DTX (N=236)		RR (N=141)		NT (N=53)		Total (N=657)	
	BL	12 mth	BL	12 mth	BL	12 mth	BL	12 mth	BL	12 mth
Psychopathology:										
SF-12 Mental health component score (mean)	32.3	43.4	31.2	39.8	28.4	40.2	37.7	40.3	31.5	41.2
Current Major Depression (%)	26	11	32	18	31	13	13	15	28	14
Suicidality:										
Thought a lot about committing suicide (%)	22	7	28	11	33	8	9	13	25	9
Made a suicide plan in past month (%)	13	4	21	6	19	6	6	6	17	5
Attempted suicide in preceding month (%)	3	1	8	3	6	1	2	4	5	2

3.11 Criminal activity and other sources of income

In parallel with the reductions in drug use and improvements in mental health, there was a marked reduction in the percentage of respondents who had committed crime in the month preceding interview (Table 9). Specifically, self-reported involvement in any criminal activity in the past month fell from 45% to 19% among the MT group, from 59% to 28% among the DTX group and from 61% to 27% among the RR group. In comparison, there was a less marked drop in crime among the non-treatment group, from 60% to 40%. Property crime (16%) and dealing (11%) remained the most common forms of crime reported by the sample at 12 months.

A logistic regression examining factors associated with criminal activity at 12 months was conducted. Variables entered into the model were age, gender, criminal activity at baseline, the cumulative number of treatment days and number of treatment episodes over the 12 month follow-up period. The model was significant (χ^2=85.8, df=5, p<.001), and had a good fit (Hosmer-Lemeshow χ^2=3.06, df=8, p=0.93) . Having committed crime in the month prior to baseline (OR 3.67, 95% CI: 2.38-5.65) and having a greater number of treatment episodes over the follow-up period (OR 1.18, 95% CI: 1.08-1.29) were independently associated with crime at 12 months. Younger age (OR 0.97, 95% CI: 0.95-1.00) was of marginal significance in predicting crime at 12 months. There was no effect of gender or cumulative treatment days.

Table 9: Criminal activity at baseline and 12 months by index group

	MT (N=227)		**DTX (N=236)**		**RR (N=141)**		**NT (N=53)**		**Total (N=657)**	
	BL	12 mth	BL	12 mth	BL	12 mth	BL	12 mth	BL	12 mth
Any crime in preceding mth (%)	45	19	59	28	61	27	60	40	55	26
Type of crime committed (%):										
Dealing	29	7	39	13	48	11	42	23	27	11
Property	22	14	30	17	27	16	40	25	38	16
Fraud	12	1	16	6	25	7	21	15	17	5
Violent	4	2	11	2	7	1	2	2	7	2

Reductions in self-reported criminal activity were paralleled by reductions in the percentages of respondents who reported criminal activity as their major source of income. Specifically, the percentage of people reporting criminal activity fell from 14% to 1% among the MT group, from 21% to 3% among the DTX group and from 24% to 3% among the RR group. In contrast, the reduction in the percentage of people in the non-treatment group who reported criminal activity as their primary income source was less marked: from 32% to 17%.

4. Discussion

4.1 Major findings

The first major finding of this study concerned the feasibility of conducting longitudinal research with heroin users. The follow-up rate of 80% indicates that such research is highly feasible. The major finding, in terms of outcome, was that there were considerable reductions in heroin use across all three treatment modalities, and a less notable reduction among the NT group. There were also substantial reductions in injection frequency, needle risk-taking behaviours, criminal involvement, injection-related health problems and heroin overdose. There were large declines in levels of Major Depression in all treatment groups, and improvements in general mental health. In contrast, the psychological health of the NT group varied little. Positive outcomes at 12 months tended to be associated with a greater cumulative number of treatment days experienced over the 12 month follow-up period *(treatment dose)*, fewer treatment episodes undertaken in that time *(treatment stability)* and better baseline functioning.

4.2 Sample retention

At 12 months, 80% of those recruited for the ATOS study were successfully located and re-interviewed. This response rate exceeds those of other longitudinal studies of treatment seeking drug use populations conducted overseas[9,30-32], and indicates that, despite the often chaotic lifestyle of people with opioid dependence, it remains feasible to conduct longitudinal studies of treatment outcomes in this group. Importantly, there appeared to be little difference between individuals re-interviewed at 12 months and those lost to follow-up, assessed on baseline characteristics. Most importantly, these two groups did not differ on levels of heroin use at baseline.

4.3 Treatment retention and other treatment experiences

A strength of the ATOS study design was that comprehensive information on treatment experiences between baseline and follow-up was obtained. Among the MT group the rate of treatment retention was moderate, with 44% retained in their index treatment at 12 month follow-up. As expected, given the short term nature of detoxification treatment, no individuals in the DTX group had remained in a single treatment episode for 12 months. Similarly, none of the RR group had been retained for the follow-up period. Nonetheless, many individuals in the treatment modalities subsequently received some

form of treatment: 47% of those entering MT, 88% of those entering DTX and 68% of those entering RR. While 74% of those in the NT group also accessed some form of treatment for heroin dependence during the 12 month follow-up period, it is important to note the limited extent of their treatment exposure. The NT and DTX groups spent significantly fewer days in any treatment for heroin dependence over the follow-up period than participants who had entered long-term treatments (i.e. MT and RR) at baseline. This is relevant given the association between better outcomes and longer cumulative treatment exposure. Nonetheless, it is likely that some of the observed improvements in drug use and other outcomes among NT participants were the result of their access to treatment, albeit limited. Consequently, comparisons between the treatment and non-treatment groups in this study may provide only a conservative estimate of the potential benefits of treatment for heroin dependence.

4.4 Heroin and other drug use

There were dramatic reductions in heroin use amongst the index treatment groups. Both the extent of treatment exposure over the follow-up period and stability of treatment (number of treatment episodes) were important predictors of the level of heroin use at 12 months. An association between multiple treatment enrolments over a 12 month period and poorer outcome has also been reported in the United Kingdom[33]. Past month abstinence rates among the index treatment groups ranged from 52% to 65% at 12 month follow-up, with only 25% of the NT group being abstinent. Similar levels of abstinence at 12 months post treatment entry have been reported internationally[8,34]. Heroin abstinence over the entire ATOS study period was not so common, with a minority of participants in the treatment groups, and none of the NT group achieving continuous abstinence. While ATOS relies on self-report to measure drug use at 12 months, it should be noted that a review of the literature has shown that such self-report among injecting drug users has respectable reliability and validity[35]. Furthermore, hair sampling was conducted among the ATOS cohort at the time of the three month follow-up interview, as a bio-marker for heroin use over the month preceding interview[36]. The analyses revealed a high rate of concordance between self reported heroin use and hair morphine concentrations.

Overall, it appeared that the use of other drugs also declined among the treatment groups, and to a lesser extent among the NT group. There was no evidence to suggest a

process of substitution whereby reduced heroin use was countered by an increase in the use of other drugs such as benzodiazepines. In conjunction with reductions in drug use among these participants, there were substantial reductions in injection frequency, and needle risk-taking behaviours. Heroin overdose also declined markedly, particularly among the index treatment groups, with treatment stability (fewer episodes) associated with reduced risk. Similar treatment outcomes have been reported in the United Kingdom[33,37].

4.5 Mental health

Mental health improved markedly across the treatment groups, but remained relatively unchanged in the NT group. A similar trend towards improvement was seen in relation to current Major Depression. As was the case with heroin use, stability of treatment (i.e. fewer treatment episodes) during the follow-up period was associated with better general mental health, and a reduced likelihood of depression at 12 months. Greater treatment exposure over the study period (i.e. more treatment days) was also an important predictor of better general mental health.

4.6 Physical health

While general physical health appeared to improve across all treatment modalities, treatment related factors such as extent of exposure and stability over the follow-up period were not significantly associated with better health at 12 months. Conversely, a large decline in injection-related health problems was noted across all treatment groups, and better injection related health at 12 months was associated with stability of treatment over the study period. Previous research has shown that the more injection-related health problems IDU experience, the broader the range of injection sites they tend to use [38]. By improving their injection related health, ATOS participants have potentially reduced the likelihood that they will use some of the more risky injection sites such as the hands, feet, groins or neck.

4.7 Criminal activity

There were substantial reductions in criminal activity among the treatment groups between the baseline and 12 month interviews, and a less marked reduction among the NT group. These findings parallel the existing literature showing that successful engagement with treatment services is accompanied by substantial reductions in criminal activity[8]. Such reductions can be considered a major benefit of treatment and are typically

attributed to a reduction in drug use. In the current study, stability of treatment was found to be the treatment factor associated with less criminal involvement at 12 months. Clearly, treatment for heroin dependence has a positive impact that extends beyond reducing heroin use.

4.8 Summary and conclusions

The follow-up rate of 80% at 12 months is of an international standard, and demonstrates that heroin users both in and out of treatment can be engaged in longitudinal studies. ATOS is the first Australian study to have examined medium term treatment outcomes for heroin users. Despite differences in health care delivery systems, the ATOS 12 month findings are remarkably consistent with those reported by treatment outcome studies in the United States[8] and United Kingdom[33,34]. It appears that treatment does work, with impressive reductions seen in drug use, criminality, psychopathology and injection-related health problems across all index treatment groups. There was widespread exposure to other (non-index) treatments across all groups throughout the follow-up period, but the size of the 'treatment dose' (cumulative number of treatment days) was significantly smaller among the NT group. This is an important distinction given that better outcomes tended to be associated with a larger 'treatment dose', and greater 'treatment stability.' Overall, the general functioning of all groups had substantially improved since baseline. ATOS suggests that longer-term retention in fewer treatment episodes substantially improves the health and welfare of heroin users. Importantly, further follow-up of the NSW arm of the ATOS cohort will enable longer term outcomes of treatment for heroin dependence to be examined.

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