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The impact of opioid substitution therapy on mortality post-release from prison: retrospective data linkage study

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ABSTRACT

Aims Release from prison is a high-risk period for mortality. We examined the impact of opioid substitution therapy (OST), for opioid dependence during and after incarceration, upon mortality post-release. **Design** A cohort was formed of all opioid-dependent people who entered OST between 1985 and 2010 and who, following first OST entry, were released from prison at least once between 2000 and 2012. We linked data on OST history, court and prison records and deaths. **Setting** New South Wales (NSW), Australia. **Participants** A total of 16 453 people released from prison 60 161 times. **Measurements** Crude mortality rates (CMRs) were calculated according to OST retention; multivariable Cox regressions for post-release periods were undertaken to examine the association between OST exposure (a time-dependent variable) and mortality post-release, for which covariates were updated per-release. **Findings** There were 100 978 person-years (PY) post-release; 1050 deaths occurred. Most received OST while incarcerated (76.5%); individuals were receiving OST in 51% of releases. Lowest post-release mortality was among those continuously retained in OST post-release CMR 4 weeks post-release = 6.4 per 1000 PY; 95% confidence interval (CI) = 5.2, 7.8, highest among those with no OST (CMR = 36.7 per 1000 PY; 95% CI = 28.8, 45.9). Multi-factorial models showed OST exposure in the 4 weeks post-release reduced hazard of death by 75% (adjusted hazard ratio 0.25; 95% CI = 0.12, 0.53); OST receipt in prison had a short-term protective effect that decayed quickly across time. **Conclusion** In New South Wales, Australia, opioid substitution therapy in prison and post-release appears to reduce mortality risk in the immediate post-release period.

Key words Crime, data linkage, mortality, opioid dependence, opioid substitution therapy, prison, treatment.

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INTRODUCTION

Illicit opioid dependence has significant impacts upon public health and public order [1], and is thought to be responsible for the greatest health burden of all illicit drugs [2,3]. Opioid-dependent people have significantly elevated mortality compared to the general population [4,5]. A systematic review of mortality among heroin-dependent cohorts estimated a pooled all-cause crude mortality rate (CMR) of 2.1 per 100 person-years [confidence interval (CI) = 1.9, 2.3]; the pooled standardized mortality ratio (SMR) was 14.7 (CI = 12.8, 16.5) [5].

The mainstay of treatment for opioid dependence is opioid substitution therapy (OST), with strong evidence that it is effective in reducing HIV risk and incidence [6,7], reducing opioid and other drug use and offending

behaviour and improving physical and mental health and social functioning [8–10]. In addition to these other benefits, OST also reduces mortality risk [4,11–15]: the mortality rate among opioid-dependent people when in treatment is estimated to be half that when not in treatment [5].

Studies examining the mortality risk of opioid-dependent prisoners in the post-release period have unequivocally shown high death rates from drug overdose and suicide in the first weeks post-release [16–24]. There is evidence that this heightened risk is attributable to low opioid tolerance and ongoing psychological, medical and social problems [16,25]. Prisoners with a history of opioid dependence often return to an environment with little structure, significant social and economic challenges and continual triggers for returning to heroin use [25].

Provision of OST to opioid-dependent individuals in prisons varies internationally, with increasing treatment availability in many European prison systems, but very low levels in US and Asian prison systems [26–29], making this an internationally relevant issue. No study to date has reported the impact of OST treatment during and after incarceration upon mortality in the first month post-release. Reviews of evidence on OST provision in prison have highlighted a need for careful study of the mortality impact of OST in both prison and post-release, arguing that evidence is neither sufficiently powerful nor robust to make clear conclusions about its mortality impact [30].

The current study used linked data on a cohort of opioid-dependent people who had been released from prison to examine the potential impact of OST post-release. Specifically, we linked data for all people entering OST for treatment of opioid dependence in New South Wales (NSW), Australia, between 1985 and 2010 with data on court appearances, prison episodes and mortality. We focus here on those cohort members who were released from prison at least once between January 2000 and March 2012. We examine the impact of OST exposure in prison and post-release on mortality immediately post-release and over the longer term.

METHODS

Ethical review

Approval for this study was obtained from the University of NSW, NSW Health's Population and Health Services Research Ethics Committee, the Australian Institute of Health and Welfare, the Alfred Hospital (Melbourne), Corrective Services NSW, Justice Health NSW, the NSW Aboriginal Health and Medical Research Council (AHMRC) and the Department of Justice Health Research Ethics Committee (Victoria).

Data sources

This study utilized three fully identified NSW and national administrative data sets that record information regarding opioid substitution treatment, involvement in the criminal justice system and mortality.

Opioid substitution treatment

Since 1985, the Pharmaceutical Drugs of Addiction System (PHDAS) has been a database of all methadone and buprenorphine recipients in NSW, Australia. The PHDAS records each patient's full name, date of birth, sex and postcode of residence. As proof of patient identity is required to be shown to the prescribing doctor before a prescription can be issued, the name and date of birth variables are of high accuracy in this data set. The PHDAS records patient admissions and exits from the treatment programme, and the medication dispensed.

Offending and incarceration

The Reoffending Database (ROD) is a data set maintained by the NSW Bureau of Crime Statistics and Research (BOCSAR) and contains records of all finalized court appearances in the Local, District and Supreme Courts of NSW since 1994. The ROD also contains incarceration records from the NSW Department of Corrective Services from 2000.

Mortality

The National Death Index (NDI) is a database held by the Australian Institute of Health and Welfare (AIHW) and contains mortality data collected from each Australian State or Territory Registry of Births, Deaths and Marriages. Causes of death recorded in the NDI are determined by expert clinical coders at the Australian Bureau of Statistics on the basis of information contained in death certificates and, where available, coronial files. Dates of death were available for all deaths occurring during the entire period of analysis (between 2000 and March 2012), but causes of death were available only from January 2000 and December 2010.

Data linkage and cohort definition

Linkage between the PHDAS and ROD was performed by BOCSAR staff, and linkage between the PHDAS and NDI was undertaken by AIHW staff. Linkage was completed using probabilistic linkage software. Variables used for matching purposes included full name, date of birth, sex and, where available, date and state of last known contact. These linked data sets were forwarded to the investigators with identifiers removed.

A cohort was constructed that included all people with an eligible episode of OST from 1985 to March 2012

who had also been released from prison at least once between January 2000 (the earliest date for which incarceration data were available) and March 2012. We used the first recorded OST episode as a proxy for the onset of opioid dependence. We analysed incarceration episodes that occurred during or following the first OST episode. We included all eligible prison releases for an individual. We focused on releases on or after 1 January 2000, as that was the date when incarceration records became available; cause of death data were available only to 31 December 2010, but fact of death was available to 31 March 2012.

Definitions and data analysis

New episodes of OST were defined as those that commenced 7 or more days after discharge from a previous OST episode [31,32]. A change in medication (methadone to buprenorphine, or vice versa) was considered a continuous episode if there were fewer than 7 days between ceasing one medication and commencing the other. 'Ineligible' episodes of OST were those that were noted as temporary programmes (usually interstate visitors) or were part of a buprenorphine clinical trial (during which the individual may have been allocated to placebo and therefore may not have received buprenorphine).

Deaths were coded using the International Classification of Diseases and Related Health Problems, 10th edition (ICD-10). Specific causes of death examined were accidental drug-induced deaths, suicides, accidental injury deaths and violent deaths. ICD-10 codes used to define each cause of death are provided in (Supporting information, Table S1).

Criminal offences were coded according to the Australian and New Zealand Standard Offence Classification (ANZSOC) [33] and property, violent and drug offence categories were defined by BOCSAR in its standard crime statistic reporting [34]. ANZSOC codes and offences in each offence category are provided in (Supporting information, Table S2).

Statistical analyses were undertaken in SAS version 9.3 [35]. Demographics, incarceration histories and OST histories of the cohort were examined descriptively. Frequency histograms were constructed to present numbers of post-release deaths in the first week, month and year following prison release.

CMRs with 95% Poisson confidence intervals were calculated for all time at release and whether released onto OST. Given that the outcome of interest was risk of death following release from prison, person-years at risk began to accrue from the day of first release from prison, and continued to accrue during all time out of prison (i.e. time incarcerated was excluded from person-years). Person-years ceased accruing at death or 31 March 2012 for all-cause mortality rates, and 31 December 2010 for cause-specific mortality rates.

We used Cox regression to examine the association between OST exposure and mortality in the prison post-release period. Although participants could have multiple observations within the data set, the internal computations of a Cox model are such that when there is only one event of interest per person (in this case, death), there is no need for adjustments for multiple observations [36]. We considered the outcome of all-cause mortality in relation to all time at liberty, and in the first 4 weeks post-release. OST exposure in the post-release period was coded as a time-dependent variable. Other variables tested for their association with post-release mortality were sex, Indigenous status, age at release and variables relating to treatment and criminal justice history (to account for potential differences in mortality risk among people with differing histories of criminal involvement, e.g. violent crime). We tested each variable for its bivariate association with post-release mortality, then entered all variables into a multi-factorial model. We tested the proportional hazards assumption for each static predictor in the multi-factorial model by including an interaction between it and log(time) in the model, with time measured in days. If the interaction was significant at $P < 0.05$ the predictor was considered to violate the proportional hazards assumption, and the interaction was retained in the model. We then tested the statistical significance of interactions between post-release OST exposure and significant variables that remained in the multi-factorial model. This was to test whether there were differing associations between being in OST and mortality risk for different groups. Each interaction was entered into the main-effect multi-factorial model separately, and interactions significant at $P < 0.05$ were retained in the final multi-factorial model.

RESULTS

The cohort comprised 16 453 people who had received OST for opioid dependence and were released from prison at least once between January 2000 and March 2012 (Table 1). The majority of the cohort were men (78.7%) and 29.9% of the cohort were identified as Indigenous. The median age of first incarceration during the observation period was 30 years, ranging between 14 and 64 years. The majority of individuals were prescribed OST at some point while incarcerated (76.5%; $n = 12\,650$). Individuals were released from prison on 60 161 occasions and were in receipt of OST upon release in 51% of releases ($n = 30\,397$; Table 2).

Cohort members were observed for 100 978 person-years at liberty (PY) from their first recorded prison

Table 1 Characteristics of people with a history of opioid dependence ($n = 16\,453$) who had at least one prison episode, 2000–12.

	n = 16 453	
Demographic variables	*n*	*% (min–max)*
Male	12 945	78.7
Indigenous	4 919	29.9
Treatment variables		
Ever received OST in prison	12 650	76.5
Received OST for the first time in prison	3 372	20.5
Ever released while receiving OST	11 100	67.1
Criminogenic variables		
Median age (min–max) at first recorded criminal charge[b]	23 years	(10–64)[a]
Median age (min–max) at first incarceration during the study period[b]	30 years	(14–64)
Previous history of a juvenile offence (under 18 years)[b]	3 998	24.6[a]
Median (min–max) number of prior charges at baseline	13	(0–304)
Median (min–max) number of incarcerations during observation	3	(1–35)
Any property offence during observation period	8 201	49.8
Any violent offence during observation period	6 670	40.5
Any drug offence during observation period	6 055	36.8

[a]Data missing for 188 participants. [b]Note that this is the first recorded age of these variables (2000 for custody data and 1993 for criminal charges data). However, data on age of incarceration were available prior to 2000 for those people still in custody as at 1 January 2000. OST = opioid substitution therapy.

Table 2 Characteristics of incarceration episodes and prison releases among people with a history of opioid dependence who were imprisoned at least once ($n = 16\,453$), 2000–12.

	n = 16 453
	n (%)
Number of incarceration episodes	62 262
Median length (min–max) of completed incarceration episodes ($n = 58\,462$)	68 days (1–4447)
Number of prison releases	60 161
Number of prison releases by year	
2000	4 423
2001	5 253
2002	4 863
2003	5 039
2004	4 930
2005	5 154
2006	5 188
2007	5 372
2008	4 217
2009	4 719
2010	4 785
2011	5 023
2012 (January–March)	1 195
Number (%) of incarceration episodes where OST was received in prison	36 316 (58%)[a]
Methadone	32 962 (53%)
Buprenorphine	4 836 (8%)
Number (%) of incarceration episodes where OST was received on release	30 397 (51%)
Methadone	26 997 (45%)
Buprenorphine	3 400 (6%)

[a]More than one treatment type could be received in an incarceration episode. OST = opioid substitution therapy.

episode, during which time there were 1050 deaths, for a CMR of 10.4 per 1000 PY (95% CI = 9.8–11.0). Figure 1 shows the number of cohort deaths that occurred within 1 week, 4 weeks and 1 year of release from prison. It is apparent that deaths are concentrated within the first month post-release (Fig. 1c), with most of those deaths occurring in the first 2 weeks post-release (Fig. 1b). All-cause and cause-specific CMRs for the first day, first week, first 2 weeks and first 4 weeks post-release are provided in Table 3.

CMRs according to post-release OST exposure

For simplicity of presentation (Fig. 2, Table 3), we defined people according to the extent of their exposure to OST during follow-up for up to the first 4 weeks post-release: none, 'full' (i.e. the whole period) and 'partial' (i.e. only part of that time was spent in OST). If someone died in this period, then they were classified according to their OST history up to the point post-release that they died. If up to the point a person died they had been in OST they were classified as 'retained'; if some time was spent in and out of OST then they were classified as 'partially retained'.

Retention in OST post-release was associated with lower mortality rates (Fig. 2, Table 4). No individuals released from prison on OST died in the first day post-release, but there were four first-day deaths in those released without OST (CMR 49.1 per 1000 PY; 95% CI = 13.4–125.6; Table 4). For those who were fully retained in treatment for the first week post-release (or until death in that period), the CMR was 10.9 per 1000 PY (95% CI = 4.0–23.8), compared to 59.5 per 1000 PY (95% CI = 41.0, 83.6) for releases without OST. The same pattern was observed for the first 2 and 4 weeks post-release, with the lowest mortality rate seen in those with total OST coverage, increasing with partial OST exposure

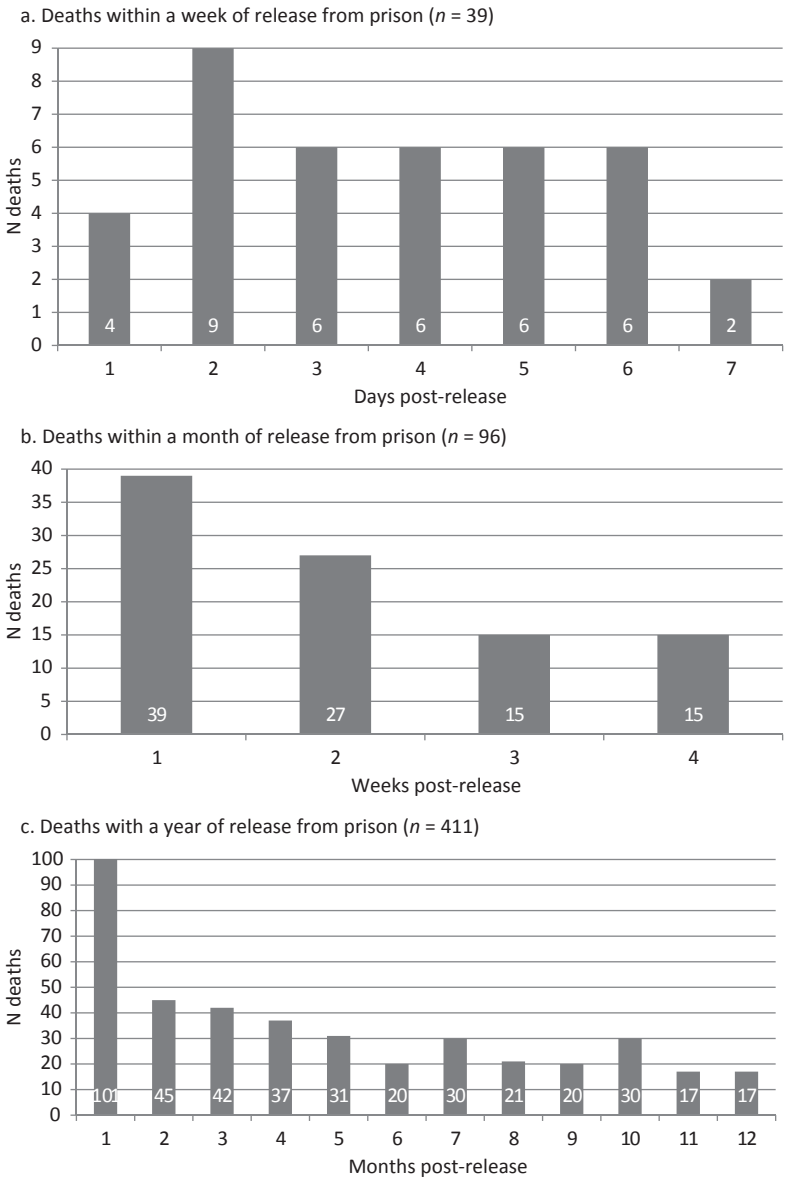

Figure 1 Number of deaths among people with a history of opioid dependence who were released from prison, in the (a) first week, (b) first month and (c) first year following release from prison, 2000–12

during the period of interest, and increasing again in releases with no OST exposure (Table 4). Figure 2 shows the impact of retention in OST on mortality in the first 4 weeks (Fig. 2a) and first year post-release (Fig. 2b) according to the extent of retention in OST for the first 4 weeks post-release.

Predictors of post-release mortality

In unadjusted Cox regression models, post-release OST reduced the hazard of death in the first 4 weeks post-release by 78% [hazard ratio (HR) = 0.22; 95% CI = 0.13, 0.37) (Table 5). In a multi-factorial model adjusted for potential confounders, exposure to OST during the first 4 weeks following release from prison reduced the hazard of death during this time by 75% (adjusted HR = 0.25; 95% CI = 0.12, 0.53). OST receipt in prison had an independent protective effect, which was time-dependent [OST in incarceration × log(time) variable]: having been in OST in prison was initially protective against mortality post-release, but this effect decayed quickly over time.

Similar findings emerged from the Cox regression models examining mortality risk during total time at liberty. In an unadjusted model, OST exposure reduced the hazard of death while at liberty by 78% (HR = 0.22; 95% CI = 0.19, 0.26). In a multi-factorial model, OST exposure following release from prison was associated with an 83% reduction in mortality hazard (adjusted HR = 0.17; 95% CI = 0.14, 0.20). There was again an interaction between OST exposure during incarceration and time: having been in OST prior to release was initially protective against mortality, but this effect decayed significantly over time.

Table 3 Total and cause-specific post-release crude mortality rates per 1000 person-years among incarcerated people with a history of OST, 2000–12.

	Males			*Females*			*Total*		
All deaths (2000–March 2012)	*n*	*PY*	*CMR (95% CI)*	*n*	*PY*	*CMR (95% CI)*	*n*	*PY*	*CMR (95% CI)*
Total	841	77 558	10.8 (10.1, 11.6)	209	23 444	8.9 (7.7, 10.2)	1050	101 003	10.4 (9.8, 11.0)
First day	3	132	22.8 (4.7, 66.6)	1	33	30.2 (0.8, 168.2)	4	165	24.3 (6.6, 62.2)
First week	33	907	36.4 (25.0, 51.1)	6	228	26.3 (9.7, 57.3)	39	1 135	34.4 (24.4, 47.0)
First 2 weeks	59	1 780	33.1 (25.2, 42.8)	7	448	15.6 (6.3, 32.2)	66	2 228	29.6 (22.9, 37.7)
First 4 weeks	85	3 437	24.7 (19.8, 30.6)	11	863	12.7 (6.4, 22.8)	96	4 300	22.3 (18.1, 27.3)
First year	343	26 888	12.8 (11.4, 14.2)	68	7 063	9.6 (7.5, 12.2)	411	33 950	12.1 (11.0, 13.3)
Accidental drug-induced deaths (2000–10)									
Total	312	74 631	4.2 (3.7, 4.7)	69	22 531	3.1 (2.4, 3.9)	381	97 163	3.9 (3.5, 4.3)
First day	2	118	17.0 (2.1, 61.3)	1	30	33.5 (0.8, 186.7)	3	148	20.3 (4.2, 59.4)
First week	21	812	25.8 (16.0, 39.5)	5	206	24.3 (7.9, 56.8)	26	1 018	25.5 (16.7, 37.4)
First 2 weeks	35	1 595	21.9 (15.3, 30.5)	5	403	12.4 (4.0, 28.9)	40	1 999	20.0 (14.3, 27.3)
First 4 weeks	50	3 080	16.2 (12.0, 21.4)	6	778	7.7 (2.8, 16.8)	56	3 858	14.5 (11.0, 18.8)
First year	166	24 031	6.9 (5.9, 8.0)	31	6 342	4.9 (3.3, 6.9)	197	30 373	6.5 (5.6, 7.5)
Suicide deaths (2000–10)									
Total	79	74 631	1.1 (0.8, 1.3)	11	22 531	0.5 (0.2, 0.9)	90	97 163	0.9 (0.7, 1.1)
First day	0	118	–	0	30	–	0	148	–
First week	1	812	1.2 (0.03, 6.9)	0	206	–	1	1 018	1.0 (0.02, 5.5)
First 2 weeks	1	1 595	0.6 (0.02, 3.5	0	403	–	1	1 999	0.5 (0.01, 2.8)
First 4 weeks	3	3 080	1.0 (0.2, 2.8)	0	778	–	3	3 858	0.8 (0.2, 2.3)
First year	19	24 031	0.8 (0.5, 1.2)	3	6 342	0.5 (0.1, 1.4)	22	30 373	0.7 (0.5, 1.1)
Accidental injury deaths (2000–10)									
Total	39	74 631	0.5 (0.4, 0.7)	7	22 531	0.3 (0.1, 0.6)	46	97 163	0.5 (0.3, 0.6)
First day	0	118	–	0	30	–	0	148	–
First week	1	812	1.2 (0.03, 6.9)	0	206	–	1	1 018	1.0 (0.02, 5.5)
First 2 weeks	3	1 595	1.9 (0.4, 5.5)	0	403	–	3	1 999	1.5 (0.3, 4.4)
First 4 weeks	5	3 080	1.6 (0.5, 3.8)	0	778	–	5	3 858	1.3 (0.4, 3.0)
First year	22	24 031	0.9 (0.6, 1.4)	4	6 342	0.6 (0.2, 1.6)	26	30 373	0.9 (0.6, 1.3)
Violent deaths (2000–10)									
Total	22	74 631	0.3 (0.2, 0.4)	10	22 531	0.4 (0.2, 0.8)	32	97 163	0.3 (0.2, 0.5)
First day	0	118	–	0	30	–	0	148	–
First week	0	812	–	0	206	–	0	1 018	–
First 2 weeks	1	1 595	0.6 (0.02, 3.5)	0	403	–	1	1 999	0.5 (0.01, 2.8)
First 4 weeks	2	3 080	0.6 (0.08, 2.3)	0	778	–	2	3 858	0.5 (0.06, 1.9)
First year	13	24 031	0.5 (0.3, 0.9)	5	6 342	0.8 (0.3, 1.8)	18	30 373	0.6 (0.4, 0.9)

CMR = crude mortality rate; PY = person-years; CI = confidence interval; OST = opioid substitution therapy. Person-years accrued from date of first observed release from prison and ceased at/during re-incarceration and at death.

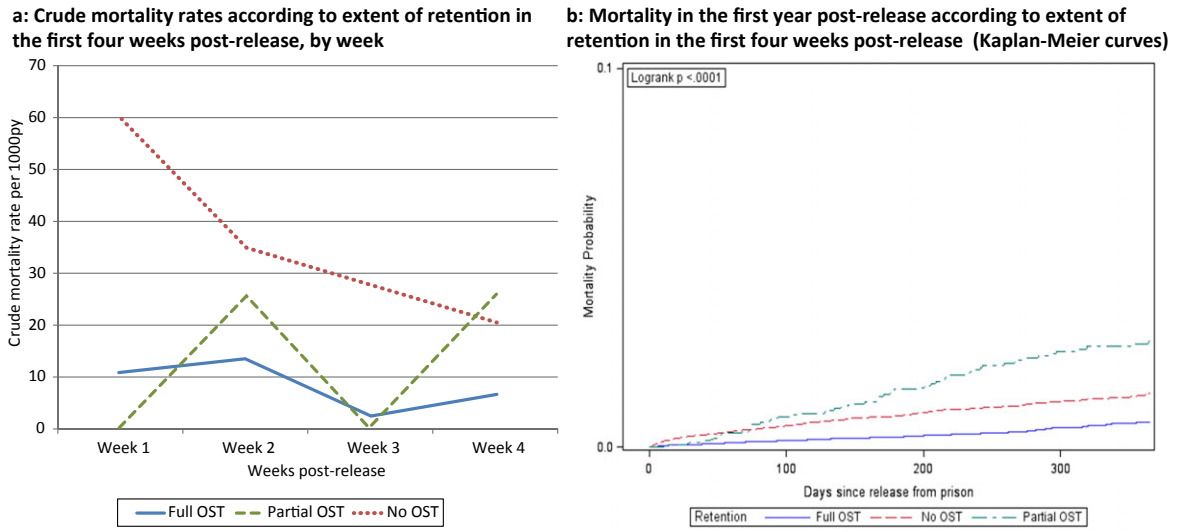

Figure 2 All-cause mortality post-prison release among people ($n = 14\,532$) with a history of opioid dependence ($n = 60\,161$ prison releases), according to extent of retention in opioid substitution therapy (OST) in the immediate post-release period, 2000–12. (a) Crude mortality rates according to extent of retention in the first 4 weeks post-release, by week. (b) Mortality in the first year post-release according to extent of retention in the first 4 weeks post-release (Kaplan–Meier curves). Retention in (b) refers to whether an individual received OST for all, some or none of the first 4 weeks following release from prison

DISCUSSION

This large-scale linked data study has demonstrated the high mortality risk that opioid-dependent prisoners face after prison release, particularly from accidental drug-induced deaths, suicide, accidental injury and violence. This is not unexpected considering that, upon release, these people often experience poor social support, isolation, medical comorbidities, financial stress, debts and continued exposure to drugs in the communities to which they return [25].

This study provides unequivocal evidence of the significant benefit of OST on post-release mortality of opioid-dependent people leaving prison. Post-release OST exposure was highly effective in reducing the mortality risk in the first month at liberty. The lowest mortality rates were seen in those individuals who were continuously retained in OST in the post-release period, whereas the highest mortality rates were seen in those opioid-dependent individuals with no OST in the post-release period.

When mortality in the first year post-release was examined according to extent of exposure in the first 4 weeks post-release (Fig. 2b), those who had been partially retained in OST during that time had higher mortality during the first year post-release than the other two groups (no OST and fully retained in OST). It is difficult to interpret this finding, given that in this particular analysis we were focusing only upon OST exposure in the first month, so we did not take into account later OST exposure across the groups. It is possible, however, that variation in tolerance might explain this higher mortality. Those who cycled in and out of OST would be exposed to multiple high-risk periods—during induction onto methadone [32] and following cessation of OST [32]. Future research would need to examine whether this was the case.

Although the reductions in mortality observed among people receiving OST in the immediate post-release period may reflect motivational or other differences from those who did not enter OST, the findings make pharmacological and clinical sense. Indeed, controlling for significant demographic and criminographic variables, exposure to OST in the first month following prison release, assessed in a time-dependent manner, reduced the hazard of death by 75% (adjusted HR = 0.25; 95% CI = 0.12, 0.53). The effect of OST upon mortality risk across time outside prison was also significant (adjusted HR = 0.17; 95% CI = 0.14, 0.20). OST receipt in prison had a protective effect that was independent of the OST post-release effect, although this protective effect decayed quickly over time. There were no observed interactions between OST exposure and any of the main effects examined, suggesting that the protective effect of post-release OST was similar in nature across broad demographic and criminographic characteristics.

The reduction was particularly evident in rates of drug-induced deaths. Drug overdoses in the post-release period can arise from a lack of knowledge concerning lowered pharmacological tolerance, or from intentional overdose as a response to the stress and anxiety of prison release [25].

Table 4 Crude mortality rates per 1000 person-years during specific post-release periods according to OST exposure in the immediate post-release period (first day, week, 2 weeks and 4 weeks)[a] among people with a history of opioid dependence ($n = 60\,161$ prison releases), 2000–12.

	Mortality according to extent of exposure to OST in the immediate post-release period								
	Retained in OST[a]			*Partial OST*[a]			*No OST*		
All deaths (2000–December 2012)	*n*	*PY*	*CMR (95% CI)*	*n*	*PY*	*CMR (95% CI)*	*n*	*PY*	*CMR (95% CI)*
First day post-release	0	83	–				4	82	49.1 (13.4, 125.6)
First week post-release	6	548	10.9 (4.0, 23.8)	0	32	–	33	555	59.5 (41.0, 83.6)
First 2 weeks post-release	12	1 028	11.7 (6.0, 20.4)	3	122	24.5 (5.1, 71.6)	51	1 078	47.3 (35.2, 62.2)
First 4 weeks post-release	16	1 822	8.8 (5.0, 14.3)	5	433	11.5 (3.7, 26.9)	75	2 046	36.7 (28.8, 45.9)
First year post-release	98	15 296	6.4 (5.2, 7.8)	63	2367	26.6 (20.4, 34.0)	250	16 286	15.4 (13.5, 17.4)
Accidental drug-induced (2000–10)									
First day post-release	0	78	–				3	69	43.2 (8.9, 126.3)
First week post-release	3	517	5.8 (1.2, 17.0)	0	30	–	23	472	48.8 (30.9, 73.1)
First 2 weeks post-release	5	972	5.1 (1.7, 12.0)	2	112	17.9 (2.2, 64.8)	33	916	36.0 (24.8, 50.6)
First 4 weeks post-release	6	1 736	3.5 (1.3, 7.5)	4	385	10.4 (2.8, 26.6)	46	1 737	26.5 (19.4, 35.3)
First year post-release	34	14 131	2.4 (1.7, 3.4)	30	2020	14.9 (10.0, 21.2)	133	14 222	9.4 (7.8, 11.1)
Suicide (2000–10)									
First day post-release	0	78	–				0	69	–
First week post-release	0	517	–	0	30	–	1	472	2.1 (0.05, 11.8)
First 2 weeks post-release	0	972	–	0	112	–	1	916	1.1 (0.03, 6.1)
First 4 weeks post-release	0	1 736	–	0	385	–	3	1 737	1.7 (0.4, 5.0)
First year post-release	4	14 131	0.3 (0.08, 0.7)	5	2020	2.5 (0.8, 5.8)	13	14 222	0.9 (0.5, 1.6)
Accidental injury (2000–10)									
First day post-release	0	78	–				0	69	–
First week post-release	1	517	1.9 (0.05, 10.8)	0	30	–	0	472	–
First 2 weeks post-release	1	972	1.0 (0.03, 5.7)	1	112	9.0 (0.2, 50.0)	1	916	1.1 (0.03, 6.1)
First 4 weeks post-release	2	1 736	1.2 (0.1, 4.2)	1	385	2.6 (0.06, 14.5)	2	1 737	1.2 (0.1, 4.2)
First year post-release	6	14 131	0.4 (0.2, 0.9)	6	2020	3.0 (1.1, 6.5)	14	14 222	1.0 (0.5, 1.7)
Violence (2000–10)									
First day post-release	0	78	–				0	69	–
First week post-release	0	517	–	0	30	–	0	472	–
First 2 weeks post-release	1	972	1.0 (0.03, 5.7)	0	112	–	0	916	–
First 4 weeks post-release	2	1 736	1.2 (0.1, 4.2)	0	385	–	0	1 737	–
First year post-release	9	14 131	0.6 (0.3, 1.2)	4	2020	2.0 (0.5, 5.1)	5	14 222	0.4 (0.1, 0.8)

CMR = crude mortality rate; PY = person-years; OST = opioid substitution therapy. Person-years accrued from date of first observed release from prison and ceased at/during re-incarceration and at death. [a]These groups were defined to take account of extent of exposure to OST during follow-up. If someone died in this period, then they were classified according to their OST history up to the point post-release that they died. If up to the point a person died they had been in OST, they were classified as 'retained'; if some time was spent in and out of OST, then 'partially retained'. Retention categories for first year post-release based on retention in first 4 weeks of release.

Policy and clinical implications

We have demonstrated that OST provided in prison and post-release independently reduce mortality in the immediate post-release period. Prison OST is also effective in reducing drug-related HIV risk behaviours [37], and significantly increases the probability that someone will enter OST in the days after release [38]; there are also impacts of prison-based and post-release OST on risk of reincarceration [39]. Despite these benefits, considerable inequities remain in the provision of care for opioid-dependent individuals in prisons compared with those in the community [29,40]. Although international agencies have emphasized its effectiveness [30,41], policymakers in many countries are resistant to calls for OST in prison settings [42]. In light of the increasingly robust scientific evidence demonstrating the benefits of prison OST, continued resistance to implementing and expanding OST in correctional settings seems unwarranted.

We have demonstrated a clear benefit of post-release OST in preventing death, but ensuring that recently released prisoners enter and remain in treatment in the community can be complex. People released from prison typically have few social supports, inadequate housing

Table 5 Cox regression model of the factors predicting mortality in the first 4 weeks following release from prison, and for all time at liberty.

	4 weeks post-release		*Total time post-release*	
	Unadjusted HR (95% CI)	*Adjusted HR (95% CI)*	*Unadjusted HR (95% CI)*	*Adjusted HR (95% CI)*
Demographic variables				
Male	1.87 (1.00, 3.52)	1.33 (0.69, 2.55)	1.21 (1.04, 1.41)	1.02 (0.87, 1.20)
Indigenous	0.78 (0.50, 1.20)	0.81 (0.51, 1.28)	0.91 (0.79, 1.05)	0.87 (0.75, 1.01)
Age at prison release[b] (years)	1.03 (1.01, 1.06)	1.32 (1.25, 1.39)	1.05 (1.04, 1.06)	1.00 (0.95, 1.05)
Age at prison release × log(time)		0.96 (0.95, 0.97)		1.01 (1.00, 1.02)
Treatment variables				
Post-release exposure to OST[a]	0.22 (0.13, 0.37)	0.25 (0.12, 0.53)	0.22 (0.19, 0.26)	0.17 (0.14, 0.20)
OST during most recent incarceration[b]	0.32 (0.21, 0.50)	0.06 (0.01, 0.30)	0.90 (0.80, 1.02)	0.72 (0.34, 1.54)
OST during most recent incarceration × log(time)		1.47 (1.16, 1.87)		1.13 (1.02, 1.26)
Number of prior OST episodes[b]	0.94 (0.85, 1.04)	0.97 (0.87, 1.07)	1.03 (1.00, 1.06)	1.04 (1.00, 1.07)
Criminographic variables				
Juvenile offending history	0.93 (0.58, 1.47)	0.88 (0.48, 1.61)	0.68 (0.57, 0.81)	0.34 (0.10, 1.15)
Juvenile offending history × log(time)				1.18 (1.00, 1.40)
Length of most recent incarceration[b]				
Less than 1 month	Referent	Referent	Referent	Referent
1–6 months	1.93 (1.17, 3.18)	2.65 (1.56, 4.51)	1.04 (0.90, 1.21)	0.96 (0.83, 1.11)
6–12 months	1.45 (0.78, 2.68)	1.93 (0.98, 3.78)	0.92 (0.77, 1.10)	0.78 (0.65, 0.93)
More than 12 months	1.28 (0.61, 2.70)	1.79 (0.79, 4.04)	0.95 (0.78, 1.17)	0.72 (0.58, 0.89)
Number of prior incarcerations[b]	1.00 (0.92, 1.08)	1.00 (0.92, 1.10)	1.04 (1.01, 1.06)	1.99 (1.40, 2.82)
Number of prior incarcerations × log(time)		–		0.92 (0.88, 0.96)
Any property offence prior to release[c]	1.28 (0.61, 2.68)	2.56 (0.99, 6.63)	0.99 (0.85, 1.16)	1.24 (1.05, 1.48)
Any violent offence prior to release[c]	1.11 (0.70, 1.75)	1.07 (0.65, 1.77)	1.27 (1.12, 1.44)	1.30 (1.14, 1.49)
Any drug offence prior to release[c]	0.92 (0.62, 1.38)	18.03 (4.81, 67.65)	0.89 (0.79, 1.01)	0.95 (0.84, 1.08)
Any drug offence prior to release × log(time)		0.64 (0.53, 0.79)		

All prison releases included (i.e. multiple releases for an individual could occur). There were 16 453 individuals who were released from prison on 60 161 occasions. HR = hazard ratio; OST = opioid substitution therapy; CI = confidence interval. [a]Time-dependent variable. [b]These variables were not time-dependent for a given prison release for an individual, but they could change over successive prison releases for an individual who was released from prison more than once in the study period. [c]Prior to first prison release.

and employment, limited financial means and complex health needs [25,43]. Daily attendance at a clinic, as is often required in order to obtain OST, is therefore just one of many competing priorities for releasees, but may provide a structure and opportunity for social interaction for those in treatment. As noted above, access to treatment while incarcerated increases the likelihood of post-release treatment entry [38], but access to in-prison OST is limited in many parts of the world [29,40].

Whether or not prison OST is provided, comprehensive pre-release planning, with follow-up support after release, may be required to ensure immediate access to a community OST provider. Barriers to treatment, such as waiting lists and fees, should be waived for newly released prisoners in recognition of their high mortality risk and demonstrated effectiveness of OST in reducing this risk. Given our finding that releasees who drop out of OST in the post-release period have high mortality risks, it is clear that ongoing efforts must be made to retain released opioid-dependent prisoners in treatment.

Limitations

The benefits of using linked population data such as these are that the entire sample is included (ascertainment is unbiased), large sample sizes allow the investigation of low frequency but clinically important outcomes, and the results are highly generalizable. Some inconsistencies could have arisen in the data linkage process, as half the linkage was completed by BOCSAR and the other half by AIHW. Although this is a possibility, we are confident in the high level of accuracy of these data sets and their linkage. As noted earlier, as proof of identity must be shown to the prescriber, name and date of birth variables in the PHDAS data set are considered to be of high quality. Linkage algorithms were developed by both groups to minimize errors, with clerical checking to evaluate possible matches. Validation studies have supported this [44–46]. Any inaccuracy in correct linkages is likely to bias against obtaining significant findings, supporting the robustness of the results.

In NSW, prisoners who have received OST in prison are released with a prescription for methadone or buprenorphine, and Justice Health coordinates with public community clinics, such that a specific clinic is aware that a patient with a Justice Health prescription will be attending on a given date, and the prescribed medicine dispensed by the clinic under the Justice Health prescription. The only situation in which a prisoner on OST is released without a prescription is in cases of unexpected release. We are unable to identify these from our data.

This was a descriptive study without random allocation to OST. It is possible that some of the differences are accounted for by differential treatment allocation, with differences in the characteristics of people who did or did not enter OST upon release from prison, and/or external differences (such as prison-level or community-level variables). We address these below.

First, we did not have specific clinical indicators such as current opioid dependence and/or severity of dependence in prison or post-release. Secondly, we did not have assessment of other clinical variables, assessment of social and other supports or housing status post-release. However, this is likely to have meant that our estimates of OST effect are conservative, as among those not receiving OST we would have had both dependent and currently/persistently abstinent people who would probably be at different background mortality risks. Thirdly, data were not available at the institution level (prison type, prison location, public or private OST clinic, office-based prescribing with community pharmacy dosing, etc.), so a multi-level regression model was not possible, for example, to consider geographic or prison-level variation in OST provision. Future work might consider a more detailed examination of this issue using multi-level modelling, in order to examine how much of the variability in mortality rates is caused by factors at both institution and individual patient levels.

Finally, we did not have patient-level data on OST dose, nor details of the way in which OST was delivered in prison or in the community. This meant that our findings were a summary effect across varied doses, dosing settings and with variable quality of OST provision. This means that our findings reflect the average effect across these factors, not the potential impact of 'optimal' OST provision. However, this reflects the realities of prescribing of OST, and might therefore be considered a strength rather than a limitation.

CONCLUSIONS

This Australian study has provided strong, population-level evidence that OST provision in prison and post-release from prison both have significant impacts upon mortality risk in the immediate post-release period. The study provides evidence to support the scale-up of OST provision in prison to reduce this risk, and that continuation of OST post-release be maximized to the fullest extent possible.

Ethics committee approval

Ethics approval for this study was obtained from the University of New South Wales; NSW Health's Population and Health Services Research Ethics Committee; the Australian Institute of Health and Welfare; the Alfred Hospital Melbourne; Corrective Services NSW; Justice Health NSW; the NSW Aboriginal Health and Medical Research Council (AHMRC); and the Department of Justice Health Research Ethics Committee (Victoria).

Declaration of interests

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Supporting information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Table S1 International Classification of Diseases 10th edition (ICD-10) codes for causes of death.

Table S2 Australian and New Zealand Standard Offence Classification (ANZSOC) codes for offence categories.

Table S3 Post-release CMR per 1000 PY for incarcerated people with a history of opioid dependence, according to their OST status on day of release ($n = 60\ 161$ releases), 2000–12.

