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Is treatment for alcohol use disorder associated with reductions in criminal offending? A national data linkage cohort study in England *

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ABSTRACT

BACKGROUND: This is the first English national study of change in criminal offending following treatment for alcohol use disorder (AUD).

METHODS: All adults treated for AUD by all publicly funded treatment services during April 2008-March 2009 (n=53,017), with data linked to the Police National Computer (April 2006-November 2011). Pre-treatment offender sub-populations were identified by Latent Profile Analysis. The outcome measure was the count of recordable criminal offences during two-year follow-up after admission. A mixed-effects, Poisson regression modelled outcome, adjusting for demographics and clinical information, the latent classes, and treatment exposure covariates.

RESULTS: Twenty-two percent of the cohort committed one or more offences in the two years pre-treatment (n=11,742; crude rate, 221.5 offenders per 1,000). During follow-up, the number of offenders and offences fell by 23.5% and 24.0%, respectively (crude rate, 69.4 offenders per 1,000). During follow-up, a lower number of offences was associated with: completing treatment (adjusted incident rate ratio [IRR] 0.82; 95% confidence interval [CI] 0.79-0.85); receiving inpatient detoxification (IRR 0.84; CI 0.80-0.89); or community pharmacological therapy (IRR 0.89; CI 0.84-0.96). Reconviction was reduced in the sub-population characterised by driving offences (n=1,140; 11.7%), but was relatively high among acquisitive (n=768; 58.3% reconvicted) and violent offending sub-populations (n=602; 77.6% reconvicted).

CONCLUSIONS: Reduced offending was associated with successful completion of AUD treatment and receiving inpatient and pharmacological therapy, but not enrolment in psychological and residential interventions. Treatment services (particularly those providing psychological therapy and residential care) should be alert to offending, especially violent and acquisitive crime, and enhance crime reduction interventions.

Keywords*:* alcohol use disorder; treatment; crime; re-offending; outcome

1. Introduction

Alcohol consumption and chronic excessive drinking are dose and exposure-linked to several hundred physical and psychological health problems (World Health Organisation, 2007; Rehm et al., 2010). In 2004, global alcohol consumption was associated with 3.8% of all deaths and 4.6% of the total burden of disease and injury (Rehm et al., 2009). Alcohol misuse is now ranked third as the leading global disease risk factor after hypertension and tobacco smoking (Lim et al., 2012).

Excessive drinkers can also cause harm to people in the family, in the workplace, on the road, and in the community. For example, a heavy drinker's family are vulnerable to interpersonal conflict and financial problems (Casswell et al., 2011; Boden, Fergusson and Horwood, 2013). In the workplace, alcohol use is associated with accidents and reduced productivity (in one survey, 9.2% of employees in the United States [US] reported presenting for work with a hangover, and 1.7% admitted presenting for work while intoxicated on alcohol; Frone, 2006). On the road, driving a motor vehicle while intoxicated risks serious injury to other users (Hingson and Winter, 2003; Taylor and Rehm, 2012). In the United Kingdom (UK), 6% of motorists report driving over the legal alcohol limit each year; and in 2013, 15% of all road traffic deaths were estimated to be alcohol-related (Department of Transport, 2015). In the community, among an estimated 1.3 million incidents of interpersonal and stranger violence during 2013 in England and Wales, 53% of victim reports stated a belief that the perpetrator had been intoxicated (Office for National Statistics, 2015). Observational studies also link alcohol consumption to theft and property crime (Fergusson and Horwood, 2000; Rossow, 2001; Maldonado-Molina, Reingle and Jennings, 2011).

Against this background, governments are called on to make effective interventions available to help people with drinking problems and to implement control policies to reduce societal harm (World Health Organisation, 2014). Internationally, most developed healthcare systems encourage people with alcohol use disorders (AUD) to access clinical interventions. There is an array of controlled trial supported AUD interventions which use psychological change methods (e.g. motivational, cognitive, behavioural, family, peer and social network support) and pharmacological therapies for relapse prevention with acamprosate, naltrexone, nalmefene or disulfiram (National Institute for Health and Care Excellence, 2011).

Many countries use criminal justice system (CJS) orders to refer people to AUD treatment services, and these orders sit alongside self, family and healthcare referral routes. This forms a mixed patient population including those with no criminal involvement; those with criminal conviction histories but no current CJS involvement; and offenders who are court-ordered to enter treatment as part of formal supervision. While AUD treatments have a primary aim to help patients overcome dependence and drinking-related problems, tackling offending risk is a particular focus for certain cases and societally important secondary measure of effectiveness.

An important, but under-studied question, is whether treatment reduces offending in the AUD population. In the US, court-ordered counselling for people convicted of driving while intoxicated on alcohol (DWI) appears to be modestly effective in reducing subsequent alcohol-related road traffic accidents (Cavaiola and Wuth, 2002; Wells-Parker and Williams, 2002). In the UK, recent small-scale evaluations of AUD patients involved in the CJS, present a mixed picture: in one study there was reduced recidivism among male offenders following cognitive behavioural therapy (Needham et al., 2015); but in a study of court-ordered multi-modality treatment there was found no reduction in convictions in comparison to an untreated comparison group (McSweeney, 2015).

To our knowledge, there has been no national-level research on the effectiveness of AUD treatment to reduce crime. Accordingly, we report on the first analysis of the effectiveness of all English public-sector treatments services for AUD to reduce offending, asking:

(1) Is treatment associated with a reduction in criminal offending?

(2) Is this association linked to the type of treatment received?

(3) Do sub-populations of offenders have a differential treatment response?

2. Methods

2.1 Design, settings and cohort

This was a longitudinal database linkage study of all publicly funded AUD treatment and recorded offending in England, reported following the STROBE guideline for cohort research (von Elm et al., 2007). Treatment interventions included all inpatient withdrawal management, residential rehabilitation and community setting psychological and pharmacological therapies. These treatments were provided by all 1,012 operational specialist clinics and primary health care teams in the National Health Service (NHS) and the third-sector. The study included AUD treatment services in 324 local authority districts (36 metropolitan boroughs, 32 London boroughs, 201 non-metropolitan districts and 55 unitary authorities).

We identified all adults (≥18 years) diagnosed with AUD (with no comorbid non-medical substance use) who attended assessment for treatment between 1 April 2008 and 31 March 2009 (N=61,688) and ensured that each individual had two years of follow-up observation. The start of follow-up was anchored on the date of the patient's first contact with a clinical service for assessment, and ended on 31 March 2011 (or earlier in the event of their death; n=425). The cohort included those who had a single episode of AUD treatment and also those who received two or more episodes

(n=14,011). Eight per cent of the treatment population did not receive treatment at any time during follow-up and were removed (n=4,909).

2.2 Databases

All patient demographic and clinical data for the study were reported by treatment services to the English National Drug Treatment Monitoring System (NDTMS). NDTMS includes almost all specialist services for alcohol and drug use disorders. It reports annually on the characteristics of patients treated (see Public Health England, 2014a, 2014b) and provides national outcome monitoring of treatment episodes and performance benchmarking for local treatment systems (see Marsden et al. 2009; Marsden et al., 2012).

Following NDTMS guidance, each patient level 'treatment journey' comprised: a single episode of psychological or pharmacological therapy; or enrolment in a concurrently delivered psychological *and* pharmacological treatment; or a continuing care package in which an initial inpatient, residential or community setting episode was followed by one or more further treatment interventions (commencing not later than 21 days from the preceding one).

Offending data for England were obtained from the Ministry of Justice Police National Computer (PNC). The PNC is the national criminal offence database for the UK which includes approximately 500 'recordable' offences which can result in imprisonment. The date that each offence was committed was used for the present treatment follow-up design. The PNC data included offences for individual cases with the start and end of the extract covering the two-year period before the first (or only) episode of treatment for all members of the patient cohort.

2.3 Outcome measure

The study outcome measure was the number of criminally proven recordable offences in the two years from the start of each patient's first treatment episode to the end of the two-year follow-up. All offence types were included where an individual was charged, then subsequently proven guilty and either convicted, cautioned, reprimanded or warned. The two-year observation period was used to allow sufficient time for police and court processing of offences committed before treatment.

The count of offences from a crime register has been successfully used for evaluation of opioid maintenance treatment (e.g. Bukten et al., 2012) but not, to our knowledge, for evaluation of AUD. Our focus was on re-offending, but we also recorded offending among those who did not have an criminal record for the two years before admission.

2.4 Data linkage procedure

At the level of clinical service delivery, each patient gave their informed consent for their data to be used for aggregated analysis. A memorandum of understanding with the Ministry of Justice authorised use of the PNC data. Patient confidentiality was assured under a national information governance policy (Public Health England, 2013).

Patient initials, gender, date of birth and local district of residence from NDTMS were used to search the PNC extract for a probabilistic match to an individual with an offence record with the same demographic information. This method was developed by Millar et al. (2008) and has been used successfully in other recent studies of offending and mortality in substance use disorder treatment cohorts (see Pierce et al. 2015; White et al., 2015).

After data linkage, 7,492 (0.3%) of cases in the PNC were removed because they could not be uniquely identified, relating to 3,762 (6.6%) of the NDTMS cohort. The final analysis cohort comprised 53,017 matched individuals and 11,742 (22.1%) had one or more criminal records in the two years before their first triage assessment.

Based on UK Home Office reporting (Home Office, 2013), we classified the offences into nine types as follows:

- violence (including robbery; and sexual offences);
- public order (violent disorder and affray[1]);
- driving while intoxicated (DWI) and related offences;
- other driving;
- criminal damage;
- acquisitive (theft, burglary, fraud and forgery);
- illicit drug (possession or supply);
- weapons (unauthorised possession or use);
- other (not classified above).

The type and count of these pre-treatment offences were used to identify offender sub-populations (see section 2.6.1), and to set a baseline level of the outcome measure for the main analysis.

2.5 Covariates

We followed an general evaluation approach used by our group in which an outcome measure is adjusted by pre-treatment offending; patient level demographics; local area deprivation; clinical indicators of clinical disorder severity and complexity; and summary measures of treatment exposure (see Marsden et al. 2012; Marsden et al., 2014).

[1] Violent disorder and affray are classified as serious 'behavioural offences' under the UK Public Order Act. They are committed when three or more persons (acting as a group or independently) use, or threaten, unlawful violence towards another person.

A set of 16 covariates from NDTMS (or as otherwise shown) were used for the analysis, as follows:

2.5.1 Socio-demographics. Sex; age; ethnic origin (a legal requirement for monitoring; Race Relations Act, 2000); housing problems (including homelessness and short-term hostel provision); and social deprivation. Deprivation in each electoral/ward-level neighbourhood was measured by the Department for Communities and Local Government Indices of Multiple Deprivation (IMD; English Indices of Deprivation, 2010). An IMD score was assigned to the patient's home postcode district (or if this was not available, to the postcode of their first treatment provider during the follow-up), and then grouped by quintile (following UK local government reporting convention).

2.5.2 Clinical severity and case complexity characteristics. Whether the patient had been previously treated for AUD; referred by the CJS; and they total grams of alcohol they reported consuming during the 28 days before admission (the latter recorded by treatment services in the context of a structured face-to-face clinical interview), then grouped by tertile given a non-normal skewed distribution.

2.5.3 Treatment interventions and exposure. We recorded the number of enrolments each patient had in the inpatient and residential setting, and in community psychological and pharmacological therapies across the follow-up. In the context of AUD continuing care, we judged that the best treatment exposure measure was the total weeks spent in AUD treatment aggregated across these intervention categories.

2.5.4 Treatment status. Whether patient remained in their first treatment episode at the end of the follow-up; successfully completed their first treatment episode (defined as a clinic report that the patient had achieved their care plan goals and there was mutual agreement for discharge); dropped out; had treatment prematurely terminated due to incarceration; or was re-admitted during the follow-up.

2.6 Statistical analysis

With alpha and power pre-set to 0.05 and 0.90, the reliability of the analysis of 16 covariates on the offence outcome measure was assessed against the size of the smallest anticipated treatment group (residential rehabilitation). We calculated that 226 patients in residential treatment would be needed to detect a medium effect on the outcome measure (f^2=0.15; Cohen, 1988). In the event, there were 578 pre-treatment offenders in this group, assuring reliable detection of an effect of this magnitude.

The analysis was implemented following a pre-specified statistical analysis plan in Stata (version 13) and Mplus (version 7.1), as follows:

2.6.1 Offender sub-populations. Given anticipated heterogeneity in the type and number of convictions among the pre-treatment offenders, we took the count of each of the nine offence types

(i.e. violence, public order; DWI; other driving; criminal damage; acquisitive; illicit drug; weapons; other) in the two years before admission and used latent profile analysis (LPA) in Mplus to identify discrete, non-overlapping sub-populations. One-to-five unconditional models were computed sequentially, with 5,000 random sets of starting values to guard against convergence on local maxima (McLachlan and Peel, 2000; Nylund et al., 2007). We set a minimum class size of five per cent for utility. Class identification was iterative and informed by posterior fit statistics (Lazarsfeld and Henry, 1968). A multinomial logistic regression in Stata was then used to characterise latent classes on the socio-demographic and clinical description covariates. The classes were taken forward for the analysis of change in the number of offenders, the rates of re-conviction, and the outcome measure.

2.6.2 Post-admission offending. Ninety-five percent confidence intervals (CI) for crude rates were calculated using Byar's approximation (Breslow and Day, 1987). Incident rate ratios (IRR) were computed for the outcome measure with 95% CI (Sahai and Khurshid, 1993). With patient data nested within local government districts, we used a two-level, mixed-effects, multivariable Poisson regression (patients, level 1: fixed; area, level 2: random) to model the association of patient and treatment covariates on outcome (Stata procedure: *meqrpoisson*). The regression was adjusted by the baseline count of pre-treatment offences, the latent classes, and all other covariates. We judged there was a rationale to include one interaction: gender by age.

2.6.3 Sensitivity analyses. There were two pre-planned sensitivity analyses. The first addressed missing covariate data at admission. Among the pre-treatment offenders, 72% had data on all covariates, but there were missing data on the following variables: referral from the CJS (1.5%); ethnicity (4.1%); past month alcohol consumption (16.4%); and housing problems (19.5%). In total, 26.5% of the cohort had at least one covariate with a missing value. We considered that reliance on a complete case model risked precision and increased bias due to this missing data (Sterne et al., 2009). With no contrary evidence to our assumption that outcome and covariate data were missing-at-random (Little and Rubin, 1987), the mixed-effects model was repeated using a multiply imputed dataset created by chained equations (Stata procedure: *mi:impute chained*). This included all covariates and the patient's local area of residence. Procedure *mlogit* was used for the categorical covariates and predictive mean matching for the total treatment exposure measure. With relative efficiency above 98%, 20 datasets of probabilistic values were imputed (Rubin, 1987). These were analysed independently and estimates were then combined according to Rubin's rules.

The second sensitivity analysis addressed a study design validity threat from regression to the mean (RTM). RTM is a universal statistical phenomenon which can obscure or account for observed change in longitudinal research through random measurement error and change in outlying values of an outcome measure (Barnett, van der Pois and Dobson, 2005; Marsden et al., 2011). Based on a recommendation from Linden (2013), we set the following criteria to identify

outliers in the cohort: the number of offences committed by the top five per cent, and an extreme group whose number of offences was at three standard deviations (SD) from the mean. Stata procedure *rtmci* was used to estimate whether the observed IRRs associated with treatment exceeded the level expected to be due to RTM at these two outlier thresholds.

3. Results

3.1 Cohort characteristics

Table 1 displays the socio-demographic, referral history, admission alcohol use, AUD treatment interventions received, and treatment status at the end of the two-year follow-up for the pre-treatment offenders (n=11,742) and the pre-treatment non-offenders (n=41,275). Psychological interventions were received by 93.1% of the cohort. Approximately 1:10 received inpatient or pharmacological treatment, and 1:20 received residential rehabilitation.

Among the 11,742 pre-treatment offenders, the crude pre-treatment offending rate was 221.5 offenders per 1,000 (95% CI 217.5-225.5). Compared to the non-offenders, pre-treatment offenders were less likely to complete their first AUD treatment episode successfully (45.3% vs. 49.2%; odds ratio [OR] 0.85; 95% CI 0.82-0.89), and more likely to re-present for further AUD treatment during the follow-up (31.2% vs. 25.1%; OR 1.35; 95% CI 1.29-1.41).

3.2 Pre-treatment offender sub-populations

Thirty-nine percent of the pre-treatment offenders committed more than two offence types and 27% committed more than three types. The prevalence of each offence in the two years before admission was as follows: violence (49.4%; 5,797 offences); DWI (26.7%; 3,136 offences); acquisitive (23.7%; 2,786 offences); other (23.6%; 2,774 offences); criminal damage (21.0%; 2,466 offences); public order related (18.7%; 2,1994 offences); other driving (11.1%; 1,300 offences); illicit drug (7.3%; 857 offences); and weapons (5.9%; 690 offences).

One-to-five class unconditional LPA models were estimated successfully using the count of each offence type (**Table 2**). Falling Akaike Information Criterion and Bayesian (and adjusted Bayesian) Information Criterion values indicated that each subsequent class model was better fitting than the previous one. However, the 5-class model had the smallest drop in the bootstrapped likelihood ratio test, and this model also contained a single sub-population with just 1.3% of the cohort as members. On the basis of the model fit statistics, class size, and inspection of estimated means we judged that the 4-class model was optimal. This solution had 89% entropy and class membership probabilities ranging from 0.82-0.99.

The mean count of offences in the two years before admission to treatment characterised the four class solution as follows:

- ***Class 1*** (n=9,232; 78.6% - general). This sub-population had a relatively low number of offences recorded (mean, 1.96; SD, 1.34) with no characteristic offence type discernable;
- ***Class 2*** (n=1,140; 9.7% - driver). This sub-population had a predominantly DWI or other motoring conviction and (relative to *Class 1)* a more frequent crime profile (mean, 4.42; SD, 2.38);
- ***Class 3*** (n=602; 5.1% - violent). This sub-population had a relatively high-level offence profile characterised by violent offending (committed alone or with others; mean, 12.11; SD, 6.87);
- ***Class 4*** (n=768; 6.5% - acquisitive). This sub-population included those with a relatively frequent conviction profile typified by acquisitive offending (mean, 9.38; SD 5.16).

A multinomial logit model included treatment admission characteristics to further investigate class membership. Relative to the pre-treatment non-offender group, each of the four classes contained more men (Relative Risk Ratio [RRR] range 1.78-3.57); was relatively younger (RRR range 0.64-0.82); ware more likely to have been previously treated for AUD (RRR range 1.60-3.90); and was more likely to be referred to treatment by the CJS (RRR range 1.45-16.10). Pre-admission housing problems were experienced by *Class* 1 (RRR 1.45), *Class* 3 (RRR 3.76) and *Class* 4 (RRR 13.05), but not *Class* 2 (RRR 1.16; 95% CI 0.95-1.40). Estimates from this regression are displayed in **Table S1**.

3.3 Post-treatment offending

Among the 8,983 post-treatment offenders, the crude offending rate during the two year follow-up was 169.4 offenders per 1,000 (95% CI 166.0-173.0). **Table 3** shows the change in the number of offenders and offences, and the re-conviction rate for the characteristic offence type in each of the the driver, violent and acquisitive class sub-populations.

Overall, there was a 23.5% reduction in offenders (11,742 to 8,983) and a 24.0% reduction in offences (37,608 to 28,585). There was a 15.9% reduction in the membership of *Class* 3 (violent); a 22.0% reduction in *Class* 4 (acquisitive); a 55.7% reduction in *Class* 2 (driver); and a 59.5% reduction in *Class* 1 (general). The Cohen's *d* effect size for the within-class reduction ranged from 0.33 (*Class* 1) to 1.13 (*Class* 2). Change in each of the nine crime types for each latent class is displayed in **Table 4**.

Table 5 shows the analysis of the outcome measure among the pre-treatment offenders. The second and third column of the table shows the unadjusted and adjusted IRR estimates for members of the cohort with data on all covariates (n=8,475). Column four shows the multiply imputed regression model for all cases (n=11,742).

Following negative screening for multi-colinearity among covariates, the complete-case adjusted model indicated that less offending was associated with patients who completed their treatment (of

any kind) successfully (IRR 0.82; 0.79-0.85), and the small group who stayed in treatment continuous for two years (n=347; 3.0%; IRR 0.81; 95% CI 0.72-0.91). While the adjusted model did not contain a statistically significant estimate for total time spent in treatment across the follow-up, less offending was independently associated with inpatient (IRR 0.84; 95% CI 0.80-0.89) and pharmacological treatment (IRR 0.89; 95% CI 0.84-0.96), but not residential rehabilitation (IRR 0.93, 95% CI 0.87-1.01) or psychological treatment (IRR 0.97; 95% CI 0.88-1.07).

Compared to *Class* 1, greater post-treatment offending was associated with: *Class* 3 (violent; IRR 2.01; 95% CI 1.89-2.14); *Class* 4 (acquisitive; IRR 1.64; 95% CI 1.55-1.73); previous AUD treatment (IRR, 1.11; 95% CI 1.06-1.15); CJS referral (IRR 1.11; 95% CI 1.07-1.16); the mid and highest tertile of pre-treatment alcohol consumption (IRR 1.10 and 1.24, respectively); treatment termination due to incarceration (IRR 1.65; 95% CI 1.55-1.76); and re-admission (IRR 1.43; 95% CI 1.37-1.48).

3.4 Sensitivity analysis

The multiply imputed, adjusted model of post-treatment offending is shown in the fourth column of **Table 5**. The IRRs deviated only modestly from the estimates in the complete case model, with no sign of differential effects. For the RTM assessment, the top five percent of the cohort had four or more recorded offences in the two years before admission. For these individuals, we estimated that a reduction of 1.83 offences (95% CI 1.73-1.93) could be due to RTM. However, the observed mean reduction (3.58 offences; 95% CI 3.39-3.77) was substantially greater than the RTM threshold. Among the extreme outliers (those with seven or more pre-treatment offences at 3 SD form the cohort mean), there was an expected reduction of 2.98 offences which could reflect RTM (95% CI 2.82-3.15) but a actual reduction of 5.21 offences (95% CI 4.84-5.59).

4. Discussion

We observed a reduction in offending during a two-year follow-up after treatment for AUD (crude pre-treatment and post-treatment offending rate per 1,000 falling from 221.5 to 169.4). Less offending was independently associated with completion of treatment (and long retention) and inpatient withdrawal management and/or pharmacological therapy.

There is population heterogeneity in the pattern, volume and temporal course of offending (c.f. Maguire and Bennett, 1982; D'Unger et al., 1998; Fox and Farrington, 2012). In our study, the most prevalent offence type was individual or public order violence (committed by 49.4%). This class and those with a characteristic driving (n=1,140), violence (n=602) or acquisitive (n=768) offending profile had characteristic responses on the offending outcome measure. The strongest effect was observed for the driving offence class (n=1,140), with an 11.7% reconviction rate for DWI and other motoring offences (and a large overall reduction in offending (66.4%; d = 1.13; 95% CI 1.04-1.22). For the acquisitive class, the acquisitive crime reconviction rate was 58.3%, although there was a

substantial overall reduction in offending (47.1%; *d* = 0.77; 95% CI 0.66-0.87). Independent, direct or indirectly causal relationships have been suggested to explain impulsive or deliberate acquisitive offending (Greenland and Morgenstern, 2001; Hughes et al., 2008).

A salient finding in the present study was the association between AUD and violent offending. We lacked data on psychological, motivational and contextual factors to explore this association, but previous studies do show a dose-relationship between alcohol intoxication, AUD severity and violence (Bushman, 1997; Felson and Staff, 2010; Boden, Fergusson and Harwood, 2012). And naturalistic research describe how some violent criminals drink prior to committing crime (Quigley and Leonard, 2000). There is also a well-established link between alcohol and physical trauma presentations to hospital emergency departments (Warburton and Shepherd, 2004; Prekker et al., 2009), and victims experiencing alcohol-related crime are at risk of traumatic stress reactions (McFarlane, 1998). While all offending did reduce among the violent latent subpopulation in the present study (39.1%; *d* = 0.61; 95% CI 0.49-0.72), the high level of reconviction for violence is a particular concern (77.6%). It seems likely that alcohol disinhibition is an important contributing factor in instances of aggression and sudden violence (Boden, Fergusson, and Horwood, 2012). Preventing violent reconviction must have particularly high priority.

4.1 Strengths and limitations

Study strengths are firstly the large-scale, nationally representative cohort of all adults admitted for specialist interventions for AUD in England during 2008-2009 and use of data registries for recording treatment exposure and outcome. Second, the analysis was not biased through missing data. The complete-case modelling of patient-level and variable-level associations with post-admission offending was highly comparable to a multiply imputed analysis for missing observations among the covariates. Third, the observed reductions in offending are important and withstood validity threats from RTM (observed CIs above the upper bound of the RTM prediction threshold). Together, we contend that our analysis and findings have good internal and external validity and generalise well to the UK treatment system.

Several study limitations are also acknowledged: firstly, the PNC is a proxy of actual offending behaviour and only includes crimes that come to the attention of the police. It is not possible to estimate the difference between recorded and actual crime. During the follow-up observation period (2008-2011), the national offence detection rate was approximately stable (27.7-28.8%; Smith, Taylor and Elkin, 2013), but variations in police operations may have directly influenced prosecuted crime. Second, our analysis of offender sub-populations is data dependent and latent class composition could change among AUD treatment populations recruited after 2009. Third, although NDTMS recorded incarceration as a reason for treatment discharge, we were not able to access data on the time subsequently spent in prison during which some types of offences cannot be committed. However, we note that prior offences and criminal proceedings apply to inmates as

to those at liberty. Fourth, AUD treatment is not the only influence on crime behaviour change among those with AUD, and CJS sanctions have an independent effect.

4.2 Conclusions

In this first national evaluation of crime outcomes associated with AUD treatment, there were reductions in the number of offenders and the number of offences in a two-year follow-up. These gains were linked to treatment completion, retention, inpatient withdrawal management and pharmacological interventions but not residential or psychological interventions. Pre-treatment offenders were less likely to complete AUD treatment and more likely to be re-admitted for more treatment. Reconviction was lowest among the driver latent class and relatively high among the violent class.

These findings emphasise the importance of disaggregating the AUD treatment population in terms of criminality profile, since response to treatment and change in offending is likely to vary by offender sub-population. There are now opportunities for AUD clinics (particularly those providing psychological therapy and residential care) to learn from the content and delivery of therapy programmes which directly target violence prevention (e.g. Polashek and Collie, 2004) as well as the broader intervention literature which addresses desistance, impulsivity and social disadvantage (see Ministry of Justice, 2013). We also see opportunities for a future study which uses growth mixture modelling to identify change and transitions among latent offender classes (c.f. Nylund et al., 2007).

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Contributors

The design and statistical analysis plan for this study was developed and implemented by H.W., J.M. and B.E. J.M and H.W. wrote the first draft of the manuscript. Following input from H.W, I.G and B.E, J.M. wrote a further draft of the manuscript and took the decision to submit for publication.

Conflict of interest

J.M. works in an integrated university and National Health Service academic health sciences centre (Institute of Psychiatry, Psychology and Neuroscience [IoPPN], King's College London and King's Health Partners). He is supported by research grants from the Department of Health, Institute for Health Research (NIHR), and the NIHR Biomedical Research Centre for Mental Health at South London and Maudsley NHS Mental Health Foundation Trust (SLaM MHFT) and has part-time employment as Senior Academic Advisor for the Alcohol, Drugs and Tobacco Division, Health and Wellbeing Directorate, Public Health England. He declares untied educational grant funding from the pharmaceutical industry at IoPPN and SLaM MHFT for a study of psychological interventions in opioid maintenance (2010-2016; Indivior PLC via Action on Addiction). He has received honoraria from Merck Serono in 2013 and 2015 (clinical oncology medicine) and from Indivior via PCM Scientific in relation to the Improving Outcomes in Treatment of Opioid Dependence conference (faculty member, 2012-2013; co-chair, 2015; 2016). He holds no stocks in any company.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at: XXXXXXX.

REFERENCES

Barnett, A.G., van der Pols, J. C., Dobson, A. J., 2005. Regression to the mean: what it is and how to deal with it. Int. J. Epidemiol. 34, 215-220.

Boden, J.M., Fergusson, D.M., Horwood, L.J., 2012. Alcohol misuse and violent behavior: Findings from a 30-year longitudinal study. Drug Alcohol Depend. 122, 135-141.

Boden, J.M, Fergusson, D.M, Horwood, L.J., 2013. Alcohol misuse and relationship breakdown: findings from a longitudinal birth cohort. Drug Alcohol Depend. 133, 115-120.

Breslow, N.E., Day, N.E. 1987. Statistical Methods in Cancer Research, Volume II: The Design and Analysis of Cohort Studies. Lyon: International Agency for Research on Cancer, World Health Organization.

Bukten, A., Skurtveit, S., Gossop, M., Waal, H., Stangeland, P., Havnes, I., Clausen, T., 2012. Engagement with opioid maintenance treatment and reductions in crime: a longitudinal national cohort study. Addiction 107, 393-399.

Bushman, B.J., 1997. Effects of alcohol on human aggression: Validity of proposed explanations. Recent Developments in Alcoholism 13, 227–243.

Casswell, S., You, R., Huckle, T., 2011. Alcohol's harm to others: reduced wellbeing and health status for those with heavy drinkers in their lives. Addiction 106, 1087-1094.

Cavaiola, A., Wuth, C., 2002. Assessment and Treatment of the DWI Offender. New York: Haworth.

Cohen, J., 1988. Statistical Power Analysis for the Behavioral Sciences (2nd Edition). Hillsdale, NJ: Lawrence Earlbaum Associates.

Department of Transport. 2015. Estimates for reported road traffic accidents involving illegal alcohol levels: 2013 (second provision). Self-reported drink and drug driving for 2013/14. Statistical Release.
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/402698/rrcgb-drink-drive-2013-prov.pdf (accessed 05.01.16).

D'Unger., Land. K.C., McCall, P.L., Nagin, D.S., 1998. How many latent classes of delinquent/ criminal careers? Results from mixed poisson regression analyses. Am. J. Sociology 103, 1593–1630.

English Indices of Deprivation, 2010. Communities and Local Government.
http://www.communities.gov.uk/documents/statistics/pdf/1871208.pdf (accessed 05.01.16).

Felson, R.B., Staff, J., 2010. The effects of alcohol intoxication on violent versus other offending. Crim. Justice Behav. 37, 1343-1360.

Fergusson, D.M., Horwood, L.J., 2000. Alcohol abuse and crime: a fixed-effects regression analysis. Addiction 95, 1525-1536.

Fox, B.H., Farrington, D.P., 2012. Creating burglary profiles using latent class analysis: a new approach to offender profiling. Crim. Justice Behav. 39, 1582-1611.

Frone, M.R., 2006. Prevalence and distribution of alcohol use and impairment in the workplace: A U.S. national survey. J. Stud. Alcohol. 67, 147-156.

Greenland, S., Morgenstern, H., 2001. Confounding in health research. Ann. Rev. Pub. Health 22, 189-212.

Hingson, R., Winter, M., 2003. Epidemiology and consequences of drinking and driving. Alcohol Res. Health. 27, 63-78.

Home Office. 2013. Counting Rules for recorded crime – offence classification index. https://www.gov.uk/government/publications/counting-rules-for-recorded-crime (accessed 05.01.16).

Hughes, K., Anderson, Z., Morleo, M., Bellis, M.A., 2008. Alcohol, nightlife and violence: the relative contributions of drinking before and during nights out to negative health and criminal justice outcomes. Addiction 103, 60-65.

Lazarsfeld, P.F., Henry, N.W., 1968. Latent Structure Analysis. Boston: Houghton Mifflin.

Linden, A., 2013. Assessing regression to the mean effects in health care initiatives. BMC Med. Res. Methodol. 13, 119.

Little, R.J.A., Rubin, D.B. 1987. Statistical Analysis with Missing Data. New York: Wiley and Sons.

Lim, S., Vos, T., Flaxman, A. et al. 2012. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. The Lancet 380, 2224–2260.

Maguire, E.M.W., Bennett, T. 1982. Burglary in a dwelling: the offence, the offender and the victim. London: Heinneman Educational Books.

Maldonado-Molina, M.M., Reingle, J.M., Jennings, W.G., 2011. Does alcohol use predict violent behaviors? The relationship between alcohol use and violence in a nationally representative longitudinal sample. Youth Violence Juv. Justice 9, 99-111.

Marsden, J., Eastwood, B., Bradbury, C., Dale-Perera, A., Farrell, M., Hammond, P., Knight, J., Randhawa, K., Wright, C., National Drug Treatment Monitoring System Outcomes Study Group, 2009. Effectiveness of community treatments for heroin and crack cocaine addiction in England: a prospective, in-treatment cohort study. The Lancet 374, 1262-1270.

Marsden, J., Eastwood, B., Wright, C., Bradbury, C., Knight, J., Hammond, P., National Drug Treatment Monitoring System Outcomes Study Group, 2011. How best to measure change in evaluations of treatment for substance use disorder. Addiction 106, 294-302.

Marsden, J., Eastwood, B., Jones, H., Bradbury, C., Hickman, M., Knight, J., Randhawa, K., White, M., National Drug Treatment Monitoring System Outcomes Study Group, 2012. Risk adjustment of heroin treatment outcomes for comparative performance assessment in England. Addiction 107, 2161-2172.

Marsden, J., Eastwood, B., Ali, R., Burkinshaw, P., Chohan, G., Copello, A., Burn, D., Kelleher, M., Mitcheson, L, Taylor, S., Wilson, N., Whiteley, C., Day, E., 2014. Development of the Addiction Dimensions for Assessment and Personalised Treatment (ADAPT). Drug Alcohol Depend. 139: 121-131.

McFarlane, A.C., 1998. Epidemiological evidence about the relationship between PTSD and alcohol abuse: the nature of the association. Addict. Behav. 23, 813-825.

McSweeney, T., 2015. Calling time on ‘alcohol-related’ crime? Examining the impact of court-mandated alcohol treatment on offending using propensity score matching. Criminology and Criminal Justice 15, 464-483.

McLachlan, G., Peel, D.A., 2000. Finite Mixture Models. New York: Wiley.

Millar, T., Jones, A., Donmall, M., Roxburgh, M., 2008. Changes in offending following prescribing treatment for drug misuse. Research briefing: RB35. National Treatment Agency for Substance Misuse. http://www.nta.nhs.uk/uploads/nta_changes_in_offending_rb35.pdf (accessed 05.01.16).

Ministry of Justice. 2013. Transforming Rehabilitation: a summary of the evidence on reducing offending. Ministry of Justice Analytical Series. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/243718/evidence-reduce-reoffending.pdf (accessed 05.01.16).

Needham, M., Gummerum, M., Mandeville-Norden, R., Rakestrow-Dickens, J., Mewse, A., Barnes, A., Hanoch, Y., 2015. Association between three different cognitive behavioral alcohol treatment programs and recidivism rates among male offenders: findings from the United Kingdom. Alcohol. Clin. Exp. Res. 39, 1100-1107.

National Institute of Health and Clinical Excellence. 2011. Alcohol-use disorders: diagnosis, assessment and management of harmful drinking and alcohol dependence. Clinical Guideline 115. http://publications.nice.org.uk/alcohol-use-disorders-diagnosis-assessment-and-management-of-harmful-drinking-and-alcohol-cg115 (accessed 05.01.16)

Nylund, K.L., Asparouhov, T., Muthén, B.O., 2007. Deciding on the number of classes in latent class analysis and growth mixture modeling: a Monte Carlo simulation study. Struct. Equat. Model. 14, 535-569.

Nylund, K., Bellmore, A., Nishina, A., and Graham, S., 2007. Subtypes, severity, and structural stability of peer victimization: What does latent class analysis say? Child Development, 78, 1706–1722.

Office for National Statistics, 2015. Crime Statistics, Focus on Violent Crime and Sexual Offences, 2013/14. http://www.ons.gov.uk/ons/rel/crime-stats/crime-statistics/focus-on-violent-crime-and-sexual-offences--2013-14/index.html (accessed 05.01.16).

Pierce, M., Bird S., Hickman, M., Marsden, J., Dunn, G., Jones, A., Millar, T., 2015. Impact of treatment for opioid dependence on fatal drug-related poisoning: a national cohort study in England. Addiction, doi: 10.1111/add.13193. [Epub ahead of print].

Polaschek, D.L.L., Collie, R.M., 2004. Rehabilitating serious violent adult offenders: An empirical and theoretical stocktake. Psychology, Crime and Law, 10, 321-334.

Prekker, M.E., Miner, J.R., Rockswold, E.G., Biros, M.H., 2009. The prevalence of injury of any type in an urban emergency department population. J. Trauma 66, 1688-1695.

Public Health England, 2013. Confidentiality toolkit. http://www.nta.nhs.uk/uploads/ndtmsconfidentialitytoolkitv6.3.pdf (accessed 05.01.16).

Public Health England, 2014a. Adult alcohol statistics from the National Drug Treatment Monitoring System (NDTMS), 1st April 2013 to 31st March 2014. http://www.nta.nhs.uk/uploads/adult-alcohol-statistics-report-2013-14.pdf (accessed 05.01.16).

Public Health England, 2014b. Adult drug statistics from the National Drug Treatment Monitoring System (NDTMS), 1st April 2013 to 31 March 2014. http://www.nta.nhs.uk/uploads/adult-drug-statistics-from-the-national-drug-treatment-monitoring-system-2013-14.pdf (accessed 05.01.16).

Quigley, B., Leonard E., 2000. Alcohol Use and Violence Among Young Adults. National Institute on Alcohol Abuse and Alcoholism, National Institute of Health.

Race Relations (Amendment) Act 2000. http://www.legislation.gov.uk/ukpga/2000/34/contents (accessed 05.01.16).

Rehm, J., Baliunas, D., Borges, G., Graham, K., Irving, H., Kehoe, T., Parry, C., Patra, J., Popova, S., Poznyak, V., Room, R., Samokhvalov, A., Taylor, B., 2010. The relation between different dimensions of alcohol consumption and burden of disease: an overview. Addiction 105, 817-843.

Rehm, J., Mathers, C., Popova, S., Thavorncharoensap, M., Teerawattananon, Y., Patra, J., 2009. Global burden of disease and injury and economic cost attributable to alcohol use and alcohol-use disorders. The Lancet 373, 2223-2233.

Rossow, I., 2001. Alcohol and homicide: a cross-cultural comparison of the relationship in 14 European countries. Addiction 96 Suppl 1, S77-92.

Rubin, D.B., 1987. Multiple Imputation for Nonresponse in Surveys. New York: Wiley.

Sahai, H., Khurshid, A., 1993. Confidence Intervals for the Mean of a Poisson Distribution: A Review. Biometrical J., 35, 857-867.

Smith, K., Taylor, P., Elkin, M., 2013. Crimes detected in England and Wales 2013/13. Home Office Statistical Bulletin. HOSB: 02/13. Crown Copyright: Home Office.

Sterne, J.A.C., White, I.R., Carlin, J.B., Spratt, M., Royston, P., Kenward, M.G., Wood, A.M., Carpenter, J.R., 2009. Multiple imputation for missing data in epidemiological and clinical research: potential and pitfalls. BMJ, 338, b2393.

Taylor, B., Rehm, J., 2012. The relationship between alcohol consumption and fatal motor vehicle injury: high risk at low alcohol levels. Alcohol. Clin. Exp. Res. 36, 1827-1834.

von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP; STROBE Initiative. 2007. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. Lancet 370, 1453-1457.

Warburton AL, Shepherd JP., 2004. Development, utilisation, and importance of accident and emergency department derived assault data in violence management. Emerg. Med. J. 21, 473-477.

Wells-Parker, E., Williams, M., 2002. Enhancing the effectiveness of traditional interventions with drinking drivers by adding brief individual intervention components. J. Stud. Alcohol 63, 655-664.

White, M., Burton, R., Darke, S., Eastwood, B., Knight, J., Millar, T., Musto, V., Marsden, J., 2015. Fatal opioid poisoning: a counterfactual model to estimate the preventive effect of treatment for opioid use disorder in England. Addiction 110, 1321-1329.

World Health Organisation, 2007. WHO Expert Committee on Problems Related to Alcohol Consumption (WHO technical report series; no 944; second report). Geneva: WHO.

World Health Organisation, 2014. Global status report on alcohol and health. World Health Organisation. Geneva: WHO.

Table 1
Cohort description, treatments received and status at end of two-year follow-up (N=53,017).

Characteristic	Pre-treatment offenders (11,742; 22%)	Pre-treatment non-offenders (41,275; 78%)	Total 53,017
Social/demographics			
No. (%) male	8,901 (75.8)	24,823 (60.1)	33,724 (63.6)
Mean age (SD; range 18-92 years)	37.0 (10.8, 18-82)	43.4 (11.3, 18-92)	42.0 (11.5, 18-92)
No. (%) non-White UK ethnic group	510 (4.5)	2,038 (5.2)	2,548 (5.0)
No. (%) at each quintile, deprivation index [a]			
1 (least deprived)	2,380 (20.3)	8,269 (20.0)	10,649 (20.1)
2	2,319 (19.7)	8,396 (20.3)	10,715 (20.2)
3	2,264 (19.3)	7,832 (19.0)	10,096 (19.0)
4	2,354 (20.0)	8,576 (20.8)	10,930 (20.6)
5 (most deprived)	2,425 (20.7)	8,202 (19.9)	10,627 (20.0)
No. (%) self-reported housing problem	1,994 (20.6)	4,063 (11.7)	6,057 (13.7)
Clinical description			
No. (%) previously treated for AUD [b]	2,427 (20.7)	5,820 (14.1)	8,247 (15.6)
No. (%) referred by criminal justice system	2,587 (22.4)	1,130 (2.8)	3,717 (7.1)
No. (%) alcohol used past month at each tertile (grams; range 0-28,000 grams):			
Abstinent	1,175 (11.8)	3,989 (11.2)	5,164 (11.3)
1 (8-2,496)	2,974 (29.8)	10,548 (29.7)	13,522 (29.7)
2 (2,520-5,376)	2,688 (26.9)	11,258 (31.7)	13,946 (30.6)
3 (>5,400)	3,156 (31.6)	9,764 (27.5)	12,920 (28.4)
Treatment received during follow-up [c]			
No. (%) inpatient withdrawal management	1,312 (11.2)	5,007 (12.1)	6,319 (11.9)
No. (%) residential rehabilitation	578 (4.9)	1,804 (4.4)	2,382 (4.5)
No. (%) pharmacological interventions	1,163 (9.9)	4,881 (11.8)	6,044 (11.4)
No. (%) psychological interventions	11,123 (94.7)	38,257 (92.7)	49,380 (93.1)
Median treatment exposure, weeks (IQR) [d]	25.00 (34.29)	22.29 (33.43)	23.14 (33.57)
Treatment status at end of follow-up			
No. (%) still enrolled in index treatment	347 (3.0)	1,654 (4.0)	2,001 (3.8)
No. (%) completed treatment successfully	5,321 (45.3)	20,318 (49.2)	25,639 (48.4)
No. (%) dropped out	5,750 (49.0)	19,155 (46.4)	24,905 (47.0)
No. (%) prison terminated treatment	324 (2.8)	148 (0.4)	472 (0.9)
No. (%) re-admitted to treatment	3,659 (31.2)	10,352 (25.1)	14,011 (27.5)[e]

SD, standard deviation; AUD, alcohol use disorder; IQR, inter-quartile range.

[a] Indices of Multiple Deprivation (2010); [b] Two years before treatment admission; [c] Received during the two-year follow-up; [d] Total time in treatment during follow-up; [e] Among those who were discharged from treatment.

Table 2
Unconditional latent profile analysis of offence categories by offenders at admission to treatment (n=11,742)

	Model [a]				
Parameter	1-*class*	2-*class*	3-*class*	4-*class*	5-*class*
No. of parameters	9	19	29	39	49
AIC	174,192.44	156,194.01	150,338.83	146,927.39	144,849.26
BIC	174,258.78	156,334.06	150,552.59	147,214.86	145,210.44
aBIC	174,230.18	156,273.68	150,460.43	147,090.92	145,054.72
Change in aBIC (%)	-	-10.3	-3.7	-2.2	-1.4
Entropy	-	0.92	0.89	0.89	0.87
BLRT	-	18,018.43	5,875.18	3,431.44	2,098.13
Reduction in BLRT (%)	-	-	-67.6	-41.9	-38.9
Class count (probability)					
1	-	0.113 (0.886)	0.797 (0.993)	0.786 (0.991)	0.100 (0.846)
2	-	0.887 (0.992)	0.104 (0.838)	0.097 (0.804)	0.053 (0.839)
3	-	-	0.100 (0.892)	0.051 (0.867)	0.748 (0.984)
4	-	-	-	0.065 (0.822)	0.013 (0.924)
5	-		-	-	0.086 (0.733)

AIC, Akaike Information Criterion;
BIC, Bayesian Information Criterion;
aBIC, sample-size adjusted BIC;
BLRT, bootstrapped likelihood ratio test (all P<0.00005);

[a] For nine crime types: violence, driving under the influence, acquisitive, other, criminal damage, public order, other driving, illicit drugs and weapons (see Table 1 for details)
[b] Classification of offenders based on most likely latent class membership.

Table 3
Number of offenders and mean number of offences recorded in the two-years after admission, by offender latent class (n=11,742)

Offenders/Offences	Latent class [a]				Total [d]
	Class 1: General	*Class* 2: Driver	*Class* 3: Violent	*Class* 4: Acquisitive	
Number of offenders					
Pre-treatment	9,232	1,140	602	768	11,742
Post-treatment	3,739	505	506	599	8,983
Change (%)	-59.5	-55.7	-15.9	-22.0	-23.5
Re-conviction for characteristic offence (%) [b]	-	11.7	77.6	58.3	-
Mean offences					
Pre-treatment	18,070	5,044	7,289	7,205	37,608
Post-treatment	11,628	1,696	4,438	3,812	28,585
Change (%)	-35.7	-66.4	-39.1	-47.1	-24.0
Effect size (95% CI) [c]	0.33 (0.29-0.36)	1.13 (1.04-1.22)	0.61 (0.49-0.72)	0.77 (0.66-0.87)	0.36 (0.33-0.38)

[a] Class determination via latent profile analysis of the count of nine types of offences in the two-years before treatment;
[b] Re-conviction within the two-year follow-up as follows:
Class 2 – DWI and other driving offences;
Class 3 – robbery, sexual offences, public order, violent disorder and affray;
Class 4 – theft, burglary, fraud and forgery;
[c] Within-class and overall change in offences (Cohen's *d*);
[d] This includes 3,634 pre-treatment non-offenders who were convicted after admission and added 7,011 offences to the total count.

Table 4
Number of offences in the two-years before treatment and after admission by offence type and offender latent class

Offence	Latent class [a]						
	Non offenders (n=41,275)	*Class* 1: General (n=9,232)	*Class* 2: Driver (n=1,140)	*Class* 3: Violent (n=602)	*Class* 4: Acquisitive (n=768)	Total	Crude rate per 1,000 (95% CI) [b]
Violence [c]							
Pre-treatment	-	6,916	392	1,688	718	9,714	183.2 (179.6-186.9)
Post-treatment	2069	3,506	380	935	545	7,435	140.2 (137.1-143.5)
% difference	-	-49%	-3%	-45%	-24%	-23%	
Public order							
Pre-treatment	-	1,609	125	2,740	360	4,834	91.2 (88.6-93.8)
Post-treatment	681	1,825	167	1,902	453	5,028	94.8 (92.2-97.5)
% difference	-	13%	34%	-31%	26%	4%	
DWI							
Pre-treatment	-	2,224	1,098	21	125	3,468	65.4 (63.3-67.6)
Post-treatment	1076	440	106	18	42	1,682	31.7 (30.2-33.3)
% difference	-	-80%	-90%	-14%	-66%	-51%	
Other driving							
Pre-treatment	-	0	2,502	17	435	2,954	55.7 (53.7-57.8)
Post-treatment	415	413	292	25	129	1,274	24.0 (22.7-25.4)
% difference	-	-	-88%	47%	-70%	-57%	
Criminal damage							
Pre-treatment	-	2,148	172	751	397	3,468	65.4 (63.6-67.6)
Post-treatment	620	1,135	115	265	218	2,353	44.4 (42.6-46.2)
% difference	-	-47%	-33%	-65%	-45%	-32%	
Acquisitive [d]							
Pre-treatment	-	1,905	327	705	3,625	6,562	123.8 (120.8-126.8)
Post-treatment	1043	2,155	342	628	1,722	5,890	111.1 (108.3-114.0)
% difference	-	13%	5%	-11%	-52%	-10%	
Illicit drug [e]							
Pre-treatment	-	686	99	120	222	1,127	21.3 (20.0-22.5)
Post-treatment	251	442	82	71	136	982	18.5 (14.1-16.2)
% difference	-	-36%	-17%	-41%	-39%	-13%	
Weapons [f]							
Pre-treatment	-	576	46	75	103	800	15.1 (14.1-16.2)
Post-treatment	183	248	21	44	60	556	10.5 (9.6-11.4)
% difference	-	-57%	-54%	-41%	-42%	-31%	
Other							
Pre-treatment	-	2,006	283	1,172	1,220	4,681	88.3 (85.8-90.9)
Post-treatment	673	1,464	191	550	507	3,385	63.8 (61.7-66.0)
% difference	-	-27%	-33%	-53%	-58%	-28%	

DWI, driving while intoxicated;

[a] Latent class using count of nine types of offences in the two-years before treatment;
[b] 53,017 as denominator and Byar's approximation to calculate CIs (Breslow and Day, 1987);
[c] Including theft, burglary, fraud and forgery;
[d] Including breach offences, and obstructing justice;
[e] Possession or supply;
[f] Possession or use.

Table 5
Unadjusted and adjusted mixed-effects Poisson model of post-treatment offending.

Covariate	Unadjusted, complete case IRR (n=8,475)	Adjusted, complete case IRR (n=8,475)	Imputed, all cases IRR (n=11,742)
Number of offences before treatment	**1.11 (1.11, 1.11)**	**1.07 (1.07, 1.07)**	**1.07 (1.07, 1.07)**
Offender latent class [a]			
Driver	**1.22 (1.14, 1.29)**	0.97 (0.91, 1.03)	**0.93 (0.89, 0.98)**
Violent	**5.84 (5.59, 6.11)**	**2.01 (1.89, 2.14)**	**1.94 (1.84, 2.04)**
Acquisitive	**3.81 (3.64, 3.99)**	**1.64 (1.55, 1.73)**	**1.65 (1.57, 1.72)**
Social/Demographics			
Male	**1.66 (1.59, 1.74)**	**1.29 (1.18, 1.40)**	**1.30 (1.22, 1.40)**
Age [b]	**0.88 (0.87, 0.88)**	**0.88 (0.86, 0.90)**	**0.89 (0.88, 0.91)**
Male x age interaction	**1.02 (1.00, 1.05)**	**1.04 (1.01, 1.06)**	**1.03 (1.01, 1.04)**
Non-White UK ethnic group	**1.09 (1.01, 1.18)**	0.97 (0.90, 1.05)	**1.09 (1.02, 1.18)**
Deprivation index; quintile [c]			
2	1.07 (0.98, 1.16)	0.96 (0.88, 1.04)	0.94 (0.88, 1.00)
3	**1.09 (1.01, 1.19)**	0.92 (0.85, 1.00)	**0.91 (0.85, 0.98)**
4	**1.34 (1.24, 1.46)**	**1.10 (1.02, 1.20)**	1.01 (0.94, 1.08)
5 (most deprived)	**1.38 (1.27, 1.50)**	1.02 (0.94, 1.11)	0.99 (0.92, 1.06)
Housing problem	**1.93 (1.86, 2.00)**	**1.30 (1.25, 1.35)**	**1.25 (1.20, 1.32)**
Clinical description			
Previously treated for AUD	**1.29 (1.24, 1.34)**	**1.11 (1.06, 1.15)**	**1.12 (1.09, 1.16)**
Referred by CJS	**1.62 (1.56, 1.68)**	**1.11 (1.07, 1.16)**	**1.09 (1.05, 1.14)**
Mean alcohol use past month (tertile grams):[d]			
1 (8-2,496)	**0.92 (0.86, 0.99)**	1.03 (0.96, 1.10)	1.01 (0.93, 1.10)
2 (2,520-5,376)	1.04 (0.98, 1.12)	**1.10 (1.02, 1.17)**	1.04 (0.96, 1.12)
3 (>5,400)	**1.33 (1.25, 1.42)**	**1.24 (1.16, 1.33)**	**1.16 (1.07, 1.26)**
Treatment received during follow-up [e]			
Inpatient withdrawal management	**0.91 (0.86, 0.95)**	**0.84 (0.80, 0.89)**	**0.88 (0.83, 0.92)**
Residential rehabilitation	1.06 (0.98, 1.14)	0.93 (0.87, 1.01)	0.95 (0.89, 1.01)
Pharmacological intervention	**0.90 (0.85, 0.96)**	**0.89 (0.84, 0.96)**	**0.93 (0.88, 0.98)**
Psychological intervention	**1.23 (1.13, 1.34)**	0.97 (0.88, 1.07)	0.94 (0.87, 1.02)
Total treatment exposure [f]	**1.36 (1.27, 1.46)**	**1.00 (1.00, 1.00)**	**1.00 (1.00, 1.00)**
Treatment status at end of follow-up [g]			
Still enrolled in index treatment [h]	**0.81 (0.74, 0.90)**	**0.81 (0.72, 0.91)**	**0.89 (0.80, 0.98)**
Completed treatment successfully	**0.68 (0.65, 0.70)**	**0.82 (0.79, 0.85)**	**0.82 (0.80, 0.85)**
Prison terminated treatment	**2.76 (2.59, 2.93)**	**1.65 (1.55, 1.76)**	**1.69 (1.60, 1.79)**
Re-admitted to treatment	**1.72 (1.66, 1.77)**	**1.43 (1.37, 1.48)**	**1.46 (1.42, 1.51)**
Adjusted model statistics	-		
Intercept (95% CI)	-	0.90 (0.77, 1.04)	0.99 (0.86,1.13)
Random effects parameter (area, Level 2)	-	**0.17**	**0.13 - 0.17**
Wald χ^2	-	13522	13,522- 18,623

IRR, incident rate ratio (95% CI); bold face, P<0,05);

[a] Referent is Class 1: General offence pattern;
[b] Centred at age 18, grouped in 5 year increments;
[c] Referent is quintile 1 (least deprived area); [d] referent groups is abstainer (28 days before admission);
[e] During follow-up; [f] Mean weeks in treatment during follow-up;
[g] Referent is dropped out from index treatment;
[h] Index treatment is first intervention received during follow-up.

SUPPLEMENTARY MATERIAL

Table S1
Multinomial logistic regression contrasting offender classes (n=11,742) and non-offenders (n=41,275)

Covariate	*Class* 1: *General* (n=9,232; 78.6%)	*Class* 2: *Driver* (n=1,140; 9.7%)	*Class* 3: *Violent* (n=602; 5.1%)	*Class* 4: *Acquisitive* (n=768; 6.5%)
Social/demographics				
Male	**1.78 (1.67, 1.89)**	**3.57 (2.92, 4.37)**	**1.96 (1.52, 2.51)**	**2.63 (2.06, 3.35)**
Age [a]	**0.82 (0.81, 0.83)**	**0.79 (0.76, 0.82)**	**0.74 (0.70, 0.77)**	**0.64 (0.61, 0.67)**
Non-White UK ethnic	**0.75 (0.66, 0.86)**	1.09 (0.81,1.47)	1.05 (0.69, 1.61)	0.88 (0.59, 1.33)
IMD by quintile [b]				
2	0.95 (0.87, 1.03)	0.95 (0.87, 1.03)	0.96 (0.67, 1.36)	1.15 (0.84, 1.56)
3	0.99 (0.91, 1.09)	0.99 (0.91, 1.09)	1.16 (0.82, 1.63)	1.15 (0.84, 1.56)
4	**0.89 (0.81, 0.97)**	**0.89 (0.81, 0.97)**	1.09 (0.78, 1.52)	0.90 (0.66, 1.23)
5 (most deprived)	**0.91 (0.83, 0.99)**	**0.91 (0.83, 0.99)**	**1.55 (1.14, 2.12)**	**1.59 (1.21, 2.10)**
Housing problem	**1.45 (1.34, 1.56)**	1.16 (0.95, 1.40)	**3.76 (3.05, 4.64)**	**3.05 (2.52, 3.70)**
Clinical description				
Previously treated [b]	**1.72 (1.60, 1.84)**	**1.60 (1.33, 1.92)**	**3.90 (3.14, 4.85)**	**2.26 (1.82, 2.81)**
Referred by CJS	**7.04 (6.39, 7.75)**	**10.86 (9.10, 12.95)**	**16.10 (12.80, 20.26)**	**14.52 (11.81, 17.85)**
Alcohol used past month; tertile (gram) [c]				
1 (8-2,496)	1.07 (0.97, 1.19)	1.11 (0.84, 1.45)	0.79 (0.55, 1.12)	**0.59 (0.42, 0.81)**
2 (2,520-5,376)	0.96 (0.86, 1.06)	1.20 (0.91, 1.57)	0.81 (0.56, 1.16)	0.75 (0.55, 1.03)
3 (>5,400)	**1.12 (1.01, 1.25)**	1.27 (0.97, 1.66)	1.14 (0.81, 1.60)	1.16 (0.86, 1.56)

Numbers in table are relative risk ratios (95% confidence intervals);
Referent = non-offenders;
IMD, indicators of multiple deprivation;
CJS, criminal justice system;

[a] Centred at 18 years and grouped in 5 year increments
[b] Reference category is first quintile (least deprived);
[c] Reference group is past month alcohol abstainer.