Emergency department based intervention with adolescent substance users: 10 year economic and health outcomes

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Abstract (249 words)

Background: Alcohol and other drug (AOD) use is a significant cause of disease burden and costs among adolescents.

Methods: We conducted a randomized trial in hospital emergency departments (ED) following an AOD-related presentation, comparing usual care with brief advice and referral to link adolescents aged 12-19 years with external AOD services. Subsequently, we used health data linkage to assemble data on mortality, hospital admissions, ED attendances, out-patient mental health and use of opiate pharmacotherapies in the next 10 years. From these, treatment costs and rates of events were estimated and compared using generalized linear models.

Results: Those who received the intervention had lower costs ($22 *versus* $227: z=3.16, *p*=0.002) and rates (0.03 versus 0.25: z=2.57, *p*=0.010) of ED mental health AOD presentations. However, the intervention did not significantly reduce overall mean health costs per patient (intervention $58746 *versus* control $64833, *p*=0.800). Similarly, there was no significant difference in the costs associated with hospitalizations ($48920 *versus* $50911 *p*=0.924), overall ED presentations ($4266 *versus* $4150, *p*=0.916), out-patient mental health services ($4494 *versus* $7717, *p*=0.282), or opiate pharmacotherapies ($1013 *versus* $2054, *p*= 0.209). Injecting drug use was a significant baseline predictor of subsequent costs in the cohort (z=2.64, *p*=0.008).

Conclusions: An ED delivered intervention may reduce direct ED costs and subsequent ED AOD attendances. There was also some indication that overall costs may be impacted, with economically large but non-significant differences between the groups. The high costs and morbidity incurred by some of this cohort illustrate the importance of targeting high-risk adolescents.

1. Introduction

Alcohol brief interventions (BI) have been shown to be effective across a range of populations. The most robust evidence for the effectiveness of alcohol BI is among middle aged males receiving interventions from primary care physicians (O'Donnell et al., 2014). In non-treatment seeking populations, the effect of face-to-face BI on alcohol consumption is estimated at $d = 0.26$ at 6-12 months post intervention (Moyer et al., 2002). Alcohol BI have also been evaluated in hospital emergency departments (ED) with typically positive results although questions remain about both the feasibility of delivering interventions under often chaotic conditions, and the receptiveness of the patient with trauma and or intoxication (Nilsen et al., 2008).

There are few data available on the effectiveness of BI among youth in clinical setting, especially for periods greater than 12 months (Wachtel and Staniford, 2010). A review of ED based BI for youth (≤21 years) with alcohol or other drug related harms produced more equivocal results than for adults, with no clear benefit for this type of intervention (Newton et al., 2013). In addition, BI strategies generally exclude those with more severe alcohol problems, with these people referred for more extensive intervention. Nevertheless, a fully integrated package of screening, brief intervention and referral for treatment (SBIRT) can be delivered in hospital settings (Babor et al., 2007). Recent evidence suggests SBIRT interventions are cost-effective in general ED patients (Barbosa et al., 2015) with universal screening for alcohol use by injured patients mandated for level I and II trauma centers in the USA (American College of Surgeons Committee on Trauma, 2014). However, again data on this type of more comprehensive intervention for adolescents are scarce (Mitchell et al., 2013). In addition, the effectiveness of SBIRT in addressing other drug use is in doubt (Bogenschutz et al., 2014).

Notwithstanding the potential benefits of delivering alcohol BI, obstacles remain to their adoption. Hospital EDs are likely to yield a high proportion of people with at-risk alcohol use, but structural and attitudinal impediments have been identified to introducing these as standard practice (Johnson et al., 2011). To overcome these obstacles, it is argued that specifically trained staff should be hired to provide screening and brief intervention given the current workloads in ED (Johnson et al., 2011; Woolard et al., 2011). However, it is important to recognize that even these interventions offer cost benefits to society, the cost of the intervention falls to the health or hospital sector (Irvin et al., 2000) so to encourage their deployment, evidence is also needed showing direct savings to the health or hospital sector.

The current paper reports on the 10-year outcomes arising from an intervention for youth who presented to hospital EDs with a condition relating to AOD. Rather than attempting to deliver a standard BI, the focus was on referral to treatment so the objective was to advise and connect participants to external treatment services. However, it should be noted that most referral to treatment studies have been with those assessed as dependent and there has been little research on the referral to treatment component of SBIRT (Simioni et al., 2015; Substance Abuse and Mental Health Services Administration, 2013). The review by Simioni and colleagues concluded that there was insufficient evidence to clearly support the efficacy of brief advice on referral to off-site treatment (Simioni et al., 2015).

We have previously reported on the research outcomes at four months (Tait et al., 2004) and 12 months for the referral to treatment intervention (Tait et al., 2005). In addition, we have evaluated the impact in terms of the number, and time to event of hospital admissions, and ED presentations over 12 months (Tait and Hulse, 2005). The intervention and control groups had a similar number of events in the 12 month period, but those who were using illicit drugs in the usual care group had markedly greater risk of further hospital events than alcohol users. This difference was not apparent for those in the intervention group (Tait and Hulse, 2005). This paper examines the costs and potential saving in terms of reduced ED costs and overall hospital costs for the 10 years post intervention. An additional objective was to identify predictors of costs to aid in targeting future interventions.

2. Method

2.1 Participants

Between November 1999 and June 2002, 127 adolescents were recruited into a randomized control trial across four public hospitals in in Perth, Western Australia (WA). Eligible participants were aged 12-19 years whose presentation to ED was AOD related. Age criteria and potential AOD presentations were determined in discussion with ED staff. Patients were only approached with the consent of medical staff and written informed consent for the research was obtained from the young person and where appropriate, a parent or guardian. Those randomized to the control group received treatment as usual, typically acute care only, whilst the intervention group had their referral to an external local treatment service facilitated by a research officer. Computer generated randomization codes were held in numbered, sealed envelopes (Tait et al., 2004). We recruited 127 adolescents from the 184 approached, with 67 randomized to treatment as usual and 60 to the intervention.

2.2 Intervention

The aim of the intervention was to facilitate access to an appropriate local treatment service. This typically involved identifying and discussing the negative consequences that the young person had incurred from their drug use, such as the current hospital visit. The research officer ("link worker") also discussed how to reduce the negative consequences of their AOD use and helped the young person identify high-risk or trigger situations for AOD use. The young person was given advice on relevant local treatment services and programs that were available and potential impediments to accessing treatment services were discussed. The "link worker" made an initial appointment with the service. They also made a reminder call prior to the first appointment to encourage the adolescent to attend. The link worker would also accompany the young person if required (Tait et al., 2004). From the intervention group, 28 of 60 received a follow-up contact from the link worker. At 12 months, 12 had accessed an external treatment service, compared with four in the control group (Tait et al., 2005).

2.3 Measures

To compare the costs and potential savings associated with intervention in the 10 years following its delivery, costs were calculated for patients treated in the intervention and control groups. Total costs were comprised of the cost associated with hospital admissions, ED attendances, out-patient mental health events and the use of opioid pharmacotherapies (methadone or buprenorphine). The cost of delivering the intervention was also calculated, and factored into the difference between costs in the two groups.

2.4 Record linkage

Identifying information from the 127 participants was submitted to the WA Data Linkage Unit, where they were probabilistically matched against data from the Hospital Morbidity Data System (HMDS), the Emergency Department Data Collection (EDDC), the Mental Health Information System (MHIS), WA Death Registrations, and the Monitoring of Drugs of Dependence System (MODDS). Data were provided for 10 years post treatment with the exception of data from the EDDC, which only contained data from 2002 onward. To address this, ED data for all patients was collated from 2.5 to 10 years post treatment so that the data were comparable for all participants, regardless of when they were recruited to the study.

The original study received approval from the University of Western Australia human research ethics committee plus the ethics committees for the contributing hospitals. The current study received approval from the University of Western Australia human research ethics committee plus the committee overseeing the WA Data Linkage System.

2.5 Economic analysis

2.5.1 Hospital costs

Australian-refined diagnosis related group (AR-DRG) codes for each admission from the HMDS were matched to national schedules for public hospital costs. Cost weights for AR-DRG versions 5.1, 5.2 and 6.0x were obtained from the National Hospital Cost Data Collection (Department of Health, 2009, 2012). For AR-DRG codes that did not have a published cost weight (not 5.1, 5.2 or 6.0x), a similar code in version 6.0x was used after matching based on the code description. Average length of stay was applied to the published cost per separation to calculate the average cost per bed day for each diagnosis-related group. Bed day costs were then converted to 2014-15 Australian dollars using appropriate health index deflators (Australian Institute of Health and Welfare, 2014b).

The cost of ED presentations was calculated by weighting the average cost per ED event in Western Australia based on Urgency Diagnosis Groups (UDGs) weights (Inter-Government and Funding Strategies Branch, 2011), adjusting for admission to hospital following the ED event.

Costs associated with outpatient mental health events were calculated using the average cost per non-admitted community mental health event (Independent Hospital Pricing Authority, 2014).

Costs associated with the use of methadone and buprenorphine for the treatment of opiate dependence was estimated from best practice treatment guidelines (Community Pharmacotherapy Program, 2014). MODDS data listed months in which the patient received treatment. In calculations of length of treatment, it was assumed that patients received treatment on each day during that month unless missed doses were reported.

The total hospital costs (including those associated with inpatient admissions, ED presentations, mental health outpatient and MODDS data) in the 10 year follow-up period post index admission for the intervention group were compared to the ‘standard care’ group. Average hospital costs were calculated over the intervention and standard care group to produce a mean cost per patient.

2.5.2 Program cost

The difference in resource use between standard care (control) and intervention was retrospectively assessed based on the research protocols outlining the delivery of the intervention and interviews with hospital staff. Members of the alcohol and drug liaison service as well as an on-ward psychiatrist at Sir Charles Gairdner Hospital were consulted to determine the standard clinical care for an adolescent entering ED with AOD related health problems.

The link worker hired to deliver the brief intervention was identified as the main difference in resource use between the two treatment services. The annual salary of a senior social worker employed by the WA Department of Health was used to calculate the average cost to deliver the brief intervention per patient ($55). The total time used by the link worker to deliver the intervention was assumed to be one hour per patient; this included the time spent with the adolescent and / or parents as well as time taken to set up the first meeting with an appropriate external counsellor to initiate treatment and any follow-up calls.

2.6 Analyses

An initial comparison of raw data was conducted using STATA generalized estimating equation (xtgee) models with an exchangeable correlation matrix and a negative binomial distribution. However, health care costs and admission numbers were highly skewed, with a number of excessive outliers in terms of hospital cost, number of hospital admissions and number of out-patient mental health events. To address this issue, the data were winsorized with the outliers set to the value of the 97.5 percentile. In the total costs there were five people (two intervention and three control) with costs exceeding $600000, including one exceeding $2 million. Subsequent analyses were conducted using STATA using generalized linear models with a gamma distribution and log link function for cost data and negative binomial distribution for event data. The cost of the intervention was included in the overall cost analysis but not the sub-analysis.

In addition to all cause hospital and ED attendances, rates of cause specific attendances using assigned ICD-10 codes (World Health Organisation, 1996) were assessed. Specifically the study compared rates of alcohol and other drug poisoning (T36 - 51), mental health disorders associated with substance use (F10-19.9) (termed “mental health AOD”) and non-substance mental health disorders (F00-09.9, F20-99.9) (termed “mental health non-AOD”). Hospital admissions were assigned up to 22 ICD-10 codes, while ED attendances were only assigned a single code.

Baseline characteristics including substance involved in their initial ED attendances and history of substance use, self-harm and injecting drug use were examined as factors affecting subsequent health costs using a univariate and multivariate generalized linear model with a gamma distribution and a log link.

Costs were censored at death or 10-years. We also modeled predicted costs for those who died before 10 years, but this had a trivial impact on the outcomes, so only the main analyses are reported. Return on investment (ROI) for each year period was calculated as the (mean difference between the control group and intervention group in total hospital costs minus the intervention cost) divided by the intervention cost.

3. Results

3.1 Demographics

A total of 127 adolescents (aged 12 – 19, mean 16.7 years, standard deviation 1.8) were recruited and randomized to receive either a brief intervention (n = 60) or treatment as usual (n = 67). The demographics of the two cohorts have previously been described in detail (Tait and Hulse, 2005; Tait et al., 2004). There were 67 (53%) alcohol only presentations, 31 (24%) alcohol plus another drug(s), 28 (22%) illicit ± licit and one missing data. The record linkage process identified 116 of the 127 participants (91.3%). Of the 11 people not linked, 2 were from the intervention and 9 from the control group (Fisher's Exact p=0.058). Descriptive characteristics of the identified 116 people included in the current study are shown in Appendix 1.

3.2 Mortality

Five fatalities were observed in the cohort during the 10 year follow-up, equating to 4.0 deaths per 1000 patient years (ptpy). Rates of mortality were not significantly different in the two treatment groups with 3 fatalities observed in the intervention cohort (5.1 ptpy) and 2 in the control cohort (3.0 ptpy) (Odds ratio (OR) 0.58, 95% confidence interval (CI) 0.09 – 3.62). In the intervention group, cause of death was attributable to intentional self-harm/asphyxiation, cardiomyopathy and cervical cancer. In the control group, cause of death was attributed to intentional self-harm/asphyxiation and accidental poisoning.

Insert figure 1a and 1b about here

3.3 Overall morbidity

Mean admissions and costs per year for the raw data are shown in figure 1a and 1b. Those in the control group had a significantly increased risk of admission (incident rate ratio IRR 1.84 (95% CI 1.34-2.52), p<.001). In terms of costs, there was no significant difference in costs between the groups (IRR 0.85 (95% CI 0.67 – 1.09) p=0.206). We noted that one person in the control group had 123 admissions in year 8, 77 in year 9 and 72 in year 10. Excluding this case, the admissions for the control and BI were similar in the final years. A peak in costs was seen for the BI group with one case having total costs of $279 151, $425 291 and $585 589 in years 8-10. These were the three highest costs per year for any patient. The remaining results report the winsorized data (figure 2a and 2b). Appendix 2 shows the results of the main analysis conducted with raw data.

Insert figure 2a and 2b about here

No statistical difference was observed in the total cost of ED presentations ($4266 *versus* $4150: p = 0.916) in patients who received the intervention or treatment as usual. Similarly, there was no significant difference in the costs associated with hospitalizations (p = 0.924), out-patient mental health services (p = 0.282), or opiate pharmacotherapies (p= 0.209) (Table 1). No significant difference was observed in the average number of ED (p = 0.849), hospital (p = 0.870), or outpatient-mental health (p = 0.632) events per person. Finally, overall costs associated with health care utilization did not differ between the groups ($58 746 *versus* $64 833: p = 0.800). The overall mean cost per person was $61 932 (SD $135 422). In the first 3 years there was a positive return on investment (.04, 15.93, 21.15). Of the remaining years, only year 10 yielded a positive return (33.16) but over the 10 years the ROI was 30.67.

Insert table 1 and 2 about here

There was no significant difference in the cost for opiate dependence with methadone and/or buprenorphine (p = 0.209), with eight people in both the intervention and control groups treated. However, participants in the intervention, spent significantly shorter time in treatment (mean 514 days) compared with the control group (mean 1300 days) (p = 0.006).

<u>3.4 Cause specific morbidity</u>

ED attendances with an AOD mental health diagnosis were reduced in patients treated with the intervention in terms of both costs ($22 *versus* $227: p = 0.002) and rates of presentation (0.03 *versus* 0.25: p = 0.010). Neither the costs, nor the rates were statistically different for the remaining categories of hospital or ED events (Table 2). Mental health non-AOD admissions accounted for 45.8% of costs in the intervention group and 62.9% in controls.

3.5 Intervention and subsequent treatment

Of the people who received the intervention, 28 (46.7%) received a follow-up contact from the link worker. Overall health costs in these people were on average lower than people who only received the intervention ($36 108 compared with $78 511) but not statistically different (Z = -1.56, p = 0.119). As per overall costs, ED costs ($3 161 compared with $5 233), average hospital costs ($29 000 compared with $66 407), and out-patient mental health costs ($2 931 compared with $5 862) were reduced in people contacted by the link worker, but not significantly reduced.

3.6 Indicators of health costs

A number of baseline variables were predictive of costs. At the initial ED presentation, people with alcohol alone presentations, incurred significantly lower costs than those not involving alcohol, i.e. presentations involving licit or illicit drugs only. A history of injecting drug use was also associated with increased costs in the following 10 years with a history of opiate use showing a trend in the same direction (p = 0.05) (Table 3). In the multivariate analysis, only a history of injecting drug use remained as a significant predictor of costs (p=.008).

Insert table 3 about here

4. Discussion

The study cohort accrued substantial health costs over a 10 year period, identifying this group as a high priority for intervention both from health and fiscal perspectives. The objective of the original study was to reduce AOD presentations by young people by facilitating their attendance at local treatment services. On this measure the intervention was successful, in that the intervention reduced subsequent ED costs and presentations from alcohol and other drug use but was not shown to reduce overall costs associated with health service utilization. However, given that only a minority of those in the intervention arm attended an external treatment service and the large variability in costs, the study was potentially underpowered to detect this effect. The findings also provide guidance on where scarce resources could be targeted to potentially reduce future costs and morbidity.

Health care costs were highly variable ranging from zero to more than $2.1 million. The average healthcare cost per person was in excess of what would be expected from standard individuals in this age group. The mean per person/year health expenditure for 15-24 year olds on hospital in-patient, out-patient medical services and prescription pharmaceuticals in 2008-09 was $1,345 (males $1051, females $1655)(adjusted to $1,532.60 in 2015) (Australian Institute of Health and Welfare, 2014a). This is far less than the mean expenditure for this cohort of more than $6200 per person/year. As shown in Table 2, mental health care costs were a primary driver of health care costs with admission to hospital with a non-AOD diagnosis accounting for about 46% and 63% of costs for the two groups. As such, interventions that identify and target adolescents attending ED with mental health issues may have the largest potential to reduce health care costs.

There was some evidence to suggest that the intervention may have reduced problematic drug and alcohol use with significant reductions in the costs and rates of ED attendances with an AOD mental health diagnosis. However, the study did not have information on other types of health services such as general practice or non-governmental drug treatment agencies, so there may have been a transfer to these services. Additionally, length of treatment on an opiate pharmacotherapy program was significantly reduced in the intervention group. In calculating the mean cost of this treatment the whole cohort was considered. If only those who received treatment are included the costs were $7600 and $17000 in the intervention and control groups (not in results). However, these measures are open to differing interpretations with shorter duration and lower costs potentially indicating successful treatment or treatment failure. Similarly while not significant, it appeared the 28 participants who had follow-up contact with the link worker had fewer health costs than those within the intervention who did not have contact. This contact may have provided participants with future treatment options regardless of whether or not they attended treatment services immediately afterwards. Alternatively it could also be associated with the level of motivation observed in these patients, or other personal characteristics.

In a univariate analysis, several baseline variables were shown to account for high levels of variability observed in the costs. The substances involved in the initial ED presentation were shown to significantly predict future health costs, with people attending ED with an alcohol related presentation costing on average $117 525 less than those attending ED without an alcohol related event (e.g. licit or illicit drugs only). No significant difference was observed in the average cost in patients presenting for alcohol use alone and alcohol in combination with other drugs. We speculate that the presence of alcohol may be indicative of type of situation and/or the type of user involved. Alcohol consumption may be suggestive of an acute social or party type event or a recreational drug user, while the absence of alcohol may be associated with patients who are substance dependent or who mainly use opiates or other drugs of abuse. In keeping with this, patients with a history of injecting drug use and opiate use cost on average $67 090 and $78 428 more respectively that those without these histories. In the multivariate analysis, the prior injecting use of drugs was the only baseline variable associated with a significant increase in subsequent hospital costs. However, high rates of collinearity between the variables may have suppressed other effects.

The major limitation of the study is clearly the small sample size of the original study which was not designed with the current analyses in mind. This was compounded by the number of participants who received the intervention, but who did not subsequently attend an external treatment service, which was the objective of the intervention. If a new service was developed from this intervention, we would recommend attempted to gain the young person's consent to contact significant others in their life to increase engagement. Given that most of the categories of costs favored the intervention group, care should be taken to avoid a type II error by rejecting the possible savings of this approach. Nevertheless, we have been cautious in the interpretation of the statistically significant outcomes due to the multiple statistical significance tests undertaken.

Because ED data were not available for all participants across the initial two years of the study, we decided to conduct the analysis on ED presentations after two years. Potentially, the major changes associated with the intervention could have occurred in this initial period. The seminal review by Moyer et al noted that alcohol consumption and problems were reduced in the first 12 months but not thereafter among non-treatment seeking groups (Moyer et al., 2002). We have previously reported on the first 12 months after the intervention using a combination of record linkage and hand searching of emergency department records. There were 35 AOD admissions in the control group and 30 in the intervention during that period. However, data to enable costs to be calculated were not collected (Tait and Hulse, 2005). The lack of cost data for the initial period following the intervention limits interpretation of findings. Finally, we noted that only 116 of 127 participants were matched via record linkage for this study whereas at 12 months, 122 were identified in just the admissions data (Tait and Hulse, 2005). It is unclear why the matching software performed less well on this occasion.

Given the high, and extremely variable, costs associated with people in this adolescent cohort, finding a model that could assist medical staff in predicting people that will likely have high health service utilization in the future would potentially be highly advantageous for targeted interventions to reduce health costs.

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Conflicts of Interest

The funding body had no right of veto over the contents of the manuscript. None of the authors have a conflict with respect to the study.

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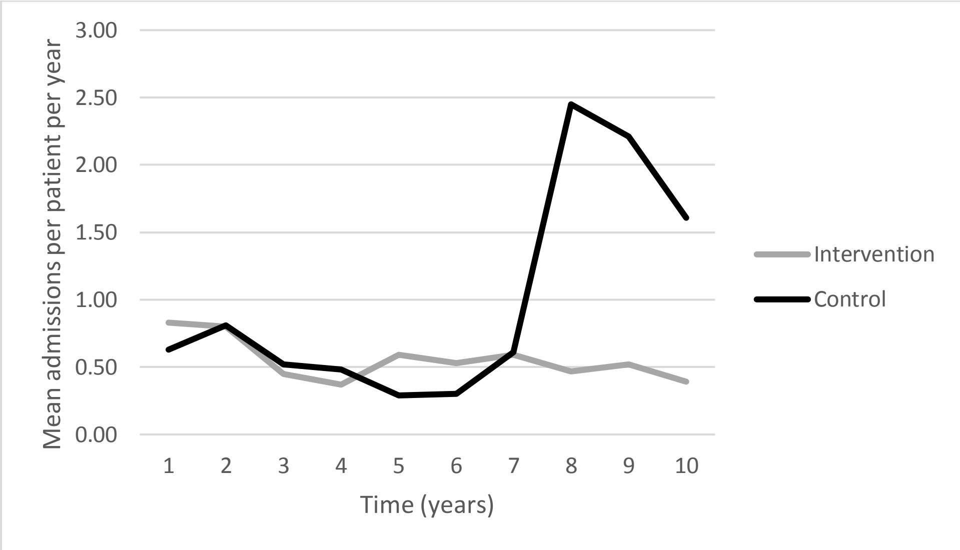

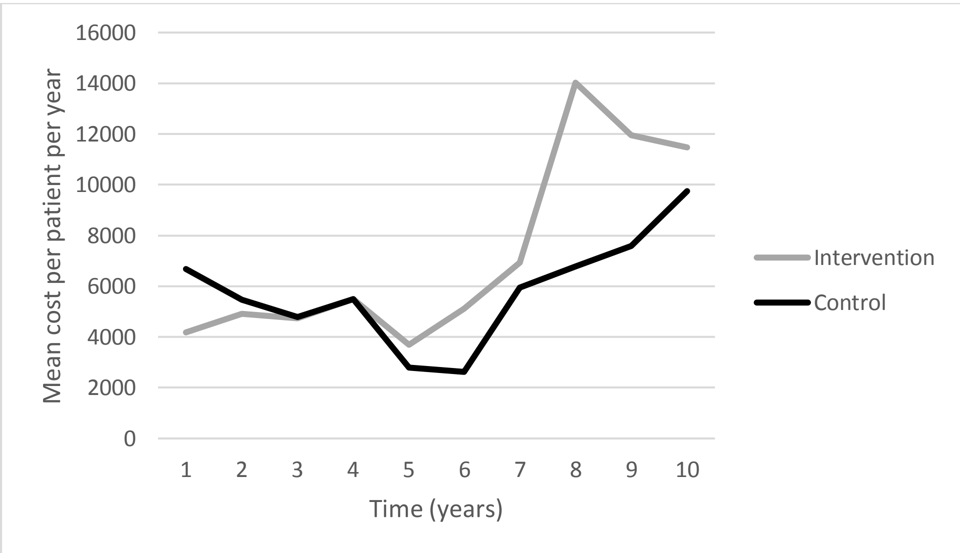

Figure 1a and 1b. Mean (a) hospital admissions and (b) costs per year - raw data

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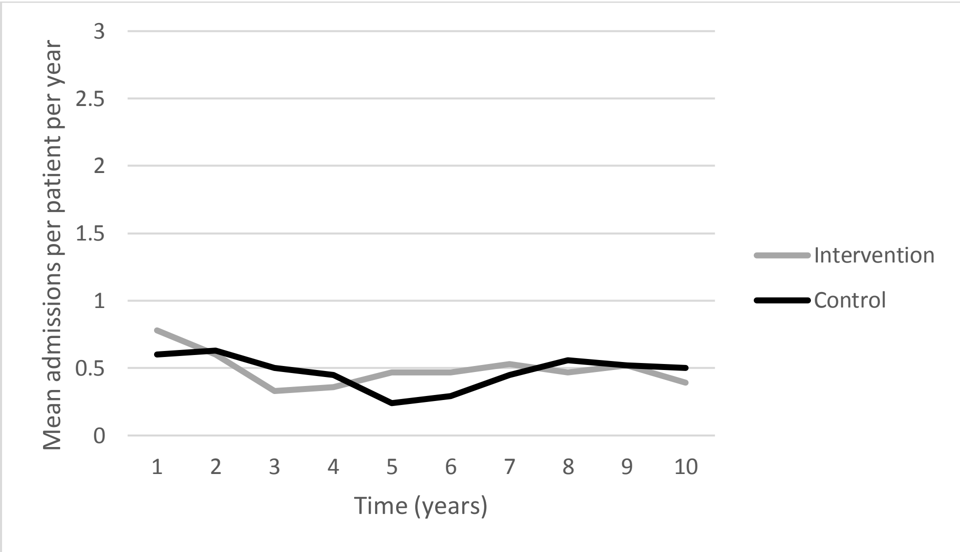

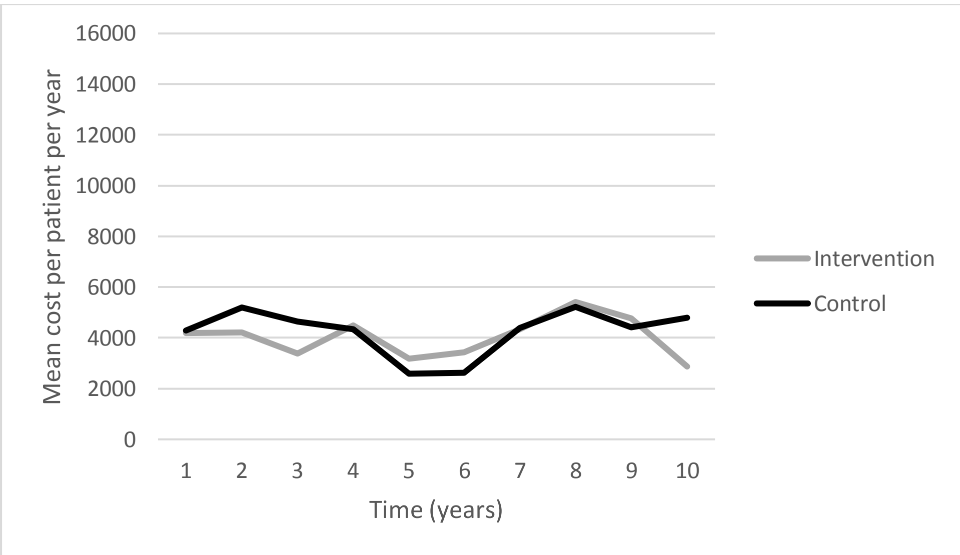

Figure 2a and 2b. Mean (a) hospital admissions and (b) costs per year - winsorized data

Appendix 1: Baseline descriptive characteristics of those identified by the record linkage system

		Intervention (n=58)	**Control (n=58)**	**Statistic**
Sex female	n (%)	31 (53)	25 (43)	Chi^2 1.24 (1) *p*=0.265
Age	mean (SD)	16.6 (1.7)	16.5 (1.9)	*t* 0.3 (114) *p*=0.755
Hazardous alcohol yes	n (%)	49 (85)	41 (71)	Chi^2 0.17 (1) *p*=0.678
IDU yes	n (%)	17 (29)	15 (26)	Chi^2 3.17 (1) *p*=0.075
AUDIT-C	mean (SD)	6.7 (2.5)	6.2 (3.2)	*t* 0.8 (113) *p*=0.409
GHQ12	mean (SD)	17.9 (9.3)	16.2 (8.1)	*t* 1.1 (114) *p*=0.295
FAD	mean (SD)	28.3 (7.9)	26.8 (6.9)	*t* 1.1 (114) *p*=0.262

AUDIT-C = Alcohol Use disorders Identification Test: first 3 items (Babor et al., 2001; Meneses-Gaya et al., 2009)

FAD = Family Assessment Device: – range 12-48 with lower scores showing healthier family functioning (Epstein et al., 1983)

GHQ 12 = General Health Questionnaire (12 item version): - range 0-36 with lower score showing better mental health (Goldberg and Williams, 1988; Tait et al., 2003)

Hazardous alcohol use defined as 5 or more (males) and 4 or more (females) on the AUDIT-C

IDU = injecting drug use

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Appendix 2: Raw Costs and events

Location	**Brief Intervention**				**Control**			
	Events / person	Mean	Median	Range	Events / person	Mean	Median	Range
Intervention	1.0	$55	-	-	0.0	$0	-	-
Emergency presentations	7.4	$4 653	$2 127	$0 – 52 433	7.2	$4 558	$1531	$0 – 56 239
Hospital admissions	5.8	$72 746	$12 094	$0 –1 999 584	10.3	$58 007	$6478	$0 – 889 503
Out-patient mental health	22.9	$4 585	$0	$0 – 84 870	51.5	$10 334	$0	$0 – 248 794
Opiate treatment	13.3%[1]	$1 013	$0	$0 – 14 924	11.9%[1]	$2 054	$0	$0 – 31 078
Total		**$83 051**	**$16 761**	**$0 – 2 136 944**		**$74 954**	**$10 116**	**$0 – 932 893**

Total cost = Intervention + emergency costs + hospital costs + out-patient costs + opiate treatment cost. Sub totals do not sum to the totals due to rounding.

[1] Percentage of people that received methadone and/or buprenorphine