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Research Paper

Quantifying the societal cost of methamphetamine use to Australia

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ABSTRACT

Globally, there are increasing concerns about the harms associated with methamphetamine use. This paper i) reports on the results of a cost-of-illness (CoI) study that quantified the social costs associated with methamphetamine use in Australia and, ii) drawing on examples from this study, critically examines the general applicability of CoI studies for the alcohol and other drug field. A prevalence approach was used to estimate costs in 2013/2014, the most recent year for which reasonably comprehensive data were available. The value selected for a statistical life-year in our central estimate was AUD 281,798. Other costs were estimated from diverse sources.

Total cost was estimated at AUD 5023.8 million in 2013/14 (range, AUD 2502.3 to AUD 7016.8 million). The greatest cost areas were crime including costs related to policing, courts, corrections and victims of crime (AUD 3244.5 million); followed by premature death (AUD 781.8 million); and, workplace costs (AUD 289.4 million).

The social costs of methamphetamine use in Australia in 2013/14 are high, and the identification of crime and premature mortality as the largest cost areas is similar to USA findings and represents important areas for prevention and cost remediation. However, caution is required in interpreting the findings of any CoI study, as there is uncertainty associated with estimates owing to data limitations. Moreover, CoI estimates on their own do not identify which, if any, of the costs are avoidable (with drug substitution being a particular problem) nor do they shed light on the effectiveness of any potential interventions. We also recognise that data limitations prevent some costs from being estimated at all.

Introduction

Globally, it is estimated that between 13.9 and 53.4 million people used methamphetamine or amphetamine type stimulants (ATS) in 2014 (United Nations Office on Drugs & Crime, 2015). The production of methamphetamine has also increased, as suggested by a doubling of seizures by authorities between 2009 and 2011 (United Nations Office on Drugs & Crime, 2015). Between 1990 and 2010, use of ATS was second only to opioids in terms of the global disease burden from illicit substances (Degenhardt et al., 2013) with a 37% increase in disability adjusted life years (DALYs) associated with dependence on stimulants (Degenhardt et al., 2014). In Australia, the crude mortality rate for methamphetamine related deaths doubled between 2009 and 2015 (Darke, Kaye, & Duflou, 2017). In the USA, the estimated total social cost of methamphetamine use was USD 23,384 million in 2005 (Nicosia, Pacula, Kilmer, Lundberg, & Chiesa, 2009).

Cost of Illness (CoI) studies identify and evaluate the total cost of a disease or condition to society and are primarily used to inform policy and in planning healthcare services, to prioritize research, to encourage debate and to support advocacy (Larg & Moss, 2011; Rice, 1994). CoI analyses have been conducted across an expanding array of conditions and have also been subject to meta-analysis to support evidence-based decision making (Anderson, 2010; Larg & Moss, 2011). They can also generate considerable public, media and political interest. However, the usefulness of the CoI approach has been questioned (Byford, Torgerson, & Raftery, 2000; Larg & Moss, 2011; Makela, 2010; Reuter, 2006).

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Efforts to estimate the social cost of methamphetamine use in Australia were prompted by the increased harms reported from its use (e.g. hospital admissions, demand for meth/amphetamine treatment services, (Degenhardt, Sara et al., 2016)). These harms have been attributed to an increase in the use of high purity crystalline methamphetamine in Australia (including an apparent increase in dependent use), including a corresponding increase in smoking methamphetamine over other non-injecting routes of administration (Degenhardt, Sara et al., 2016)). These changed usage patterns have prompted public, media and political concern, including the establishment of a national taskforce (Commonwealth of Australia, 2015).

The analysis drew on the methodology of a major USA study (Nicosia et al., 2009) and previous Australian studies on the social costs of alcohol, tobacco and illicit drugs that produced a single cost category for all illicit drugs (Collins & Lapsley, 1991, 1996; Collins & Lapsley, 2002, 2008). In 2007, the social cost for (meth)amphetamine use relating to health, crime and road accidents was estimated at AUD 3730 million per annum (Moore, 2007). Others have estimated the cost impost of illicit drugs on governments (Ritter, McLeod, & Shanahan, 2013). The one Australian study (Moore, 2007) that derived working estimates of the social costs of methamphetamine was based on the number of dependent methamphetamine users in 2003: however, it predates recent increases in crystalline methamphetamine consumption and apparent increases in the number of dependent users.

The objective of this study was to quantify the economic and social costs arising in a single year from methamphetamine, with the financial year 2013/14 selected as the most recent period with comprehensive data available. In addition to presenting the costs, this paper also discusses the challenges of conducting CoI studies, the utility of the findings and the inherent limitations of the approach and offers lessons for wider applicability of the approach across the alcohol and other drug, and health and human services sectors.

Method

Harms and costs were identified across eight broad areas: criminal justice, premature mortality, workplace, health care, child protection and maltreatment, road crashes, prevention and harm reduction and clandestine laboratories. Each cost category examined drew on multiple and different sources of data (see Table 1), used specific methods and was underpinned by unique assumptions in quantifying the harms in that area. It is not feasible to present in detail all methods and assumptions; however, the key methodological decisions and data are provided in Table 1, with further information on each cost area provided in on-line Appendix A. A central estimate of costs (in 2013/14 AUD) based on the best evidence available is reported for every category, with a lower and upper estimate also provided, where feasible.

One key decision was to use a prevalence rather than an incidence approach. This approach captures harms that occur in the target year (2013/14) regardless of when use occurred and is appropriate for determining the current economic cost of a disease or condition. The alternative, incidence approach, instead seeks to estimate the future impact of illness caused by use in the target year (World Health Organization, 2009).

Another important overarching decision was the value assigned to loss of life; the choice of value can have a major bearing on the final valuation (Rice, 1994). One approach, the *human capital* approach considers the discounted lifetime market value of a person's productivity, but its focus on market earnings means some people's lives (e.g., the retired) appear to have little value (Rice, 1994). The *willingness-to-pay* method examines resources people would invest to avoid the probability of illness/premature death, an approach that can result in substantially higher valuations of a life (Rice, 1994; Single et al., 2003), and is usually expressed as the value of a statistical life, or the value of a statistical life year. The value of a statistical life, is the hypothetical cost that society would pay to reduce the number of deaths by one, with the value of a statistical life year being that value divided by the years of life prematurely lost (Department of the Prime Minister & Cabinet, 2014). The central estimate and upper bound values used in the present analysis were both derived from willingness to pay methods, while the lower bound was the value used by the Pharmaceutical Benefits Advisory Board in its drug approval decisions (which effectively represents willingness to pay on the part of a government agency): this latter value is implied rather than explicitly stated (Community Affairs References Committee, 2015).

The values for a statistical life year used ranged from a lower bound of AUD 45,000 (Community Affairs References Committee, 2015) to an upper bound of AUD 841,393 (US Department of Transportation, 2015), equating to values of a statistical life of AUD 0.88 million and AUD 13.50 million respectively. The central value was an Australian 2007 estimate inflated by the growth rate in the average nominal national per capita income[1] since that time (Abelson, 2008) giving a central estimate of AUD 281,798. This equates to statistical life value of AUD 4.5 million. The calculation of a statistical life can generate widely varying values driven by the technique used and the dataset, with a review reporting values for developed countries ranging from AUD 0.26 million to AUD 151.21 million in 2013/14 values, with a median of AUD 9.8 million. Values derived from administrative practices in the health sector were notably lower, ranging from AUD 0.26 million to AUD 11.63 million with a median of AUD 5.72 million (Access Economics, 2008).

Another important driver of the cost of methamphetamine use is the prevalence of use, and importantly, the number of people dependent on methamphetamine, as the latter accounts for a disproportionately large share of the harms and costs (Moore, 2007). We used the most recent peer-reviewed estimate of dependence (1.24% of those aged 15–54 years in Australia or 160,000 people, 95% CI 110,000–232,000) (Degenhardt, Larney et al., 2016).

Where data existed, attributable fractions (AF) were used to identify the harms caused by methamphetamine. However, the need for data on: the relative risk of a given condition being caused by methamphetamine; the rate of that condition in the population; and the prevalence of methamphetamine use in the population meant it was only feasible to use AF for some health conditions, and within the criminal justice sector.

Considerable effort was also undertaken to avoid "double counting" both where sectors overlapped and in the context of poly-drug use when comparable studies may be conducted for other substances. To reduce potential double counting where poly-drug use was recorded, a decision was made not to include any health care resources except where it had been recorded that methamphetamine was the "most responsible" substance for the condition. With respect to premature mortality, where additional factors were identified as causal, the fraction attributable to methamphetamine (1/number of potentially causal factors identified in the coronial record) was calculated.

Table 1 provides the data sources used in each cost domain and briefly summaries key difficulties and issues in each area. More extensive information on the methods and assumptions is provided in the on-line Appendix 1 and elsewhere (Whetton et al., 2016). The Appendix uses the same headings and order as Table 1 to aid crosschecking. Each dataset possessed unique features and limitations and required the

[1] The rate at which a value of statistical life should increase over time as national incomes increase is determined by the income elasticity of demand for reductions in the risk to life, with the elasticity representing the proportionate increase in the VSL for a given increase in per capita incomes, e.g. an income elasticity of 0.5 implies that for a 1% increase income the VSL would increase by 0.5%. These have been variously estimated at 0.5 to 0.6 (Viscusi & Aldy, 2003), 1.23 (Kniesner, Viscusi, & Ziliak, 2010) and 1.5 to 1.6 (Costa & Kahn, 2004). We followed the US Department of Transportation in adopting a relatively conservative assumption of an income elasticity of 1 (US Department of Transportation, 2015).

Table 1
Summary of data sources and methods in estimating cost of methamphetamine use (with the relevant page numbers for the online appendix).

Category (appendix pages)	Major data source(s)	Methods	Concerns
Criminal Justice (1–5)	DUMA: SCRGSP: ABS CC: ABS PIA: ABS RC: ABS crime victimisation survey: AIC	DUMA data on police detainees AFs for their most serious offence was applied to total crimes (MA = 16.2% of all crime). Estimated 64% police costs crime related. The AFs were also applied to Magistrates and Higher courts weighted by complexity of cases. The AFs were applied to prison unit costs minus offset saving (e.g. reduced government payments). The AFs were applied to victims of crime data with costs from Smith 2014 (Smith, Jorma, Sweeney, & Fuller, 2014).	Representativeness and validity of DUMA; excluded non-adult crimes and associated costs; excluded Federal police and courts; extends DUMA from detainees through to prison costs; victims of crime data reports on number of people not number of offences; and, excluded business victims of crime.
Premature mortality (5–7)	NCIS	A keyword search for meth/amphetamine related terms was conducted in the NCIS data. Included were 1) all cases where MA was listed as sole medical cause of death, 2) cases where clear causal role for MA (e.g. cardiomyopathy with no other risk factors) had been established by the forensic pathologist conducting the autopsy, 3) a fraction of any case where MA was one of several causes of death, 4) a fraction of any case where MA listed as an "object" (rather than "cause") and no other causal factors were identified.	Homicide determinations appear low (likely due to court cases delaying closure of NCIS cases); and, suicide attributions appeared low compared to estimates obtained via the Global Burden of Disease (GBD) AF applied to all NCIS suicide/intentional self-harm deaths (Degenhardt, Larney et al., 2016, 2013) (i.e. our estimate 55 cases *versus* 114 cases using GBD AF).
Workplace costs [b] (7–8)	NDS: ABS WRIS: NDSHS	Injury to the MA user and others was calculated using an existing methodology (Safe Work Australia, 2015) and data sourced from Safe Work Australia and Safework Laboratories. Costs include lost productivity, human capital, medical, administration, transfer and other costs, borne by employers, employees and communities. Absenteeism was estimated via secondary analysis of NDSHS self-report data.	This section used incident rather than prevalence approach due to data availability; and, many costs were not quantified e.g. presenteeism, staff turnover, workplace drug testing, under-reporting especially for non-compensated injuries.
Health care (9–10)	NHMD: AR-DRG: IHPA: MHSA: AODTS	Main components were: inpatient hospital stays, ED visits, community mental health, treatment for dependence, HIV /AIDS, ambulance cases and GP visits. Rules for allocating AFs were developed for selected diagnoses. Inpatient stays were identified via the NHMD. AR-DRG data were used to assign costs to these admissions (N = 11,412). The number of cases of HIV/AIDs and hepatitis C attributed to MA were estimated by combining prevalence data with the percentage who usually inject. ED presentations and GP contacts were estimated using data from the literature (MATES) with a resulting 68,345 visits & 678,262 contacts and costs sourced from IHPA and Medicare benefits. Community mental health care events from MHSA data (codes F15 to F15.99 = 0.2% of cases and 0.2% of budget). The ambulance cases from a Victorian study (n = 1706) were used to apportion national costs (SCRGSP). Other treatments (e.g. withdrawal, counselling, rehabilitation) were sourced from AODTS where MA primary drug of concern (plus 17% of cases where treatment for drug use by another person) and costs sourced from state based providers.	Extrapolated from small samples / state data to national costs; few MA specific AFs available; limited data on costs of treatments; and, excluded private sector treatment.
Child protection and maltreatment [a] (10–11)	SCRGSP: AIHW drug treatment series	A total of 40,844 "substantiated" child protection cases are reported in SCRGSP. The number of "substance abuse" and "alcohol and drug use" estimated cases was sourced from the literature (Laslett et al., 2013); with proportion due to MA being the proportion of all treatment cases that were attributed to MA (27.4%) (Australian Institute of Health & Welfare, 2015) gives 5.7% of all child protection cases: Alternative estimate from South Australian case review (Jeffreys, Hirte, Rogers, & Wilson, 2009) equals 7.3% of cases.	No data on harms to children exposed to clandestine laboratories or from impaired parenting or in utero exposure
Road crashes (11–12)	AIHW, BITRE; NCIS	Road crash frequency, costs and severity from BITRE 2009 report: road fatalities from BITRE 2016 report, hospital separations from AIHW database. Odds ratio of drivers with MA in system being at fault for an accident from Drummer et al. (2003). From NCIS data we estimate 1.86% of road crash fatalities due to MA. Hospital costs estimated from AR-DRG codes. Insurance costs estimated from Victoria Transport Accident commission. Work place disruption costs from BITRE 2009 report. 2006 property damage costs for injury and non-injury crashes converted to 2013/14 values and estimated number of crashes. Legal costs	Key data source used 2006 data and little reliable data on MA prevalence across all crash types.

(*continued on next page*)

Table 1 (*continued*)

Category (appendix pages)	Major data source(s)	Methods	Concerns
		and other administration from BITRE 2009 report converted to 2013/14 values.	
Prevention and harm reduction (12–14)	SCRGSP	School prevention programs – estimated from 2002 report on program hours for all illicit drugs (Auditor General Victoria, 2003), with costs from SCRGSP. General population programs – extrapolated from Victoria and WA data plus Federal spending on Indigenous programs and National Illicit Drug Strategy. Blood borne virus / needle syringe (prevention) programs – extrapolated from 2007/8 budget. ProjectStop costs extrapolated from Miller, 2009 (Miller, 2009) and other precursor control programs – costs only included in upper estimate due to uncertainly.	No data on programs in non-government schools; extrapolated from states to national costs; and, dated primary source.
Clandestine laboratories (14–14)	IDDR, WA EHO	Number of laboratories from IDDR report. Remediation component costs from WA EHO and contractors. Injury costs (laboratory accidents) from WA case series.	Unable to estimate first responder costs; extrapolated from small samples to national figures; and, environmental damage not quantified. Only those laboratories detected by police were able to be included.

ABS WRIS = Australian Bureau of Statistics Work-Related Injuries Survey: ABS CC = Australian Bureau of Statistics Criminal Courts: ABS PIA = Australian Bureau of Statistics Prisoners in Australia: ABS RC = Australian Bureau of Statistics Recorded Crime – Victims: AIC = Australian Institute of Criminology: AIHW = Australian Institute of Health & Welfare: AODTS = Alcohol and Other Drug Treatment Services: AR-DRG Australian Refined Diagnosis Related Group: BITRE Bureau of Infrastructure, Transport and Regional Economics: DUMA = Drug Use Monitoring in Australia: IDDR = Illicit Drug Data Report: IHPA = Independent Hospital Pricing Authority: MA = methamphetamine: MATES = Methamphetamine Treatment Evaluation Study: MHSA = Mental Health Services Australia: NCIS = National Coronial Information System: NDS = National Dataset Compensation-based Statistics: NDSHS = National Drug Strategy Household Survey: NHMD = National Hospital Morbidity Database: SCRGSP = Steering Committee for the Review of Government Service Provision: WA EHO = Western Australian Environmental Health Office.

[a] Deaths included elsewhere.

[b] Deaths and transport related injuries included elsewhere.

estimation of the fraction of events or costs attributable to methamphetamine use. As each step in the estimation is subjective and potentially open to criticism, it is vital that CoI studies are transparent in reporting the assumptions and methods underpinning the analysis.

Results

Cost estimates for each of the eight broad areas are presented in Table 2. Total cost for all included areas was estimated at AUD 5023.8 million in the financial year 2013/14. Table 2 also includes upper and lower estimates, the total range being AUD 2502.3 to AUD 7016.8 million. The criminal justice sector was the largest single cost area at AUD 3244.5 million (65% of the total cost), though it was not possible to estimate methamphetamine attributable Federal police/border protection costs, or costs associated with juvenile justice, due to data limitations (see *Implications* below). Next in magnitude was the value attached to premature mortality (170 deaths), resulting in a cost of AUD 781.8 million. Just considering costs in a single year, this gives a range of AUD 150.0 million, based on the Pharmaceutical Benefits Advisory Board value, to AUD 2310.2 million derived from the US Department of Transport value. This is further increased if the full present value of lost income from work over 30 years is used (AUD 3750 million). The estimate of methamphetamine attributable deaths is likely to be an underestimate as it depends on coronial data, which only reports cause of death for closed cases. For the financial year 2013/14, 18% of 2013 cases and 33% of 2014 cases were open at the time of the analysis, with this under-reporting likely to disproportionately affect deaths caused by homicide and suicide/self-harm.

Most Australians who report using methamphetamine recently (i.e. in the last year) are employed (Pidd, 2015). Our central estimate for workplace injuries due to methamphetamine use was AUD 250.9 million with further costs arising from absenteeism (AUD 38.5 million). In

Table 2
: Summary of the estimated cost of methamphetamine use to Australia in 2013/14.

Category	Best estimate ($million)	Lower estimate ($million)	Upper estimate ($million)
Criminal justice costs (including policing, courts, prisons & victims of crime)	3244.5	1,547.3	4,314.6
Premature mortality [a, c]	781.8	150.0	1,404.1
Workplace costs (including accidents & absenteeism) [b]	289.4	259.5	319.5
Health care costs (e.g. hospital, ED, treatment, GPs, BBV, ambulance)	270.8	241.6	351.7
Child maltreatment & child protection services [b]	260.4	229.1	291.7
Road crash costs (including property damage) [b]	125.2	30.5	281.9
Prevention activities & harm reduction measures [c]	40.0	40.0	41.9
Clandestine laboratories remediation and harms	11.7	4.3	11.7
Total	5023.**8**	**2502.3**	7016.**8**

Internalities and intangible costs to the partners and resident children of dependent MA used are not included in these estimates.

[a] The upper estimate for deaths includes costs and offsetting savings lost beyond 2013/14 not just costs in that year using the Abelson value of a statistical life, if the US Department of Transport value with up to 30 years of full present value is used, the upper estimate is AUD 3750.3 million.

[b] Deaths included under premature mortality.

[c] No lower bound estimated: BBV = Blood borne viruses: ED = Emergency Department: GP = general practitioners: Columns may not sum due to rounding.

addition, a proportion of overall road traffic costs (AUD 125.2 million) would be likely to have occurred during work related travel.

Discussion

This was the first comprehensive study of the social costs incurred by methamphetamine use in Australia since crystalline methamphetamine became the preferred form for consumers (Australian Institute of Health & Welfare, 2014a). There are limited current data from other countries. Of eight cost domains addressed, crime and premature mortality contributed the largest costs which is consistent with USA findings (Nicosia et al., 2009). These domains represent important areas for future policy initiatives, prevention and cost remediation. It is notable that current spending on supply reduction (police and court costs related to drug offences) and on treatment appear low compared to the overall CoI borne by society.

Overall findings

The overall costs to society of methamphetamine identified in this study are substantial. It is noted that our caution in interpreting the data may have resulted in more conservative estimates than previously provided, when increased prevalence of use and dependence are considered. For instance, if the number of dependent (160,000) and regular non-dependent (108,000) methamphetamine consumers in 2013/14 are substituted into the Moore costings (Moore, 2007), in place of the 2003 prevalence data (73,257 dependent: 495,500 regular non-dependent) and the cost per case (AUD 58,075 for dependent and AUD 1204 for regular non-dependent) adjusted for CPI (Australian Bureau of Statistics, 2016a), then the adjusted figure equates to AUD 9422.0 million in 2013/14. This higher cost occurs despite the Moore estimation including fewer cost areas than the current analysis, with crime accounting for 80% of their total (AUD 3.0 billion).

In making comparisons between countries, there is further uncertainty due to differences in the cost structures, prevalence of use, legal sanctions and so forth (Jarl, 2010). This caveat notwithstanding, in 2005, the cost of methamphetamine use in the USA was about USD 23,384.4 million. This can be converted to 2005 Australian dollars using the average purchasing-power-parities exchange rate between USD and AUD for 2005 (Organisation for Economic Cooperation & Development, 2016). Adjusting for CPI to June 2014 values (Australian Bureau of Statistics, 2016b) this equates to AUD 41,445.92 million (tangible social costs of AUD 19,022.66 million plus intangible costs (internalities) of AUD 22,423.26 million). In terms of 2014 Australian dollars, the overall cost per dependent user in the USA (n = 314,273) (Nicosia et al., 2009) equated to AUD 131,879 or AUD 60,529 in tangible costs. In the current estimate, with a total cost of AUD 5023.8 million, the figure is AUD 31,399 for each dependent user. A major driver of this difference was the estimated cost of mortality, at 37% in the USA versus about 16% in Australia. In particular, the USA analysis used a higher value for a statistical life, at USD 4.5 million in 2005.

Implications

The key policy implications are concerned with research to advance more accurate cost-of-illness studies. As noted throughout the paper, there are significant and substantial uncertainties, which need to be dealt with before cost-of-illness studies can directly inform policy. Furthermore, the role of cost-of-illness studies is ultimately comparative – that is, to enable policy makers to decide between policy actions in one domain (such as in relation to methamphetamines) compared to another domain (such as road infrastructure, or housing, or defence). Or more acutely, within the area of alcohol and other drugs, comparing cost-of-illness estimates for alcohol with opioids and with methamphetamine – suggesting which substances may generate the highest social costs and therefore present an (economic) priority to governments. Cost-of-illness studies are also policy relevant from the perspective of contributing towards comparative policy analysis over time. While a single cost-of-illness study cannot reveal what policy makers should do, if measured over time, and in the context of policy developments, it provides an evaluative tool to assess progress. In this light, the most important focus should be on improving the approach and methods for cost-of-illness research.

Cost-of-illness studies in the future also need to be sensitive to geography. Rates of methamphetamine use may be twice as high in rural and remote areas compared to major cities (4.5% versus 1.8%) (Australian Institute of Health & Welfare, 2014b; Roche & McEntee, 2017), and social costs are likely to vary substantially. Hence, a component of the study (Whetton et al., 2016) was a qualitative investigation to identify what type of additional costs might be incurred in these regions (not reported here). This highlights the importance of mixed methods and research capacity to move between quantitative economic data and qualitative data that can inform economic estimates. Another key research problem for cost-of-illness studies in our domain is the issue of harms attributable to more than one substance where poly-drug use is prevalent. To address this issue requires that we: i) develop a consistent approach to allocating some portion of poly-substance harms to each of the substances involved in the harm; ii) be careful in developing that calculation to ensure that the total attributions only add up to 1; and iii) preferably, conduct a CoI evaluation for all substances simultaneously, so that potential double counting is clear at the time and can be addressed.

The importance and extent of harms caused to others by substance use is an area of increasing research interest (Laslett, Dietze, & Room, 2013, 2015; Orford, Velleman, Natera, Templeton, & Copello, 2013) but the data are limited in this area. Excluding intangible costs to the drug user, the USA RAND report (Nicosia et al., 2009) estimated that child endangerment was the third leading cost area for methamphetamine use (after crime and premature death). Existing Australian data only allowed circuitous estimation of child protection costs. Improving or at least validating existing data on "drug use" and "alcohol and drug use" within child protection records should be a priority. However, the authors emphasize that drug use *per se* does not necessarily imply neglect or abuse. The relationship is more complex. Similarly, a very broad estimate of the costs to partners and resident children was calculated in the original study (Whetton et al., 2016). However, due to the high level of uncertainly as to the number of people impacted, and the extent to which these harms are already captured in other cost items such as victim of crime costs, these harms were not included in our final cost estimation. Further, we were unable to provide any indication of the wider costs to family and friends.

The cost associated with law enforcement and criminal justice administration was the single largest component, and while the difficulties that arise in calculating this cost are acknowledged there is considerable room to improve these data. A more sophisticated set of police activity based costs would greatly assist the process, for instance. Lack of solid data meant that there were significant exclusions. While it may be difficult to provide an accurate quantum to be attributed to border protection activities, the costs associated with juvenile offending could be estimated if, for example, the Drug Use Careers of Offenders (Juvenile DUCO) (Prichard & Payne, 2005b, 2005b) report was updated. We note that the DUCO study identified a range of social determinants associated with juvenile substance use and crime including poor family relationships, family substance use problems and poor educational outcomes. Finally, we were also unable to quantify the costs of crime incurred by business (e.g. theft, additional security, insurance premiums).

Assumptions underpinning CoI studies

CoI studies are predicated on the assumption that removing the condition would remove the cost. This assumption has been challenged in general terms (Byford et al., 2000) but is even more problematic with respect to illicit drug use where drug-substitution may occur if the availability of a particular drug is reduced (Degenhardt & Day, 2004). Currently, there are few data with which to estimate the extent of substitution. Thus, overall costs and harms may not be significantly decreased if a particular drug was removed from the market or supply curtailed, particularly if the harms and costs associated with the substitute drug are greater than the drug in question. Thus, the counterfactual scenario typically used in CoI studies of "no methamphetamine use" is highly improbable.

The challenge of causal attribution

Even if the premise is accepted that removing a given drug will eliminate rather than transfer the cost, there are additional issues to consider, in particular, attribution. For example, a diagnosed condition or state (e.g. psychosis) is rarely the consequence of a single cause (e.g. methamphetamine), and while a consequence of methamphetamine use may be a psychotic episode, not all who use methamphetamine will experience psychosis. A widely used method of apportioning the impact of a drug is to apply an attributable fraction (AF). Although AFs for many health conditions related to tobacco, alcohol and illicit drugs have been developed (Collins & Lapsley, 2008), there are very few AFs for methamphetamine specifically (Degenhardt et al., 2013, 2014).

Establishing attributable fractions for non-health related behaviours is a crucial future research agenda. Here, as noted in Table 1, the AFs used in the criminal justice area were derived from samples of police detainees (Coghlan, Gannoni, Goldsmid, Patterson, & Willis, 2015), and drove the estimation of cases in the police, judicial and prison systems, plus victims of crime. While triangulation of our estimates against other sources (Coghlan et al., 2015; Stretesky, 2009; Torok, Darke, & Kaye, 2008), increased our confidence in our estimate of the scale of criminal activity that could be attributed to methamphetamine, a new program of research is desperately needed in this area.

Internalities or private costs to the substance user

In the alcohol and other drug field, the issue of internalities, or the private costs to the consumer, is a challenge when assessing costs. Traditionally, within the discipline of economics, it is held that consumption patterns represent a rational decision, and that therefore the price paid for a product (and any harms to the user associated with its consumption) is less than or equal to the benefit that the consumer gains from it (Single et al., 2003). While some have suggested that dependent substance use can be conceptualised as a rational process with the risk and consequences of dependence included in the consumption decision (Becker & Murphy, 1988), this supposition is contested by other researchers (Melberg, 2010; Single et al., 2003). Given the differences of opinion among experts on the inclusion of internalities, in particular the cost of drugs to the consumer, the known challenges around assessing and valuing quality of life, and the debate over whether consumption is rational or informed (Makela, 2012), internalities were not included in the overall total cost reported here, although estimates of these costs were calculated in the full study (Whetton et al., 2016) and are tentatively estimated to be between $2.1 billion and $8.6 billion.

Other cost considerations

There were further considerations in the determination of costs. Theft, for example, does not reduce the total goods in society and is therefore not typically treated as a social cost within economic analysis. However, the value of stolen property is reduced when sold (Single et al., 2003). Some argue that profits to those "fencing" stolen goods and the utility enjoyed by recipients of stolen items may offset this deficit; hence, inclusion of stolen goods in CoI studies is not warranted (Makela, 2012). Yet, there is a cost to the victim from the intangible harms arising from the theft (reduced sense of security in the home, disutility of having goods stolen, time spent to replace stolen items, increased insurance premiums etc.) which may even exceed the monetary value of the stolen good. Estimates of these intangible costs (AUD 662.4 million) were included in our study, but the value of stolen property was not.

Uncertainty

As with most cost-of-illness studies, the final number is subject to substantial uncertainty. In our case, it ranged between AUD 2502.3 and AUD 7016.8 million. We argue that for cost-of-illness studies to be policy-relevant, this uncertainty range must be reduced through the kinds of data and research requirements outlined here.

Conclusions

Given the complexity of CoI studies and the associated caveats, it would be easy to retreat to scientific nihilism and not attempt these evaluations. It is argued that the raw data on which CoI analysis studies are based, such as mortality and morbidity, are more accurate and less value-laden than attempting to monetarise them via CoI analysis (Makela, 2012). However, if drug use outcomes are not monetarised via CoI analyses, then value-laden decisions still need to be made on some other basis. With government agencies increasingly turning to cost-benefit analysis to assess potential investment decisions, not having credible estimates of the burden of disease associated with substances of concern could lead to underinvestment in crucial areas. Estimates from CoI studies can support robust policy decisions if used appropriately with a focus on avoidable costs.

CoI studies do not provide evidence of how these costs can be reduced. They do, however, focus attention on key areas for intervention. For such studies to provide meaningful and complete information, better quality epidemiological and criminological data are required – as well as improved methods to allocate costs across programs. In addition, a much more rigorous approach is required on how CoI studies are interpreted and used. This approach is most suited to policy appraisals or evaluations where there is clear evidence (or, at least, a plausible hypothesis about the potential impact) of how the policy in question is likely to reduce the prevalence of a particular harm and that estimate needs to include a rigorous assessment of the potential for substance substitution. An investigation of drug substitution in different consumer groups could facilitate this aim. Finally, urgent attention is required to develop a consensus on how best to handle the problem of attribution in a way that avoids double counting without a major proportion of the harm being either allocated opaquely to "poly-substance use" or ignored completely.

Declaration of competing interests

none

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Appendix A. Supplementary data

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