Return on investment 2:

Evaluating the cost-effectiveness of needle and syringe programs in Australia

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Contents

Glossary

Abbreviations

AIDS	Acquired immune deficiency syndrome
ARV	Antiretroviral therapy
CPI	Consumer price index
DALYs	Disability-Adjusted-Life-Years
HIV	Human immunodeficiency virus
HCC	Hepatocellular carcinoma
HCV	Hepatitis C Virus
IDU	Injecting drug user
IQR	Inter-quartile range (25-75% interval)
ICER	Incremental cost-effectiveness ratio
IRID	Injection related injuries and disease
NCHECR	National Centre in HIV Epidemiology and Clinical Research
NDM	Needle dispensing machine
NPV	Net present value
NSP	Needle and syringe program
QALYs	Quality-Adjusted-Life-Years
SVM	Syringe vending machine

Definition of terms

Cost-effectiveness	Efficiency of a program: estimate of costs spent or saved in relation to health outcomes averted or reduced
Incidence	A measure of the number of new cases of a disease in a population in a given time (usually yearly)
Direct cost	A cost that is directly traced to the delivery of specific goods or services
Discount rate	The rates used to discount future cash flows to their present value
Economic analysis	Economic evaluation that compares two or more alternative courses of action in terms of both their costs and consequences
Incremental cost	The change in cost associated with a program or intervention compared to an alternate option
Incremental cost-effectiveness ratio	The incremental cost of a program or intervention divided by the incremental benefit of a program or intervention compared to an alternative
Marginal cost	The change in the total cost when the production of an outcome of interest increases by one unit
Marginal return	The additional output resulting from a one unit increase in the use of a variable input, while other inputs are held constant
Net financial cost	The cost of financing the purchase of a program or intervention minus any costs or cost savings for the consequences of an intervention
Net monetary benefit	The net costs and cost-offsets of a program allowing for a government or societal willingness to pay for a unit of health gain
Net present value	Total present value (PV) of a time series of cash flows; it is a standard method for using the time value of money to appraise long-term projects
Prevalence	The proportion of individuals in a population with disease
Productivity gains and losses	Gains or losses of production related to sick leave, absences from work, total and permanent disability or death in participants in a program or population measured in monetary values
Undiscounted	Evaluations based on assumptions of all monetary terms having equal values in the future as the current value of money
Unit cost	Cost of a unit of production

Executive summary

This project aimed to:

1. Estimate the population benefits of needle and syringe programs (NSPs) on HIV and hepatitis C virus (HCV) related outcomes among injecting drug users (IDUs) in Australia and in each State and Territory over the period from 2000 to 2009.
2. Explore changes in the provision of NSPs, populations at risk, and sharing behaviour on these outcomes.
3. Calculate the net present value and future values and cost-effectiveness of NSPs in terms of HIV and HCV infections averted from a health sector (government as third party payer) perspective.

Population model methods

A mathematical epidemic model was developed to simulate HIV and HCV transmission among IDUs in Australia. The model was informed by detailed biological data, Australian IDUs behavioural data (e.g., the annual NSP survey/finger prick survey), and the number of injecting equipment units distributed by NSPs each year. The model described IDUs in the community and not those in prisons. The extensive available data enabled the model to describe well the complex injecting behaviour and mixing patterns of Australian IDUs and viral transmissions within this population. The model was used to determine the population-level effectiveness of NSPs in preventing transmissions of HIV and HCV through the distribution of sterile injecting equipment. It accurately reflected the current HIV and HCV epidemiology in Australia. Separate analyses were carried out for IDUs in Australia and by each Australian state and territory as well as Australian Aboriginal and Torres Strait Islander people who inject drugs.

The decade from 2000-2009 was investigated to estimate the number of HIV and HCV infections with and without NSPs in the past, thus determining the effectiveness of NSPs. The model was then used to forecast epidemic trajectories over the next 70 years (2010-2079) under assumptions that funding and services of NSPs or behaviour of IDUs remain unchanged or according to changes in conditions. This time horizon was chosen in order to consider whole of lifetime impacts. Shorter timeframes are also analysed. These results became inputs into an economic analysis.

Economic analysis methods

An economic analysis used the epidemic model results and detailed data on costs. Costs associated with NSPs were provided by State and Territory health departments. Healthcare costs for HIV and HCV were estimated from activity-based analysis and national databases. All costs are presented in 2008 Australian dollars. The outcome of interest from the economic analysis was:

- Disability-Adjusted-Life-Years (DALYs).

A range of time horizons were chosen for the analyses:

- 2000-2009
- 2010-2019
- 2010-2029
- Life-time of current IDU cohort.

Discounting was applied at 3% and 5% where appropriate (discounting assesses the value of money at different time periods) [1].

Summary of investment

- The number of needles and syringes distributed in Australia increased during the past decade (from ~27 million to ~31 million).
- Expenditure on NSPs increased by 36% (adjusted for inflation) over this time period, mostly associated with personnel and not principally for equipment (Table a); a significant portion of the increased investment has been the Illicit Diversion Supporting Measures for NSPs to increase referrals to drug treatment and other services.
- Over the last decade there has been
    - Increases in funding for primary sites.
    - Increases in the number of secondary sites.
    - Increases (by 15%) in the numbers of units of equipment provided.
    - Stable spending on sterile injection equipment.
    - At the time of writing there were 85 primary sites, 737 secondary sites, 20 enhanced secondary sites, and 118 vending machines.

Effectiveness of NSPs

It was estimated that over the last decade (2000-2009) NSPs have directly averted:

- 32,050 new HIV infections;
- 96,667 new HCV infections.

Table b summarises the epidemiological benefits of NSPs over the last decade. When secondary transmissions (sexual or mother-to-child transmission from infected IDUs) are considered, the epidemiological benefits are even greater. The cumulative benefits of NSPs are further pronounced if long-term projections are considered, as the preventative effects of NSPs flow through to influence the incidence of long-term clinical complications.

Economic analysis of NSPs during 2000-2009

During 2000-2009, gross funding for NSP services was $243m. This investment yielded:

- Healthcare costs saved of $1.28 billion ($1.12bn-$1.45bn, IQR).
- Approximately 140,000 DALYs gained.
- Net financial cost-saving of $1.03 billion ($876m-$1.98bn, IQR).

The net present value of NSPs (in 2000) is $896m (disc 3%)(Table c) and $817m (disc 5%).

It was estimated that:

- For every one dollar invested in NSPs, more than four dollars were returned (additional to the investment) in healthcare cost-savings in the short-term (ten years) if only direct costs are included; greater returns are expected over longer time horizons.
- NSPs were found to be cost-saving over 2000-2009 in seven of eight jurisdictions and cost-effective in the other jurisdiction. Over the longer term, NSPs are highly cost saving in all jurisdictions.
- The majority of the cost savings were found to be associated with HCV-related outcomes. However, when only HIV-related outcomes were considered in the analysis, it cost $4,500 per DALY gained associated with HIV infection.
- If patient/client costs and productivity gains and losses are included in the analysis, then the net present value of NSPs is $5.85bn; that is, for every one dollar invested in NSPs (2000-2009), $27 is returned in cost savings. This return increases considerably over a longer time horizon.
- NSPs are very cost-effective compared to other common public health interventions, such as vaccinations (median cost per QALY of $58,000), allied health, lifestyle, and in-patient interventions (median cost of $9,000 per DALY gained), and interventions

addressing diabetes and impaired glucose tolerance or alcohol and drug dependence (median cost of $3,700 per DALY gained) [2].

Results about future NSPs

If NSPs were to decrease in size or number, then relatively large increases in both HIV and HCV could be expected with associated losses of health and life and reduced returns on investment (Table d). Significant public health benefits can be attained with further expansion of sterile injecting equipment distribution.
Investment in NSPs was cost-saving for current NSP funding when analysed for all time periods. Cost savings were:

- $782m (2010-2019)
- $3.23bn (2010-2029)
- $17.75bn (2010-2059)
- $28.71bn (2010-2079).

The net present value of current NSP investment at 2010 (discounted 3%):

- $641m (2010-2019)
- $2.27bn (2010-2029)
- $8.41bn (2010-2079).

Increased funding and provision of NSPs would be associated with greater cost-savings. The maximum return would be achieved at 125% to 200% of current levels (Table e); this is when the total net savings (NPV) is maximal. Expansion of NSPs in all jurisdictions would be cost-saving. There is potential for expansion, considering that only approximately 50% of all injections are currently with a sterile syringe.

Conclusions

Investment in NSPs (2000-2009) has resulted in:

- An estimated 32,050 HIV infections and 96,667 HCV infections averted;
- Substantial healthcare cost savings to government related to HCV and HIV;
- Substantial gains in Disability Adjusted Life years.

For every dollar currently spent on the activities of NSP, more than four dollars will be returned (in addition to the investment; i.e., five times the investment) and approximately 0.2 days of disability-adjusted life gained. Over a longer time horizon there is even greater return.

Results from model-based projections into the future (2010 onwards) suggest that:

- Maintenance of current levels of NSP funding will continue to provide
    - substantial and increasing healthcare cost savings;
    - gains in life years.
- Increases in the funding and provision of NSPs will:
    - avert additional HCV and HIV infections;
    - lead to further and increased cost-savings of funding up to 150-200% of current level if met with demand;
    - reduce marginal return on investment as funding increased.
    - the maximum return would be achieved at 150% to 200% of current levels.

It is important to note that this report is based on the effectiveness of NSPs in averting HIV and HCV infections among IDUs only and not on the many other benefits of NSPs, such as avoided mental health episodes and injecting related injury, psychosocial benefits, other support, referral, education and prevention etc. Costs of NSPs in this analysis included some other services (but not primary healthcare or drug and alcohol programs or the human resource cost of providing sterile injecting equipment) and thus results are conservative estimates of the true return on investment.

Key tables

Table a: Investments made by financial year in 2008 Australian dollars (unadjusted financial expenditures and adjusted for consumer price index). Note that NSP support includes human resource costs, rent and overheads; support for secondary sites consists of human resource costs.

	2000/1	2001/2	2002/3	2003/4	2004/5	2005/6	2006/7	2007/8
CONSUMABLES ($'000)								
Sterile injecting equipment	5,658	5,140	5,633	6,677	6,928	6,571	7,404	6,857
Disposal equipment	911	884	952	941	1,184	1,122	1,274	1,474
Safe sex packs	15	52	70	69	246	245	289	293
Sub-total	**6,583**	**6,076**	**6,655**	**7,686**	**8,358**	**7,938**	**8,968**	**8,624**
NSP SUPPORT ($'000)								
Primary NSP Operations	8,851	10,510	10,417	11,261	12,505	12,274	14,450	15,929
Support for Secondary NSPs	380	653	745	788	951	1,264	963	1,222
Transport	89	82	92	105	117	184	198	192
Vending Machines	10	0	0	0	0	19	246	441
Sub-total	**9,331**	**11,245**	**11,254**	**12,154**	**13,573**	**13,742**	**15,856**	**17,783**
TOTAL ($'000) (unadjusted for CPI)	15,914	17,321	17,909	19,841	21,931	21,680	24,824	26,407
TOTAL ($'000) (adjusted for CPI)	**20,119**	**21,236**	**21,312**	**23,064**	**24,850**	**23,897**	**26,500**	**27,380**
Total Client Costs ($'000)	**7,608**	**7,296**	**6,548**	**6,769**	**6,825**	**6,230**	**6,176**	**6,160**

Table b: Estimated HIV- and HCV-related outcomes, with and without NSPs (medians)

Outcome (2000-2009)	With NSPs	Without NSPs	Cases averted
HIV			
Prevalence of HIV among IDUs (2009)	0.1%	14.0%	
Cumulative incidence of HIV infections	305	32,355	32,050
Cumulative number of HIV-related deaths	383	2,574	2,191
HCV			
Prevalence of HCV among IDUs (2009)	65.1%	87.1%	
Cumulative incidence of HCV infections	103,124	199,791	96,667
Number of cirrhosis cases (2009)	4,337	5,030	693
Cumulative incidence of HCC	1,854	1,862	8
Cumulative incidence of liver failure	2,704	2,720	16
Cumulative number of liver transplants	4,277	4,278	1
Cumulative number of liver-related deaths	4,084	4,088	4

Table c: Net cost of program and gains in DALYs (undiscounted) as well as net present value (discounted (3%) and undiscounted) from the perspective of year 2000

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	SUM
Costs saved $m (IQR)	66 (57-75)	192 (171-212)	137 (119-157)	98 (84-107)	96 (86-105)	106 (94-116)	119 (107-135)	134 (119-154)	153 (134-177)	176 (148-206)	
DALY gain (median)	4087	10825	12863	12799	13089	13705	15148	16922	19301	22386	
NPV current program $m (IQR) (undisc.)	46 (37-55)	171 (149-191)	116 (98-136)	75 (61-84)	71 (61-80)	82 (70-93)	93 (80-108)	107 (92-127)	126 (107-150)	145 (118-174)	1.03bn (873m-1.98bn)
NPV current program $m (IQR) (3% disc.)	46 (37-55)	166 (145-185)	109 (92-128)	69 (56-77)	63 (54-79)	70 (60-80)	78 (67-90)	87 (74-103)	99 (84-118)	110 (90-132)	896m (758m-1.04bn)

Table d: Loss of life and reduced return associated with decreased funding period 2010-2019 (all discounted at 3%)

NSP funding	Reduction in NSP spending	Loss in DALY vs. current	Reduced return
50% of current levels	$112m	36,370	$197m
75% of current levels	$56m	16,473	$98m
90% of current levels	$22m	7,607	$36m

Table e: Gain in DALYs and net present value with level of funding in NSPs after ten years (2010-2019) compared to no program

Level of funding for NSPs	NSP investment	Gain in DALY	Net saving (NPV)	Return on investment
Period 2010-2019				
100% of current levels	$225m	97,229	$631m	current investment + 380%
110% of current levels	$248m	98,562	$633m	current investment + 360%
125% of current levels	$282m	104,005	$647m	current investment + 330%
150% of current levels	$338m	111,254	$656m	current investment + 290%
175% of current levels	$395m	116,874	$650m	current investment + 270%
200% of current levels	$451m	121,303	$635m	current investment + 240%
300% of current levels	$676m	132,595	$514m	current investment + 180%

Introduction and brief review of prior studies

Sharing of syringes by injecting drug users (IDUs) is an important mode of global transmission of blood borne viruses, such as HIV and hepatitis C virus (HCV) [3, 4]. Both HIV and HCV infection are associated with significant morbidity and mortality [5, 6]. Needle and syringe programs (NSPs) are a public health measure designed to reduce the spread of these infections among IDUs. There are large differences in HIV epidemics among IDUs between different international settings [3, 4, 7]. Ecological studies suggest that where NSPs are not easily accessible, HIV prevalence tends to be substantially greater than in locations where NSPs are available [8-16]. In contrast to HIV infection, prevalence of HCV among IDUs is generally high in all locations regardless of the existence of NSPs [4].

Overview of Needle and Syringe Programs (NSPs)

NSPs provide a range of services that include the provision of injecting equipment, education and information on reduction of drug-related harms, referral to drug treatment, medical care and legal and social services [17]. Equipment provided by NSPs includes needles and syringes, swabs, sterile water, and sharps bins for the safe disposal of injecting equipment. The primary aim of NSPs is to prevent the shared use of injecting equipment, in order to reduce the risk of acquiring blood borne infections among IDUs. IDUs are unlikely to use another person's syringes if they have convenient access to sterile needles and syringes [18, 19]. NSPs also provide condoms and safer sex education to reduce the potential for sexual transmission of infections. Additionally, NSPs add the opportunity for early uptake of treatment and increased access to HCV treatment education.

The first NSP in Australia began as a pilot study in 1986 in Sydney, New South Wales [20]. In 1987 the NSW government endorsed NSPs through policy, and other Australian States and Territories were quick to follow. The first National HIV/AIDS Strategy, released by the Commonwealth Government in 1989, provided a framework for an integrated response to the HIV epidemic and NSPs were identified as a key component of the education and prevention strategy [21]. NSPs continue to be supported by the latest National Strategy on HIV/AIDS and National Hepatitis C Strategy 2005-2008.

There are now more than 3000 NSP sites across Australia, with the sector comprising primary and secondary NSP outlets, mobile and outreach services, syringe vending machines and a significant number of pharmacies that offer NSP services [22]. More than 30 million syringes are distributed each year through Australian NSPs [23].

NSPs operate from three major outlet types and four service delivery modalities. The following outlet types and service modalities operate to varying degrees within the Australian States and Territories.

Primary NSPs

Primary NSPs are services dedicated to the provision of a wide range of sterile injecting equipment and other services to IDUs. Primary NSPs deliver information and education on issues relating to injecting drug use and health and make referrals for IDUs to a range of other services including drug treatment. Primary NSPs may also liaise with a range of local stakeholders including police, other criminal justice service providers and local government in addition to health and community services.

Secondary NSPs

Secondary NSPs operate within existing health or community services but are not directly funded to employ staff to deliver NSP services. Staff providing NSP services do so in addition to the roles for which they are primarily employed. Secondary NSPs may provide the same range of services that primary NSPs do but typically have limited capacity to deliver services other than the delivery of sterile injecting equipment and disposal facilities.

Pharmacy NSPs

Pharmacy NSPs are community retail pharmacies that choose to act as NSP services. Pharmacy NSPs distribute a range of injecting equipment, including disposal containers, to IDUs sometimes on a commercial basis. In addition to the provision of injecting equipment pharmacy NSPs may collect data, provide information and offer referral to IDUs. Pharmacy NSPs are a critical component of NSP service delivery in Australia accounting for approximately 15% of syringes used for injecting drugs.

Service Modalities

Fixed-site NSP services account for the majority of NSPs in Australia. These services operate from a designated building within identified hours including those that operate 24 hours a day. Fixed-site NSPs are often co-located in a variety of settings including hospitals, pharmacies or community health services.

Syringe Vending Machines (SVMs), also known as Needle dispensing Machines (NDMs), are self-contained units that dispense sterile injecting equipment in most cases for a small fee.

These machines are usually nondescript, do not advertise their contents, and may operate after NSP service hours or provide 24-hour access to sterile injecting equipment.

Outreach/mobile services operate from vehicles, such as a cars, vans or buses, or, in a small number of cases, use a 'foot outreach' model that involves NSP staff carrying backpacks to deliver injecting equipment and educational information. These services can operate on a specific timetable, to be present at designated locations at scheduled times, or may respond to direct requests which are usually made by phone.

Silent or unadvertised services are discrete NSPs that are often targeted at specific subgroups of injectors.

Review of previous NSP economic evaluations

The cost effectiveness of NSPs has been considered in a number of publications including the previous Return on Investment Report [24]. The Return on Investment Report (2002) economic analysis demonstrated that there had been significant financial savings accruing from the expenditure on NSPs and that savings were likely to continue in the future [24]. The net present value (present value of a series of amounts over time) was estimated to be more than $2 billion dollars (discounted at 5%). NSP cost data was collected from jurisdictions and the lifetime cost of treatment for HIV and HCV were obtained from studies in the pre-ARV era but updated with more recent data from the Australian HIV Observational Database. An ecological analysis estimated the effect of NSPs across numerous international cities and the results of the analysis were applied to estimate the impact in Australia. It was estimated that:

- ~25,000 HIV infections were prevented among injecting drug users (IDUs) by the year 2000 due to the introduction of NSPs.
- The cumulative number of HIV/AIDS deaths by the year 2000 in injecting drug users (IDUs) would be ~200 with the NSPs and ~700 without the NSPs.
- ~21,000 HCV infections were prevented among IDUs by the year 2000 due to the introduction of NSPs (of which 16,000 would have developed chronic HCV).

The cumulative number of IDUs living with HCV in 2000 was estimated to be ~200,000 with NSPs in place; it was estimated that the number would have been ~220,000 without NSPs.

In a systematic review of the international literature, 13 economic evaluation studies of NSPs were identified, most based in North America [25]. The studies all concluded that NSPs were

cost-saving or cost-effective compared to the lifetime cost of HIV. A range of approaches were used in the economic analyses, depending on the research question of technical efficiency or value for money.

In a value for money or allocative efficiency analysis, Cohen modelled the impact of a range of public health decisions on women living in the Southern United States [26]. The most cost-effective interventions were alcohol taxes, needle sale/possession, and needle syringe programs, with a cost per HIV infection averted of $3600-$9000. In a previous study, she found that needle exchange and needle deregulation programs were relatively cost-effective only when injection drug users have a high HIV prevalence [27].

Holtgrave used a hypothetical cohort of one million active IDUs in the United States, to estimate the cost-effectiveness of policies to increase access to sterile syringes and syringe disposal at various levels of coverage. A mathematical model of HIV transmission was employed to link programmatic coverage levels with estimates of numbers of HIV infections averted. A policy of funding NSPs, pharmacy sales, and syringe disposal to cover all injections would have cost just over US$423 million for one year. One third of this cost would have been paid for as out-of-pocket expenditures by IDUs purchasing syringes in pharmacies. Compared with the status quo, this policy would cost an estimated $34,278 US per HIV infection averted, a figure that was well under the estimated lifetime costs of medical care for a person with HIV infection. At very high levels of coverage (>88%), the marginal cost-effectiveness of increased program coverage became less favourable [28].

Drucker found that the failure of the federal government in the USA to implement a national needle-exchange program, despite six government-funded reports in support of needle exchanges, might have led to 4000-9700 HIV infections among IDUs, their sexual partners, and their children, during the period 1987-1995. The cost-savings of NSPs could have been between $244m and $538m [29].

A recent analysis from the UK on the cost-effectiveness of NSPs in decreasing HIV and HCV infections showed that increasing the number of IDUs receiving full NSP coverage might be cost-effective if the costs of delivering the increased intervention were not too high and the intervention achieved a moderate decrease in syringe sharing [30]. Results suggested that the impact and the cost-effectiveness of NSPs alone were likely to be greater in settings of lower HCV prevalence [30].

A number of studies have examined the technical efficiency of different programs and their delivery. An HIV prevention program based on the distribution of kits and a needle exchange service which had been in operation in Navarra, Spain was found to cost $16,000 to $88,000 per HIV infection averted [31]. A program including mobile NSPs in Hamilton, Canada returned cost-savings four times greater than the program cost [32]. Another program evaluation in Edmonton, Canada estimated that an HIV infection was averted for every C$4,800 spent [33]. A study in Belarus found that harm reduction activities among IDUs could be cost-effective, but relatively small shortfalls in funding reduced the impact and cost-effectiveness of NSPs [34]. New York State NSPs were cost-saving at $20,947 per HIV infection averted [35]. The geographical location of NSPs in a city affected cost-effectiveness: sites needed to be located where the density of IDUs was highest and the number of syringes exchanged per client needed to be approximately equal across sites [36].

Pinkerton evaluated the cost-effectiveness of a behavioural risk reduction intervention with injection drug users that emphasised safer sex and injection practices, rather than needle syringe programs alone. The intervention had been implemented in 1996 at 28 sites across the USA; he examined eight of the sites. In a threshold analysis, he found that the program would have been cost-saving if it had cost less than $2,100 per person to implement and would have been cost-effective (assuming a societal willingness to pay of $50,000 /QALY) if it had cost less than $10,300 per person [37].

In Odessa, Ukraine, with NSP coverage of 20%-38% and HIV prevalence among IDUs of 54%, projections suggested 792 HIV infections were averted, a 22% decrease in HIV incidence among IDUs, but a 1% increase in IDU HIV prevalence. The cost per HIV infection averted was estimated at $97. Scaling up the intervention to reach 60% of IDUs remained cost-effective and reduced HIV prevalence by an estimated 4% over five years [38].

One study of the cost-effectiveness of NSPs for the reduction of HCV used a random-mixing epidemiological model to examine the potential impact of harm reduction interventions. NSPs were predicted to have little impact on HCV incidence and prevalence within realistic populations of IDUs. The authors concluded that short-term incidence analysis substantially overstated syringe exchange program effectiveness and cost-effectiveness in preventing HCV [39].

Introduction to the current analysis

The previous Return on Investment report estimated that $141 million was spent on NSPs across Australia between 1991 and 2000 [24]. From a conservative financial perspective, only the direct costs of treatment saved by the avoidance of HIV and HCV were considered. But the analysis indicated that there had been significant financial savings accruing to government from the expenditure on NSPs and that these savings were expected to continue. The study demonstrated that NSPs have also yielded a significant public health benefit in terms of avoidance of deaths and gains in the duration of life and improvements in the quality of life of IDUs.

Although NSPs are effective, viral transmission still occurs among IDUs in Australia. Each year at least 30 to 40 new HIV infections and 8,000 to 10,000 HCV infections occur through the sharing of syringes [6]. The current coverage of injections with sterile syringes is ~50%. In this context, it is important to re-assess the impact of NSPs and estimate the cost-effectiveness of current programs, as well as the cost-effectiveness of increasing or decreasing the allocation of resources to NSPs and the programs that they deliver. The Australian Government Department of Health and Ageing commissioned the National Centre in HIV Epidemiology and Clinical Research (NCHECR) to undertake a study to update and extend the return on investment analysis on the cost-effectiveness of NSPs in Australia.

Brief description of the methods and key assumptions

Mathematical epidemic transmission model

A mathematical epidemic model was developed to simulate HIV and HCV transmission among IDUs in Australia. The model was used to determine the population-level effectiveness of NSPs in preventing transmissions of HIV and HCV. A detailed description of the model is provided in Appendix A and a complete listing of the parameters and assumptions of the model and explanation of values used in the analysis are provided in Appendix B. Briefly, the model considered heterogeneity in injecting behaviour, including frequency of injecting and sharing of injecting equipment as well as rates of cleaning equipment. Mathematical associations were derived to describe the coverage of injecting equipment among IDUs for different levels of NSP distribution of sterile injecting equipment. The model tracked the changing number of IDUs in the population, including the entry of new injectors and the rate of ceasing injecting behaviour. The structure of the analysis was a compartmental model based on a large system of ordinary differential equations (see Appendix A). The infection of IDUs with HIV and/or HCV was simulated based on injecting

behaviour and mixing in the population. The model also tracked the natural history of disease progression for people infected with HIV and/or HCV. The model was used to estimate the number of people in each HIV and HCV health state, including important clinical endpoints (as well as drug-related, disease-related, and background death rates), for various NSP-delivery and behavioural scenarios (see Appendix A). All available Australian behavioural and epidemiological data and international disease-related data were used as inputs to calibrate the model to the relevant Australian population (see Appendix B). The model also accounted for the total number of needles and syringes distributed to IDUs in each population, as informed by each State and Territory health department. Uncertainty and sensitivity analyses were carried out by varying all input parameters over plausible ranges, using Latin Hypercube Sampling implemented in the SaSAT software package [40], and running the mathematical model 10,000 times. One hundred model simulations for each population were chosen for the full analysis that best matched HIV and HCV notifications data as well as the prevalence of both infections, number of HIV- and HCV-infected IDUs receiving treatment, annual incidence of HCV-related fibrosis, liver failure, and hepatocellular carcinoma (HCC).

Separate analyses were carried out for Australian IDUs at a national level and by each Australian state and territory, as well as for Aboriginal and Torres Strait Islander populations. The same mathematical structure was used to describe the interaction and epidemiology of HIV and HCV among IDUs in each Australian state and territory and in Australian Aboriginal and Torres Strait Islander populations. Population-specific behavioural and epidemiological data were used to inform the inputs for the model simulations (see Appendix A). The mathematical model was calibrated in order to accurately reflect the unique HIV and HCV epidemiology (incidence and prevalence of infection and each disease outcome/health state) in each population. The model's epidemiological outputs were aligned with available national surveillance data and NSP survey data with estimations from the HCV Projections Working Group study [41]. The numbers of people in each health state over time were used to inform the economic analyses of NSPs. The decade from 2000-2009 was investigated to determine the effectiveness, and cost-effectiveness, of NSPs in the past. Analyses were also conducted to simulate what is likely to have occurred over the last decade, had NSPs not been in place or if the coverage of syringes among IDUs had been different. The model was then used to forecast epidemic trajectories over the next 70 years (2010-2079) under assumptions that behaviour of IDUs or funding and services of NSPs remain unchanged or according to changes in conditions. Epidemic projections are shown over the period 2010-2019.

Economic analysis methods

The economic analysis was designed to calculate the net present value and future values and cost-effectiveness of NSPs with respect to their benefits in averting HIV and HCV infections from a health sector (government as third party payer) perspective. Therefore, the analysis is the most conservative and rigorous estimate of the true return on investment as the many other benefits of NSPs were not factored into the analysis (support, referral, education etc.). The analysis used budget data provided by State and Territory health departments to derive the cost of NSPs and their associated interventions. Healthcare costs saved for HIV and HCV prevented by the intervention were derived from models of service delivery, calibrated with data from local and international research on utilisation and valued using appropriate government cost sources. All costs were in 2008 Australian dollars, adjusted by the consumer price index for previous costs and by 3%, 0% and 5% for costs in the future. Outcomes of interest included the life years gained, disability adjusted, of the current expenditure on NSPs, compared to a range of alternatives, including an absence of program or 'partial null'. The time horizon of the economic model was varied to reflect different decision contexts: the period 2000-2009 to reflect past investment in NSPs, 2010 to 2019 and 2029 to reflect the impact of choices made in 2009 in relation to the next 10-20 years, and 2010-2059 and 2010-2079 to consider whole of lifetime impacts.

Comparators

The current provision of NSPs was compared to a scenario where publically funded NSPs did not exist (the no program or partial null scenario). In this scenario, it is assumed that needles were available only through client purchase at pharmacies, comprising 15% of the current needle availability in Australia. This was based on the estimates of private needle purchase provided by the States and Territories. It is important to note that community pharmacies are a critical component of needle and syringe programs. If publicly funded access to sterile injection equipment had not been put in place, but simply the enabling legislation enacted, or was at some stage removed. there would most likely be substantial migration to pharmacy outlets or the numbers of IDUs utilising pharmacies would more likely have been greater.

Potential changes in the number of sterile injection equipment units provided were considered in a series of scenarios. Supply was assumed to increase or decrease by 10%, 25% or 50%. In all scenarios the cost of consumables and support for the sector increased or decreased by 10%, 25% or 50%.

NSP costs

State and Territory health departments provided data on the budgets for NSPs in responses to a standardised questionnaire developed after a stakeholder meeting. Two main categories of costs were identified that related to the activities of NSPs: (i) consumables including sterile injecting equipment, disposal costs and safe sex-equipment, and (ii) support for the NSP sector including primary NSP operations, support of secondary sites, transport and vending machines. Some jurisdictions separately identified costs such as grants, peer-support programs, and telephone information services on safe disposal of needles and training. These costs were included in the support for primary NSPs subcategory unless identified as relating to one of the other subcategories.

All jurisdictions were given the option to reflect on their initial answers in comparison with their peers and provide further data in order to ensure consistency in responses. Four jurisdictions were not able to provide complete data back to the year 2000. Missing data was imputed by applying the changes in the consumables and support in the four jurisdictions with complete data. Data related to financial years were applied to the calendar year that the financial year started. Specific funding for primary healthcare or drug and alcohol programs that occurred at the same site was not included; the human resource cost of providing sterile injection equipment at secondary sites was not included due to data uncertainty, except where specific support for enhanced secondary sites was provided.

Healthcare costs

The healthcare costs of HIV and Hepatitis C were identified through the creation of a model of service delivery reflecting current practice by the authors, who included doctors experienced in HIV and HCV. Utilisation data was derived for different health states from the literature and local data by four CD4 strata and three antiretroviral strata in HIV and by seven disease and treatment states in HCV. Assumptions and data sources are listed in Appendix C.

Outpatient items were valued from the Medicare Benefits Schedule [42] and Pharmaceutical Benefits Schedule [43] in 2008 dollars. The unit costs of admission were estimated by searching health department data on the frequency and proportions of admission to hospital with different health states of HCV and HIV [44] and then deriving a weighted average cost per admission in a health state using cost weights for admission to an Australian public hospital [45]. Health care costs are summarised in Table 1. Further details of costs are provided in Appendix C.

Table 1: Summary healthcare costs of HIV and HCV

HIV Healthcare	Annual Cost
CD4 > 500	$1,523
350 < CD4 < 500	$2,055
200 < CD4 < 350	$2,731
CD4 < 200	$5,500
1st line therapy	$14,613
2nd line therapy	$15,178
3rd line therapy	$27,776
HCV Healthcare	**Annual Cost**
Precirrhosis stage of chronic hepatitis C (fibrosis stage 0 to 3) - 1st year	$798
Precirrhosis stage of chronic hepatitis C (fibrosis stage 0 to 3) - successive years	$288
Compensated cirrhosis (fibrosis stage 4)	$827
Decompensated cirrhosis (liver failure)	$12,764
Hepatocellular carcinoma	$17,033
Liver transplant - 1st year	$114,411
Liver transplant - successive years	$12,764
Treatment of acute HCV patients with pegylated interferon and ribavirin (24 weeks)	$10,782
Treatment of chronic HCV patients with pegylated interferon and ribavirin (24 weeks)	$10,829
Treatment of chronic HCV patients with pegylated interferon and ribavirin (48 weeks)	$18,835

Patient/client costs

Client costs for the purchase of injection equipment were estimated from data on the number of sterile injection equipment provided through pharmacies and average client out-of-pocket cost of packs of sterile injection equipment. Patient and family healthcare costs for people living with HCV and HIV were approximated from studies in Canada [46] and New Zealand [47], converted to 2008 Australian dollars using the appropriate consumer price index and purchasing power parities [48]. These data were used in a secondary analysis. Time costs for the attendance at NSPs to collect equipment were not included in the client cost, because the economic analysis aimed to examine the value for money of NSPs rather than the technical efficiency of alternative provision and delivery mechanisms. Patient/client out-of-pocket costs were included in a secondary analysis of investment in NSPs because there was an absence of local recent data.

Productivity losses and gains

The methods used to estimate productivity losses and gains associated with HIV and HCV infection are described fully in Appendix D. In brief, the workforce participation rate, assumed work absenteeism and premature mortality of individuals acquiring HIV and HCV were compared to participation and mortality of individuals without the disease, similar in age, gender and injection drug use. The productivity losses due to mortality, short-term absenteeism and disability were estimated using the Friction Cost approach that assumed that individuals who left work due to illness or death could be replaced in three months. Productivity cost was discounted at 3%, 0% and 5%. Alternative time periods for replacement of a worker and approaches to costing productivity losses including the Human Capital method are reported in the chapter on productivity losses and gains. Taxation and welfare payments were not included. Due to the significant uncertainty in the parameters used, productivity losses and gains were not included in the primary analysis, but described in a secondary analysis.

Other sectors costs and cost offsets

While other sectors of the government and the economy such as local government, justice and insurance may be affected by expenditure on NSPs, the associated costs and cost-offsets are very difficult to identify, measure or value. Therefore, these costs and cost-offsets have not been included in this analysis.

Injection-related injuries and disease

Injection-related injuries and disease (IRID) may be significantly reduced by the provision of sterile injection equipment. The cost of IRID to the public health system in Victoria, Queensland and New South Wales was estimated at more than $19m in 2005/6 [49]. However there is a lack of data on the effect size of NSPs on reducing IRID, and other factors related to injection site, hygiene, demography and drug type may also be significant [50]. Therefore the potential additional cost-offsets of preventing IRID in the population of NSP users were included as a secondary analysis only.

Disability-adjusted life years

Disability-adjusted life years (DALYs) provide an outcome that takes account of morbidity and mortality associated with disease and may allow comparison between alternative public health interventions [51]. Disability adjustment weights for health states to derive DALYs were taken from data from the Global Burden of Disease project [52]. DALYs were estimated using standard methods from the outputs of the population transmission model of the number of individuals in the population living in each health state.

Economic analyses

Cost and disutility data for different health states were included in the population transmission model that was run 100 times with outputs of the prevalence of each heath state for HIV and HCV. The HIV and HCV cost was applied in an Excel spreadsheet and the cost summed for each of the 100 iterations. For each iteration, the incremental healthcare cost or cost-offset was estimated comparing one alternative with another. The median incremental healthcare cost and interquartile ranges (IQR) were calculated. The expenditure on NSPs was summarised for all jurisdictions and applied in the model. Costs reported for financial years were applied to the population model outcomes by the calendar year in which the financial year commenced, i.e. costs for NSPs in 2002/3 were deemed to be accrued in calendar year 2002. The net financial difference between the NSP expenditure and incremental healthcare cost was calculated for each year, undiscounted and discounted. The net financial value of NSPs for the period 2000-2009 was estimated from year 2000 onwards to reflect hindsight on decisions made in year 2000 and from year 2010 onwards in the analyses for future spending to reflect the perspective of a decision maker in 2009.

The DALYs for each scenario were summed in the population model and the incremental number of DALYs gained or lost estimated for each scenario compared to the no program scenario. The incremental cost-effectiveness ratios between alternative scenarios were estimated by dividing the incremental net cost of the scenarios by the incremental DALYs gained or lost. Incremental cost-effectiveness ratios for alternative options that were cheaper and more effective were not reported, instead the net financial cost-savings and gains in adjusted life years were reported.

Epidemiological impact of NSPs on Australian IDUs

Reproducing the past epidemic

The mathematical transmission model was informed by all available epidemiological, biological, behavioural, and clinical data as relevant for the Australian population of IDUs, as well as trends in the number of syringes distributed through NSPs (Figure 1). The model was calibrated to accurately reflect the HIV and HCV epidemics in this population (Figure 2; cyan curves are 100 model simulations, the black solid curve represents the median, and dashed curves represent the interquartile range). The model describes the trends in notifications data, suggesting that the annual national incidence of HIV among IDUs has decreased from approximately 39 in 2000 to 24 in 2009; similarly annual national incidence of HCV has decreased from ~13,000 in 2000 to ~8,000 in 2009. The reduction in notifications is largely due to a decrease in the number of IDUs (results not shown; had the number of injectors remained steady, expected notifications would have also remained relatively stable). In Figure 2, HIV and HCV notifications data are shown along with the best 100 model simulations under conditions of actual NSP distribution of sterile injecting equipment units.

Figure 1: Annual number of needles and syringes distributed in Australia (1999-2008)

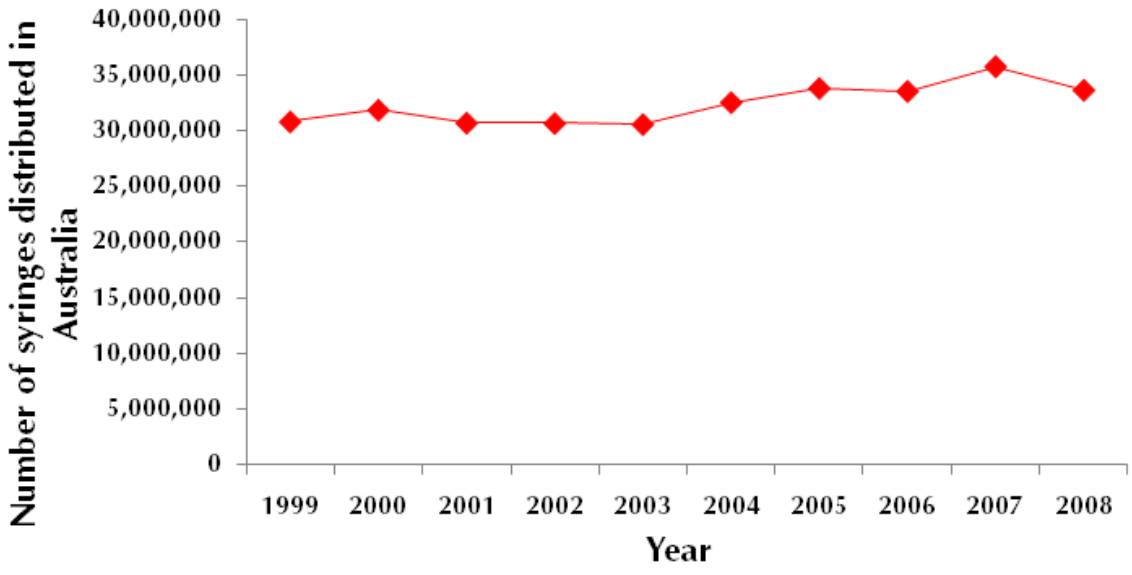
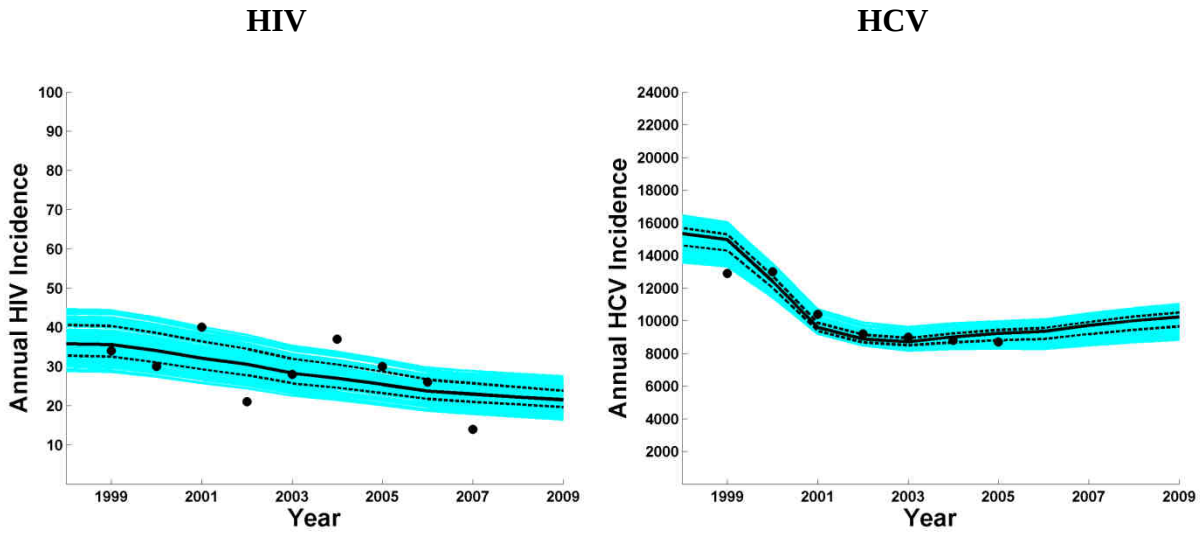


Figure 2: HIV and HCV notifications data among Australian IDUs and 100 model simulations for current NSP coverage (1999-2009)

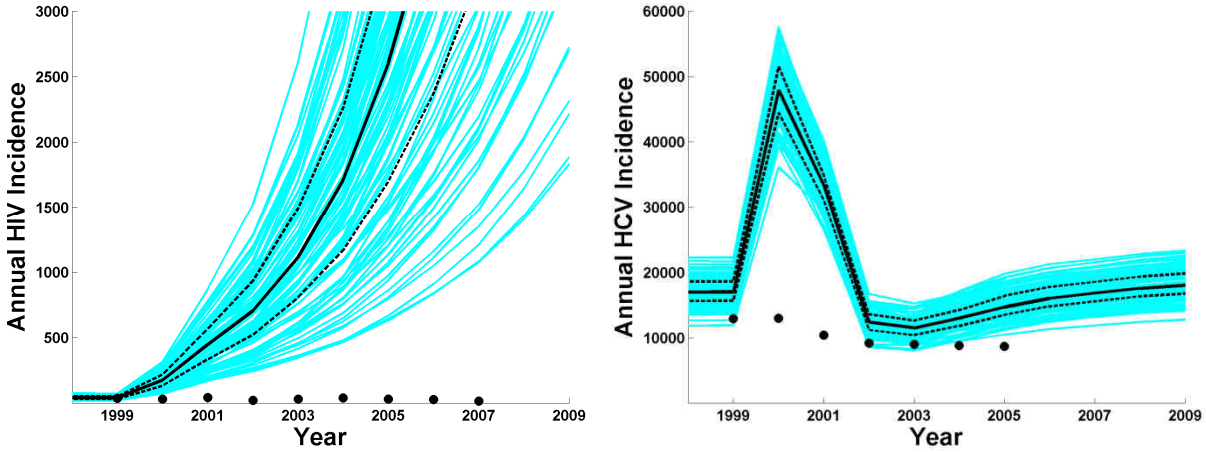


Simulating the past if NSPs had not been in place

It is estimated that approximately 10-15% of syringes used for injecting drugs are purchased from pharmacies [24]. We assume that if NSPs were not in place, the number of syringes in circulation would decrease to 15% of the current distribution. The population transmission model was used to simulate the expected epidemiological trends under conditions that no NSPs existed over the period from 2000 to 2009 (Figure 3). Based on the model, it is estimated that if NSPs were not in place, the incidence of HIV would have increased substantially (Figure 3). A large expansive epidemic of HIV among IDUs could have been expected if NSPs were not in place, with more than 3000 HIV infections per year after ten years of no needle and syringe program. High prevalence levels are common in other international settings where NSPs are not in place [4, 8-16]. The model also predicts that HCV incidence would have been substantially greater if NSPs were not in place (Figure 3). According to the model, in the first year without NSPs there would be a large increase in incidence as susceptible IDUs become infected. This would be followed by a period of decreased incidence, as the pool of susceptible people decreases. However, incidence would then return to near-current levels.

Figure 3: Expected HIV and HCV cases among Australian IDUs from 100 model simulations under conditions of no NSPs (1999-2009)

HIV **HCV**



It is estimated that over the ten year period 2000-2009, the cumulative incidence of HIV and HCV infections averted due to NSPs is ~32,050 (median; 20,765–42,211 interquartile range) and ~96,667 (92,465–103,055, IQR) respectively (Figure 4, Table 2; note that in the conservative scenario, steady state levels are assumed from the outset, which is why incidence is slightly higher following the cessation of NSPs for this scenario). Furthermore, it is estimated that the cumulative incidence of other disease outcomes have also decreased substantially due to NSPs (Table 2). It should be noted that there are only small changes in the long-term serious outcomes, such as HCC, liver failure and liver transplants, because only a ten-year timeframe was considered. The benefits in these outcomes become more marked over a longer time period as the effect of infections averted filters through to aversions of these clinical and disease-related outcomes. The modelling also suggests that NSPs have significantly reduced the potentially high prevalence of HIV and HCV that would have resulted had NSPs not been in place. In Figure 4, the cumulative number of HIV and HCV cases is shown with and without NSPs; the red curve represents the level suggested by the model as realistic numbers of cases without NSPs. For HIV, a very conservative case is also shown, where change in expected incidence is immediate due to fewer syringes in circulation but prevalence does not change with the number of new cases (that is, newly infected cases no longer share injecting equipment and are removed from the population).

Figure 4: Model-based estimate of the cumulative number of HIV and HCV incident cases (median) among Australian IDUs with and without NSPs (2000-2009).

HIV **HCV**

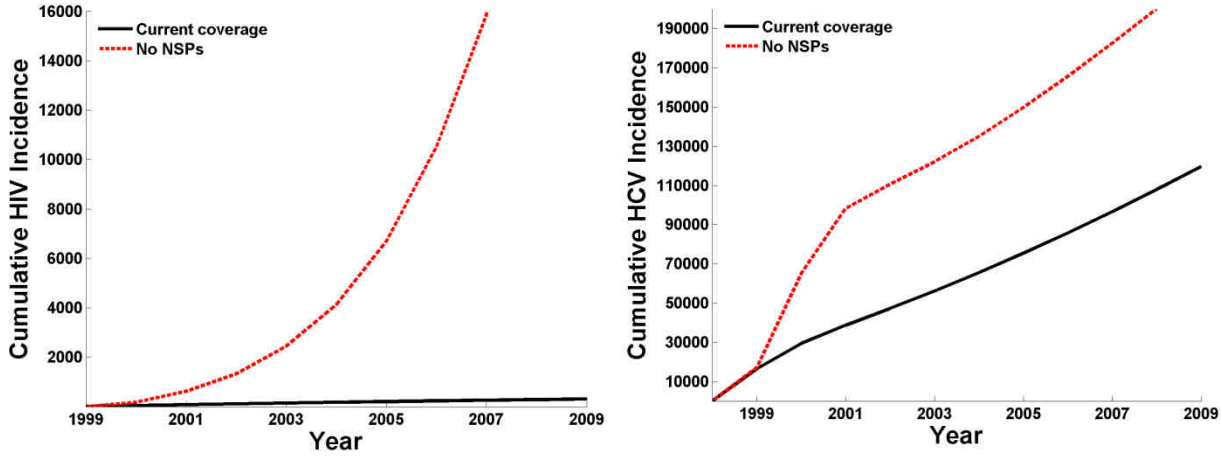


Table 2: Estimated HIV and HCV related outcomes with and without NSPs (medians)

Outcome (2000-2009)	With NSPs	Without NSPs	Cases averted
HIV			
Prevalence of HIV among IDUs (2009)	0.1%	14.0%	
Cumulative incidence of HIV infections	305	32,355	32,050
Cumulative number of HIV-related deaths	383	2,574	2,191
HCV			
Prevalence of HCV among IDUs (2009)	65.1%	87.1%	
Cumulative incidence of HCV infections	103,124	199,791	96,667
Number of cirrhosis cases (2009)	4,337	5,035	698
Cumulative incidence of HCC	1,854	1,859	5
Cumulative incidence of liver failure	2,704	2,720	16
Cumulative number of liver transplants	4,277	4,278	1
Cumulative number of liver-related deaths	4,084	4,088	4

Forecasting future epidemic trajectories

The mathematical model was used to project the expected number of HIV and HCV cases in the future according to scenarios whereby current syringe distribution levels are maintained or if there are increases or decreases in the provision of syringes through NSPs. The model simulated the epidemics up to the year 2079 for economic analyses but epidemic forecasts are shown to the year 2019. Different coverage rates were simulated across the diverse groups of IDUs (Figures 5-12). Simulations for average changes in syringe use across all groups, proportional to syringe distribution are shown in this report.

It is forecasted that under current conditions, HIV incidence among Australian IDUs will continue to decline slowly and there will be slight increases in HCV incidence (Figure 5). If NSPs cease, then relatively large increases in both HIV and HCV could be expected (Figure 6); HCV incidence will return to a higher level within a few years but HIV incidence will continue to expand over the medium-to-long term. Reductions in the distribution of sterile injecting equipment can be expected to lead to detrimental epidemiological consequences (Figures 7-9). However, epidemics are not highly sensitive to perturbations in NSP service; small changes are expected to have only modest epidemiological consequences.

Significant public health benefits can be attained with further expansion of sterile injecting equipment distribution (Figures 10-12). Because HIV incidence is already low, NSP expansion is unlikely to have a noticeable effect on HIV transmission among IDUs. However, noticeable reductions in HCV incidence can be attained with NSP expansion. It is not feasible to see large reductions in HCV, towards eradication, with NSPs. But it could be expected that declines will occur in the short term before incidence rebounds to an endemic level lower than current levels.

Figure 5: Projected HIV and HCV cases among Australian IDUs with current conditions of syringe distribution and coverage maintained (2010-2019)

HIV **HCV**

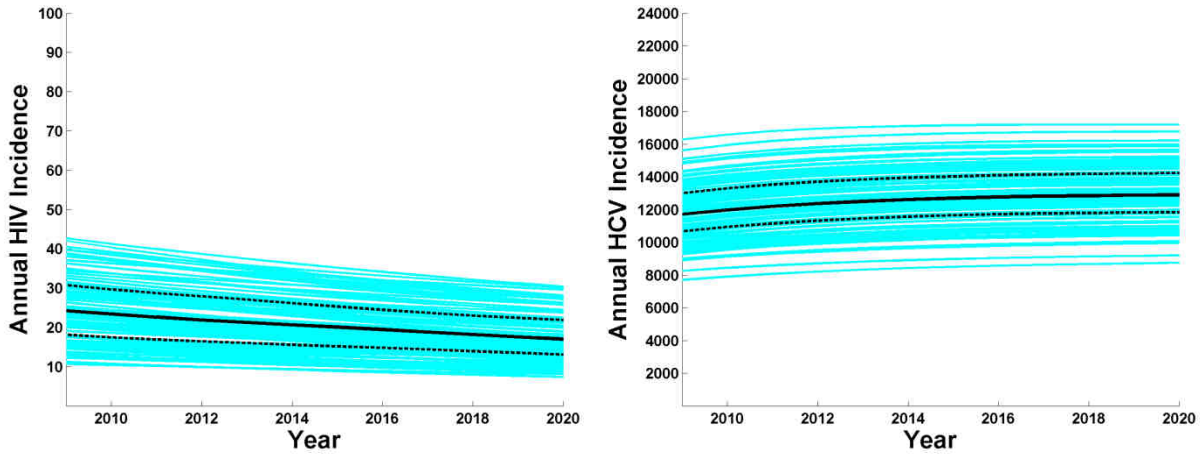


Figure 6: Projected HIV and HCV cases among Australian IDUs if NSPs cease to distribute injecting equipment (2010-2019)

HIV **HCV**

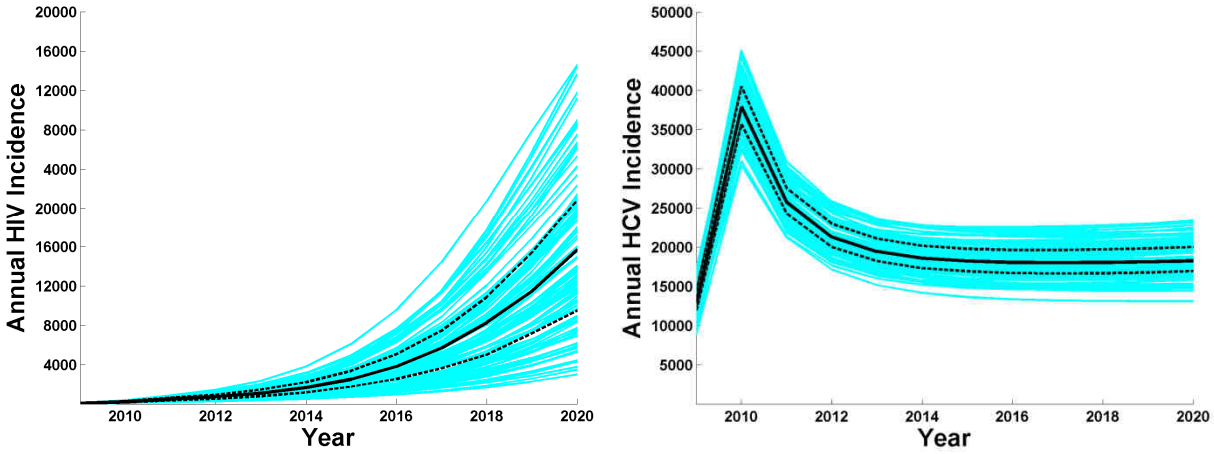


Figure 7: Projected HIV and HCV cases among Australian IDUs if NSPs decrease overall distribution of injecting equipment by 50% (2010-2019)

HIV **HCV**

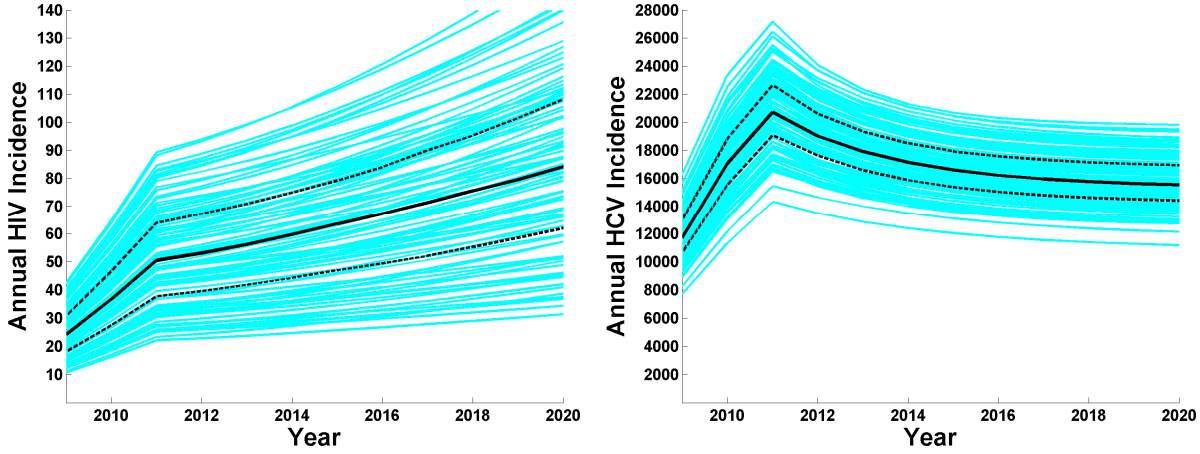


Figure 8: Projected HIV and HCV cases among Australian IDUs if NSPs decrease overall distribution of injecting equipment by 25% (2010-2019)

HIV **HCV**

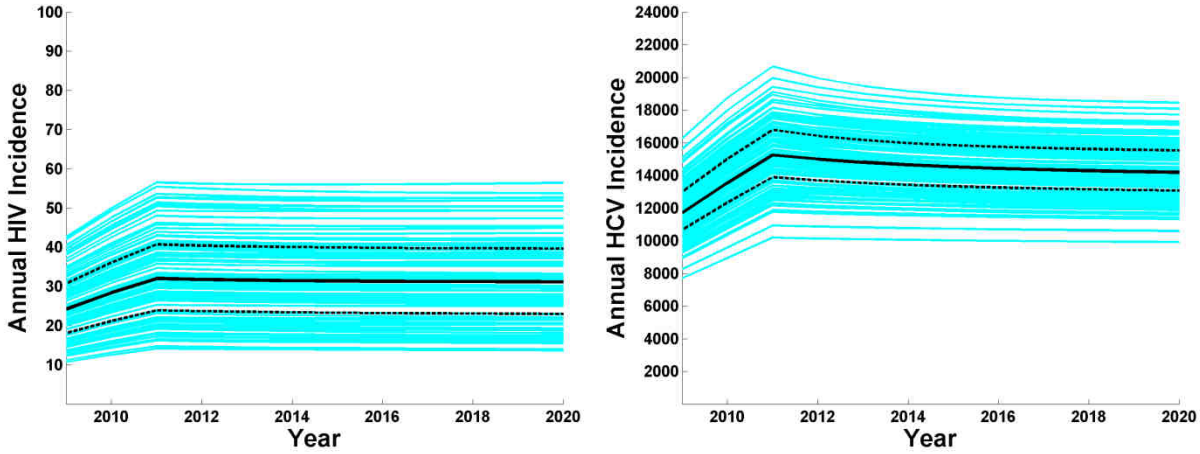


Figure 9: Projected HIV and HCV cases among Australian IDUs if NSPs decrease overall distribution of injecting equipment by 10% (2010-2019)

HIV **HCV**

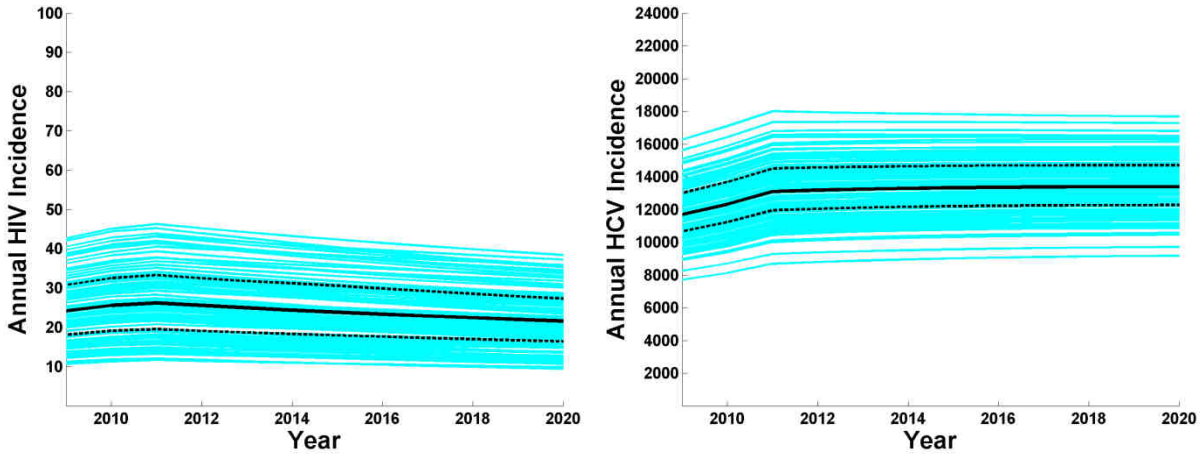


Figure 10: Projected HIV and HCV cases among Australian IDUs if NSPs increase overall distribution of injecting equipment by 10% (2010-2019)

HIV **HCV**

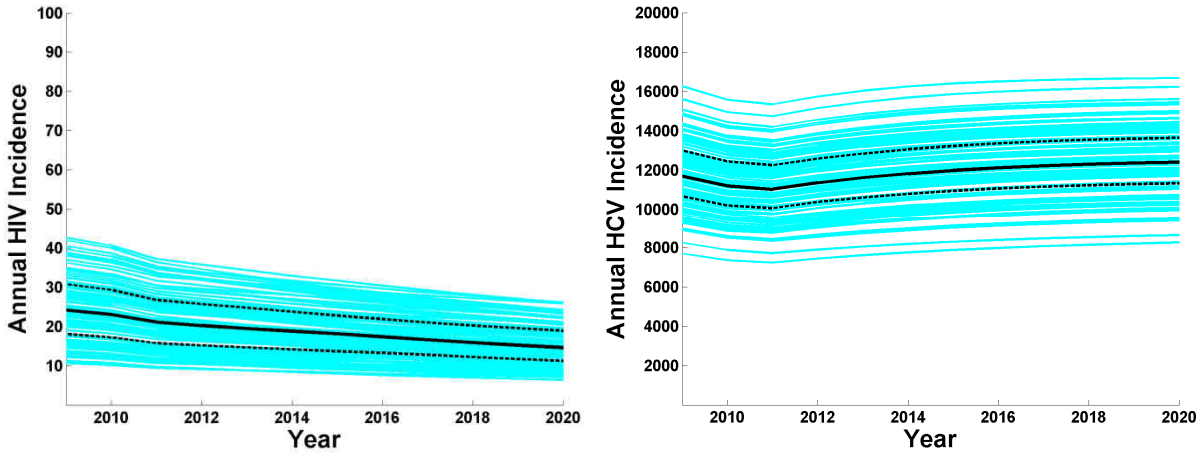


Figure 11: Projected HIV and HCV cases among Australian IDUs if NSPs increase overall distribution of injecting equipment by 25% (2010-2019)

HIV **HCV**

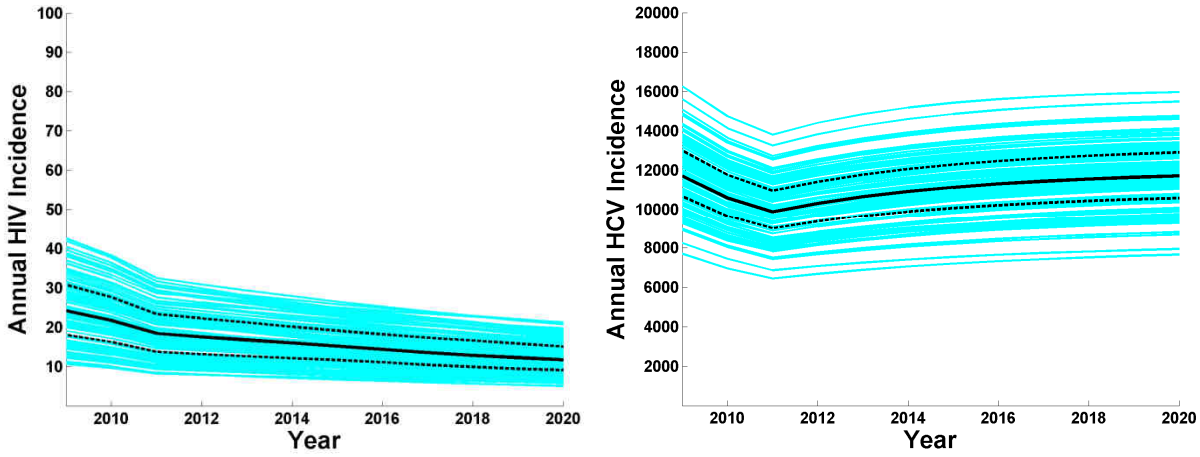
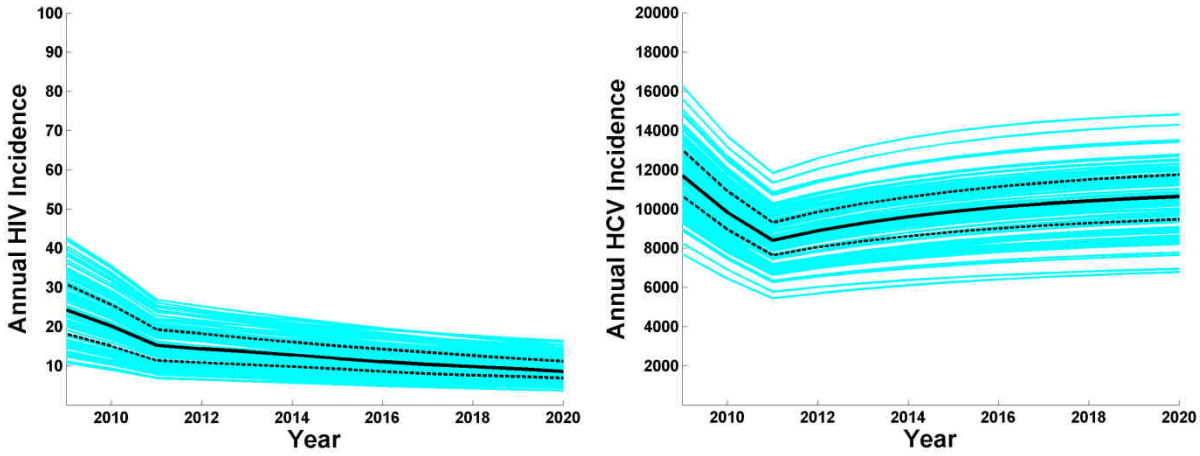


Figure 12: Projected HIV and HCV cases among Australian IDUs if NSPs increase overall distribution of injecting equipment by 50% (2010-2019)

HIV **HCV**



Forecasting epidemic trajectories if IDU populations change

The mathematical transmission model was also used to calculate projections of the expected number of HIV and HCV cases in the future if the number of IDUs in Australia changed (by the stated amount in the figure captions over a ten year period). We found that incidence of HCV is very sensitive to any change in the number of current injectors. Similarly, we found that the relatively large drop in the number of HCV cases at the beginning of the last decade (Figure 2) was predominantly due to a decrease in the number of injectors and not due to any particular injecting-related behaviour.

Figure 13: Projected HIV and HCV cases among Australian IDUs if the size of the IDU population decreases by 25% (2010-2019)

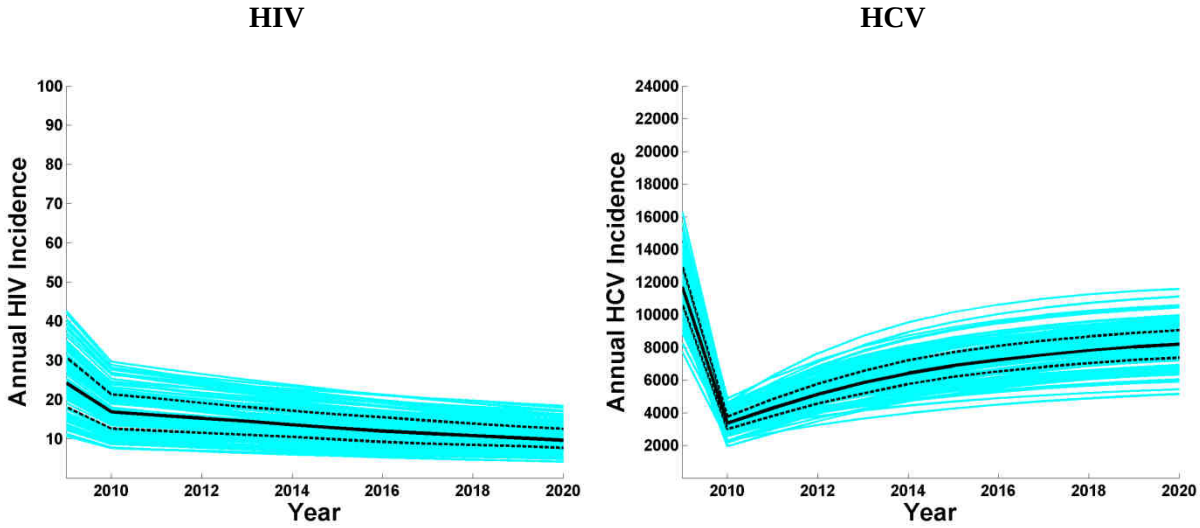


Figure 14: Projected HIV and HCV cases among Australian IDUs if the size of the IDU population decreases by 10% (2010-2019)

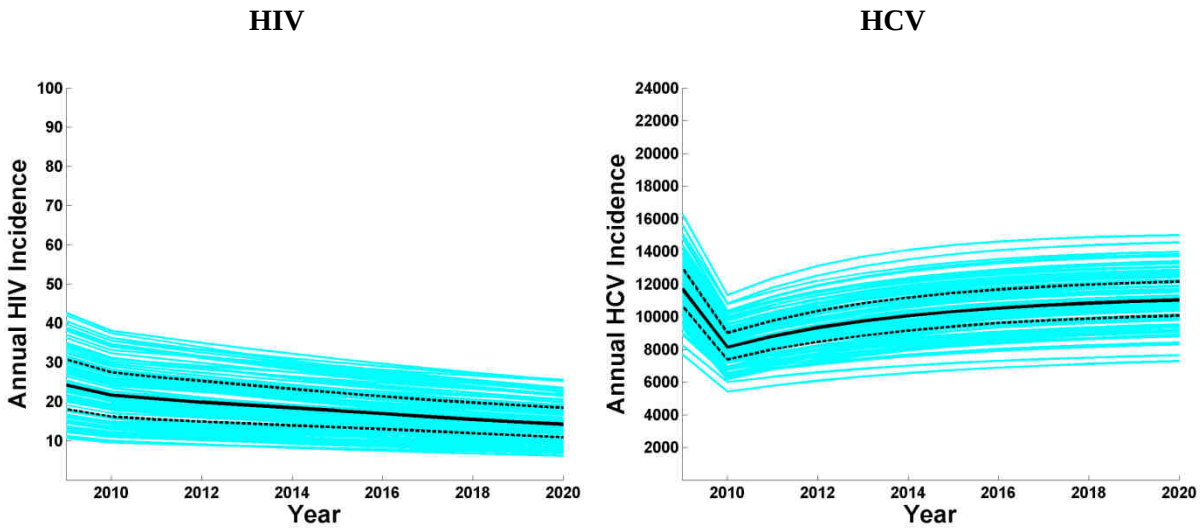


Figure 15: Projected HIV and HCV cases among Australian IDUs if the size of the IDU population increases by 10% (2010-2019)

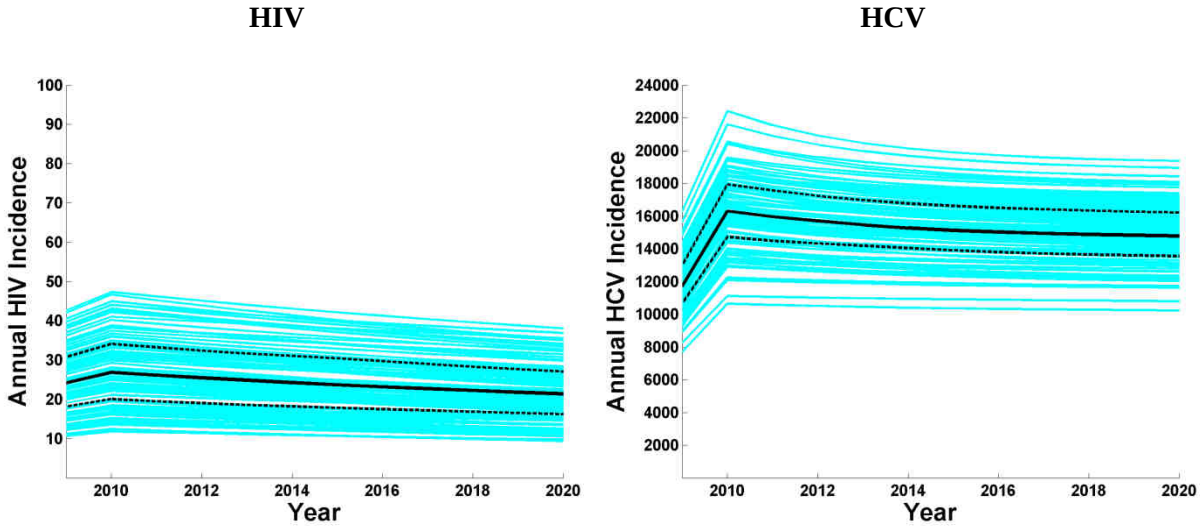
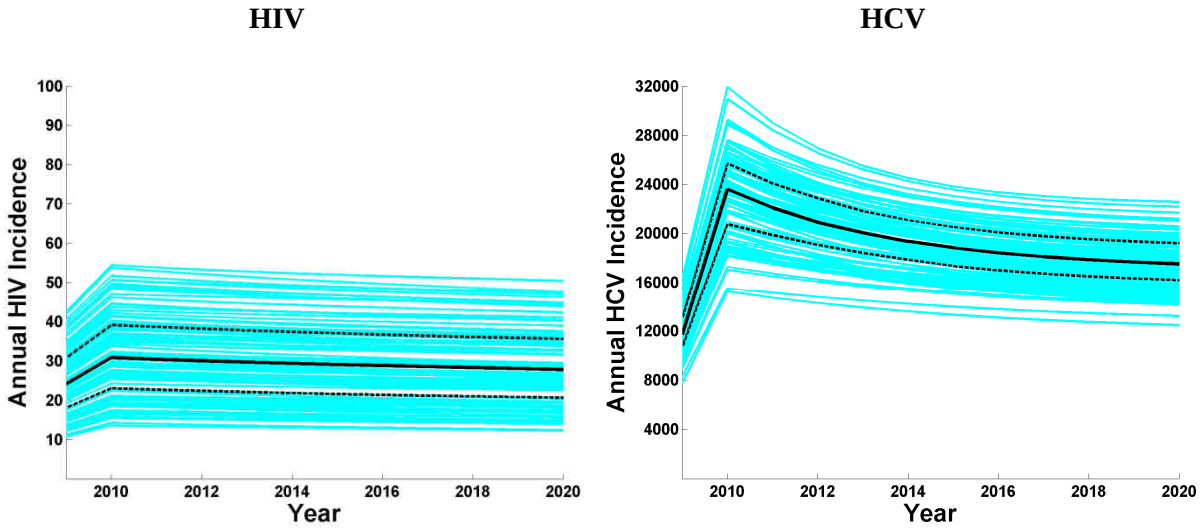


Figure 16: Projected HIV and HCV cases among Australian IDUs if the size of the IDU population increases by 25% (2010-2019)



Forecasting epidemic trajectories if injecting behaviour changes

The mathematical model was used to calculate projections of the expected number of HIV and HCV cases in the future if the average frequency of injecting changes (by the stated amount in the figure captions over a ten year period). Not surprising, we found that changes in average frequency of injecting can have noticeable effects on HIV and HCV incidence among IDUs (Figures 17-20).

Figure 17: Projected HIV and HCV cases among Australian IDUs if the average frequency of injecting decreases by 25% (2010-2019)

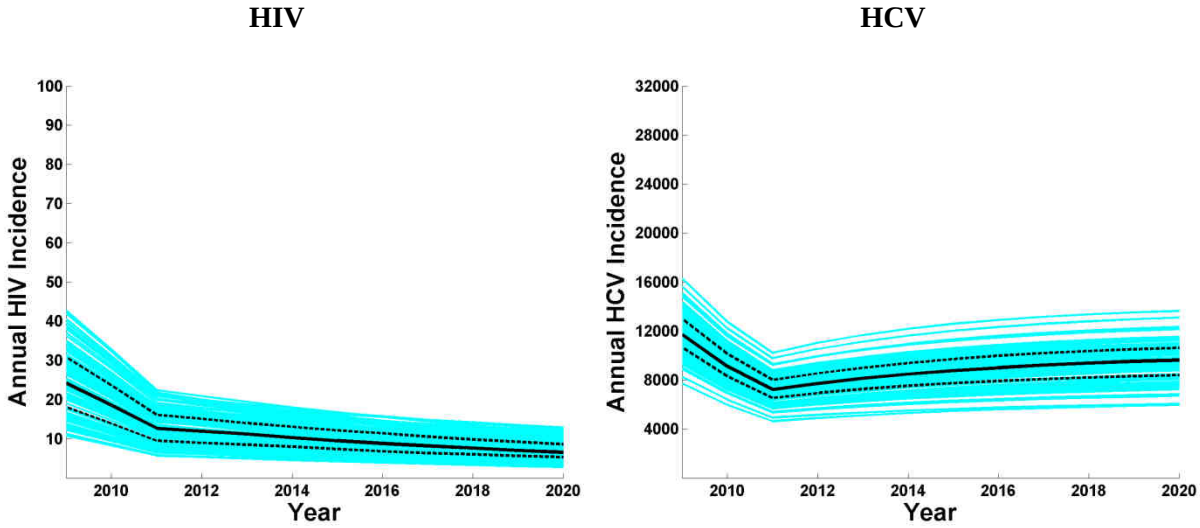


Figure 18: Projected HIV and HCV cases among Australian IDUs if the average frequency of injecting decreases by 10% (2010-2019)

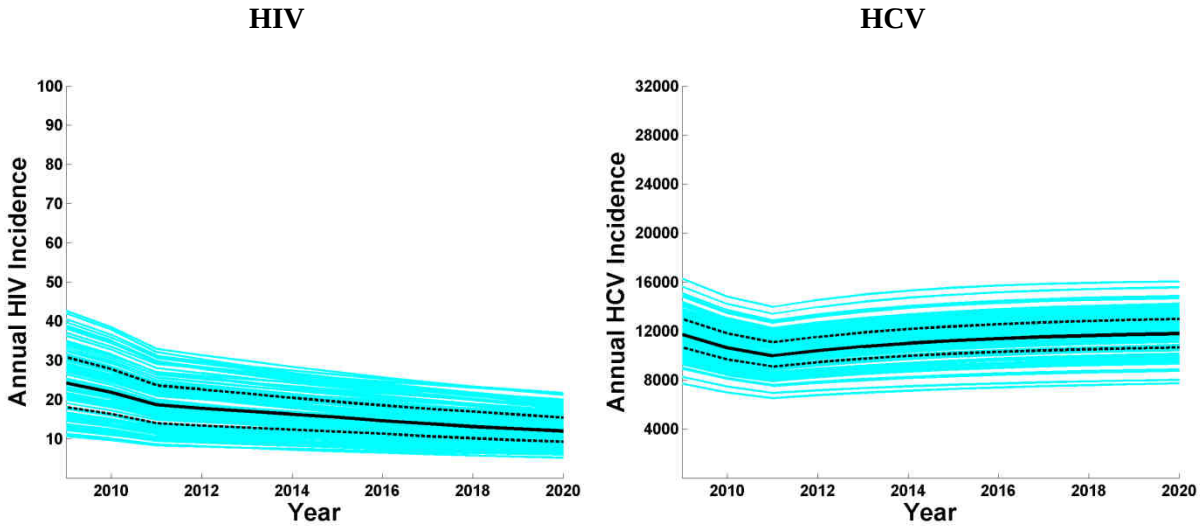


Figure 19: Projected HIV and HCV cases among Australian IDUs if the average frequency of injecting increases by 10% (2010-2019)

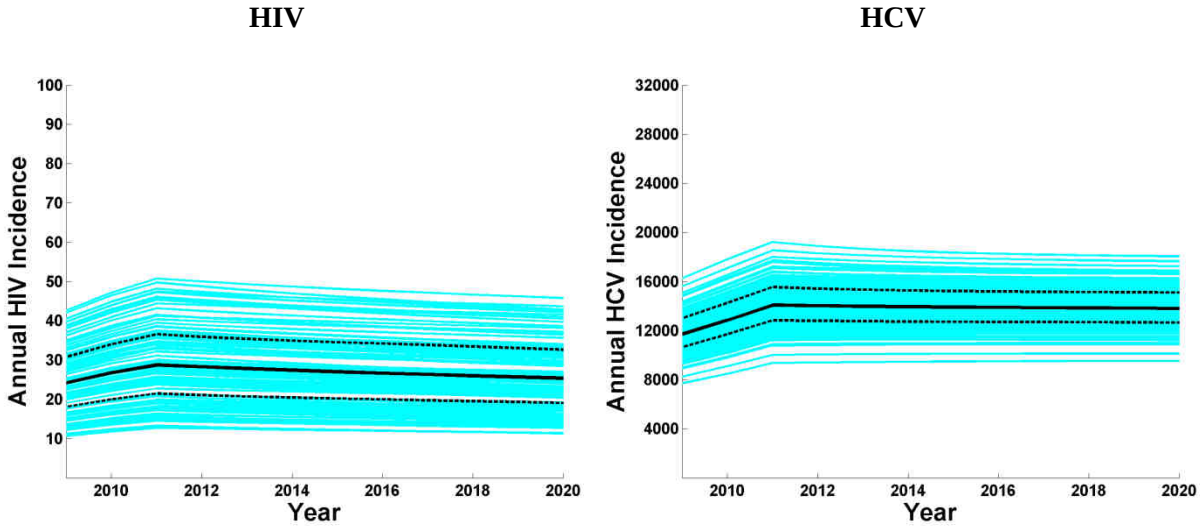
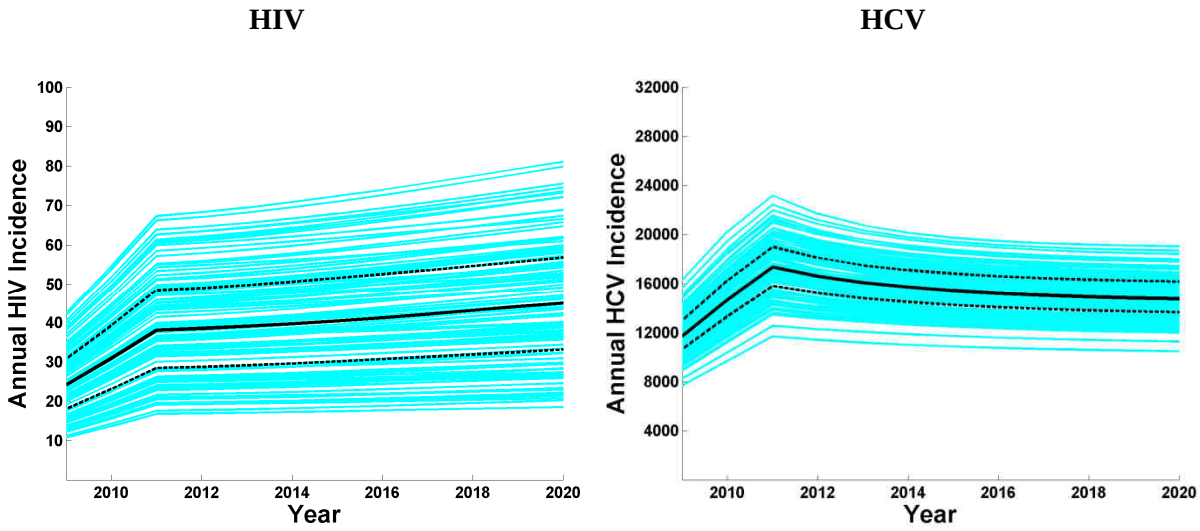


Figure 20: Projected HIV and HCV cases among Australian IDUs if the average frequency of injecting increases by 25% (2010-2019)



Secondary transmissions averted

Other calculations in this report are based on estimates of the number of primary infections averted by NSPs; that is, associated with transmissions via sharing of syringes. These yield conservative estimates of the total number of infections averted, since secondary transmissions through other routes of exposure are not included. In this section an estimate of the number of secondary transmissions averted due to NSPs, from sexual contact or mother-to-child transmission, is calculated with a simple mathematical framework (see Appendix A). Although there is large heterogeneity between individuals, average behaviour is assumed in order to estimate the order of magnitude of the number of secondary cases averted. It is estimated that ~0.44 secondary HIV cases are due to each IDU-related HIV infection and ~0.11 secondary HCV cases from each primary HCV infection (Appendix A). The estimated total numbers of HIV and HCV infections averted (primary and secondary) due to different NSP coverage levels are shown in Table 3: median estimates are shown.

Table 3: Median estimates of primary and secondary HIV and HCV infections averted (2010-2019)

Cumulative number of infections averted (2010-2019) relative to no NSPs	HIV			HCV		
	Primary	2ndary	Total	Primary	2ndary	Total
25% ↓ in NSP coverage	17,900	7,876	25,777	68,104	7,491	75,596
10% ↓ in NSP coverage	17,971	7,907	25,879	81,368	8,950	90,318
Current NSP coverage	18,008	7,923	25,931	87,789	9,657	97,445
10% ↑ in NSP coverage	18,025	7,931	25,956	95,455	10,500	105,955
25% ↑ in NSP coverage	18,051	7,943	25,994	103,915	11,431	115,345

Economic evaluation of Australia's NSPs

Spending on NSPs

$26.4 million was spent on NSPs around Australia in the financial year 2007/8, with $17.8m spent on support for the NSP sector including $15.9m on primary sites, $1.2m on secondary sites and $440,000 on vending machines. $8.6m was spent on the provision of consumables including $6.9 m on sterile injecting equipment, $1.5m on disposal and $290,000 on safe sex packs. See Table 4 for a summary of the spending on NSPs from 2000/1 to 2007/8. Results for individual jurisdictions are reported in the relevant sections.

Table 4: Expenditures made by financial year in 2008 Australian dollars (unadjusted financial expenditures and adjusted for consumer price index)

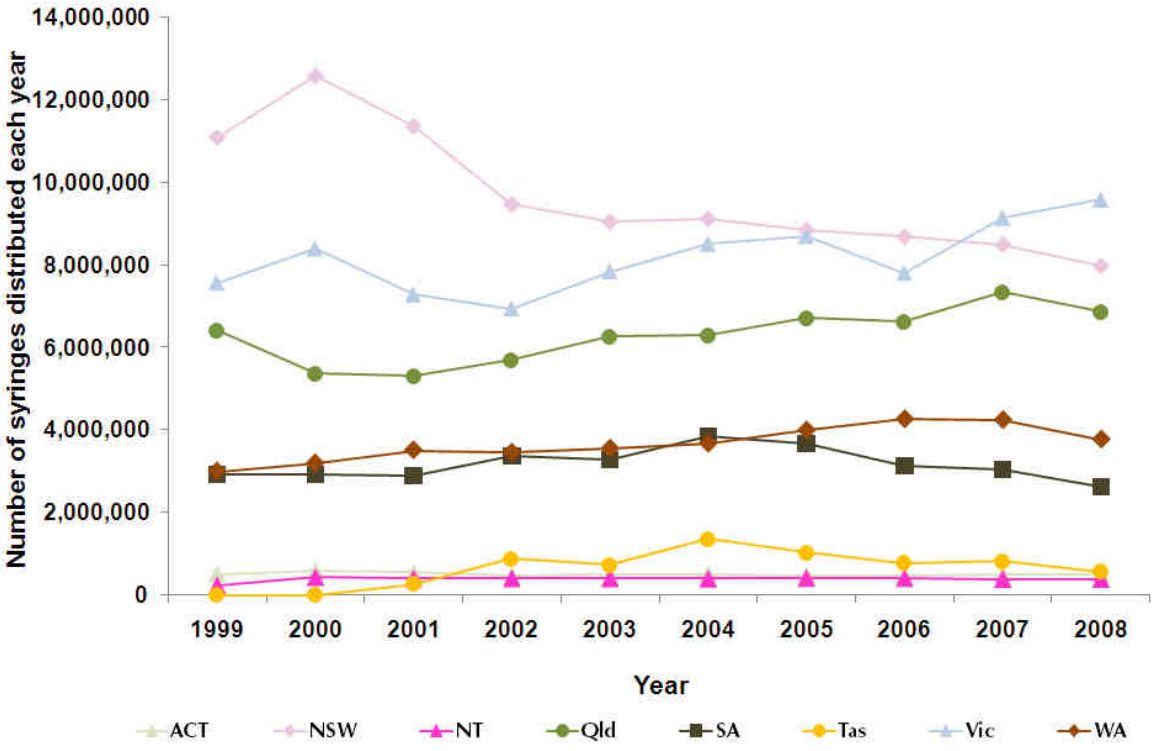
	2000/1	2001/2	2002/3	2003/4	2004/5	2005/6	2006/7	2007/8
CONSUMABLES ($'000)								
Sterile injecting equipment	5,658	5,140	5,633	6,677	6,928	6,571	7,404	6,857
Disposal equipment	911	884	952	941	1,184	1,122	1,274	1,474
Safe sex packs	15	52	70	69	246	245	289	293
Sub-total	**6,583**	**6,076**	**6,655**	**7,686**	**8,358**	**7,938**	**8,968**	**8,624**
NSP SUPPORT ($'000)								
Primary NSP Operations	8,851	10,510	10,417	11,261	12,505	12,274	14,450	15,929
Support for Secondary NSPs	380	653	745	788	951	1,264	963	1,222
Transport	89	82	92	105	117	184	198	192
Vending Machines	10	0	0	0	0	19	246	441
Sub-total	**9,331**	**11,245**	**11,254**	**12,154**	**13,573**	**13,742**	**15,856**	**17,783**
TOTAL ($'000) (unadjusted for CPI)	15,914	17,321	17,909	19,841	21,931	21,680	24,824	26,407
TOTAL ($'000) (adjusted for CPI)	**20,119**	**21,236**	**21,312**	**23,064**	**24,850**	**23,897**	**26,500**	**27,380**
Total Client Costs ($'000)	**7,608**	**7,296**	**6,548**	**6,769**	**6,825**	**6,230**	**6,176**	**6,160**

In 2008 dollar terms, expenditure on NSPs has increased by $7m from 2000/1 to 2007/8 with near-doubling of funding for primary sites and a four-fold increase in support for secondary sites. Spending on sterile injection equipment has been stable in 2008 dollar terms, although numbers of units of equipment provided have increased by 15% (see Table 5 and Figure 1); rises have been greatest in Victoria and Queensland (Figure 21).

Table 5: Number of needles/syringes distributed in Australia during financial years (1999/2000-2007/8)

	1999/2000	2000/1	2001/2	2002/3	2003/4	2004/5	2005/6	2006/7	2007/8
ACT ('000)	502	664	424	468	504	484	457	467	
NSW ('000)	11,517	12,434	10,343	9,116	9,001	8,916	8,813	8,558	8,290
NT ('000)	460	397	396	398	399	388	407	407	379
QLD ('000)	5,820	5,554	5,239	5,887	6,368	6,216	6,739	7,231	7,069
SA ('000)	2,821	3,018	2,999	3,443	3,611	3,676	3,566	2,915	2,763
TAS ('000)	756	756	756	756	1,031	1,326	777	823	692
VIC ('000)	7,972	7,829	7,100	7,379	8,165	8,593	8,241	8,464	9,350
WA ('000)	3,040	3,184	3,601	3,563	3,496	3,788	4,196	4,273	4,039
NATIONAL ('000)	**32,888**	**33,836**	**30,858**	**31,010**	**32,575**	**33,387**	**33,196**	**33,138**	**33,099**

Figure 21: Number of needles/syringes distributed in each Australian jurisdiction during calendar years (1999-2008)



The per-capita rate of needle and syringe distribution in each state and territory among the entire population and the estimated size of the IDU population are shown in Table 6. It was estimated that the average IDU receives between 160 and 290 syringes every year.

Table 6: Per-capita rate of needle/syringe distributions in 2007/8 in each jurisdiction

	Population in jurisdiction (Dec 2008, ABS [53])	Per- capita rate of needle and syringe distribution (over whole population)	Per-capita rate of needle and syringe distribution among estimated IDU population
ACT	347,800	1.5	219.1
NSW	7,041,400	1.2	157.6
NT	221,700	1.7	211.1
QLD	4,349,500	1.6	179.8
SA	1,612,000	1.7	187.6
TAS	500,300	1.4	186.4
VIC	5,364,800	1.7	236.0
WA	2,204,000	1.8	204.3
NATIONAL	21,641,500	1.6	202.9

Funds spent on disposal have increased by 28%. Vending machines have been introduced into more jurisdictions since 2005. Safe sex packs have increased nationally from $15,000 in 2000/1 to $293,000 in 2007/8.

The number of NSPs has increased since 2000 (see Table 7). There has been a steady increase in the total number of all types of outlets.

Table 7: Number of national NSP outlets (NB: the number of sites in NSW prior to 2006/7 was taken as the number in 2002 since data were not provided)

	Primary	Secondary	Enhanced secondary	Vending machine sites
2007/8	85	732	22	118
2006/7	86	710	20	114
2005/6	83	714	17	64
2004/5	82	706	17	64
2003/4	77	697	17	57
2002/3	76	667	16	57
2001/2	75	654	16	57
2000/1	71	624	16	56

Cost of HIV and HCV disease

For the economic analysis, healthcare costs for HIV were estimated by CD4 strata and antiretroviral therapy (ARV). Cost per year without ARVs ranged from $1,520 for CD4 count greater than 500 to $5,500 for CD4 less than 200. First line ARVs cost $14,600 per year, second line $15,200 per year and third and subsequent line $27,800 per year. HCV related healthcare costs were derived for seven health states (see Appendix C). Healthcare costs ranged from $288 per year for diagnosed early disease to $114,400 per year for patients requiring liver transplant (see Table 1). Patient/client and carer costs for HIV healthcare used in the secondary analysis were estimated to be $1,020 per year for CD4 greater than 500 to $3,500 per year for CD4 less than 200. For HCV, costs ranged from $860 per year for early stage disease to $13,700 for liver transplant. See brief methods section and Appendix C for detail about the cost of healthcare for both infections.

Productivity cost of HIV and HCV were estimated using the Friction Cost Approach assuming replacement of sick or deceased workers in three months with 3% discounting (see Appendix D). HIV and HCV were estimated to cost $24,000 to $25,600 per new infection respectively with uncertainty boundaries from $13,000 to $36,000. Since these estimates were based on relatively uncertain data of the impact of HIV and HCV on workforce participation by NSPs clients, they were used in a secondary analysis for illustration purposes only.

Analysis of current NSP provision compared to no government funded NSPs (2000-2009)

During the period 2000-2009, gross funding for NSP services was $243m with healthcare costs saved of $1.28 billion ($1.12bn-$1.45bn, IQR) compared to no program and more than 140,000 DALYs gained. The net financial cost-saving was $1.03 billion ($876m-$1.98bn, IQR) undiscounted (see Table 8). NSP activities were cost-saving so the incremental cost-effectiveness ratios were not calculated.

The net present value allows a funder to assess an investment in an intervention from the perspective of the start of a time period, as if a decision was being made at a point in time (i.e. year 2000 about funding of NSPs for the period 2000-2009). Costs are valued to a specific year (2008) and then costs and outcomes are discounted from the time of the start of the intervention (see economic methods section) at 3% or 5%. The net present value at year 2000 of $190m spent on NSPs over the period 2000-2009 (in year 2008 prices) was $896m (discounted at 3%) and $817m for $172m spent (discounted at 5%). In other words, ***for one dollar invested in NSPs, more than four dollars would be returned in healthcare cost-savings in addition to the investment***.

The net monetary benefit of the intervention can be calculated in economic analyses: if one assumes that a government would be willing to pay $50,000 per DALY gained through healthcare interventions, then the net monetary benefit of NSPs would be more than $8 billion undiscounted and $6.2 billion discounted at 3%.

The majority of the gain was related to the prevention of HCV disease. If the benefits of prevention of HCV disease were not included, the net cost of providing NSPs was $94.8m over ten years, with a gain of 4,034 Disability-Adjusted Life Years. NSP funding was cost-effective for HIV alone in the time period, costing $4,500 per DALY gained.

Table 8: Net cost of program and gains in DALYs (undiscounted) as well as net present value (discounted (3%) and undiscounted)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	SUM
Costs saved $m (IQR)	66 (57-75)	192 (171-212)	137 (119-157)	98 (84-107)	96 (86-105)	106 (94-116)	119 (107-135)	134 (119-154)	153 (134-177)	176 (148-206)	
DALY gain (median)	4087	10825	12863	12799	13089	13705	15148	16922	19301	22386	
NPV current program $m (IQR) (undisc.)	46 (37-55)	171 (149-191)	116 (98-136)	75 (61-84)	71 (61-80)	82 (70-93)	93 (80-108)	107 (92-127)	126 (107-150)	145 (118-174)	1.03bn (873m-1.98bn)
NPV current program $m (IQR) (3% disc.)	46 (37-55)	166 (145-185)	109 (92-128)	69 (56-77)	63 (54-79)	70 (60-80)	78 (67-90)	87 (74-103)	99 (84-118)	110 (90-132)	896m (758m-1.04bn)

Analysis of increases and decreases in NSP provision compared to no government funded NSPs (2010-2079)

Data from the epidemiological transmission model were generated for a number of different scenarios in which provision and funding of NSPs was less or more than current levels. Each scenario was compared to the no-program scenario using the start date of 2010 for the intervention and discounting to take the position of a decision maker in 2009. Costs were valued in 2008 Australian dollars.

Expenditure on NSPs was cost-saving at all levels of NSP funding when analysed for the periods 2010-2019 (10 years), 2010-2029 (20 years), or 2010-2059 (50 years) with undiscounted cost savings for current levels of NSP of $782m (10yrs), $3.23bn (20yrs), $17.75bn (50 years), and $28.71bn (70 years). The cost savings or net present value increased with more spending on NSPs, although the incremental NPV started to reduce as spending increased beyond 50% above current levels of funding (see Table 9). Analyses with longer time horizons showed greater gains and increased returns for each dollar invested (Table 9; Figure 23).

An expansion pathway was plotted of NPV vs DALY over 2010-2019 (Figure 22), demonstrating that a greater saving can be made with further expansion of NSP provision. In the period 2010-2019, the maximum net present value was obtained when NSP funding was 150% of current funding. If funding was three times current funding, the net present value was equivalent to funding at 75%, although the expansion of funding by three-fold would be cost-effective at $4,000 per extra DALY gained from current levels. If the time horizon was

2010-2029, the maximum NPV was obtained at 200% NSP or double funding and provision of NSP support and services (Table 10). If the economic analysis for the current scenario continued until 2079, when all lifetime costs and cost-offsets would accrue, the net financial saving would be $28.71bn undiscounted and $8.41bn discounted.

Decreases in funding from current level

Decreased funding from current levels would be associated with increases in HIV and HCV infections, with associated loss of health and life. The reduced return on investment would exceed any savings associated with reduced spending on NSPs: if funding was reduced by $22m or 10% over the time period 2010-2019, 7,600 DALYs would be lost and the return on investment would be reduced by $36m (Table 9 below). If funding was cut by 50%, over 36,000 DALYs would be lost with a reduction in the return on investment $197m.

Table 9: Loss of life and reduced return associated with decreased funding period 2010-2019 (all discounted at 3%)

NSP funding	Reduction in NSP spending	Loss in DALY vs. current	Reduced return
50% of current levels	$112m	36,370	$197m
75% of current levels	$56m	16,473	$98m
90% of current levels	$22m	7,607	$36m

Table 10: DALYs and Net Present Value with changes in NSPs after ten years (2010-2019) and 20 years (2010-2029) discounted at 3%

Level of funding for NSPs	NSP investment	Gain in DALY	Net Present Value of NSPs	Return on investment
Period 2010-2019				
100% of current levels	$225m	97,229	$631m	current investment + 380%
110% of current levels	$248m	98,562	$633m	current investment + 360%
125% of current levels	$282m	104,005	$647m	current investment + 330%
150% of current levels	$338m	111,254	$656m	current investment + 290%
175% of current levels	$395m	116,874	$650m	current investment + 270%
200% of current levels	$451m	121,303	$635m	current investment + 240%
300% of current levels	$676m	132,595	$514m	current investment + 180%
Period 2010-2029				
100% of current levels	$392m	365,703	$2,273m	current investment + 680%
110% of current levels	$431m	374,333	$2,091m	current investment + 590%
125% of current levels	$490m	389,043	$2,362m	current investment + 580%
150% of current levels	$588m	409,635	$2,427m	current investment + 510%
175% of current levels	$686m	426,538	$2,464m	current investment + 460%
200% of current levels	$784m	440,497	$2,480m	current investment + 420%
300% of current levels	$1,175m	478,262	$2,390m	current investment + 300%

Figure 22: DALY gain versus Net Present Value after ten years (NB: DALYs start at 50,000 and net costs are expressed as negatives (i.e. are cost-savings) and discounted at 3%)

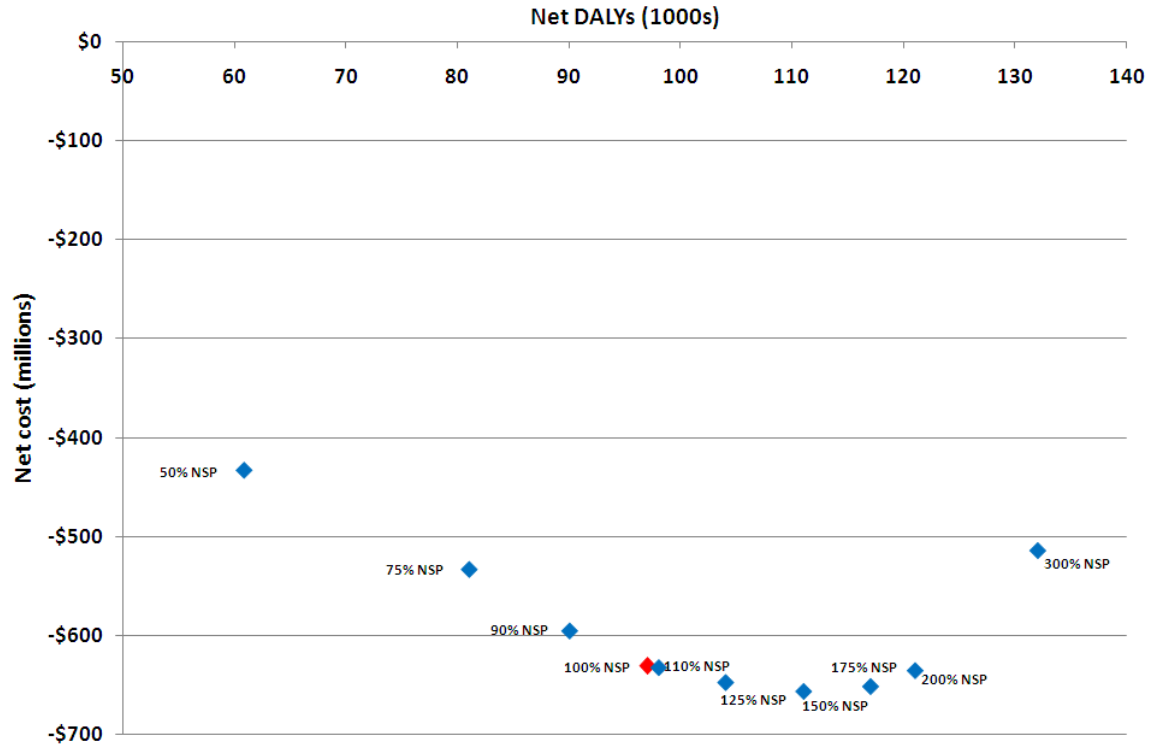
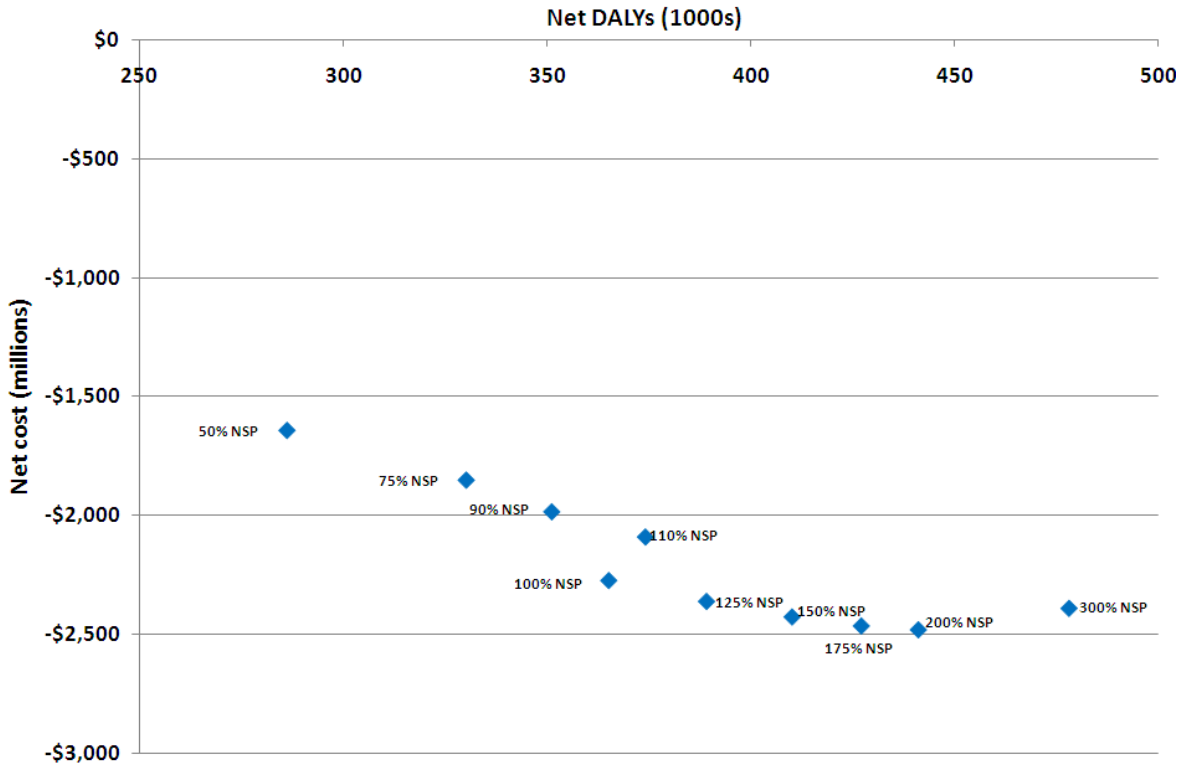


Figure 23: DALY gain versus Net Present Value after 20 years disc 3% (NB: DALYs start at 250,000)



Secondary analyses

Inclusion of patient/client costs, productivity gains and injection-related injuries and disease

Inclusion of patient/client costs in the economic analysis of current funding of NSPs from 2000 to 2009 increased the net cost-saving of current provision of NSP from $128bn to $2.48bn (undiscounted, see Table 11).

Table 11: Healthcare costs averted and net present value for current funding of NSPs (undiscounted)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Healthcare costs averted $m (IQR, undisc)	103 (94-118)	322 (294-350)	292 (270-314)	250 (229-261)	247 (226-260)	258 (238-274)	278 (259-298)	298 (277-327)	323 (296-356)	351 (323-393)
NPV $ m (current program)	83	300	271	227	222	234	251	271	296	324

Inclusion of productivity gains and losses (with patient costs) increased the net present value of current provision of NSP to $5.85bn in the period 2000 to 2009. Most of the productivity gains were related to HCV disease. It should be noted that the Friction Cost approach to productivity losses was a conservative one, compared to the frequently used Human Capital approach. This finding was based on limited data on workforce participation rates of NSP clients and people living with HCV. The cost savings to society are shown in Table 12.

Table 12: Societal costs averted, including productivity losses, and net present value for current funding of NSPs (undiscounted)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Societal costs averted $ m (IQR, undisc)	993 (931-1075)	949 (881-993)	410 (360-450)	348 (306-369)	380 (353-419)	448 (407-501)	521 (466-582)	580 (509-662)	676 (566-779)	783 (635-901)
NPV $m (current program)	973	928	388	325	355	424	494	552	648	756

If no NSPs were available, one could speculate that there would be an increase in injection related injuries and disease (IRID). If NSPs prevented 50% of the IRID that might occur in their absence, then one might assume that the additional cost-saving with current levels of NSP would be more than $20m a year or $200m in ten years (undiscounted).

Return on investment of NSPs associated only with HIV

The benefit of preventing HIV alone was considered in a secondary analysis for increases in funding scenarios from 2010-2019. Current levels of NSPs funding would be $226m (discounted) over the period 2010-2019 with healthcare costs saved of $56m and a net cost of $170m. 11,990 DALYs would be gained compared to no program for a cost of $14,200 per DALY gained. In other words, current levels of NSPs were cost effective compared to no program if only gains related to the prevention of HIV were considered over a ten year time horizon.

150% of current NSP provision and funding would cost $23,000 per DALY gained compared to no program, which would be considered cost-effective with a societal willingness to pay of $50,000 per DALY. However, the incremental cost of provision of NSPs at 150% compared to current levels was $444,000 per DALY gained when considering just the healthcare costs of HIV disease alone; in other words it would not be cost-effective to expand services on the basis of HIV alone in this ten year time horizon.

If both analyses were conducted at the 20 year time horizon, both current provision and 150% provision were cost-saving compared to no program for HIV alone, although the incremental cost per DALY gained comparing 150% with current program was $55,000 per DALY gained.

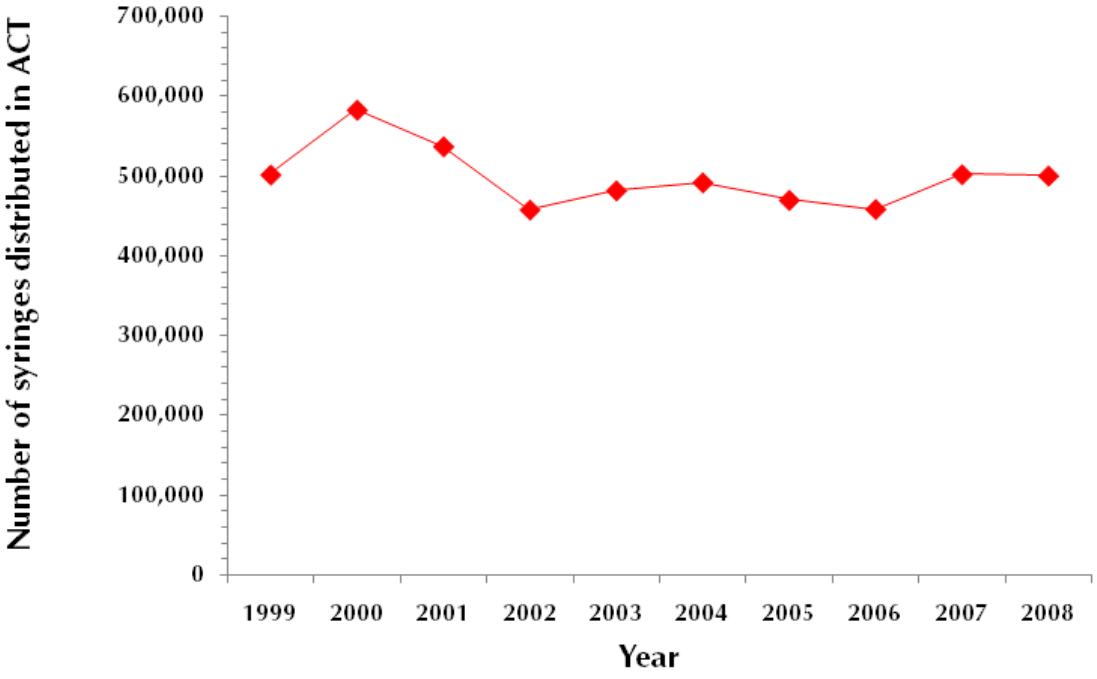
Epidemiological and economic evaluation of NSPs in the Australian Capital Territory

Overview

Needle and Syringe Programs have been operational in the Australian Capital Territory since 1989. The Australian Capital Territory has two primary outlets (both operated by DIRECTIONS ACT), seven secondary outlets (including one mobile outreach service), 31 pharmacy based outlets, and four vending machines. Many NSPs have disposal facilities, with the exception of approximately half of the pharmacy NSPs. In addition, primary outlets provide a large range of ancillary services including information, education, referral, disposal and condoms. There is no discount for people who return packs to pharmacies.

Number of NSPs:	44 (including pharmacies)
Syringes distributed 1999-2008:	4,989,520
Average syringes per year:	498,952
Total spending 2007/8:	$1,228,514

Figure 24: Number of needles and syringes distributed in the Australian Capital Territory (1999-2008)



The proportion of all Australian IDUs that reside in the Australian Capital Territory has remained steady over the last decade, as has the distribution of needles and syringes. The average frequency of injecting by IDUs in the Australian Capital Territory has decreased but sharing rates have slightly increased. The prevalence of HCV has significantly increased while HIV has remained low.

In 2007/8, 575,779 sterile needles and syringes were provided in the Australian Capital Territory: 103,000 were provided through pharmacies, 46,024 through vending machines. Vending machines are provided in the Australian Capital Territory under a commercial arrangement including lease of the machines and provision of stock. Pharmacists charge on average $2 per pharmacy pack sold. The number of NSP sites in the Australian Capital Territory is listed in Table 13. Table 14 reports the expenditure by financial year in 2008 dollars, unadjusted and adjusted for the consumer price index (CPI). As part of this spending, extra specific funding for the sector during 2007/8 is listed in Table 15.

Table 13: Number of NSP sites in the Australian Capital Territory

	Primary	Secondary	Vending machine sites
2007	2	7	4
2006	2	9	4
2005	2	9	
2004	2	9	
2003	2	9	
2002	2	9	
2001	2	9	

Table 14: Summary of expenditure in Australian Capital Territory NSPs (2000/1-2007/8)

	2000/1	2001/2	2002/3	2003/4	2004/5	2005/6	2006/7	2007/8
Consumables ($'000)								
Sterile injecting equipment	312	229	276	288	306	341	388	411
Disposal equipment	25	19	61	32	36	37	39	42
sub-total	**337**	**247**	**337**	**320**	**343**	**378**	**427**	**453**
NSP SUPPORT ($'000)								
Primary NSPs Operations	152	199	236	236	280	283	324	619
Support for Secondary NSPs	0	64	55	48	58	60	50	47
Transport	0	2	4	7	5	5	5	2
Vending machines	0	0	0	0	0	19	59	63
sub-total	**152**	**265**	**296**	**291**	**343**	**366**	**438**	**732**
TOTAL ($'000) (unadjusted for CPI)	**489**	**512**	**633**	**611**	**686**	**744**	**865**	**1,185**
TOTAL in 2008 ($'000) (CPI adjusted)	**618**	**628**	**753**	**710**	**777**	**820**	**924**	**1,229**

Table 15: Additional expenditure on NSPs in the Australian Capital Territory (2007/8)

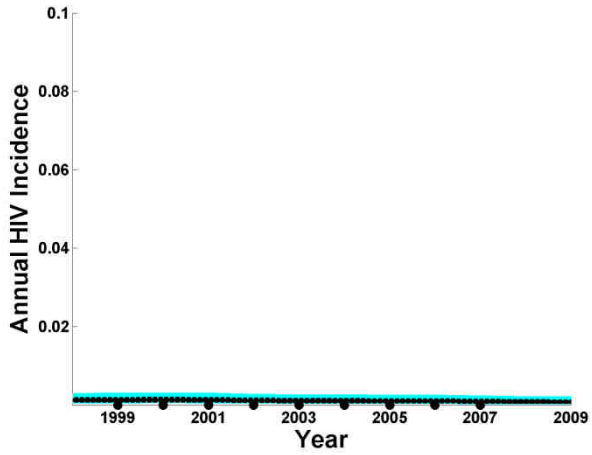
Peer support and advocacy	$95,000
Sharps hotline responses	$120,000
Sharps inspection patrols of Syringe Vending Machines'	
(SVM) surrounding areas	$13,000
Health info leaflet inserts in SVM fitpacks	$500
Admin and policy support	$10,000
TOTAL	**$238,500**

Evaluating current NSPs

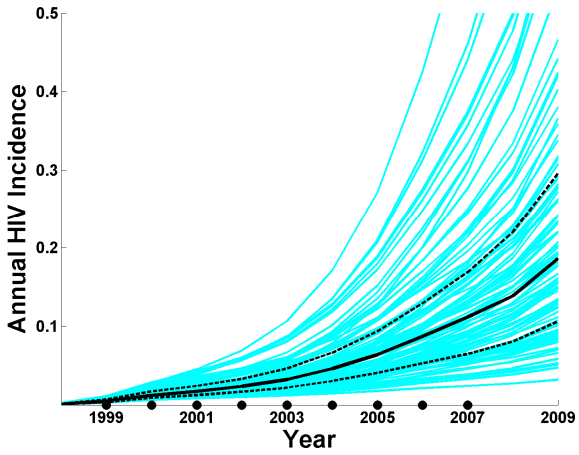
The epidemiological transmission model for HIV and HCV was applied to IDUs and NSPs specifically in the Australian Capital Territory. The model was used to evaluate current NSPs versus no program and to project likely epidemiological impacts of potential changes to the program. The model estimated the expected number of HIV and HCV cases in the Australian Capital Territory with and without NSP distribution of sterile injecting equipment (Figure 25). The estimated cumulative number of infections averted is presented in Figure 26. Less than one HIV infection would be expected due to syringe sharing by IDUs, on average, in the Australian Capital Territory even without NSPs. Thus, NSPs are currently not preventing HIV infections in the Australian Capital Territory. However, NSPs are very effective in averting HCV transmissions. It is estimated that over the last ten years they have averted 1,482 (1,451-1,534, IQR) new HCV infections.

Figure 25: Estimated HIV and HCV incidence in the Australian Capital Territory with and without NSPs

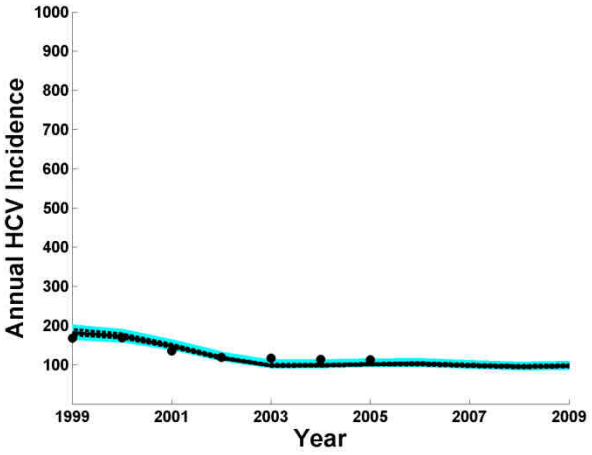
HIV cases with NSPs



HIV cases without NSPs



HCV cases with NSPs



HCV cases without NSPs

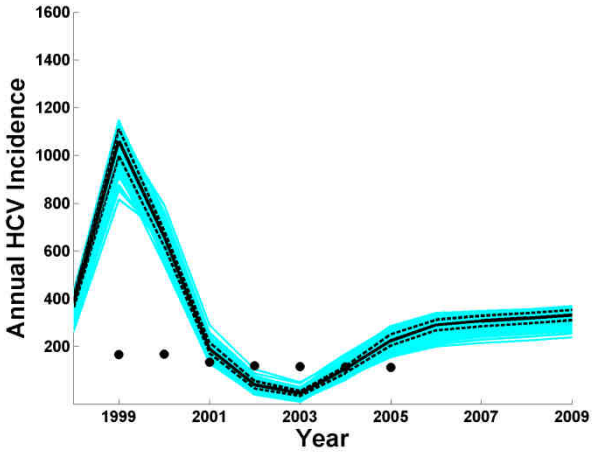
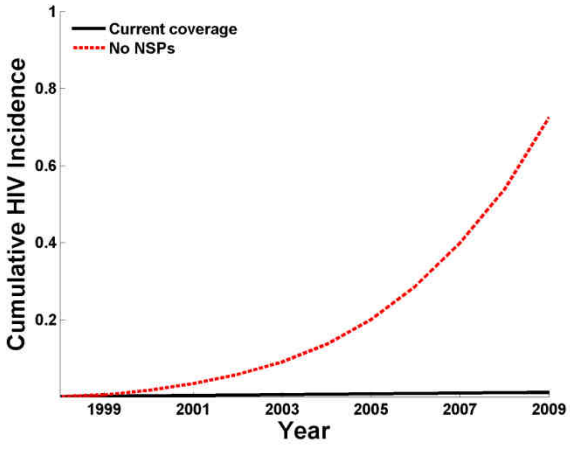
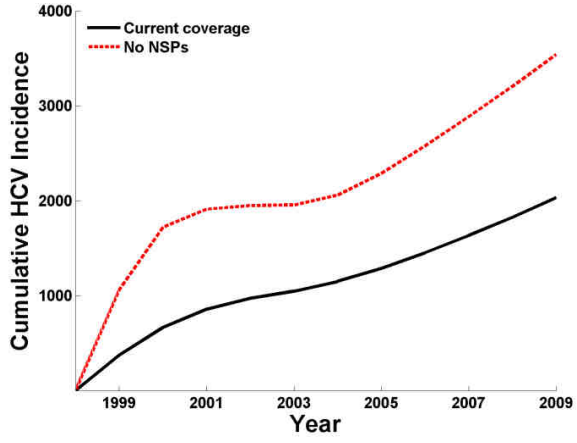


Figure 26: Estimated cumulative number of HIV and HCV cases averted in the Australian Capital Territory due to NSPs

HIV



HCV

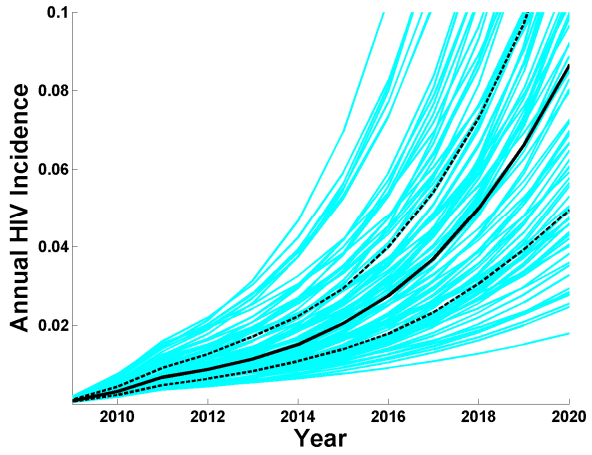


Epidemic projections in the Australian Capital Territory

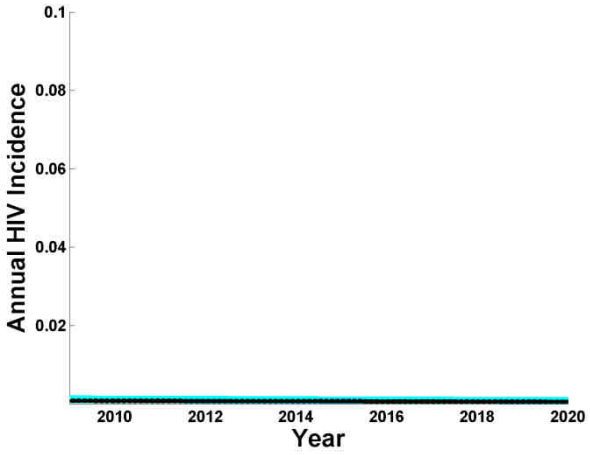
The Australian Capital Territory model was used to calculate projections of the expected number of HIV and HCV cases in the future, according to scenarios whereby current syringe distribution levels are maintained or if there are changes in the provision of syringes through Australian Capital Territory NSPs.

Figure 27: Projections of the expected number of HIV cases in the Australian Capital Territory according to different syringe distribution levels

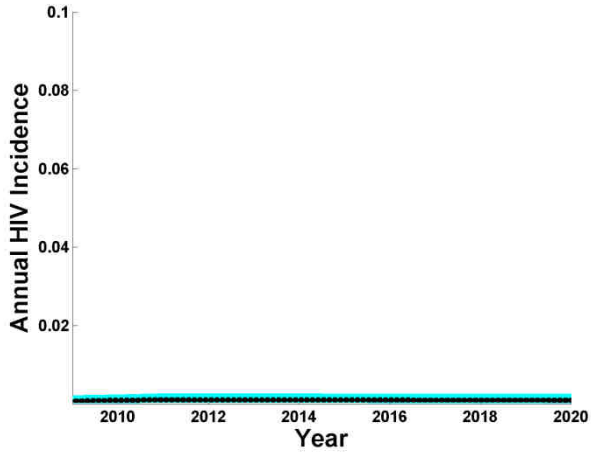
No NSPs



Current NSP distribution



NSP coverage decreases by 25%



NSP coverage increases by 25%

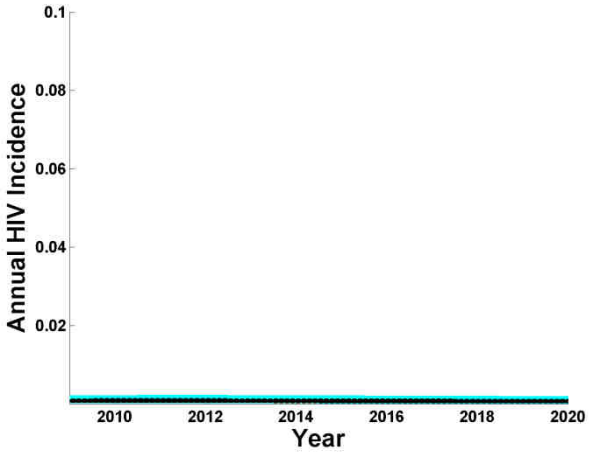
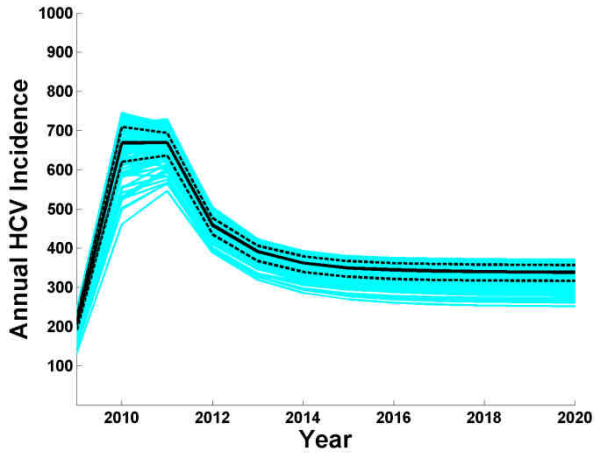
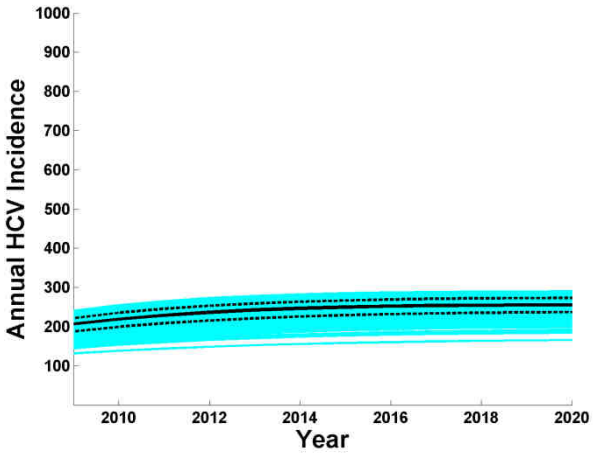


Figure 28: Projections of the expected number of HCV cases in the Australian Capital Territory according to different syringe distribution levels

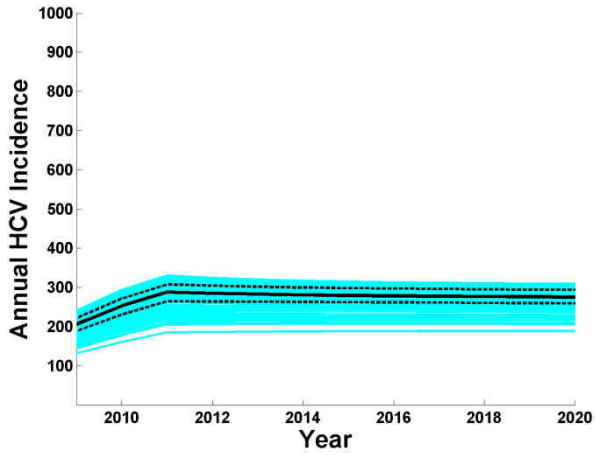
No NSPs



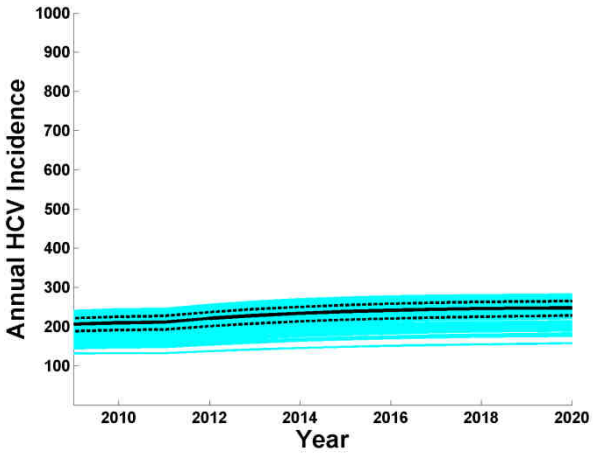
Current NSP distribution



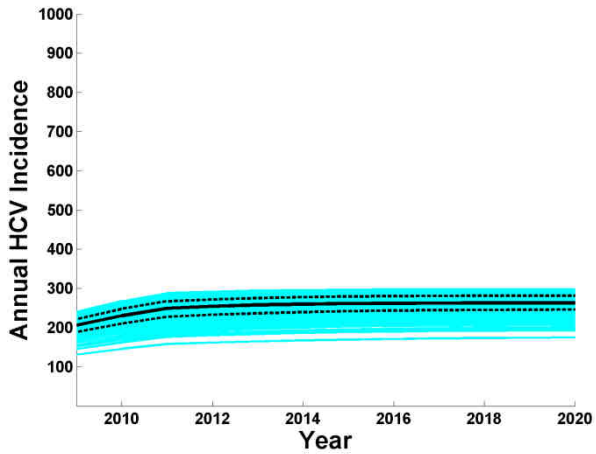
NSP coverage decreases by 25%



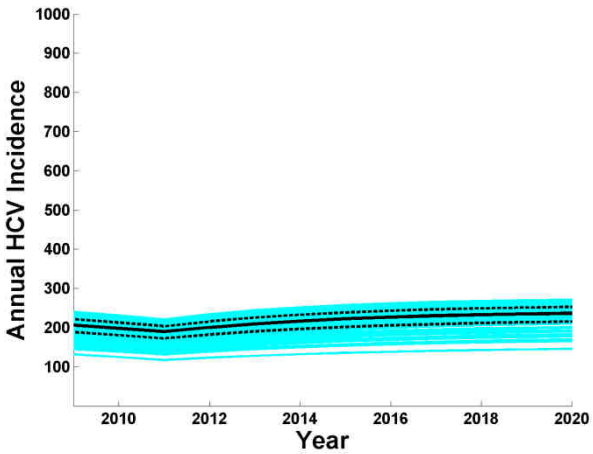
NSP coverage increases by 10%



NSP coverage decreases by 10%



NSP coverage increases by 25%



Economic evaluation of NSPs in the Australian Capital Territory

The spending of $8.8m in the funding of NSPs in the Australian Capital Territory from year 2000-2009 has resulted in a saving of $11.5m in healthcare costs, with more than 2,000 Disability Adjusted Life Years saved, with a net financial saving of $2.6m. A summary of the return on investment of NSP funding in the Australian Capital Territory is shown in Table 16. The mathematical and economic modelling estimated that if NSPs are continued at the same level of funding in the Australian Capital Territory for the next ten years, $4.9m of net financial savings will accrue ($4.36m discounted at 3%) and for twenty years $10.6m ($8.01m discounted at 3%). The lifetime net present value of investment in NSPs that took account of all healthcare costs and savings (but not costs associated with productivity losses) would be $293m ($65.9m discounted at 3%).

Table 16: Return on Investment of NSP funding in the Australian Capital Territory (2000-2009)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Healthcare costs saved $m (IQR)	1.1 (0.9-1.2)	0.6 (0.5-0.7)	0.6 (0.5-0.7)	0.9 (0.8-1.0)	1.2 (1.1-1.3)	1.3 (1.2-1.4)	1.3 (1.2-1.5)	1.4 (1.3-1.6)	1.5 (1.4-1.7)	1.6 (1.4-1.7)
NSP funding $m (median)	0.6	0.6	0.8	0.7	0.8	0.8	0.9	1.2	1.2	1.2
Net cost savings $m (median)	0.4	0.04	0.1	0.2	0.4	0.5	0.4	0.2	0.3	0.3
DALY gain (median)	206	199	182	171	171	181	196	210	222	234

Please note that any inconsistencies between the figures presented in the above text and table are due to rounding. Additionally, the results for each jurisdiction are provided to assist in assessment of local return on investment. The small numbers in some jurisdictions may distort parameter uncertainties and should not be used to compare one jurisdiction with another.

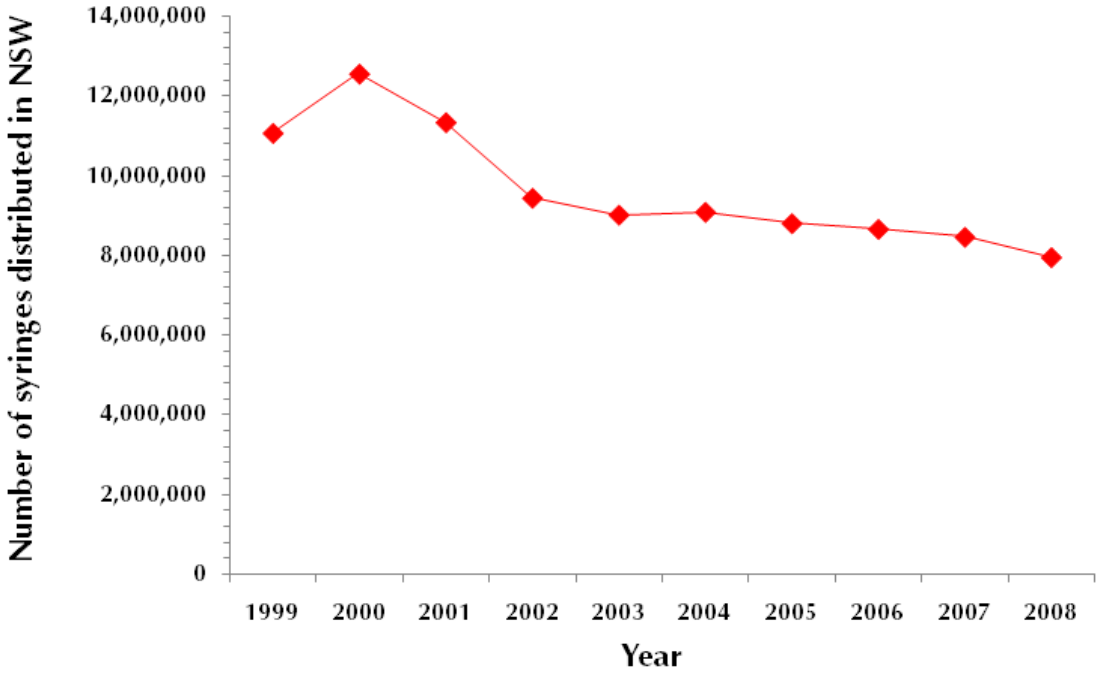
Epidemiological and economic evaluation of NSPs in New South Wales

Overview

Needle and Syringe Programs were piloted in New South Wales in 1986. In 1988, NSPs were rolled out across the state on an expanded pilot basis, with focus on access, education, consumer involvement and the free supply and exchange of equipment. New South Wales now has a relatively large number of all types of NSPs: 33 primary outlets, 295 secondary outlets, 385 community pharmacy outlets and 101 vending machines, as well as numerous outreach services. Within each of the eight Area Health Services, there is usually at least one primary outlet, often incorporating an outreach component, and a range of secondary outlets.

Number of NSPs:	814 (plus pharmacies)
Syringes distributed 1999-2008:	96,509,189
Average syringes per year:	9,650,919
Total spending 2007/8:	$9,671,362

Figure 29: Number of needles and syringes distributed in New South Wales (1999-2008)



The number of IDUs in New South Wales has decreased over the last decade. Similarly, the number of needles and syringes distributed has decreased. The average frequency of injecting by IDUs in New South Wales has decreased significantly and sharing rates have slightly decreased. The prevalence of HCV has remained relatively steady and the incidence of HIV has slightly decreased and remained low.

In 2007/8, 8,289,886 sterile injection equipment units were provided in New South Wales, with 1,576,078 provided through pharmacies and 998,110 through automated dispensing machines. Vending machines cost between $2,000 and $10,000 a year to purchase and are filled by local Area Health Service staff. Pharmacists charge out-of-pocket costs of an average of $3.50 per five-pack. All NSPs, including pharmacies, operating as part of the Pharmacy Fitpack Scheme, have disposal facilities provided as part of the program. Specific funding has contributed to the operations of the Workforce Development Program and the Needle Clean Up Hotline for several years, but has been included in Table 17 in 2007/08 only as $50,000 and $30,000 respectively. The number of NSP sites in New South Wales is listed in Table 17. Table 18 reports the expenditure by financial year in 2008 dollars, unadjusted and adjusted for the consumer price index (CPI). Table 18 includes extra specific funding in 2007/8 for the workforce development at $50,000 per year and $30,000 per year on a needle clean-up hotline.

Table 17: Number of NSP sites in New South Wales

	Primary	Secondary	Pharmacies	Vending machine sites
2007/8	33	295	385	101
2006/7	33	270	445	100

Table 18: Summary of expenditure on NSPs in New South Wales (2000/1-2007/8). Actual data only available for 2006/7 and 2007/8, previous years imputed.

Consumables ($'000)	2000/1	2001/2	2002/3	2003/4	2004/5	2005/6	2006/7	2007/8
Sterile injecting equipment	2,047	1,899	2,072	2,484	2,623	2,455	2,829	2,298
Disposal equipment	199	184	201	242	256	239	306	313
Safe sex packs	0	0	0	0	194	181	209	218
sub-total	**2,246**	**2,073**	**2,274**	**2,726**	**3,073**	**2,876**	**3,344**	**2,830**
NSP SUPPORT ($'000)								
Primary NSPs Operations	3,265	3,888	3,870	4,214	4,704	4,622	5,530	6,210
Support for Secondary NSPs	0	0	0	0	0	0	0	0
Transport	0	0	0	0	0	0	0	0
Vending machines	0	0	0	0	0	0	129	288
sub-total	**3,265**	**3,888**	**3,870**	**4,214**	**4,704**	**4,622**	**5,659**	**6,498**
TOTAL ($'000) (unadjusted for CPI)	**5,511**	**5,961**	**6,144**	**6,939**	**7,777**	**7,498**	**9,003**	**9,328**
TOTAL in 2008 ($'000) (CPI adjusted)	**5,883**	**6,363**	**6,558**	**7,408**	**8,302**	**8,004**	**9,611**	**9,671**

Evaluating current NSPs

The mathematical epidemiological transmission model for HIV and HCV was applied to IDUs and NSPs specifically in the New South Wales. The model was used to evaluate current NSPs versus no program and to project likely epidemiological impacts of potential changes to the program. The model estimated the expected number of HIV and HCV cases in the New South Wales with and without NSP distribution of sterile injecting equipment (Figure 30). The estimated number of infections averted is presented in Figure 31. An estimated 23,324 (15,392-30,819, IQR) HIV infections and 31,953 (31,096-33,657, IQR) HCV infections were averted due to NSPs in New South Wales.

Figure 30: Estimated HIV and HCV incidence in New South Wales with and without NSPs

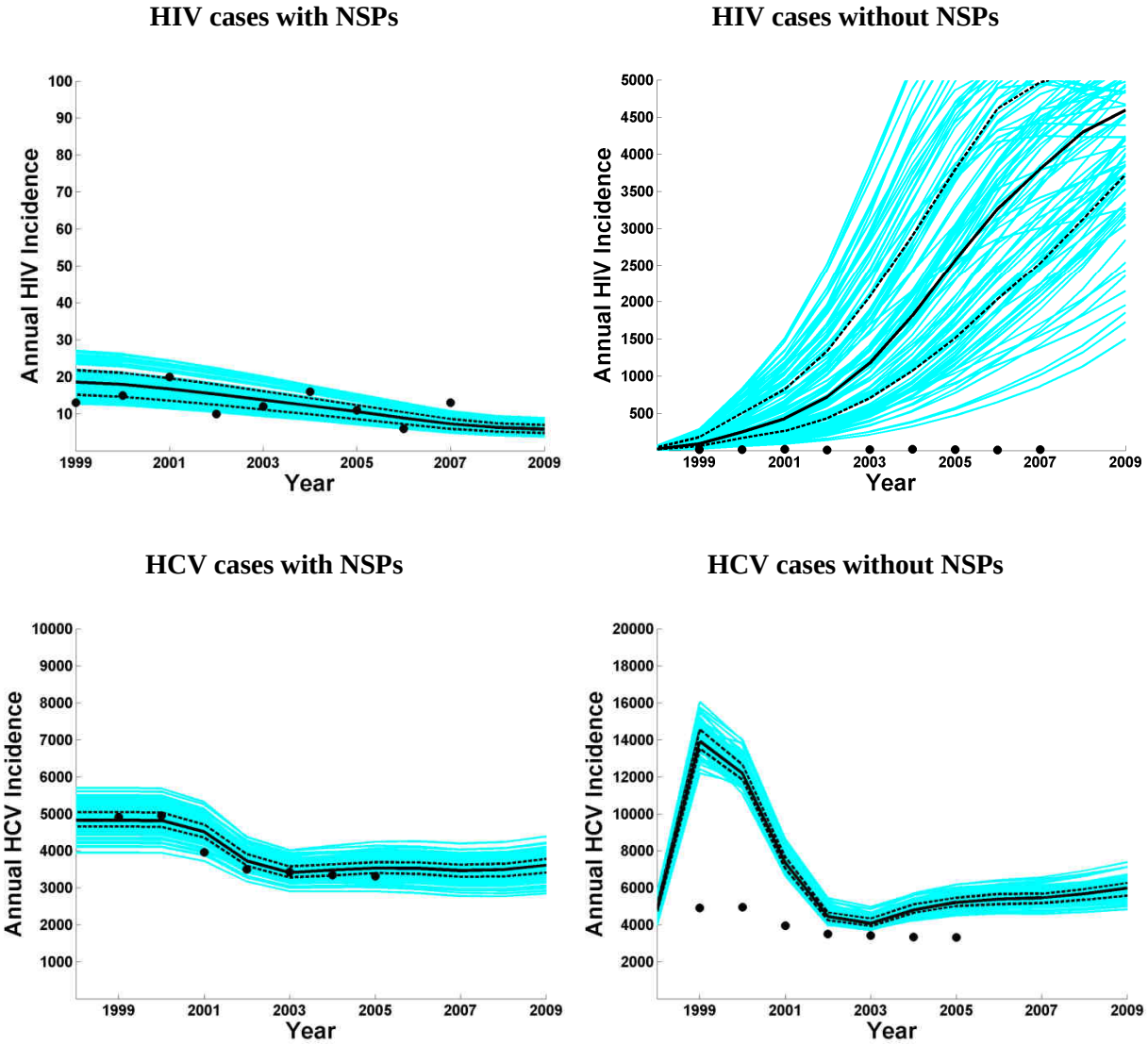
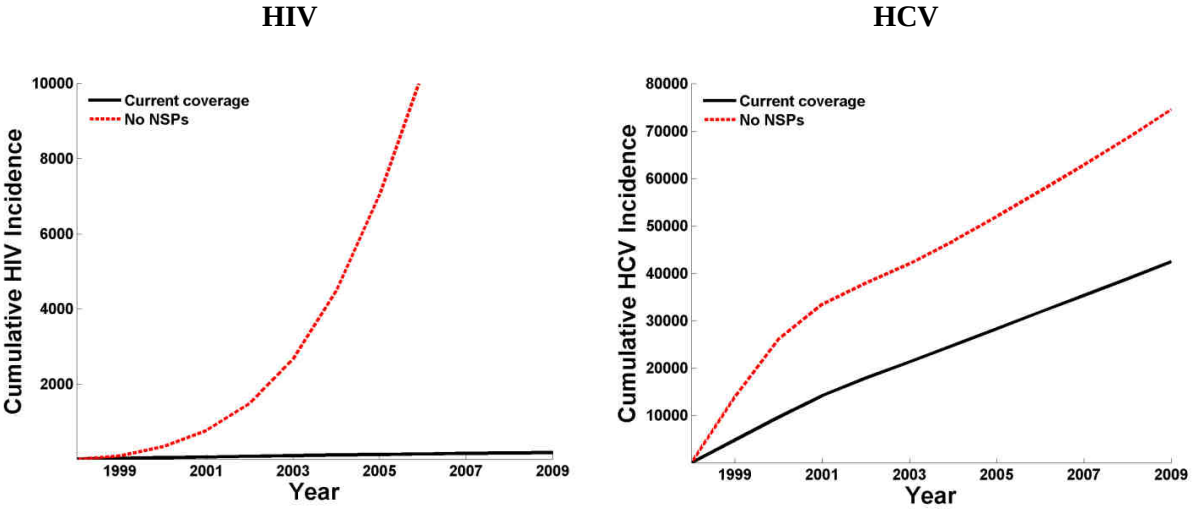


Figure 31: Estimated cumulative number of HIV and HCV cases averted in New South Wales due to NSPs



Epidemic projections in New South Wales

The New South Wales model was used to calculate projections of the expected number of HIV and HCV cases in the future, according to scenarios whereby current syringe distribution levels are maintained or if there are increases or decreases in the provision of syringes through New South Wales NSPs.

Figure 32: Projections of the expected number of HIV cases in New South Wales according to different syringe distribution levels

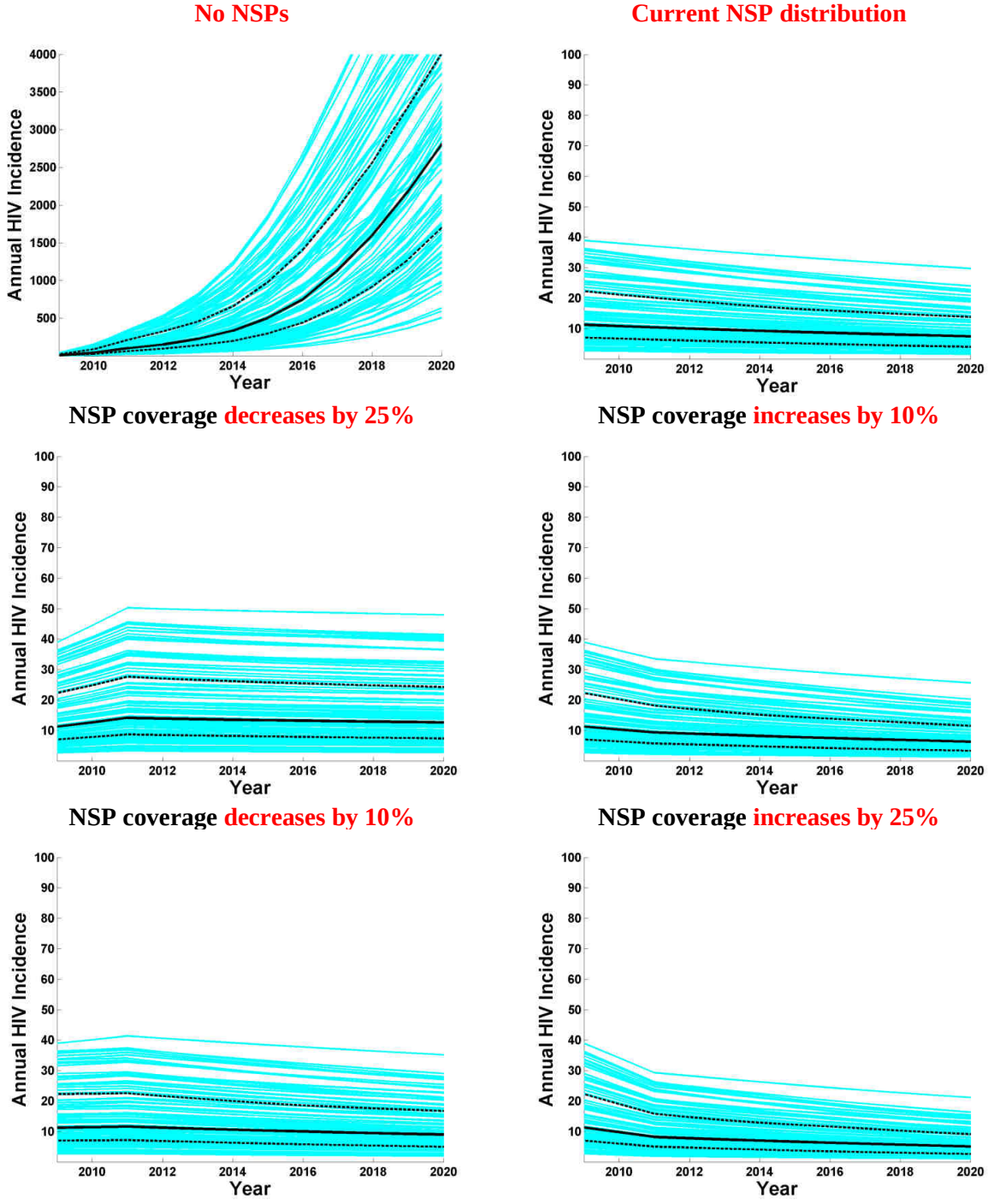
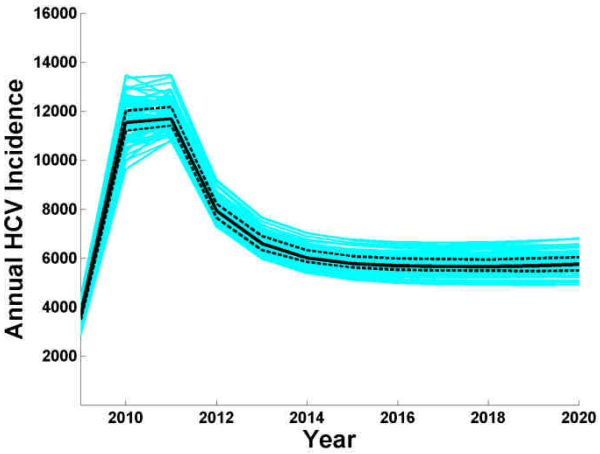
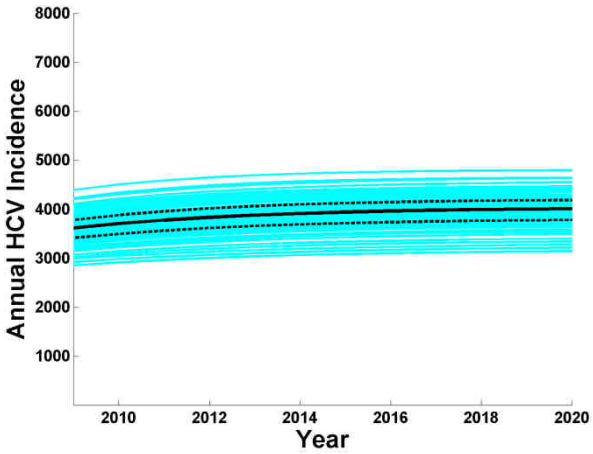


Figure 33: Projections of the expected number of HCV cases in New South Wales according to different syringe distribution levels

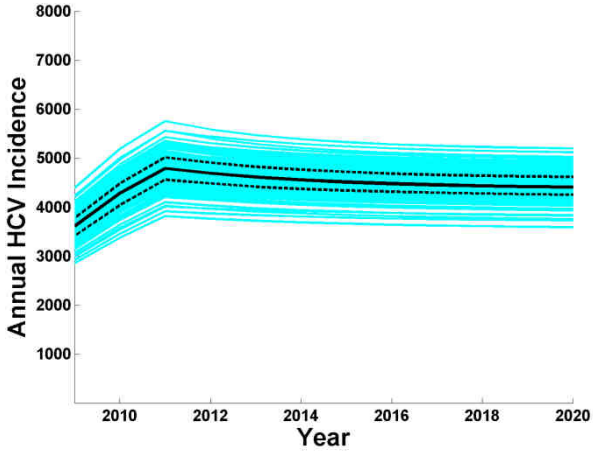
No NSPs



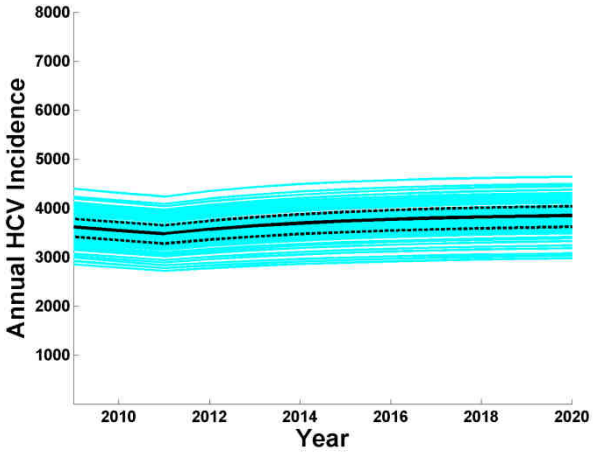
Current NSP distribution



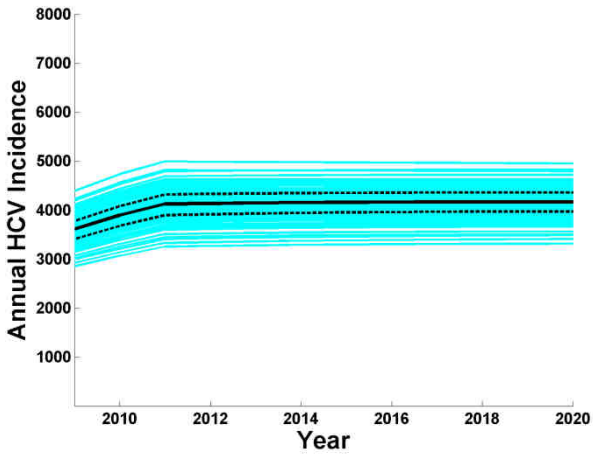
NSP coverage decreases by 25%



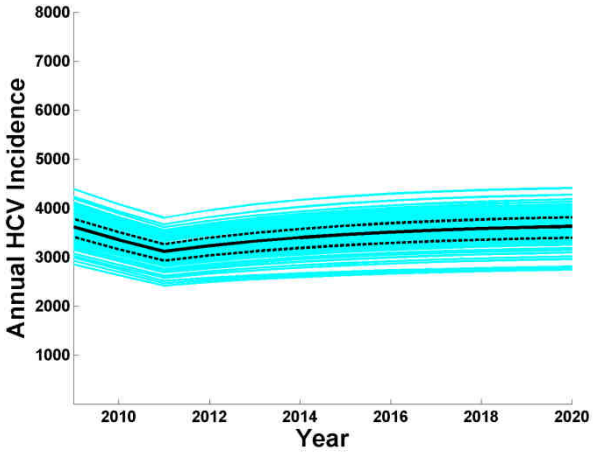
NSP coverage increases by 10%



NSP coverage decreases by 10%



NSP coverage increases by 25%



Economic evaluation of NSPs in New South Wales

The spending of $81m in the funding of NSPs in New South Wales from year 2000-2009 has resulted in a saving of $513m in healthcare costs, with more than 72,000 Disability Adjusted Life Years gained with a net financial saving of $432m. A summary of the return on investment of NSP funding in the New South Wales is shown in Table 19. The mathematical and economic modelling estimated that if NSPs are continued at the same level of funding in New South Wales for the next ten years, $1.55bn of net financial savings will accrue ($1.35bn discounted at 3%) and for twenty years $3.87bn ($2.83bn discounted at 3%). The lifetime net present value of investment in NSPs that took account of all healthcare costs and savings (but not costs associated with productivity losses) would be $21.23bn ($7.53bn discounted at 3%).

Table 19: Return on Investment of NSP funding in New South Wales (2000-2009)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Healthcare costs saved $m (IQR)	27 (24-30)	23 (21-28)	28 (24-33)	34 (28-42)	41 (33-53)	48 (40-64)	58 (46-76)	71 (55-90)	84 (65-104)	98 (74-117)
Funding for NSPs $m (median)	6	6	7	7	8	8	10	10	10	10
Net cost savings $m (median)	21	17	21	26	32	40	49	61	75	89
DALY gain (median)	3,715	4,205	4,683	5,377	6,172	7,369	8,849	10,559	12,582	14,857

Please note that any inconsistencies between the figures presented in the above text and table are due to rounding. Additionally, the results for each jurisdiction are provided to assist in assessment of local return on investment. The small numbers in some jurisdictions may distort parameter uncertainties and should not be used to compare one jurisdiction with another.

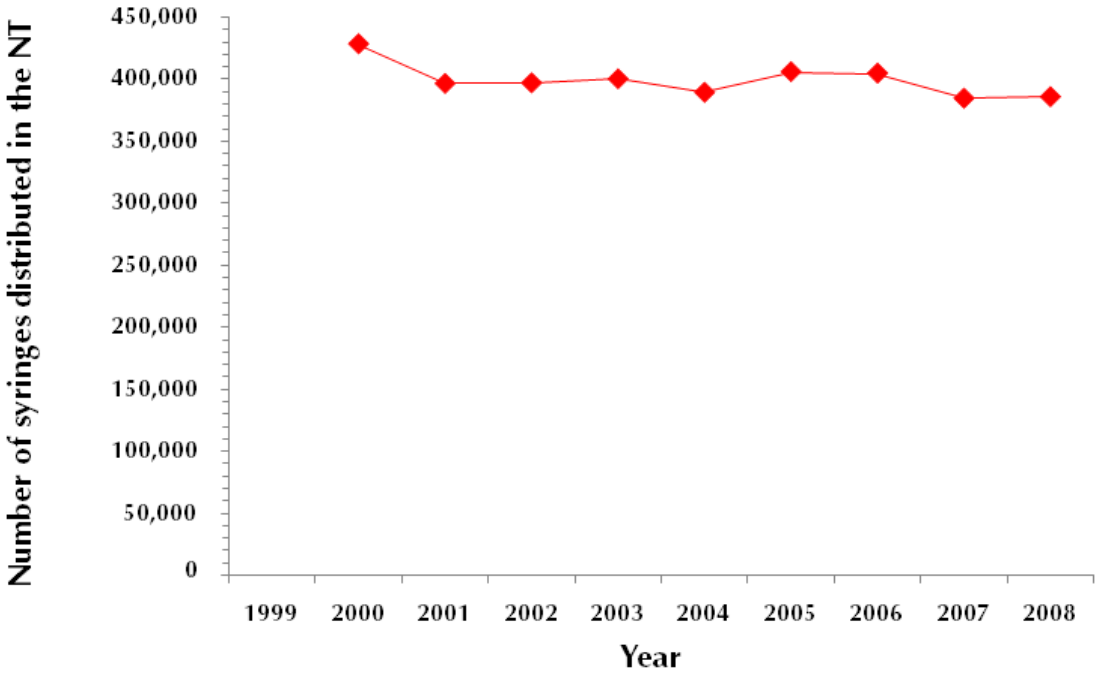
Epidemiological and economic evaluation of NSPs in the Northern Territory

Overview

Needle and Syringe Programs have been operating in the Northern Territory since 1989, when the Northern Territory AIDS Council and the AIDS Council of Central Australia were established. Distribution through pharmacies commenced in Darwin in 1991. The majority of needles and syringes disseminated through NSPs in the Northern Territory are through primary outlets in Darwin and Alice Springs. Pharmacies sell 'fit kits' on a commercial basis. In the Northern Territory there are three primary outlets and 23 secondary outlets as well as pharmacies that distribute needles and syringes.

Number of NSPs:	26 (plus pharmacies)
Syringes distributed 1999-2008:	3,822,862
Average syringes per year:	382,286
Total spending 2007/8:	$580,637

Figure 34: Number of needles and syringes distributed in the Northern Territory (1999-2008)



The number of IDUs in the Northern Territory is relatively small compared to other jurisdictions and has remained steady over the last decade. The number of needles and syringes distributed through NSPs in the Northern Territory has remained stable (Figure 34). The average frequency of injecting by IDUs in the Northern Territory has slightly decreased and sharing rates have also decreased (in contrast to most other jurisdictions). The prevalence of HCV has remained relatively steady and HIV cases are rare among IDUs in the Northern Territory.

In 2007/8, 378,856 sterile injection equipment units were provided in the Northern Territory: 10% were provided through secondary sites, including four hospital emergency departments, and 5-8% were distributed through pharmacies. Pharmacies charge an average of $5-$8 per five-pack out-of-pocket costs. The number of NSP sites in the Northern Territory is listed in Table 20. Table 21 reports the spending by financial year in 2008 dollars, unadjusted and adjusted for the consumer price index (CPI). Figures were not available before 2003/4 so the amounts prior to this assume similar levels of spending on primary services. Please note that all funding for sterile injecting equipment includes disposal equipment. Funding for the two are not separated in funds given to NSPs.

Table 20: Number of NSP sites in the Northern Territory

	Primary	Secondary
2007	3	23
2006	3	23
2005	3	22
2004	3	21
2003	2	21
2002	2	21
2001	2	21
2000	2	21

Table 21: Summary of expenditure on NSPs in Northern Territory (2000/1-2007/8)

	2000/1	2001/2	2002/3	2003/4	2004/5	2005/6	2006/7	2007/8
Consumables ($'000)								
Sterile injecting equipment	61	56	62	74	74	74	74	110
Disposal equipment	0	0	0	0	0	0	0	0
Safe sex packs	0	0	0	0	0	0	0	0
sub-total	61	56	62	74	74	74	74	110
NSP SUPPORT ($'000)								
Primary NSPs Operations	277	330	328	357	399	514	432	450
Support for Secondary NSPs	0	0	0	0	0	0	0	0
Transport	0	0	0	0	0	0	0	0
Vending machines	0	0	0	0	0	0	0	0
sub-total	277	323	328	357	399	514	432	450
TOTAL ($'000) (unadjusted for CPI)	334	386	390	431	473	588	506	560
TOTAL in 2008 ($'000) (CPI adjusted)	383	437	442	489	536	648	540	581

Evaluating current NSPs

The epidemiological transmission model for HIV and HCV was applied to IDUs and NSPs specifically in the Northern Territory. The model was used to evaluate current NSPs versus no program and to project likely epidemiological impacts of potential changes to the program. The model estimated the expected number of HIV and HCV cases in the Northern Territory with and without NSP distribution of sterile injecting equipment (Figure 35). The estimated number of infections averted is presented in Figure 36. Less than one HIV infection would be expected due to syringe sharing by IDUs, on average, in the Northern Territory even without NSPs. Thus, NSPs are currently not preventing HIV infections in the Northern Territory. However, NSPs are very effective in averting HCV transmissions. It is estimated that over the last ten years they have averted 483 (458-522, IQR) new HCV infections.

Figure 35: Estimated HIV and HCV incidence in the Northern Territory with and without NSPs

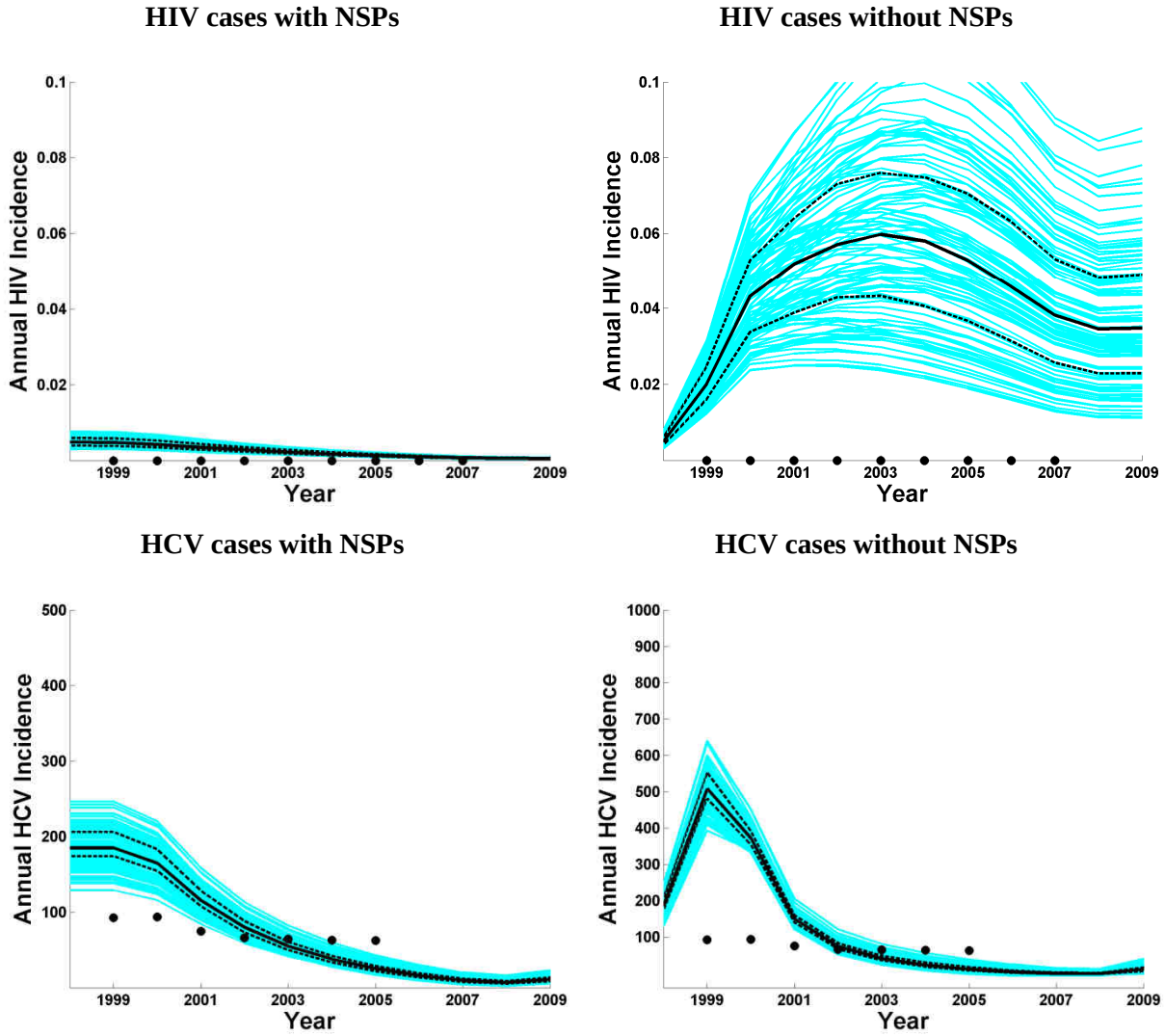
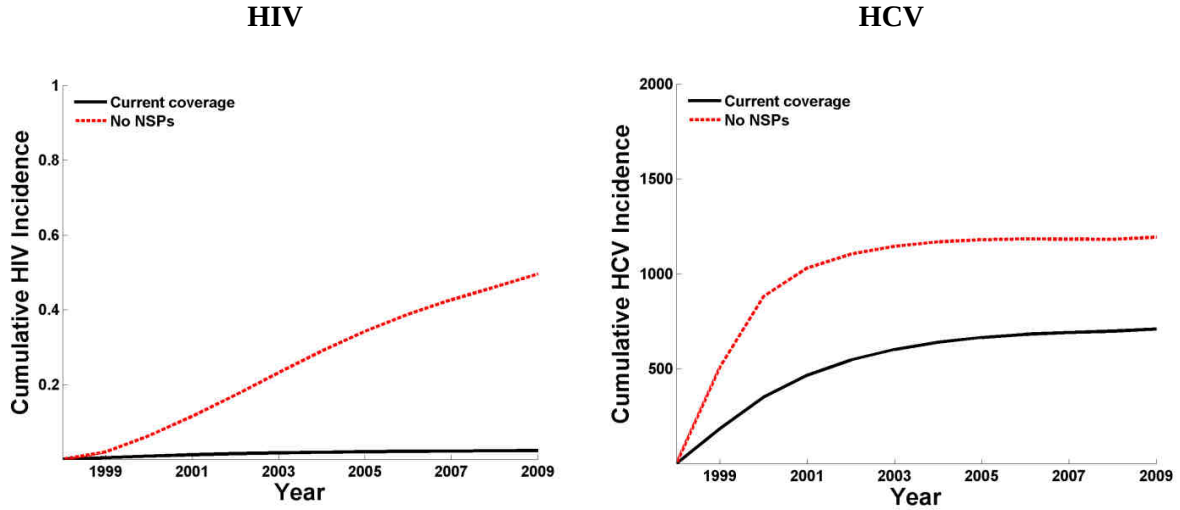


Figure 36: Estimated cumulative number of HIV and HCV cases averted in the Northern Territory due to NSPs

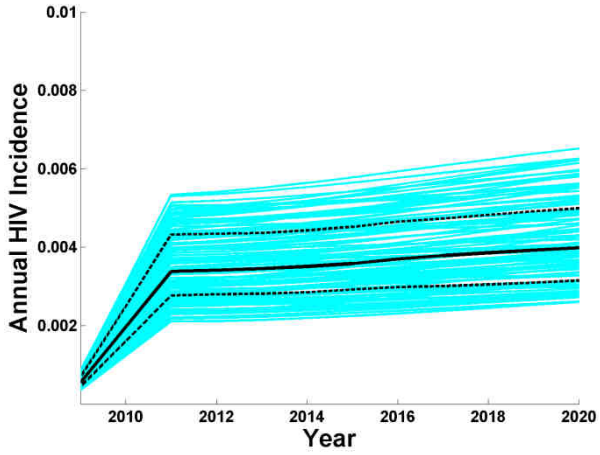


Epidemic projections in the Northern Territory

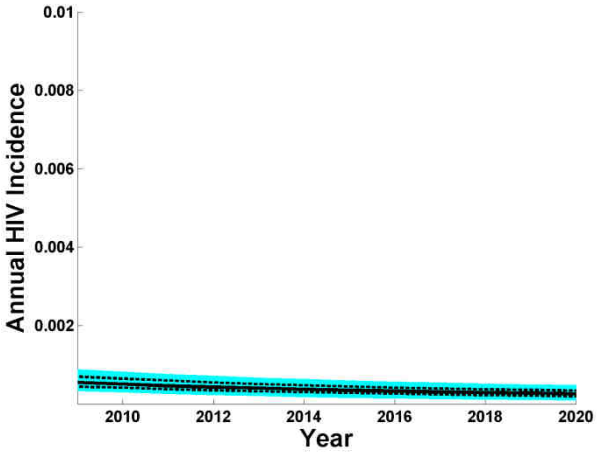
The NT model was used to calculate projections of the expected number of HIV and HCV cases in the future, according to scenarios whereby current syringe distribution levels are maintained or if there are increases or decreases in the provision of syringes through Northern Territory NSPs.

Figure 37: Projections of the expected number of HIV cases in the Northern Territory according to different syringe distribution levels

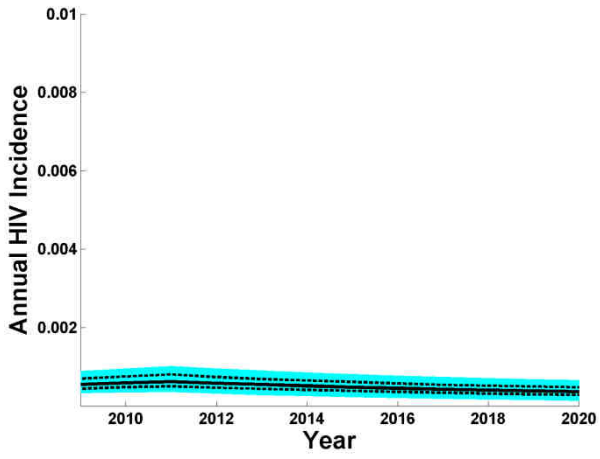
No NSPs



Current NSP distribution



NSP coverage decreases by 25%



NSP coverage increases by 25%

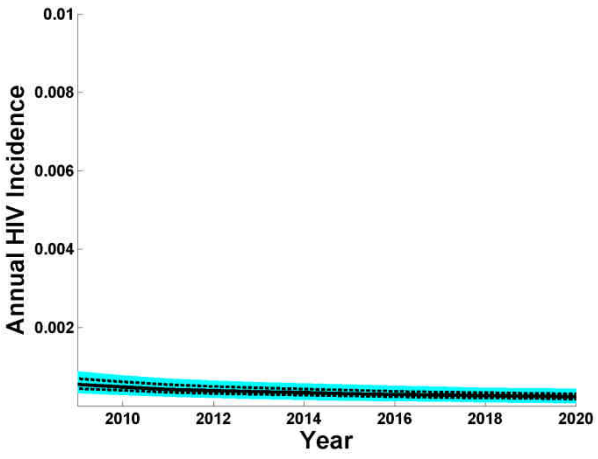
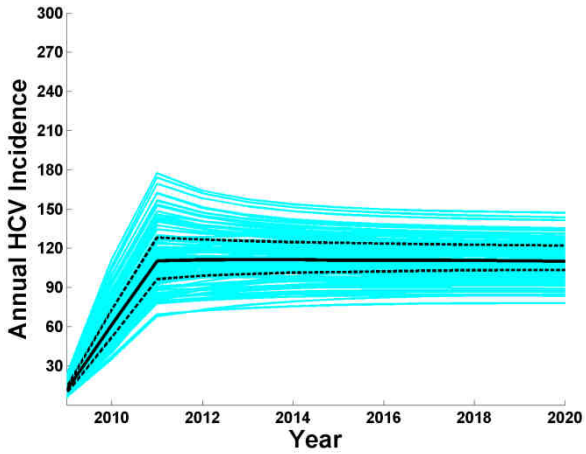
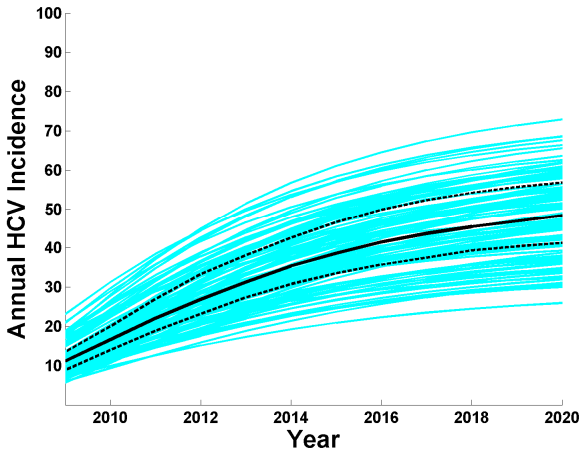


Figure 38: Projections of the expected number of HCV cases in the Northern Territory according to different syringe distribution levels

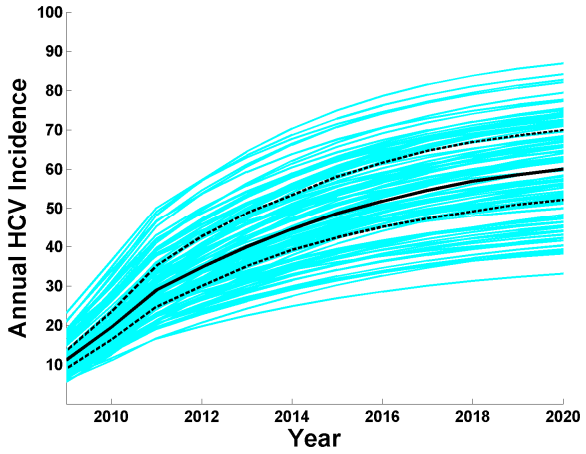
No NSPs



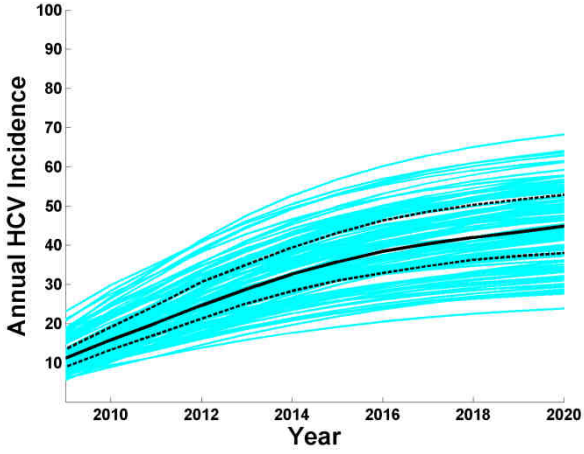
Current NSP distribution



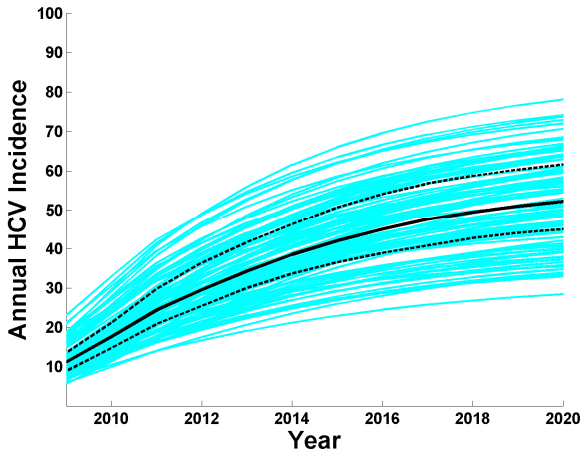
NSP coverage decreases by 25%



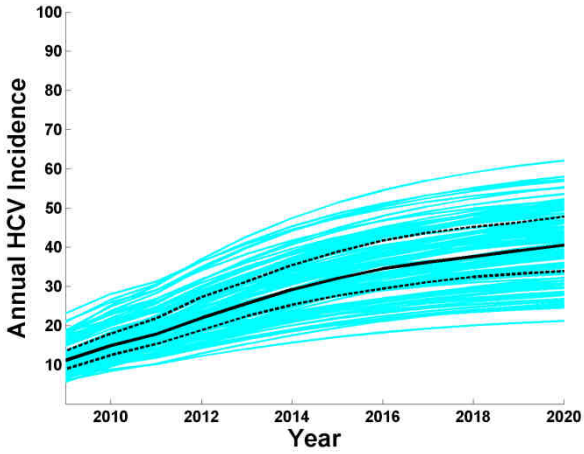
NSP coverage increases by 10%



NSP coverage decreases by 10%



NSP coverage increases by 25%



Economic evaluation of NSPs in the Northern Territory

The spending of $5.2m in the funding of NSPs in Northern Territory from year 2000-2009 has resulted in a saving of $4.2m in healthcare costs, with more than 835 Disability Adjusted Life Years with a net financial cost of $999,000, a cost of just over $1,000 per DALY gained. A summary of the return on investment of NSP funding in the NT is shown in Table 22. The mathematical and economic modelling estimated that if NSPs are continued at the same level of funding in the Northern Territory for the next ten years, $329,000 of net financial savings will accrue ($199,139 discounted at 3%) and for twenty years $3.8m ($2.4m discounted at 3%). The lifetime net present value of investment in NSPs that took account of all healthcare costs and savings (but not costs associated with productivity losses) would be $32m ($11.4m discounted at 3%).

Table 22: Return on Investment of NSP funding in the Northern Territory (2000-2009)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Healthcare costs saved $m (IQR)	0.66 (0.59-0.72)	0.45 (0.40-0.53)	0.42 (0.37-0.48)	0.40 (0.36-0.46)	0.39 (0.34-0.44)	0.37 (0.33-0.42)	0.36 (0.32-0.41)	0.36 (0.32-0.40)	0.39 (0.35-0.44)	0.44 (0.39-0.48)
NSP funding $m (median)	0.38	0.44	0.44	0.49	0.54	0.65	0.54	0.58	0.58	0.58
Net cost savings $m (median)	0.28	0.01	-0.02	-0.09	-0.15	-0.28	-0.18	-0.22	-0.20	-0.14
DALY gain (median)	102	103	98	92	85	80	74	70	66	65

Please note that any inconsistencies between the figures presented in the above text and table are due to rounding. Additionally, the results for each jurisdiction are provided to assist in assessment of local return on investment. The small numbers in some jurisdictions may distort parameter uncertainties and should not be used to compare one jurisdiction with another.

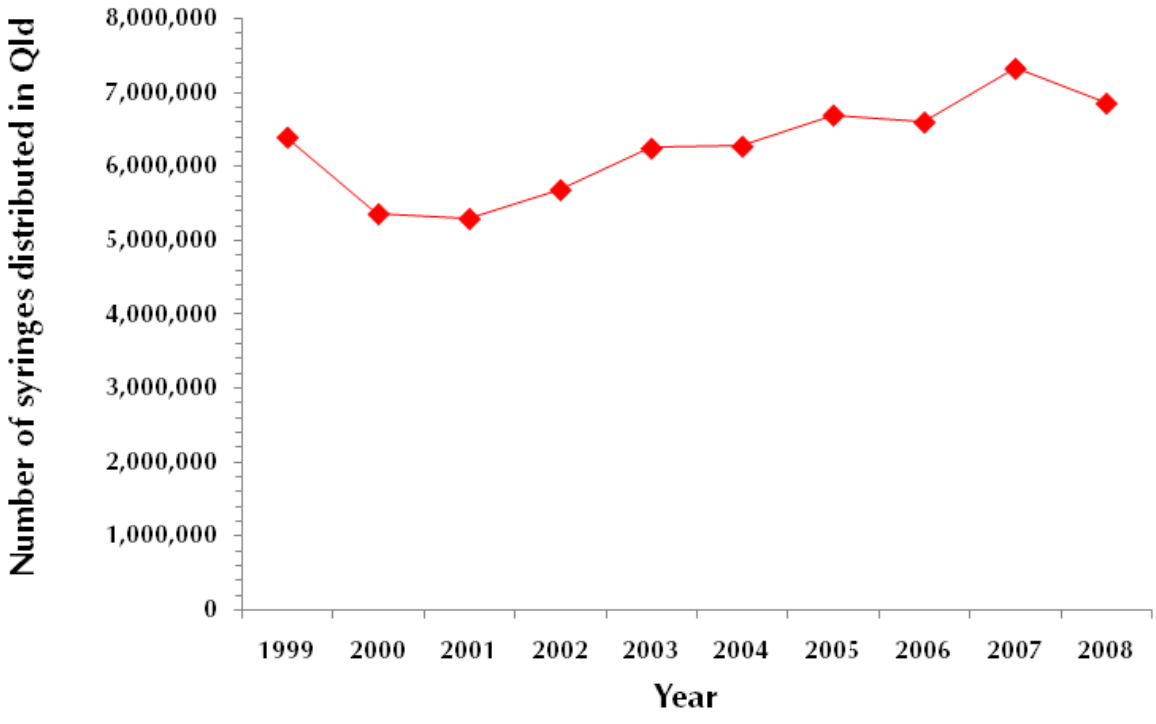
Epidemiological and economic evaluation of NSPs in Queensland

Overview

The supply of needles and syringes became legal in Queensland in 1989. Prior to 1989, single syringes were sold commercially through pharmacies. The distribution of needles and syringes increased considerably during the late 1990s. Queensland has 859 needle and syringe programs, consisting of 18 primary outlets operated by Queensland Health (and located in Brisbane and Cairns), 84 secondary outlets, four enhanced secondary outlets, 745 pharmacies, and eight vending machines. All community pharmacies are legally able to provide needles and syringes and the vast majority do so by selling pre-packaged needles and syringes on a commercial basis.

Number of NSPs:	859 (including pharmacies)
Syringes distributed 1999-2008:	62,752,480
Average syringes per year:	6,275,248
Total spending 2007/8:	$3,901,747

Figure 39: Number of needles and syringes distributed in Queensland (1999-2008)



There are no accurate estimates of the number of IDUs in Queensland. However, based on indicators of IDU populations (Appendix B) the estimated number of IDUs and syringes distributed in Queensland has been increasing, and at a faster rate than any other jurisdiction. The average frequency of injecting by IDUs in Queensland has decreased modestly but sharing rates have been slightly decreased. The prevalence of HCV among Queensland IDUs has increased markedly during the last decade and HIV cases have remained low.

In 2007/8, 7,069,405 sterile injection equipment units were provided in Queensland: 46% were through primary sites, 14% were distributed through secondary sites, 9% were provided through enhanced secondary sites, 21% were through pharmacies, and 9% through vending machines. 300,000 five packs were distributed through pharmacies. Pharmacists charge an average of $5 per five-pack out-of-pocket costs. The number of NSP sites in Queensland is listed in Table 23. Table 24 reports the spending by financial year in 2008 dollars, unadjusted and adjusted for the consumer price index (CPI).

Table 23: Number of NSP sites in Queensland

	Primary	Secondary	Enhanced secondary	Vending machine sites	Pharmacies
2007	18	84	4	8	745
2006	18	86	5	7	
2005	14	81	5	4	
2004	15	82	5	4	
2003	12	81	5		
2002	14	77	5		
2001	13	69	5		
2000	11	64	5		

Table 24: Summary of expenditure on NSPs in Queensland (2000/1-2007/8)

Consumables ($'000)	**2000/1**	**2001/2**	**2002/3**	**2003/4**	**2004/5**	**2005/6**	**2006/7**	**2007/8**
Sterile injecting equipment	889	893	1,023	1,130	1,225	1,104	1,256	1,246
Disposal equipment	160	155	164	207	207	224	266	338
Safe sex packs	0	0	0	0	0	0	0	0
sub-total	1,049	1,049	1,187	1,338	1,432	1,327	1,522	1,584
NSP SUPPORT ($'000)								
Primary NSPs Operations	1,205	1,401	1,568	1,042	1,384	1,699	1,715	1,919
Support for Secondary NSPs	0	100	129	222	132	212	186	162
Transport	16	15	23	27	33	94	113	98
Vending machines	0	0	0	0	0	0	3	0
sub-total	1,221	1,516	1,720	1,291	1,550	2,005	2,017	2,179
TOTAL ($'000) (unadjusted for CPI)	2,270	2,564	2,907	2,628	2,982	3,332	3,539	3,763
TOTAL in 2008 ($'000) (CPI adjusted)	2,870	3,144	3,460	3,055	3,379	3,673	3,778	3,902

Evaluating current NSPs

The mathematical epidemiological transmission model for HIV and HCV was applied to IDUs and NSPs specifically in Queensland. The model was used to evaluate current NSPs versus no program and to project likely epidemiological impacts of potential changes to the program. The model estimated the expected number of HIV and HCV cases in Queensland with and without NSP distribution of sterile injecting equipment (Figure 40). The estimated number of infections averted is presented in Figure 41. An estimated 7,296 (5,179-9,324, IQR) HIV infections and 21,285 (20,566-22,215, IQR) HCV infections were averted due to NSPs in Queensland.

Figure 40: Estimated HIV and HCV incidence in Queensland with and without NSPs

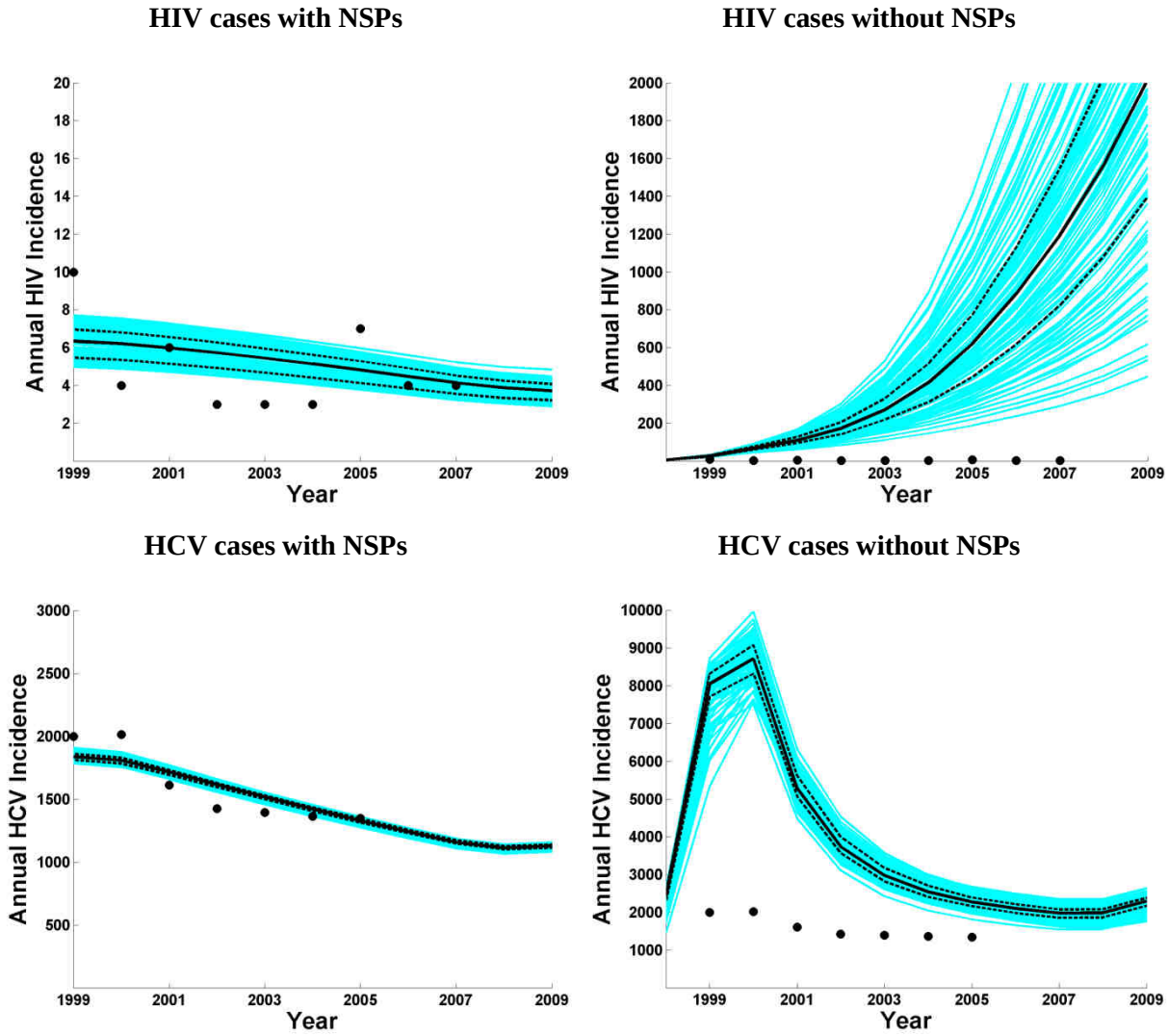
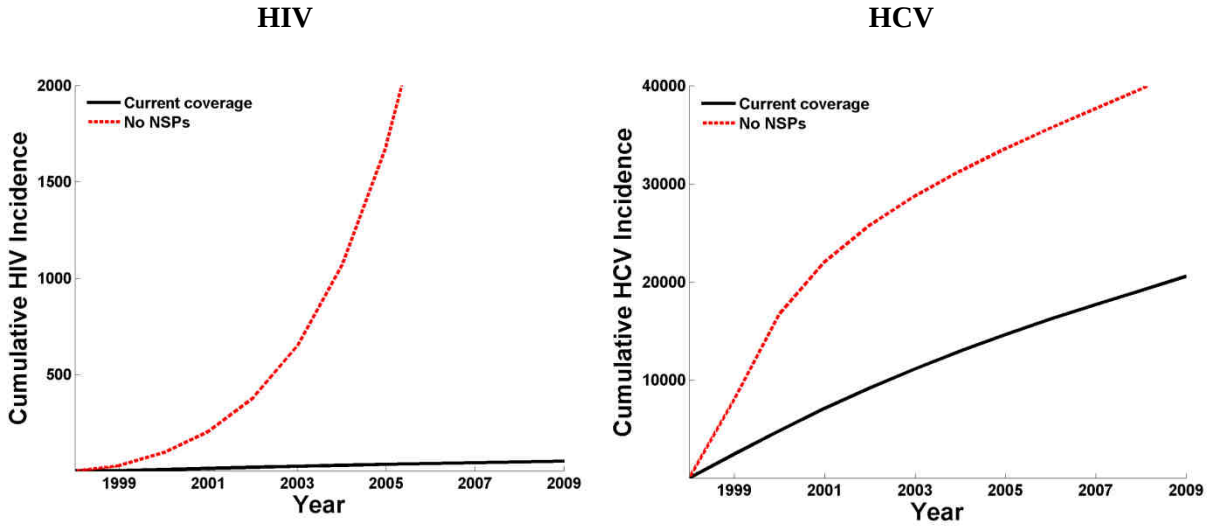


Figure 41: Estimated cumulative number of HIV and HCV cases averted in Queensland due to NSPs

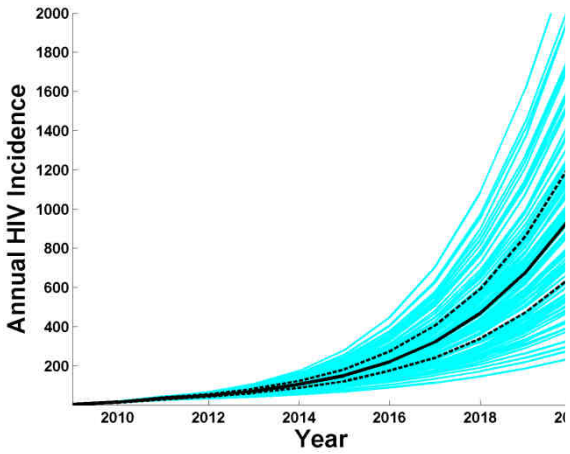


Epidemic projections in Queensland

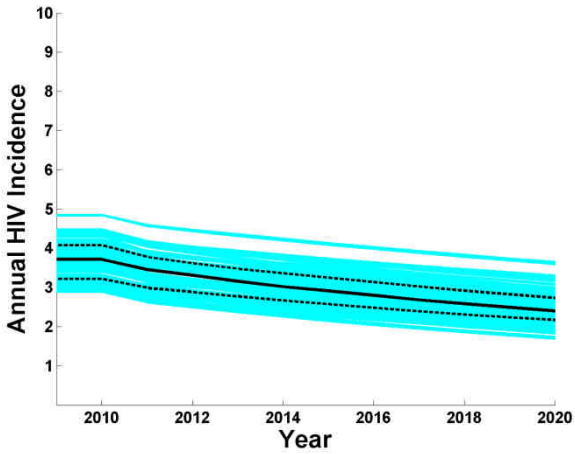
The Queensland model was used to calculate projections of the expected number of HIV and HCV cases in the future according to scenarios whereby current syringe distribution levels are maintained or if there are increases or decreases in the provision of syringes through Queensland NSPs.

Figure 42: Projections of the expected number of HIV cases in Queensland according to different syringe distribution levels

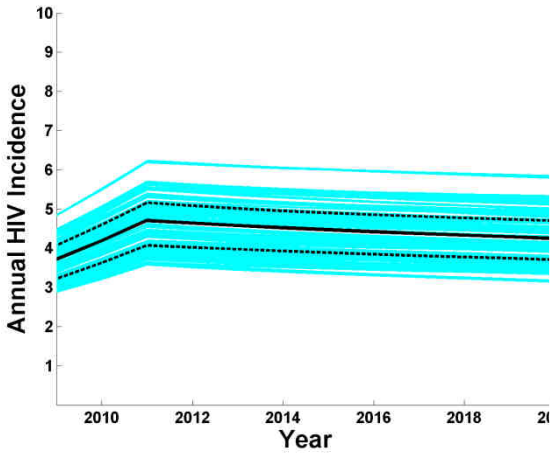
No NSPs



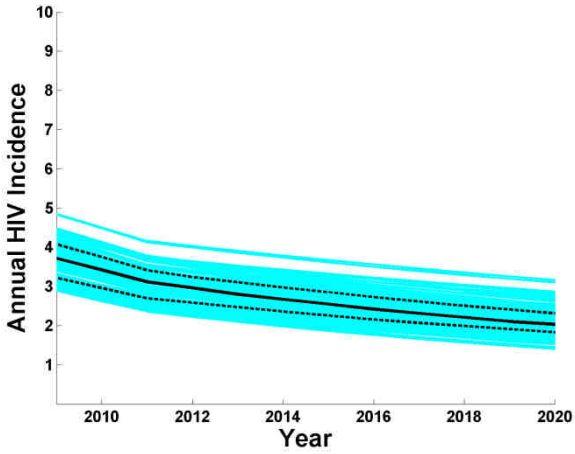
Current NSP distribution



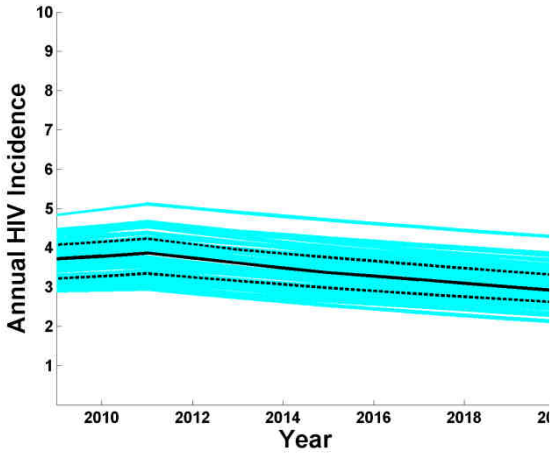
NSP coverage decreases by 25%



NSP coverage increases by 10%



NSP coverage decreases by 10%



NSP coverage increases by 25%

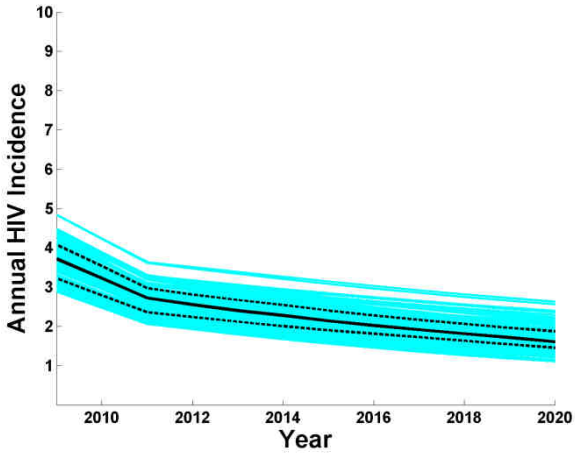
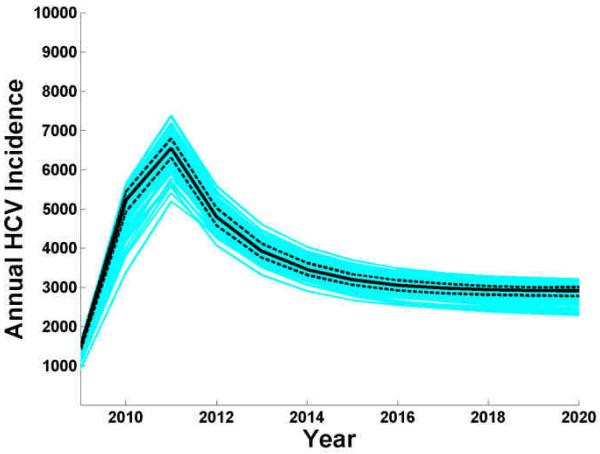
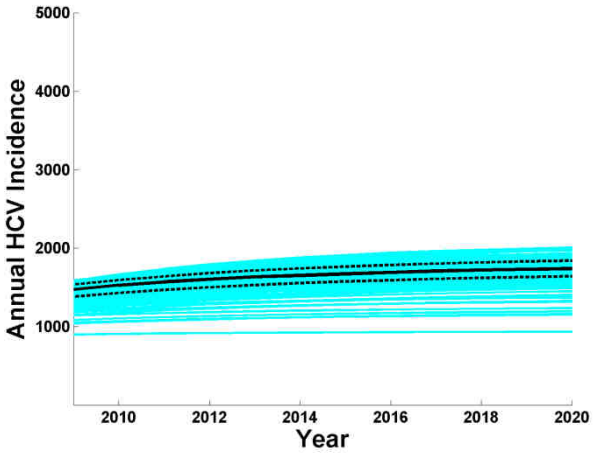


Figure 43: Projections of the expected number of HCV cases in Queensland according to different syringe distribution levels

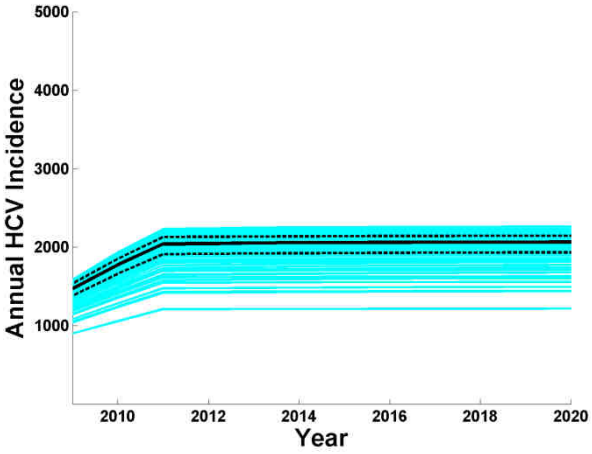
No NSPs



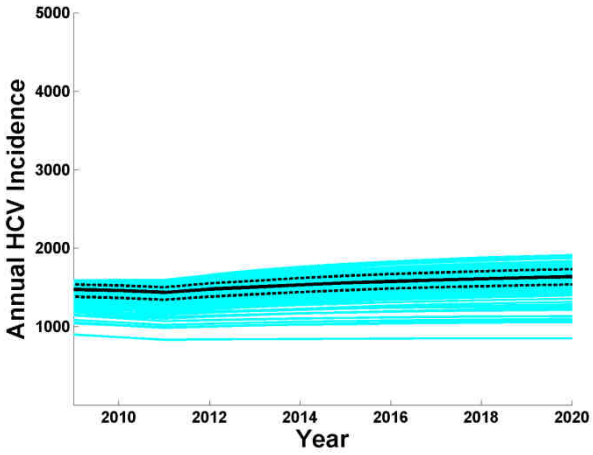
Current NSP distribution



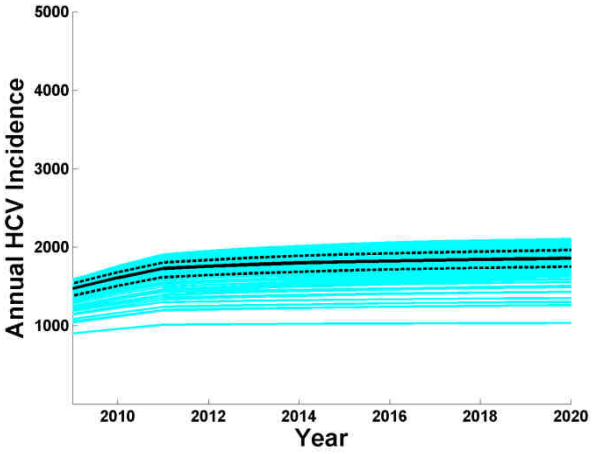
NSP coverage decreases by 25%



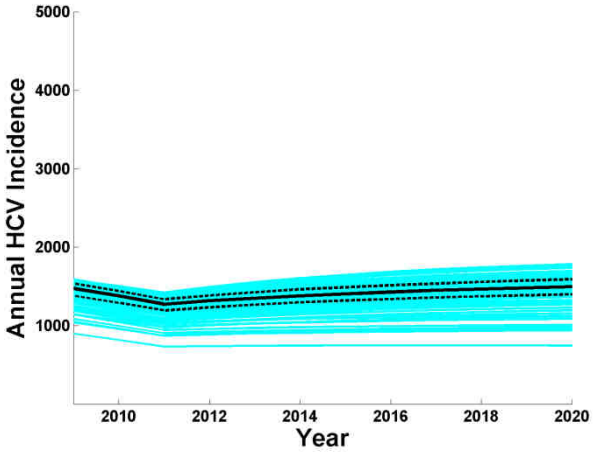
NSP coverage increases by 10%



NSP coverage decreases by 10%



NSP coverage increases by 25%



Economic evaluation of NSPs in Queensland

The spending of $35m in the funding of NSPs in Queensland from year 2000-2009 has resulted in a saving of $253m in healthcare costs, with more than 38,000 Disability Adjusted Life Years saved with a net financial saving of $218m. A summary of the return on investment of NSP funding in Queensland is shown in Table 25. The mathematical and economic modelling estimated that if NSPs are continued at the same level of funding in Queensland for the next ten years, $634m of net financial savings will accrue ($579m discounted at 3%) and for twenty years $1.58bn ($1.17bn discounted at 3%). The lifetime net present value of investment in NSPs that took account of all healthcare costs and savings (but not costs associated with productivity losses) would be $12.1bn ($3.72bn discounted at 3%).

Table 25: Return on Investment of NSP funding in Queensland (2000-2009)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Healthcare costs saved $m (IQR)	22 (20-24)	21 (19-24)	21 (19-24)	21 (19-24)	22 (19-25)	23 (21-26)	25 (23-29)	28 (25-32)	32 (28-38)	38 (33-45)
NSP funding $m (median)	3	3	3	3	3	4	4	4	4	4
Net cost savings $m (median)	19	18	18	18	18	19	21	24	28	34
DALY gain (median)	2,561	2,968	3,184	3,333	3,505	3,721	3,983	4,407	5,042	5,925

Please note that any inconsistencies between the figures presented in the above text and table are due to rounding. Additionally, the results for each jurisdiction are provided to assist in assessment of local return on investment. The small numbers in some jurisdictions may distort parameter uncertainties and should not be used to compare one jurisdiction with another.

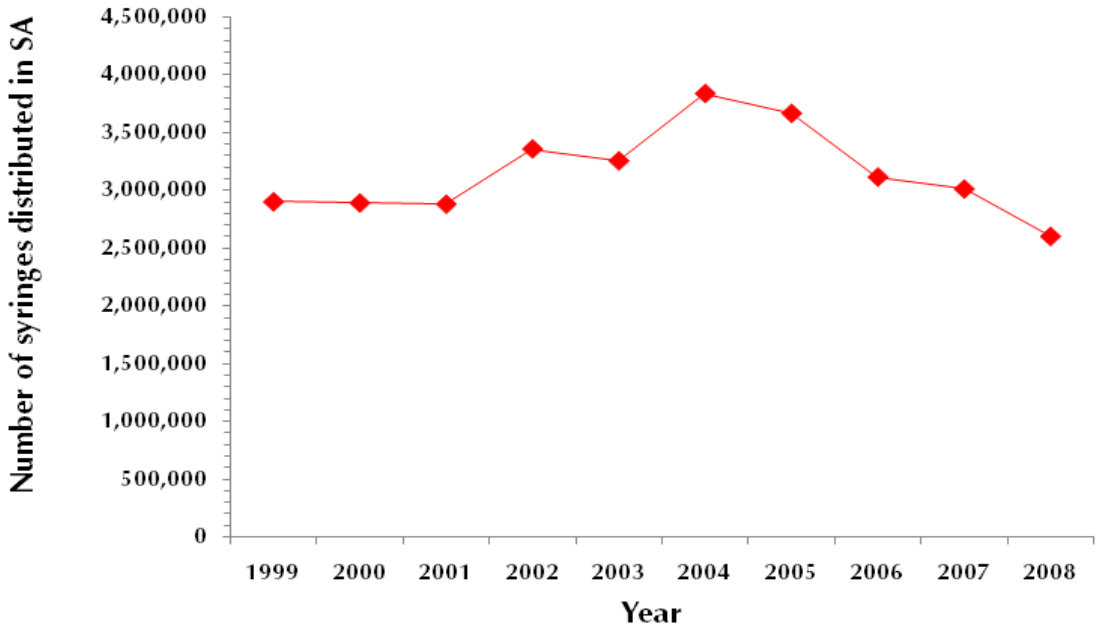
Epidemiological and economic evaluation of NSPs in South Australia

Overview

The 'Clean Needle Program', operated by the Drug and Alcohol Services South Australia, commenced in 1989. Pharmacy programs in South Australia for distributing needles and syringes commenced in the early 1990s. South Australia has 81 NSPs, consisting of one primary outlet, 69 secondary outlets and 11 enhanced secondary outlets. There are over 170 pharmacies that sell needles and syringes on a commercial basis. Primary and secondary outlets are based in metropolitan Adelaide and in rural areas. Some outreach services are also provided. Disposal facilities are provided at all community NSP sites, most pharmacies and some local councils also provide disposal facilities.

Number of NSPs:	81 (plus pharmacies)
Syringes distributed 1999-2008:	31,569,283
Average syringes per year:	3,156,928
Total spending 2007/8:	$1,536,115

Figure 44: Number of needles and syringes distributed in South Australia (1999-2008)



The proportion of Australian IDUs that are in South Australia has remained relatively steady. The number of needles and syringes distributed through NSPs in South Australia increased during 2002-2004 but has started to decline in recent years. The average frequency of injecting by IDUs in South Australia has remained steady but sharing rates have tended to increase slightly. Despite this, the prevalence of HCV among South Australian IDUs has been steady, with a slight tendency for a decrease which is in contrast to most other jurisdictions. The incidence of HIV has remained relatively low among South Australian IDUs.

In 2007/8, 2,763,030 sterile injection equipment units were provided in South Australia: 20% were distributed through secondary sites with 63% of these through enhanced secondary sites. 241,900 needles and syringes were distributed through pharmacies. Pharmacists charge an average of $5-$10 per five-pack out-of-pocket costs. The number of NSP sites in South Australia is listed in Table 26. Table 27 reports the spending by financial year in 2008 dollars, unadjusted and adjusted for the consumer price index (CPI).

Table 26: Number of NSP sites in South Australia

	Primary	Secondary	Enhanced secondary
2007/8	1	69	11
2006/7	1	67	9
2005/6	1	65	6
2004/5	1	64	6
2003/4	1	66	6
2002/3	1	66	5
2001/2	1	65	5
2000/1	1	63	5

Table 27: Summary of expenditure on NSPs in South Australia (2000/1-2007/8)

	2000/1	2001/2	2002/3	2003/4	2004/5	2005/6	2006/7	2007/8
Consumables ($'000)								
Sterile injecting equipment	494	456	501	504	430	489	405	401
Disposal equipment	253	233	256	109	260	260	274	227
Safe sex packs	0	0	0	0	0	0	0	0
sub-total	747	690	757	613	690	749	679	629
NSP SUPPORT ($'000)								
Primary NSPs Operations	182	216	215	215	215	215	215	215
Support for Secondary NSPs	147	309	370	322	388	661	386	637
Transport	0	0	0	0	0	0	0	0
Vending machines	0	0	0	0	0	0	0	0
sub-total	329	526	585	537	603	877	601	853
TOTAL ($'000) (unadjusted for CPI)	1,077	1,216	1,342	1,150	1,294	1,625	1,280	1,482
TOTAL in 2008 ($'000) (CPI adjusted)	1,361	1,490	1,597	1,337	1,466	1,792	1,367	1,536

Evaluating current NSPs

The mathematical epidemiological transmission model for HIV and HCV was applied to IDUs and NSPs specifically in South Australia. The model was used to evaluate current NSPs versus no program and to project likely epidemiological impacts of potential changes to the program. The model estimated the expected number of HIV and HCV cases in South Australia with and without NSP distribution of sterile injecting equipment (Figure 45). The estimated number of infections averted is presented in Figure 46. An estimated 122 (89-175, IQR) HIV infections and 8,987 (8,722-9,463, IQR) HCV infections were averted due to NSPs in South Australia.

Figure 45: Estimated HIV and HCV incidence in South Australia with and without NSPs

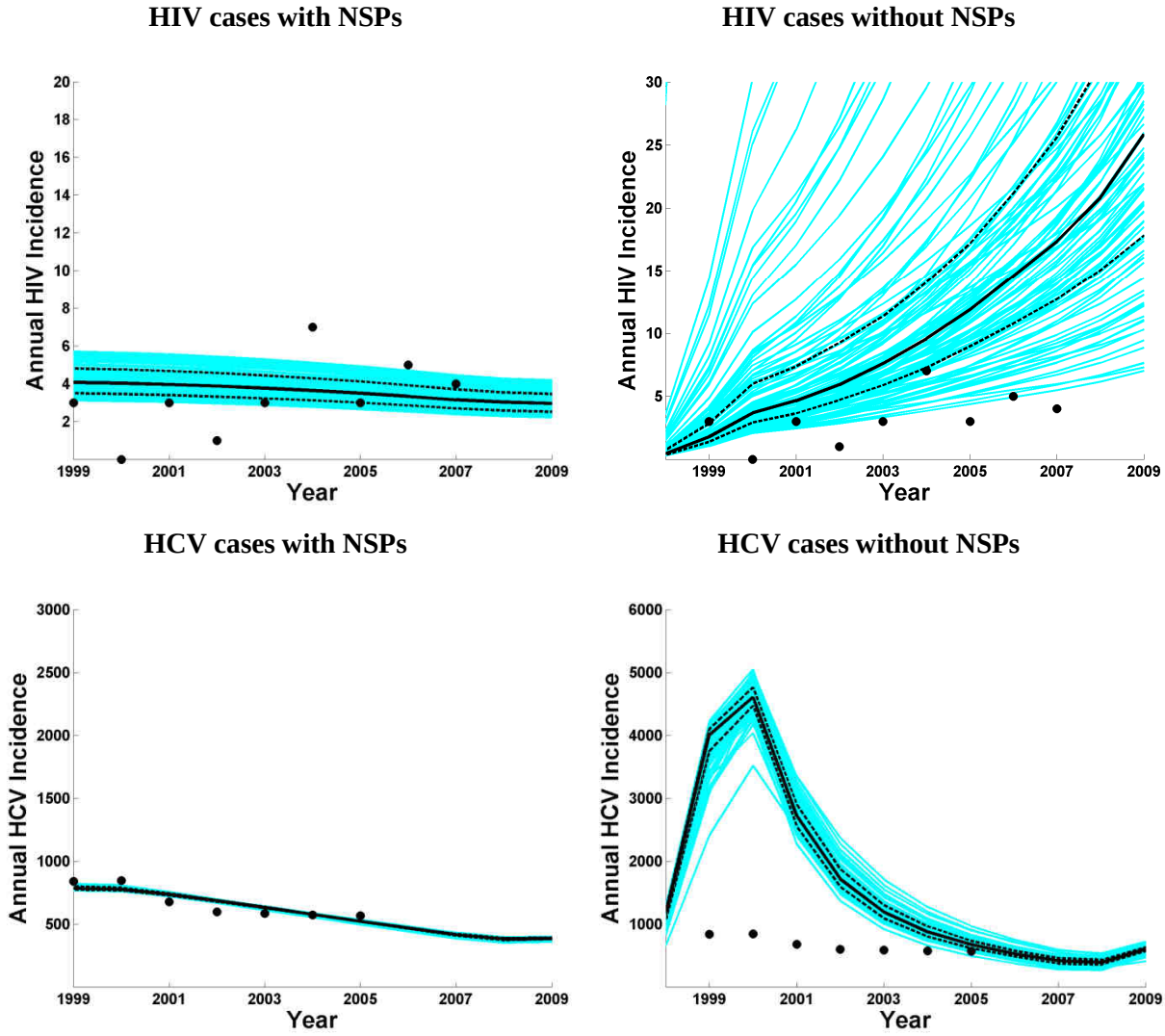
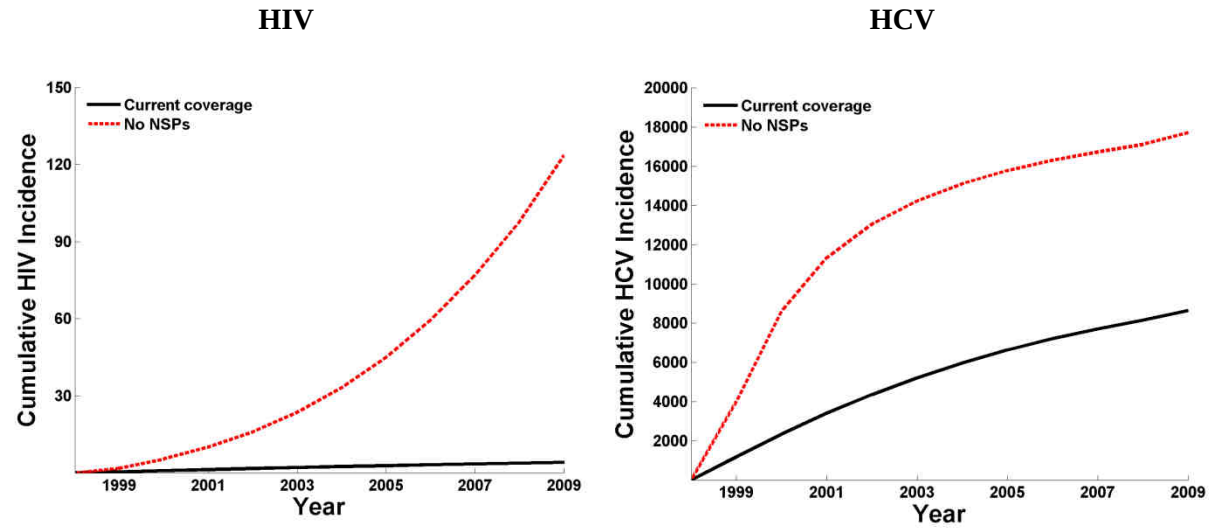


Figure 46: Estimated cumulative number of HIV and HCV cases averted in South Australia due to NSPs

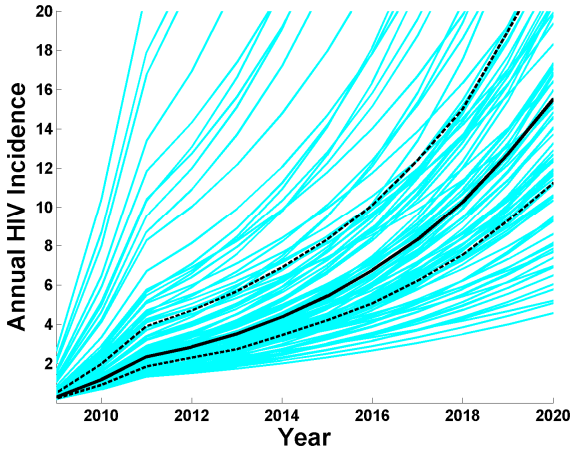


Epidemic projections in South Australia

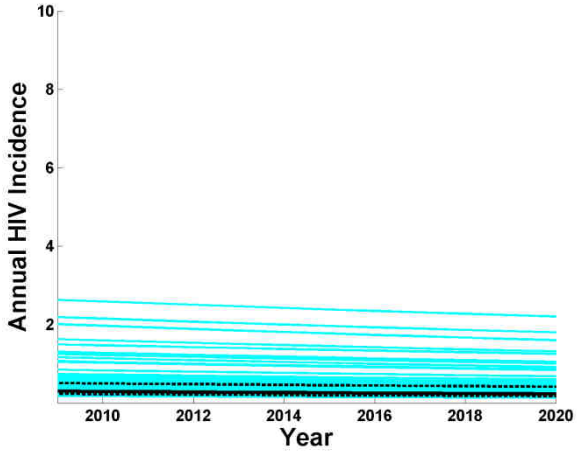
The South Australian model was used to calculate projections of the expected number of HIV and HCV cases in the future, according to scenarios whereby current syringe distribution levels are maintained or if there are increases or decreases in the provision of syringes through South Australian NSPs.

Figure 47: Projections of the expected number of HIV cases in South Australia according to different syringe distribution levels

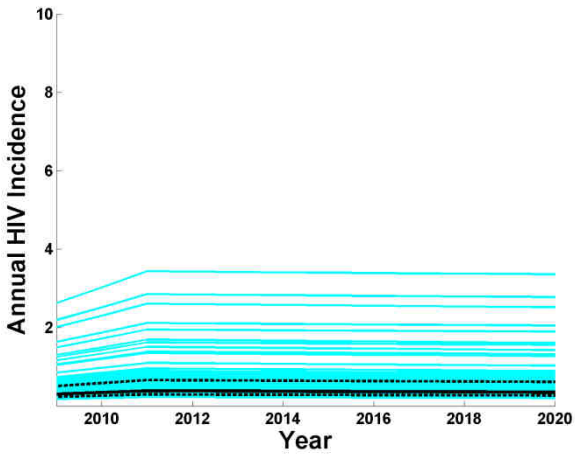
No NSPs



Current NSP distribution



NSP coverage decreases by 25%



NSP coverage increases by 25%

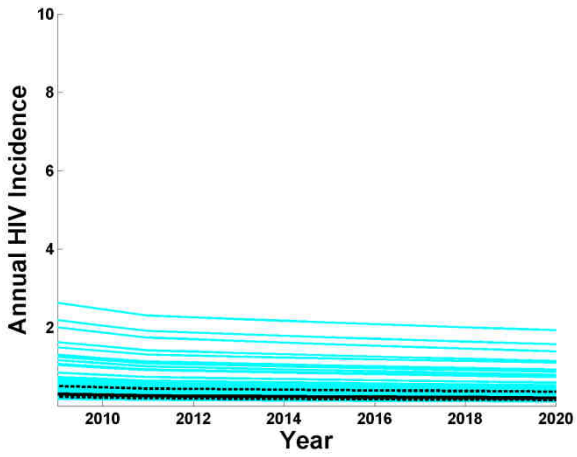
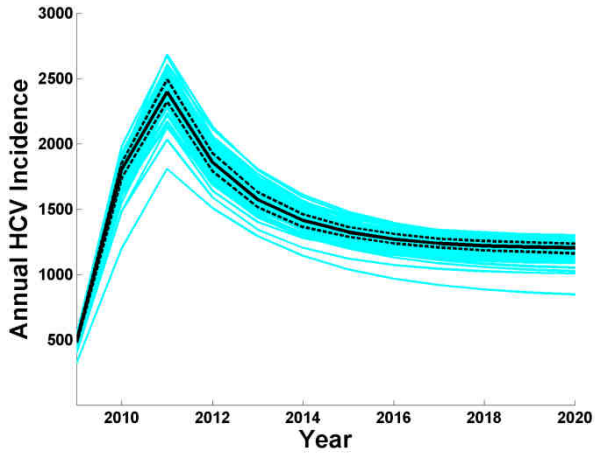
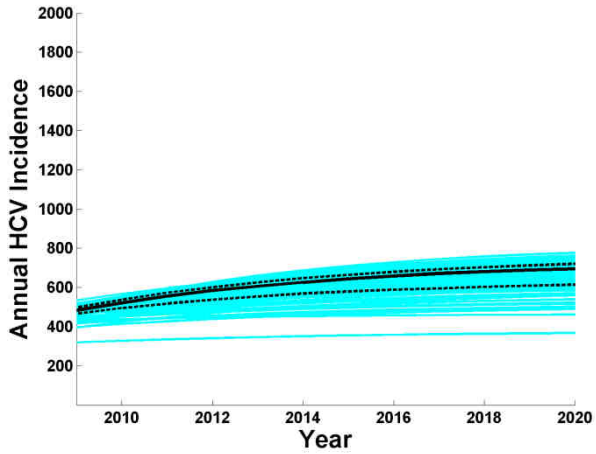


Figure 48: Projections of the expected number of HCV cases in South Australia according to different syringe distribution levels

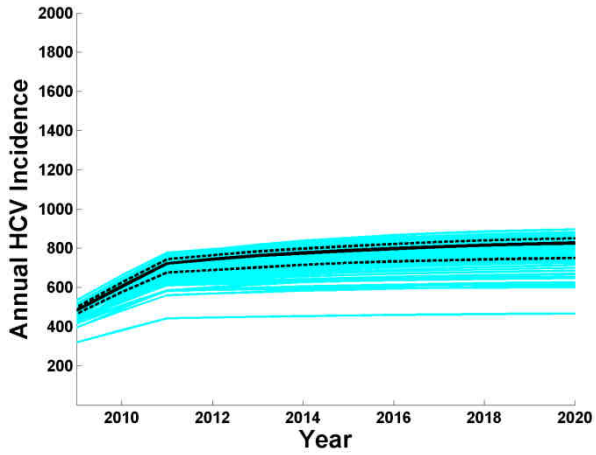
No NSPs



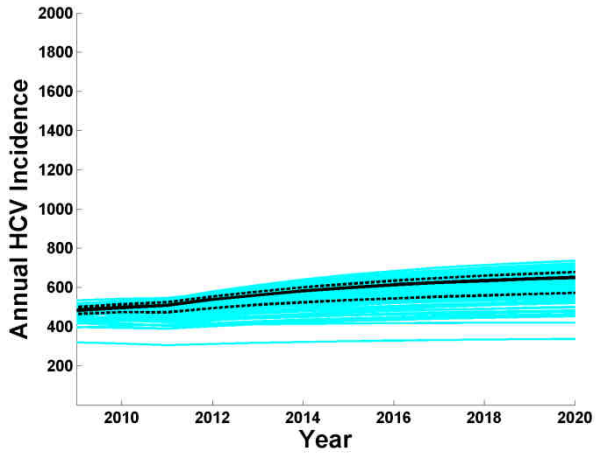
Current NSP distribution



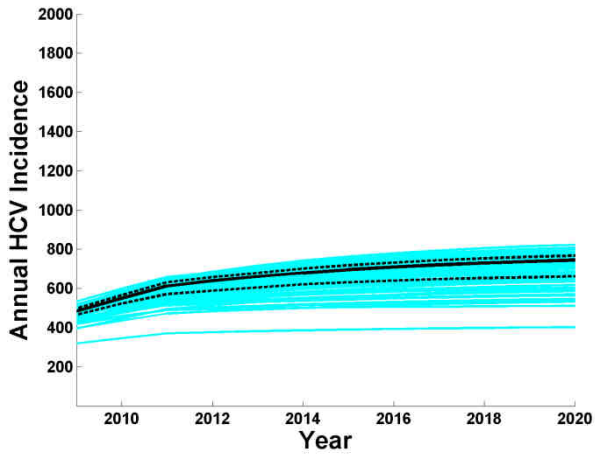
NSP coverage decreases by 25%



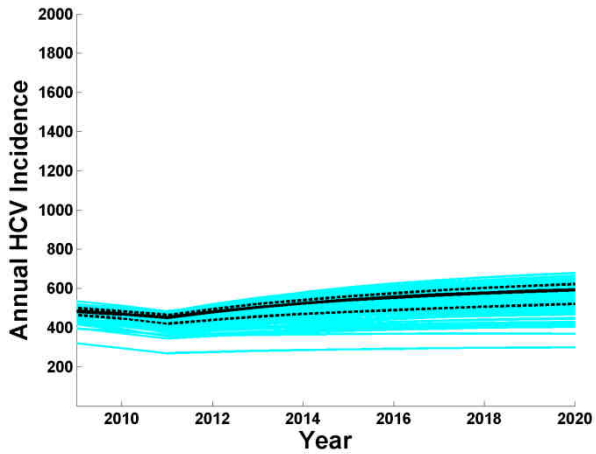
NSP coverage increases by 10%



NSP coverage decreases by 10%



NSP coverage increases by 25%



Economic evaluation of NSPs in South Australia

The spending of $15m in the funding of NSPs in South Australia from year 2000-2009 has resulted in a saving of $93m in healthcare costs, with more than 15,000 Disability Adjusted Life Years saved with a net financial saving of $80m. A summary of the return on investment of NSP funding in South Australia is shown in Table 28. The mathematical and economic modelling estimated that if NSPs are continued at the same level of funding in SA for the next ten years, $295m of net financial savings will accrue ($258m discounted at 3%) and for twenty years $605m ($458m discounted at 3%). The lifetime net present value of investment in NSPs that took account of all healthcare costs and savings (but not costs associated with productivity losses) would be $3.85bn ($1.26bn discounted at 3%).

Table 28: Return on Investment of NSP funding in South Australia (2000-2009)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Healthcare costs saved $m (IQR)	11 (10-13)	11 (10-14)	10 (9-13)	9 (8-12)	9 (8-11)	9 (7-11)	8 (7-10)	8 (7-10)	9 (7-10)	9 (8-11)
NSP funding $m (median)	1	1	2	1	1	2	1	2	2	2
Net cost savings $m (median)	10	9	9	8	8	7	7	7	7	8
DALY gain (median)	1,369	1,573	1,643	1,641	1,611	1,560	1,493	1,427	1,387	1,382

Please note that any inconsistencies between the figures presented in the above text and table are due to rounding. Additionally, the results for each jurisdiction are provided to assist in assessment of local return on investment. The small numbers in some jurisdictions may distort parameter uncertainties and should not be used to compare one jurisdiction with another.

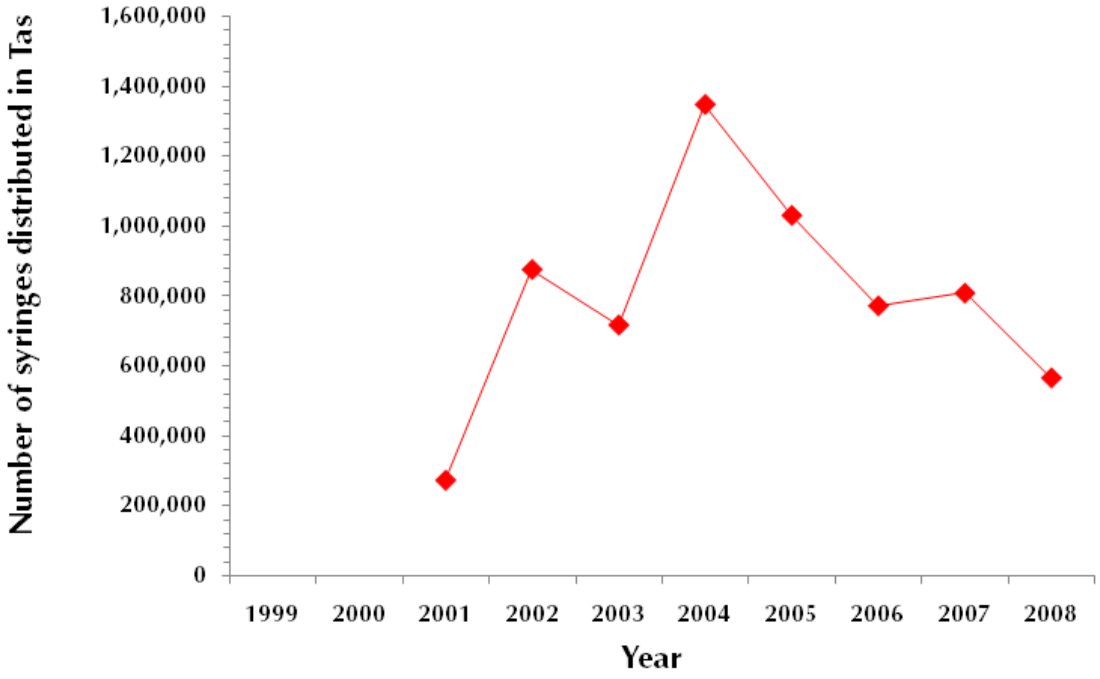
Epidemiological and economic evaluation of NSPs in Tasmania

Overview

The Tasmanian Parliament passed the *HIV/AIDS Preventive Measures Act* in 1993 that enabled the establishment of NSPs in Tasmania. Prior to this, relatively small numbers of needles and syringes were distributed informally. Tasmania now has six primary outlets, 20 secondary outlets, and 60 pharmacy-based outlets. Pharmacy-based outlets provide equipment for a fee.

Number of NSPs:	86
Syringes distributed 2001-2008:	6,409,721
Average syringes per year:	801,215
Total spending 2007/8::	$797,831

Figure 49: Number of needles and syringes distributed in Tasmania (2001-2008)



The number of IDUs in Tasmania has remained relatively constant. The number of sterile injecting equipment units increased in 2004-2005 but has generally stayed stable. The average frequency of injecting by IDUs in Tasmania has remained steady but sharing rates have been increasing. The prevalence of HCV among Tasmanian IDUs has increased significantly over the last decade but HIV infections are rare among Tasmanian IDUs.

In 2007/8, 691,668 sterile injection equipment units were provided in Tasmania: 17% were distributed through secondary sites and 23% were distributed through pharmacies. Pharmacists charge an average of $5 per three-pack out-of-pocket costs. The number of NSP sites in Tasmania is listed in Table 29. Table 30 reports the spending by financial year in 2008 dollars, unadjusted and adjusted for the consumer price index (CPI).

Table 29: Number of NSP sites in Tasmania

	Primary	Secondary
2007	6	20
2006	6	19
2005	6	19
2004	4	19
2003	3	19

Table 30: Summary of expenditure on NSPs in Tasmania (2000/1 to 2007/8). Missing values for earlier years were imputed

	2000/1	2001/2	2002/3	2003/4	2004/5	2005/6	2006/7	2007/8
Consumables ($'000)								
Sterile injecting equipment	484	447	490	595	628	588	678	340
Disposal equipment	60	55	51	56	67	71	66	76
Safe sex packs	0	0	0	0	0	0	0	0
sub-total	544	502	541	651	695	659	744	416
NSP SUPPORT ($'000)								
Primary NSPs operations	182	217	216	235	263	258	306	308
Support for secondary NSPs	0	0	0	0	0	0	0	0
Transport	6	7	7	7	8	8	10	10
Vending machines	0	0	0	0	0	0	0	35
sub-total	188	224	223	243	271	266	316	353
TOTAL ($'000) (unadjusted for CPI)	732	726	764	893	966	925	1,059	769
TOTAL in 2008 ($'000) (CPI adjusted)	871	864	909	1,038	1,095	1,019	1,131	798

Evaluating current NSPs

The epidemiological transmission model for HIV and HCV was applied to IDUs and NSPs specifically in Tasmania. The model was used to evaluate current NSPs versus no program and to project likely epidemiological impacts of potential changes to the program. The model estimated the expected number of HIV and HCV cases in Tasmania with and without NSP distribution of sterile injecting equipment (Figure 50). The estimated number of infections averted is presented in Figure 51. Less than one HIV infection would be expected due to syringe sharing by IDUs, on average, in Tasmania even without NSPs. Thus, NSPs are currently not preventing HIV infections in Tasmania. However, NSPs are very effective in averting HCV transmissions. It is estimated that over the last ten years they have averted 2,530 (2,404-2,677, IQR) new HCV infections.

Figure 50: Estimated HIV and HCV incidence in Tasmania with and without NSPs

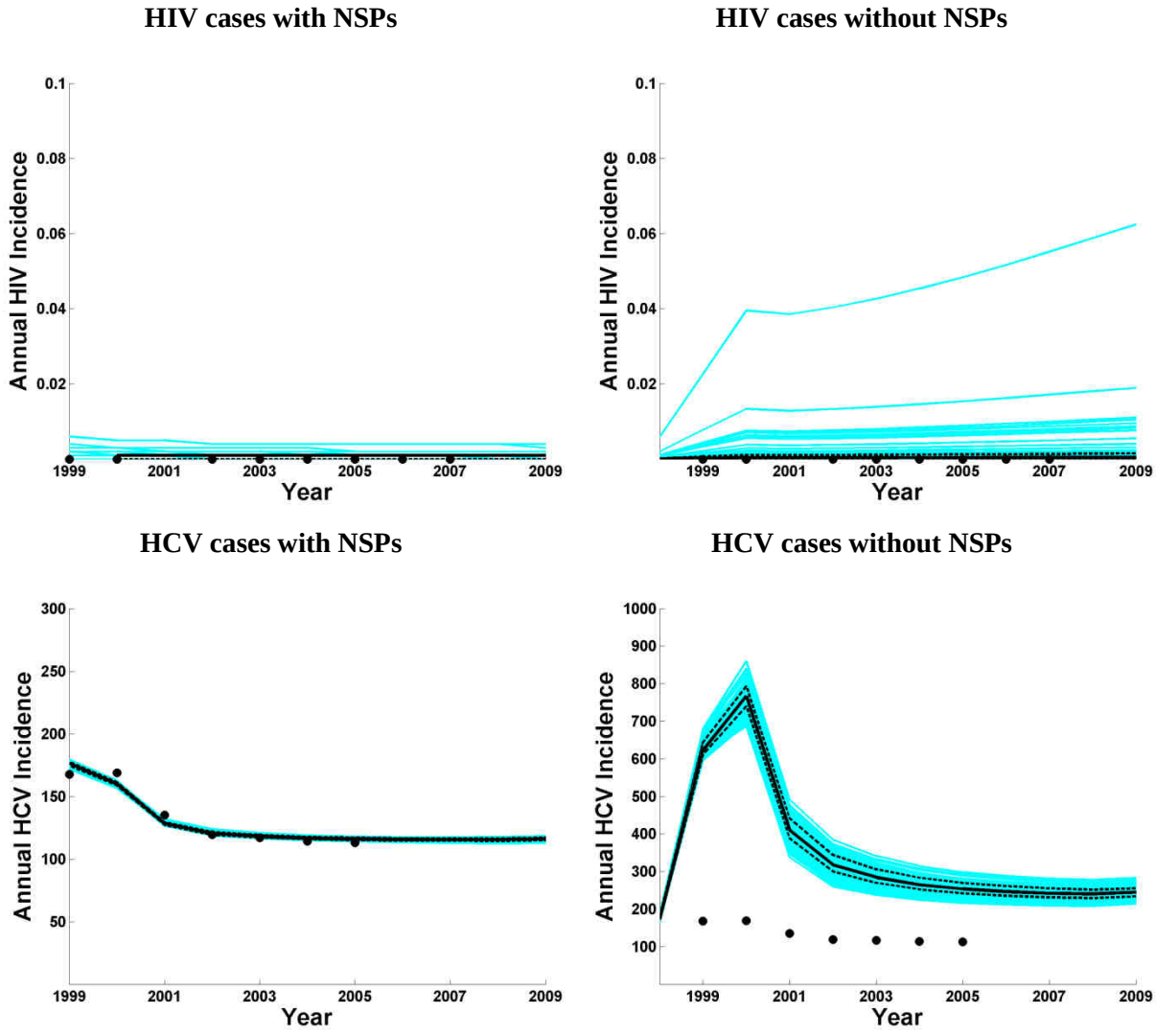
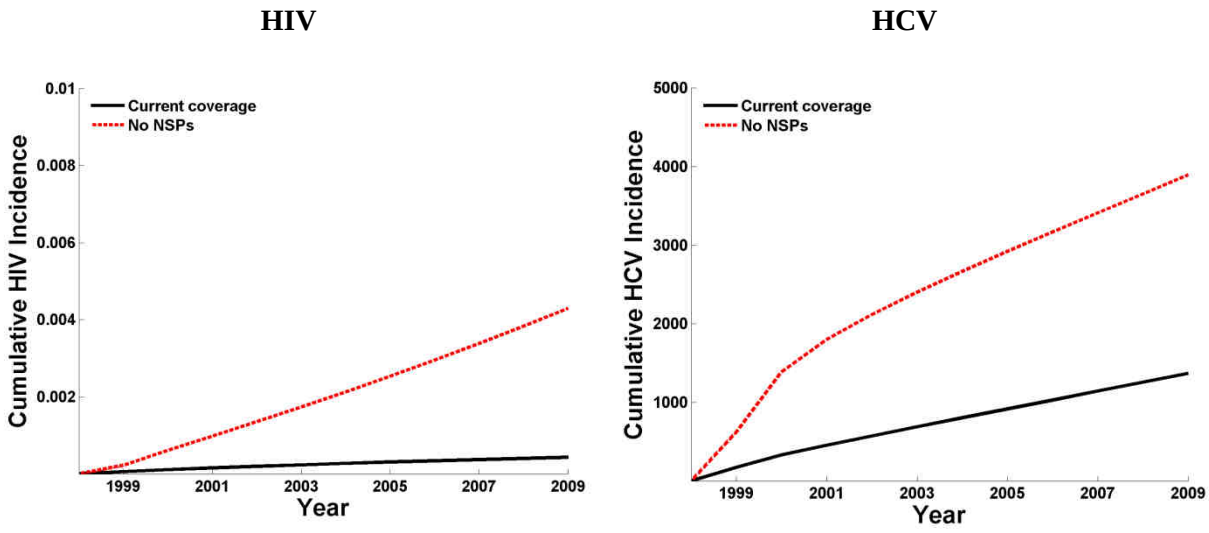


Figure 51: Estimated cumulative number of HIV and HCV cases averted in Tasmania due to NSPs



Epidemic projections in Tasmania

The Tasmanian model was used to calculate projections of the expected number of HIV and HCV cases in the future, according to scenarios whereby current syringe distribution levels are maintained or if there are increases or decreases in the provision of syringes through Tasmanian NSPs.

Figure 52: Projections of the expected number of HIV cases in Tasmania according to different syringe distribution levels

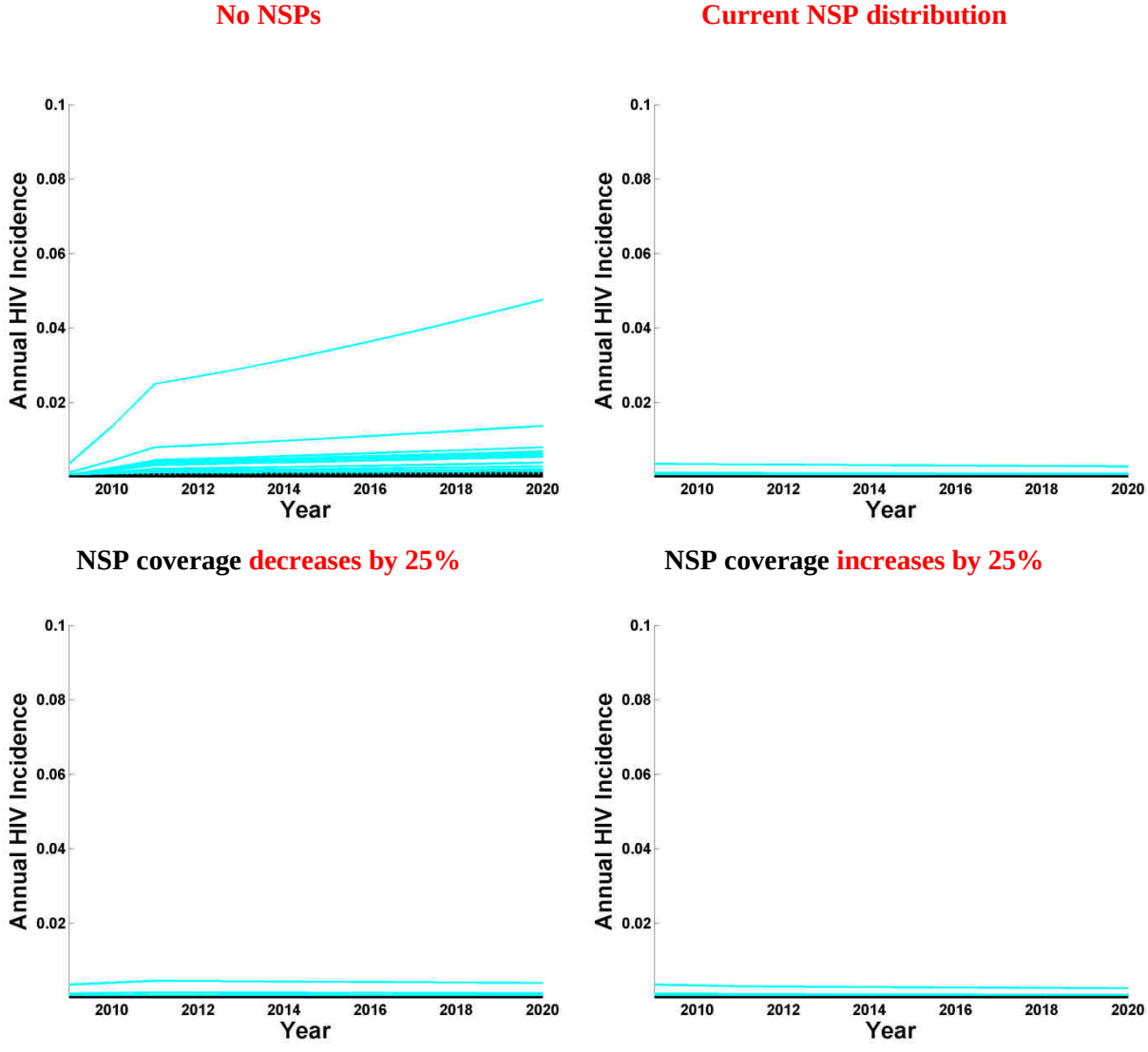
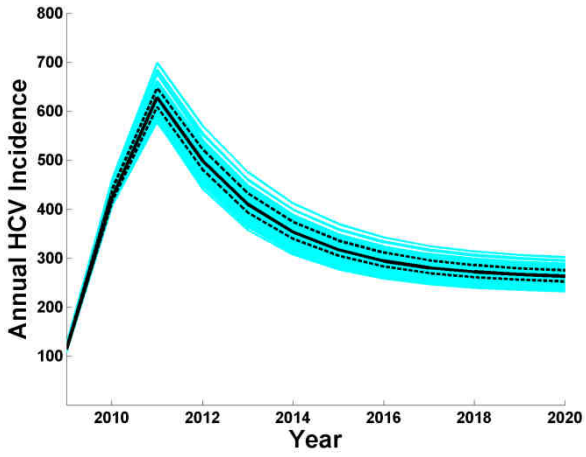
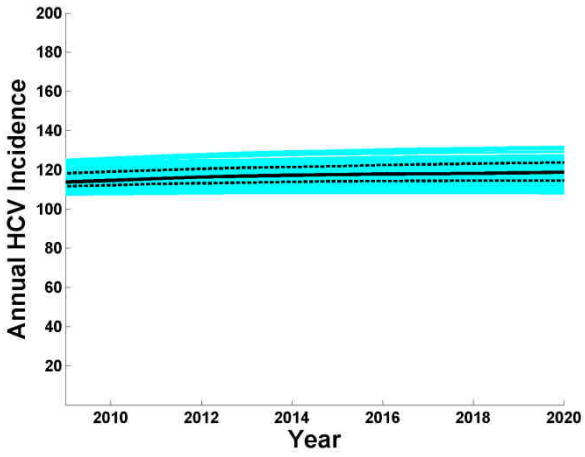


Figure 53: Projections of the expected number of HCV cases in Tasmania according to different syringe distribution levels

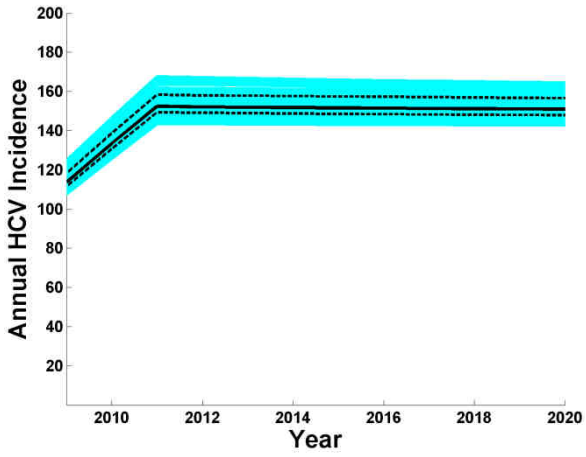
No NSPs



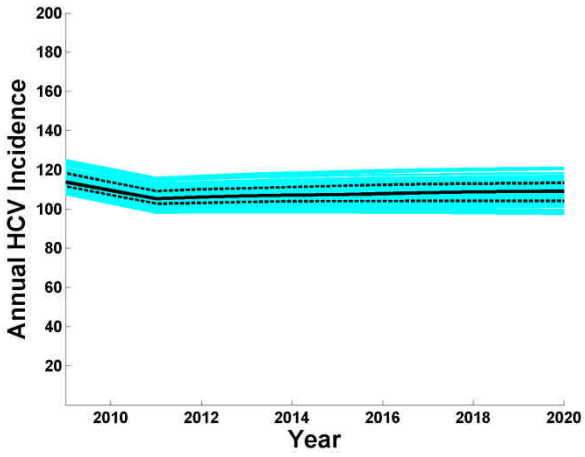
Current NSP distribution



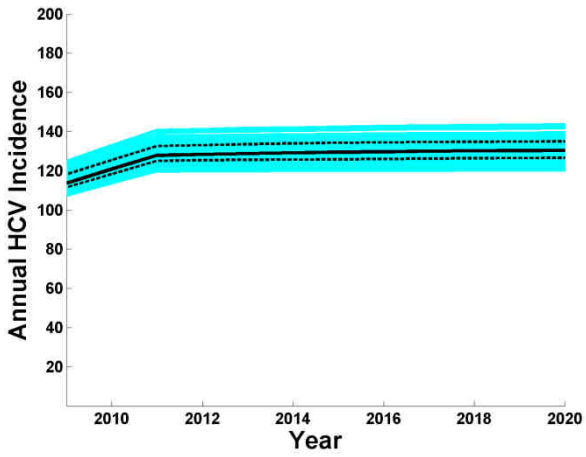
NSP coverage decreases by 25%



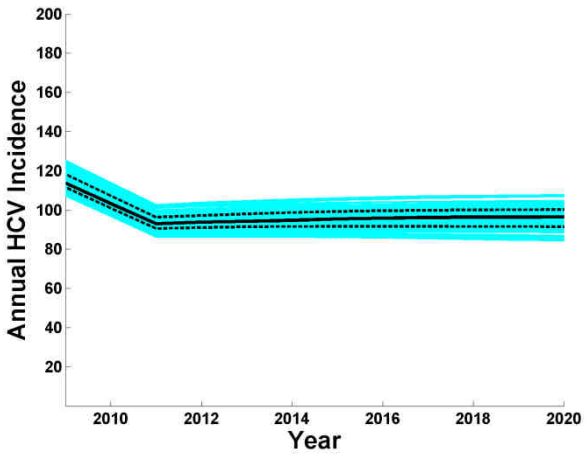
NSP coverage increases by 10%



NSP coverage decreases by 10%



NSP coverage increases by 25%



Economic evaluation of NSPs in Tasmania

The spending of $9m in the funding of NSPs in Tasmania from year 2000 to 2009 has resulted in a saving of $21m in healthcare costs, with nearly 3,000 Disability Adjusted Life Years saved with a net financial saving of $12m. A summary of the return on investment of NSP funding in Tasmania is shown in Table 31. The mathematical and economic modelling estimated that continued spending at the same level for ten years would result in $14.5m of cost savings ($12.6m with 3% discounting) and for twenty years 33m (24.8m with 3% discounting). The lifetime net present value of investment in NSPs that took account of all healthcare costs and savings (but not costs associated with productivity losses) would be $165m ($60.3m discounted at 3%).

Table 31: Return on Investment of NSP funding in Tasmania (2000-2009). Missing values from early years were imputed.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Healthcare costs saved $m (IQR)	2.0 (1.7-2.3)	2.0 (1.8-2.3)	2.0 (1.8-2.3)	2.1 (1.9-2.3)	2.1 (1.9-2.4)	2.2 (2.0-2.4)	2.2 (2.0-2.5)	2.2 (2.0-2.5)	2.3 (2.1-2.6)	2.4 (2.1-2.6)
NSP funding $m (median)	0.9	0.9	0.9	1.0	1.1	1.0	1.1	0.8	0.8	0.8
Net cost savings $m (median)	1.1	1.1	1.1	1.0	1.0	1.1	1.1	1.4	1.5	1.6
DALY gain (median)	211	252	275	293	307	318	327	335	342	349

Please note that any inconsistencies between the figures presented in the above text and table are due to rounding. Additionally, the results for each jurisdiction are provided to assist in assessment of local return on investment. The small numbers in some jurisdictions may distort parameter uncertainties and should not be used to compare one jurisdiction with another.

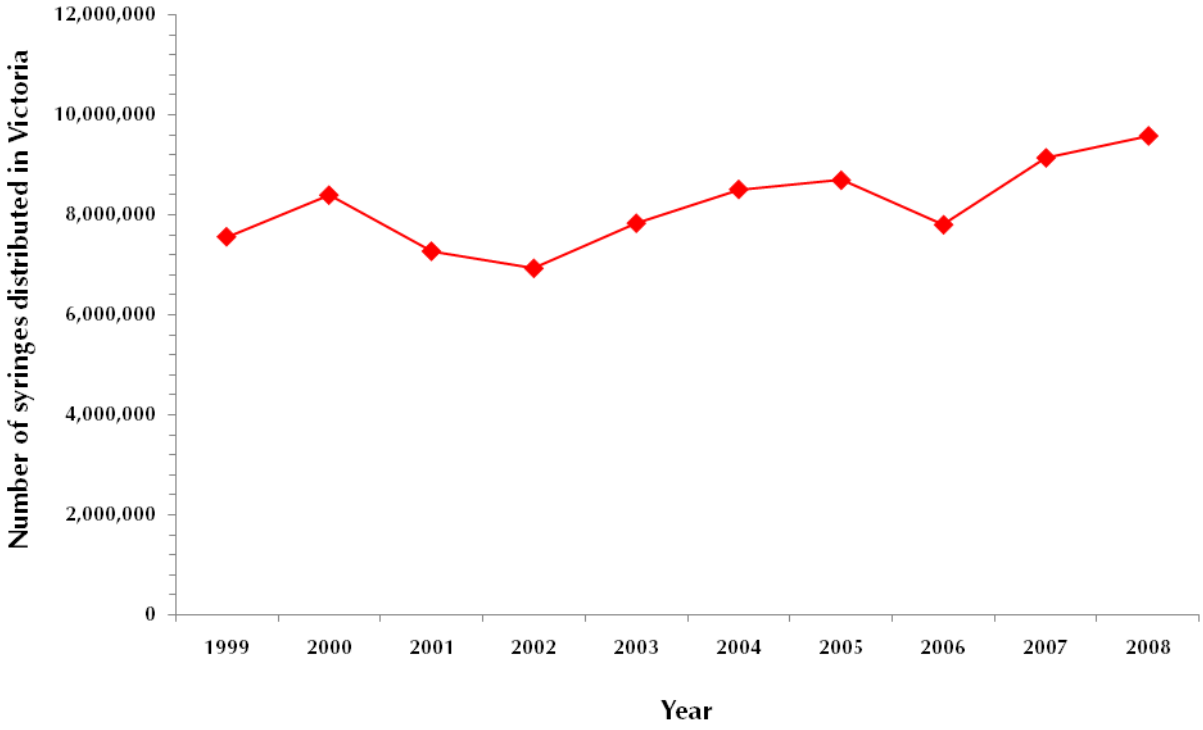
Epidemiological and economic evaluation of NSPs in Victoria

Overview

Needle and Syringe Programs commenced in Victoria with four pilot programs in 1987. In 1988, the program was expanded state-wide. Of the 285 registered programs in Victoria, 19 are primary outlets, including 12 mobile services that are fully funded through the program. Four programs are partially funded enhanced secondary outlets, 43 are pharmacy based and the remaining 219 are secondary outlets. Of the total 285, 194 were supplied with injecting equipment for distribution to clients in 2008. All NSPs provide disposal facilities. More than 900 pharmacies sell injecting equipment on a retail basis.

Number of NSPs:	194 (plus 902 retail community pharmacies)
Syringes distributed 1999-2008:	81,659,050
Average syringes per year:	8,165,050
Total spending 2007/8:	$8,248,694

Figure 54: Number of needles and syringes distributed in Victoria (1999-2008)



The proportion of Australian IDUs in Victoria has remained relatively steady. The number of needles and syringes distributed through NSPs in Victoria has increased substantially. There is no clear trend in the average frequency of injecting by IDUs in Victoria; however, it appears that after a reduction in the injecting frequency at the beginning of the decade, there has since been a modestly increasing trend. Sharing rates have been increasing slightly in Victoria. The prevalence of HCV among Victorian IDUs has been steadily increasing over the last decade. HIV incidence is steady or slightly decreasing among Victorian IDUs.

In 2008 calendar year, 9,569,336 syringes were provided in Victoria: 45.8% though primary sites; 7.8% through enhanced secondary sites; 36.9% through unfunded secondary sites and 9.6% through retail community pharmacies.

Retail community pharmacists charge an average of $5.75 per five-pack out-of-pocket costs. Vending machines are not available. A Disposal Helpline has been established to advise community members on the safe disposal of inappropriately discarded injecting equipment and to coordinate retrieval by NSP or local government services where required. The number of NSP sites in Victoria is listed in Table 32. Table 33 reports the spending by financial year in 2008 dollars, unadjusted and adjusted for the consumer price index (CPI).

Table 32: Number of NSP sites in Victoria

	Primary	Enhanced Secondary	Secondary	Pharmacy NSP
2008	19	4	141	30
2007	19	4	140	13
2006	19	4	134	10
2005	19	4	139	11
2004	19	4	132	8
2003	18	5	122	9
2002	18	5	115	9
2001	18	5	111	9
2000	17	6	108	9

Table 33: Summary of expenditure on NSPs in Victoria (2000/1-2007/8)

	2000/1	2001/2	2002/3	2003/4	2004/5	2005/6	2006/7	2007/8
Consumables ($'000)								
Sterile injecting equipment	1,096	880	897	1,158	1,190	1,084	1,171	1,448
Disposal equipment	186	194	175	244	292	220	272	424
Safe sex packs	15	52	70	69	52	63	76	71
sub-total	1,297	1,126	1,142	1,470	1,535	1,368	1,519	1,943
NSP SUPPORT ($'000)								
Primary NSPs Operations	3,105	3,713	3,475	4,323	4,551	4,028	5,274	5,566
Support for Secondary NSPs	233	173	182	186	363	321	330	365
Transport	68	59	58	64	70	78	71	82
Vending machines	0	0	0	0	0	0	0	0
sub-total	3,405	3,945	3,715	4,574	4,984	4,427	5,675	6,013
TOTAL ($'000) (unadjusted for CPI)	4,702	5,071	4,857	6,045	6,519	5,795	7,195	7,956
TOTAL in 2008 ($'000) (CPI adjusted)	5,945	6,217	5,780	7,027	7,386	6,387	7,681	8,249

A detailed breakdown of the data from Victoria is presented in Table 34; it should be acknowledged that a number of line items may not directly contribute to averting just blood borne virus transmission, but the sector's costs are included. All data were included in the summary in Table 33.

Table 34: Detailed summary of expenditure on NSPs in Victoria (2000/1-2007/8)

	2000/1 ($'000)	2001/2 ($'000)	2002/3 ($'000)	2003/4 ($'000)	2004/5 ($'000)	2005/6 ($'000)	2006/7 ($'000)	2007/8 ($'000)
Needles and syringes	798	620	643	789	878	779	874	1019
Sharps disposal containers	186	194	175	244	292	220	272	424
Alcohol swabs	121	105	104	149	116	124	110	173
Bags and boxes	15	13	14	22	8	14	15	15
Store, distribution and needle-kit assembly	94	83	78	134	119	90	100	159
Condoms and lube	15	52	70	69	52	63	76	71
Postage	68	59	58	65	70	78	71	82
CONSUMABLES	**1,297**	**1,126**	**1,142**	**1,470**	**1,535**	**1,368**	**1,519**	**1,943**
NSP agency funding (base)	2,627	2,768	2,908	3,045	3,365	3,459	3,627	4,090
Steroid peer education program	62	62	65	66	68	69	71	73
NSP agency funding (non-base)	160	-	42	574	144	4	150	544
REGIONAL SERVICE AGREEMENT	**2,849**	**2,830**	**3,016**	**3,685**	**3,577**	**3,532**	**3,848**	**4,708**
NSP sector advocacy	145	102	207	260	256	221	368	238
Harm reduction conference	20	20	21	63	104	22	53	61
Sector training	14	257	1	-	402	110	561	390
NSP recruitment	-	-	-	-	-	21	22	-
Safe needle disposal strategy projects	-	251	-	-	-	-	107	-
Disposal helpline	-	96	61	62	77	65	67	69
Disposal services	76	82	77	88	118	120	127	102
Disposal bin enclosures	-	-	-	-	-	11	34	13
Data entry	18	36	26	22	24	14	10	7
Information resources	20	8	2	64	6	40	48	1
Research and evaluation	49	10	72	-	130	-	45	11
IT and audit	-	-	-	1	-	-	7	53
HPS salaries and oncosts (not including NSP- IS EFT or other corporate support)	212	239	223	319	278	258	363	342
Administration	3	13	10	10	12	12	17	18
SECTOR SUPPORT	**556**	**1,115**	**699**	**889**	**1,407**	**895**	**1,828**	**1,305**
TOTAL NSP EXPENDITURE	**4,702**	**5,071**	**4,857**	**6,045**	**6,519**	**5,795**	**7,195**	**7,956**

Evaluating current NSPs

The epidemiological transmission model for HIV and HCV was applied to Victoria. The model was used to evaluate current NSPs versus no program and to project likely epidemiological impacts of potential changes to the program. The model estimated the expected number of HIV and HCV cases in Victoria with and without NSP distribution of sterile injecting equipment (Figure 55). The estimated number of infections averted is presented in Figure 56. An estimated 5,516 (3,794-7,819, IQR) HIV infections and 18,878 (17,426-21,049, IQR) HCV infections were averted due to NSPs in Victoria.

Figure 55: Estimated HIV and HCV incidence in Victoria with and without NSPs

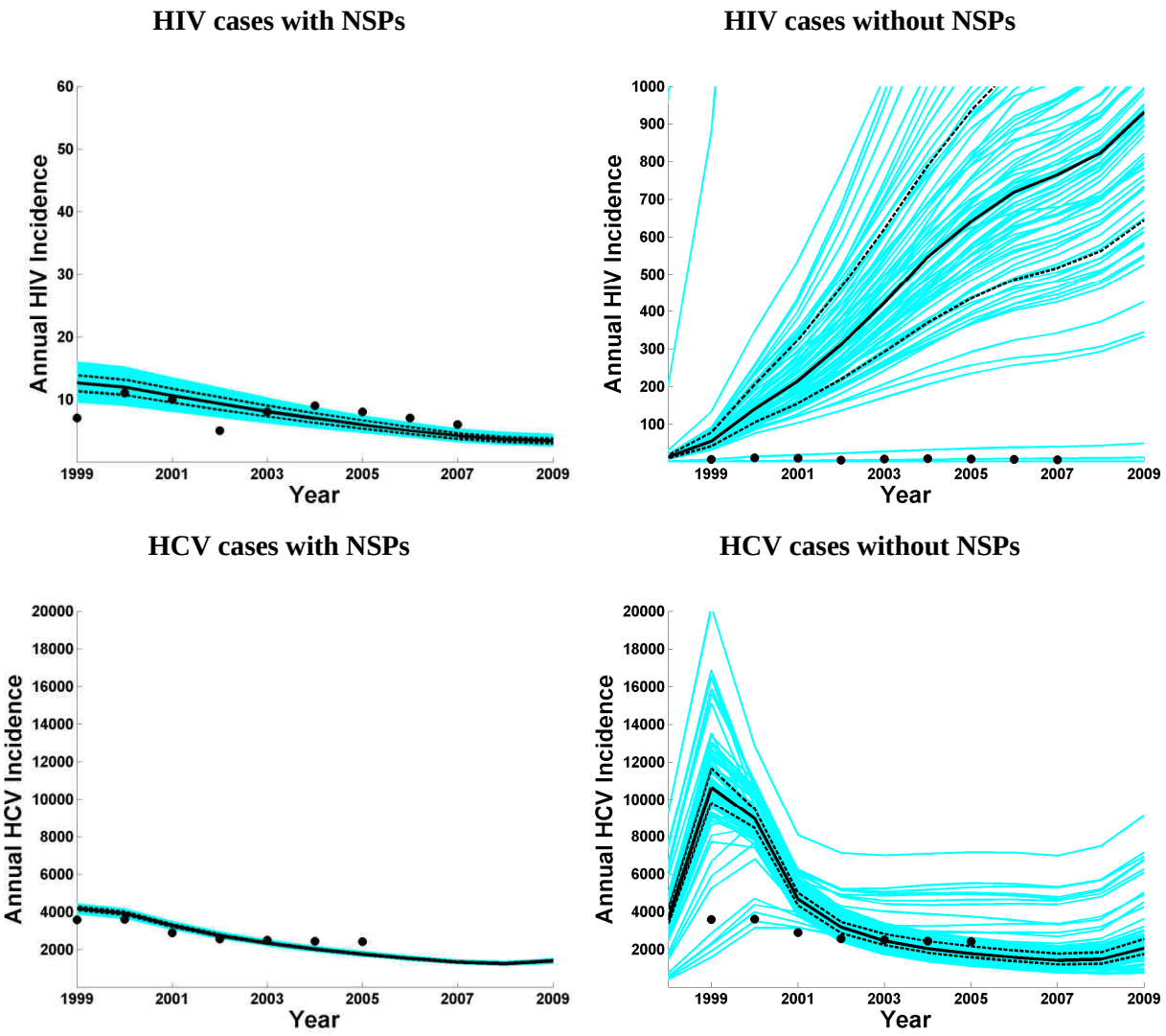
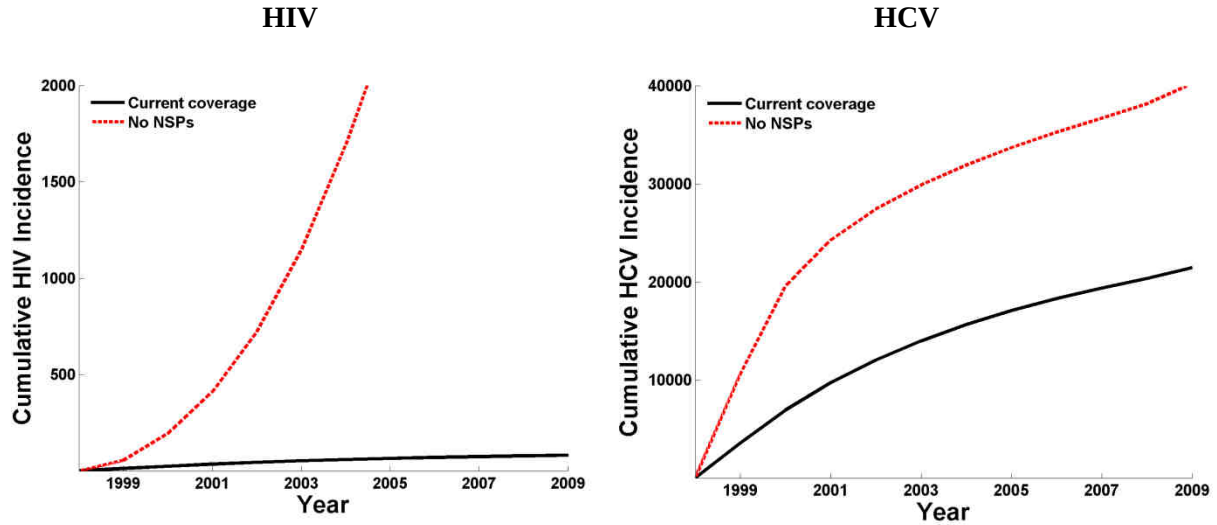


Figure 56: Estimated cumulative number of HIV and HCV cases averted in Victoria due to NSPs

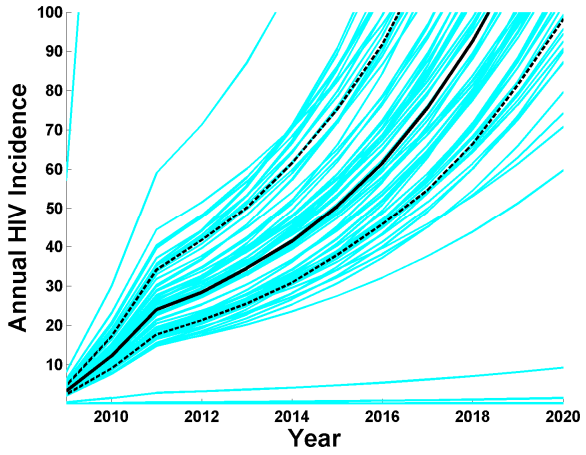


Epidemic projections in Victoria

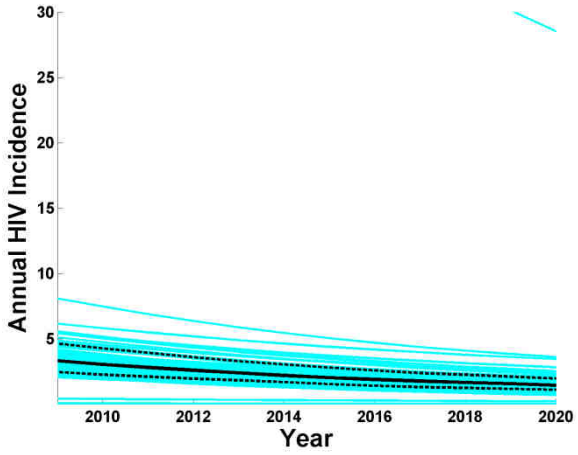
The Victorian model was used to calculate projections of the expected number of HIV and HCV cases in the future, according to scenarios whereby current syringe distribution levels are maintained or if there are increases or decreases in the provision of syringes through Victorian NSPs.

Figure 57: Projections of the expected number of HIV cases in Victoria according to different syringe distribution levels

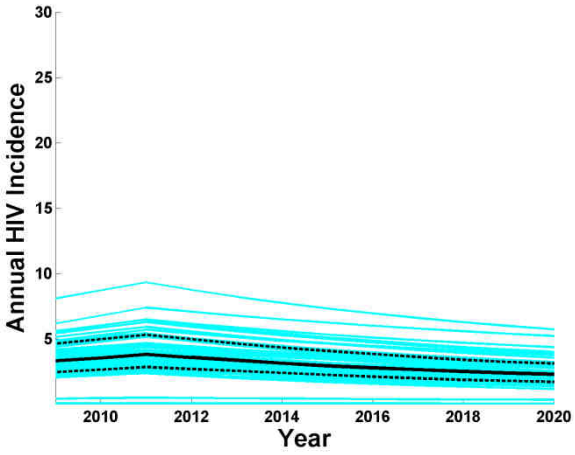
No NSPs



Current NSP distribution



NSP coverage decreases by 25%



NSP coverage increases by 25%

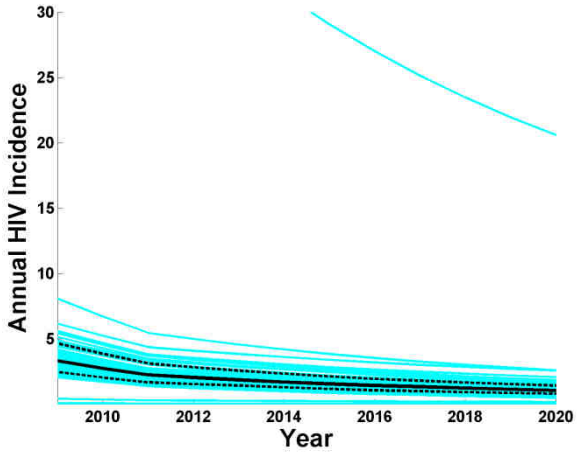
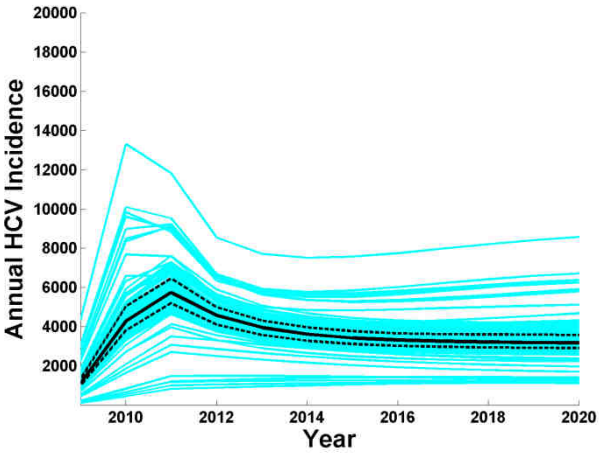
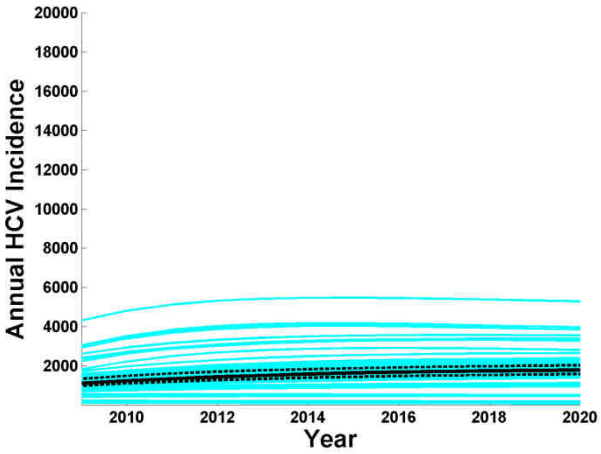


Figure 58: Projections of the expected number of HCV cases in Victoria according to different syringe distribution levels

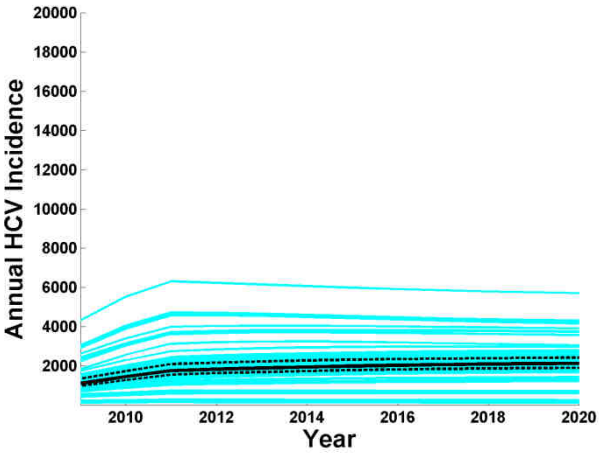
No NSPs



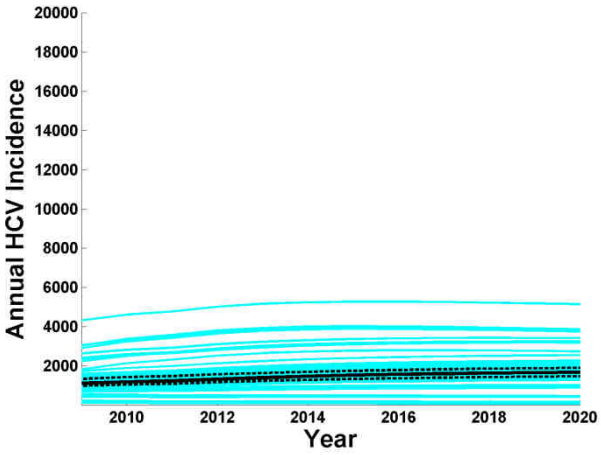
Current NSP distribution



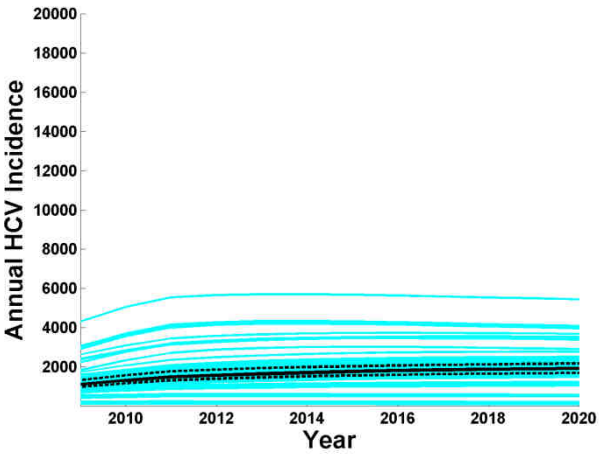
NSP coverage decreases by 25%



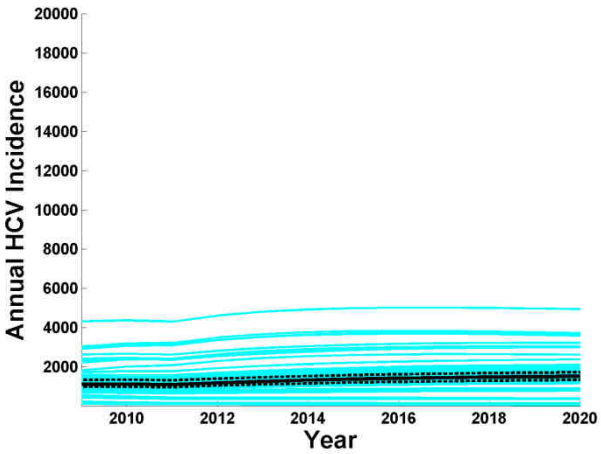
NSP coverage increases by 10%



NSP coverage decreases by 10%



NSP coverage increases by 25%



Economic evaluation of NSPs in Victoria

NSP spending in Victoria of $71m has resulted in a saving of $224m in healthcare costs across the 10 years from 2000 to 2009, yielding net financial savings of $153m, as well as more than 33,000 Disability Adjusted Life Years saved. A summary of the return on investment of NSP funding in Victoria is shown in Table 35. The mathematical and economic modelling estimated that if NSPs are continued at the same level of funding in Victoria for the next ten years, $133m of net financial savings will accrue ($106m discounted at 3%) and for twenty years $354m ($237m discounted at 3%). The lifetime net present value of investment in NSPs that took account of all healthcare costs and savings (but not costs associated with productivity losses) would be $4.53bn ($1.31bn discounted at 3%).

Table 35: Return on Investment of NSP funding in Victoria (2000-2009)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Healthcare costs saved $m (IQR)	20 (18-24)	18 (16-21)	18 (16-22)	18 (16-23)	20 (17-24)	21 (18-26)	22 (19-28)	25 (21-31)	29 (24-36)	33 (27-41)
NSP funding $m (median)	6	6	6	7	7	6	8	8	8	8
Net cost savings $m (median)	14	12	12	11	12	14	15	17	21	24
DALY gain (median)	2,574	2,835	2,961	3,039	3,135	3,284	3,512	3,750	4,079	4,557

Please note that any inconsistencies between the figures presented in the above text and table are due to rounding. Additionally, the results for each jurisdiction are provided to assist in assessment of local return on investment. The small numbers in some jurisdictions may distort parameter uncertainties and should not be used to compare one jurisdiction with another.

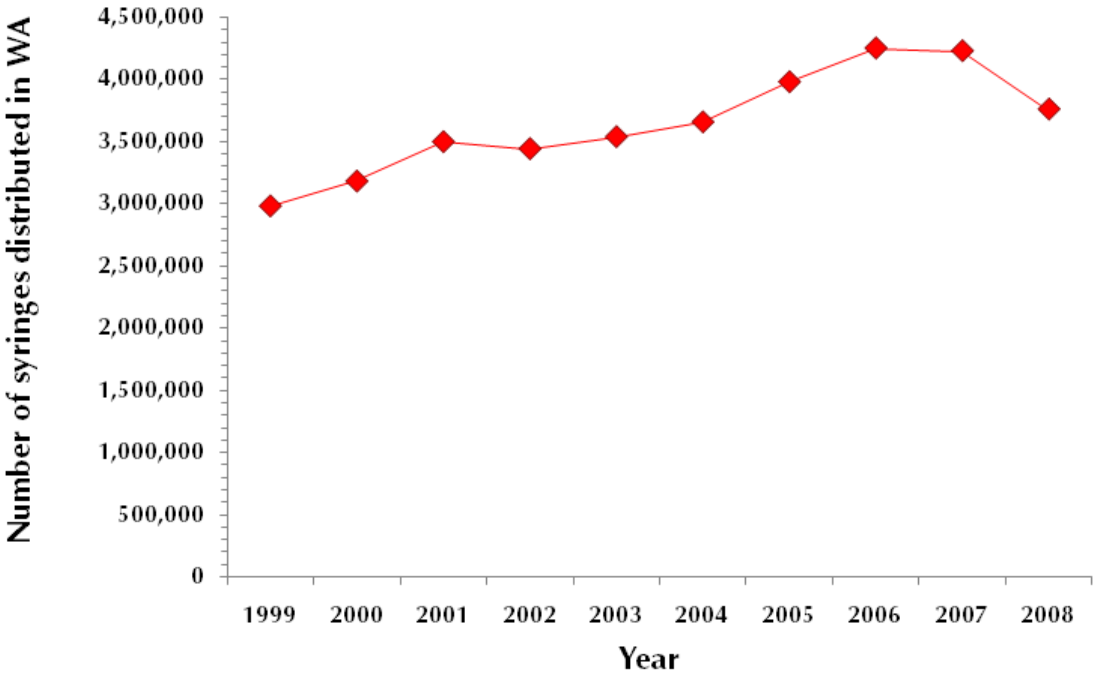
Epidemiological and economic evaluation of NSPs in Western Australia

Overview

Needle and Syringe Programs commenced in Western Australia in 1987. The Poisons Amendment Act was introduced in 1994 to allow for the legal provision of needles and syringes by approved programs. Currently, Western Australia has three primary NSP outlets, 99 secondary outlets, one enhanced secondary outlet, and five vending machines. Over the past decade in Western Australia, an increased proportion of needles and syringes have been provided through primary NSPs, while pharmacy provision has correspondingly decreased.

Number of NSPs:	108
Syringes distributed 1999-2008:	36,555,281
Average syringes per year:	3,655,528
Total spending 2007/8:	$1,415,117

Figure 59: Number of needles and syringes distributed in Western Australia (1999-2008)



The proportion of Australian IDUs in Western Australia has been steady to slightly increasing over the last decade. The number of needles and syringes distributed in Western Australia has been increasing. There is a clearly increasing trend in the frequency of injecting in Western Australia but the rate of sharing has been slowly decreasing. The prevalence of HCV among IDUs in WA has been relatively steady. HIV infections are low among Western Australian IDUs.

In 2006/7, 4,039,070 sterile injection equipment units were provided in Western Australia: 9.3% of injecting equipment units distributed in Western Australia were distributed through other outlets (e.g. hospitals, public health units, community health centres, nursing posts and other health related agencies) that could be considered secondary sites. One enhanced secondary site distributed 18,330 needles and syringes in 2007/2008. Western Australia has only had one vending machine operating for most of the past seven years. In late 2007, a further two vending machines were installed, and a further two in 2008. From 2001 to 2005 the vending machine distributed an average of approximately 4,000 packs (i.e. 20,000 needles and syringes) per year, which is <0.5% of needles and syringes distributed in Western Australia. All vending machines in Western Australia are located at regional hospital sites so filling of machines is undertaken by staff at these sites as part of their duties.

A major shift has been seen over the past decade in the proportion of needles and syringes distributed through pharmacies and NSPs. Up until about 2001 pharmacies accounted for two-thirds of needles and syringes distributed in Western Australia; now they only account for about one-third, with NSPs now accounting for over half of the needles and syringes distributed. Pharmacists may choose to sell pre-packaged needle and syringe products in the range of $5 to $8. Pharmacy NSPs operate on a commercial retail basis in Western Australia and are not subsidised by the Department of Health.

The number of NSP sites in Western Australia is listed in Table 36. Table 37 reports the spending by financial year in 2008 dollars, unadjusted and adjusted for the consumer price index (CPI).

Table 36: Number of NSP sites in Western Australia

	Primary	Secondary	Enhanced secondary	Vending machine sites
2008	3	99	1	5
2007	3	105	1	3
2006	3	100	1	1
2005	3	100	1	1
2004	3	100	1	1
2003	3	100	1	1
2002	3	100	1	1
2001	3	100	1	1
2000	2	80	0	0

Table 37: Summary of expenditure on NSPs in Western Australia (2000/1-2007/8)

	2000/1	2001/2	2002/3	2003/4	2004/5	2005/6	2006/7	2007/8
Consumables ($'000)								
Sterile injecting equipment	275	290	313	444	451	437	603	603
Disposal equipment	28	44	43	50	65	71	52	52
Safe sex packs	0	0	0	0	0	0	4	4
sub-total	302	333	356	495	517	508	658	658
NSP SUPPORT ($'000)								
Primary NSPs operations	483	545	508	637	709	655	653	641
Support for secondary NSPs	0	7	9	10	10	10	10	10
Transport	0	0	0	0	0	0	0	0
Vending machines	10	0	0	0	0	0	55	55
sub-total	493	552	517	647	719	665	718	706
TOTAL ($'000) (unadjusted for CPI)	795	885	873	1,142	1,235	1,173	1,376	1,365
TOTAL in 2008 ($'000) (CPI adjusted)	1,005	1,086	1,039	1,328	1,400	1,293	1,469	1,415

Notes provided: Data was unavailable for 2007/8 so was extrapolated from 2006/7

Transport – transport costs for equipment items to primary NSPs are generally met as part of equipment costs. As the Department of Health WA has moved to a new centralised purchasing system for supply of equipment to primary NSPs in 2008/2009, it is evident that one of the suppliers itemises freight costs separately on invoices, but prior to this transport costs cannot be determined. For secondary NSPs (hospitals etc), the Sexual Health and Blood-borne Virus Program provides Fitsticks® at no costs to the service; however, the service meets the cost of couriering the goods.

These cost figures include all equipment (needles, syringes, swabs, disposal containers etc) distributed through primary needle and syringe exchange programs (NSPs). As some items are cost recovered through NSPs, this income has been deducted from the total cost figure. Also included in this costing is the cost of all prepacked products (Fitpacks®, Fitsticks ®) provided for distribution through secondary needle and syringe programs (NSPs) such as hospitals, public health units, community health centres, nursing posts etc.

The cost figures for 'Spending on disposal equipment' are mainly the costs incurred by the primary NSPs for used needle and syringe waste disposal costs. In 2000/2001 and 20001/2002, a small amount of funding ($6,090 and $12,000 respectively) was spent on purchase of needle and syringe bins for installation in public settings, these bins were mainly provided to Local Government Authorities. These costs are included in the above figures.

Includes funding for COAG NSP projects, but does not include funding for Department of Health and Ageing Hepatitis C Education and Prevention or National Illicit Drug Strategy (NIDS) funded projects.

Other items that could be considered include: Cost to State/Territory health departments for administering programs e.g. staffing costs.

Costs involved in resource production e.g. in 2006/2007 in WA $11,320 was spent on the production on labels for Fitpacks® and Fitsticks®. There are also other resources that are produced but in total are probably not a major budget item.

There is also a range of NSP workforce development projects that are not included.

Evaluating current NSPs

The epidemiological transmission model for HIV and HCV was applied to IDUs and NSPs specifically in Western Australia. The model was used to evaluate current NSPs versus no program and to project likely epidemiological impacts of potential changes to the program. The model estimated the expected number of HIV and HCV cases in Western Australia with and without NSP distribution of sterile injecting equipment (Figure 60). The estimated number of infections averted is presented in Figure 61. An estimated 895 (564-1522, IQR) HIV infections and 12,625 (12,255-12,929, IQR) HCV infections were averted due to NSPs in Western Australia.

Figure 60: Estimated HIV and HCV incidence in Western Australia with and without NSPs

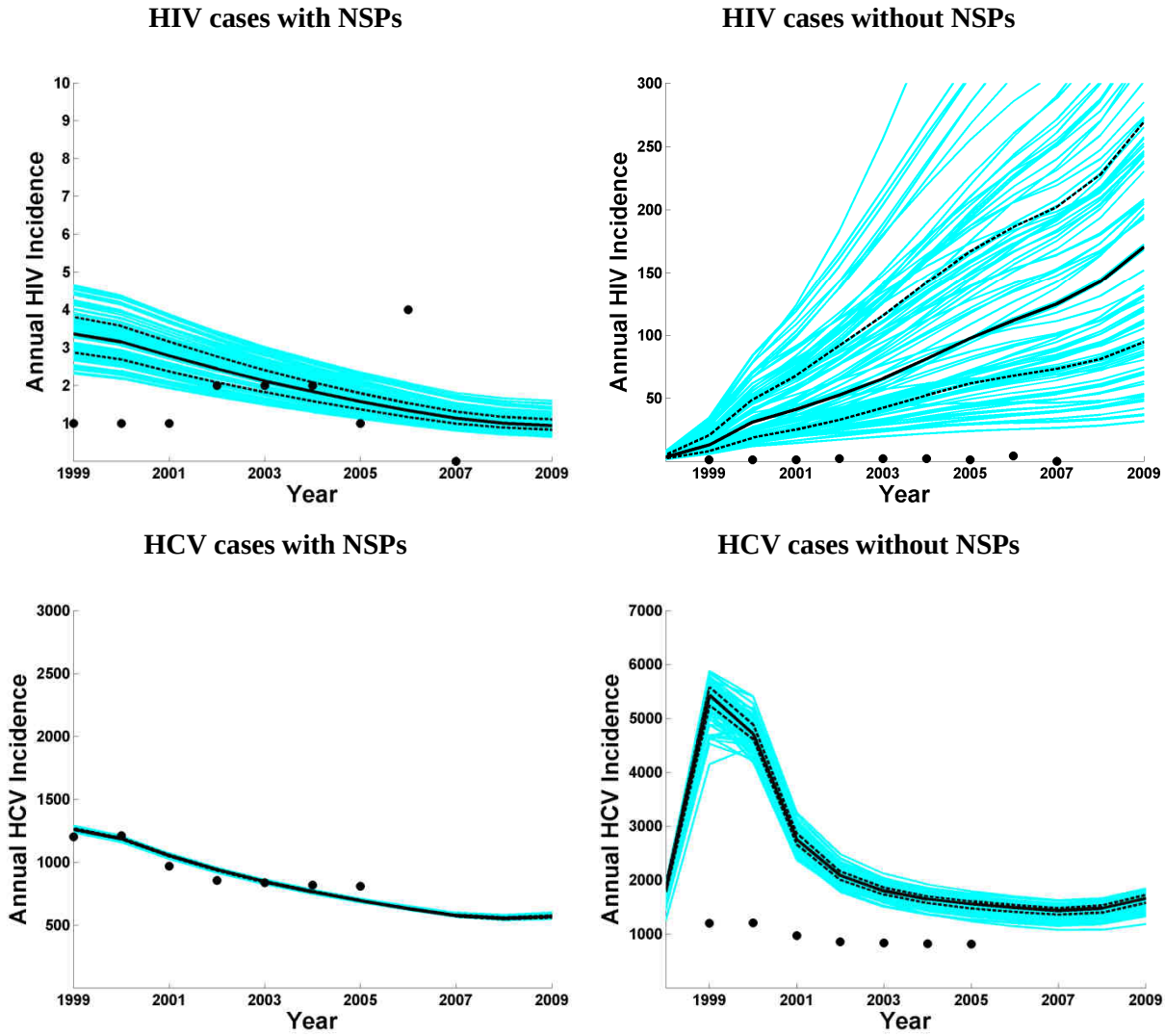
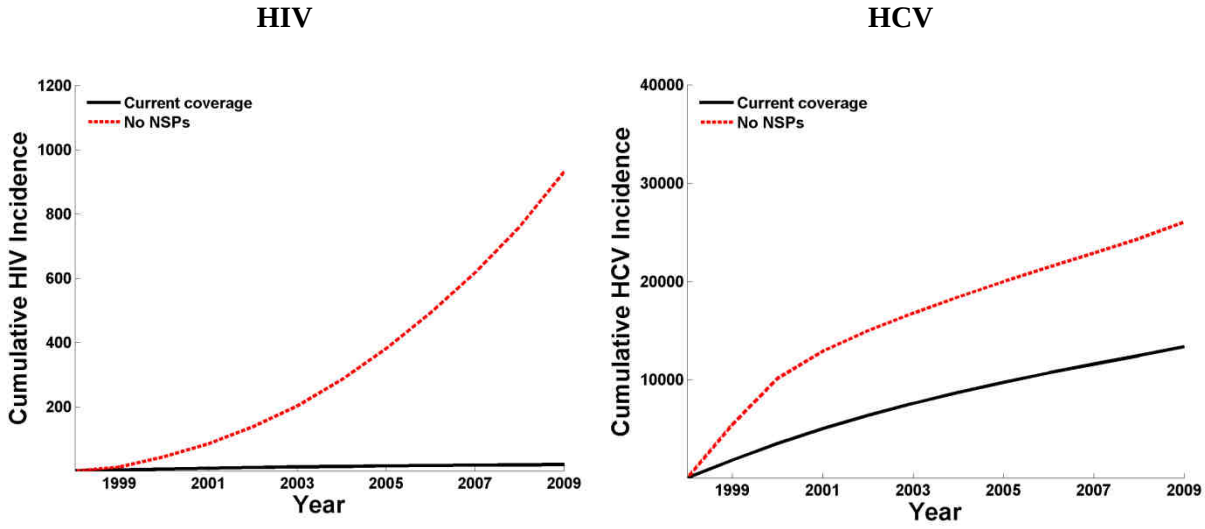


Figure 61: Estimated cumulative number of HIV and HCV cases averted in Western Australia due to NSPs

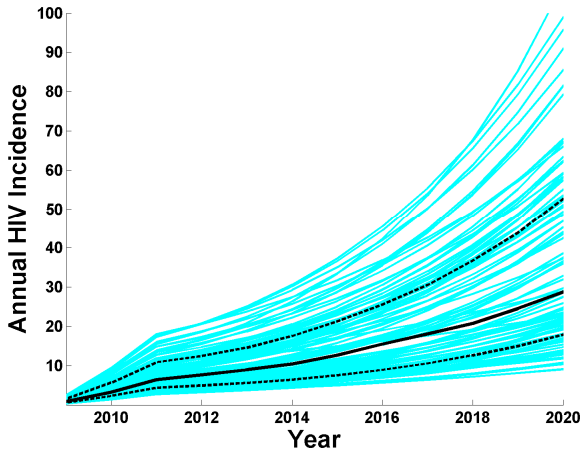


Epidemic projections in Western Australia

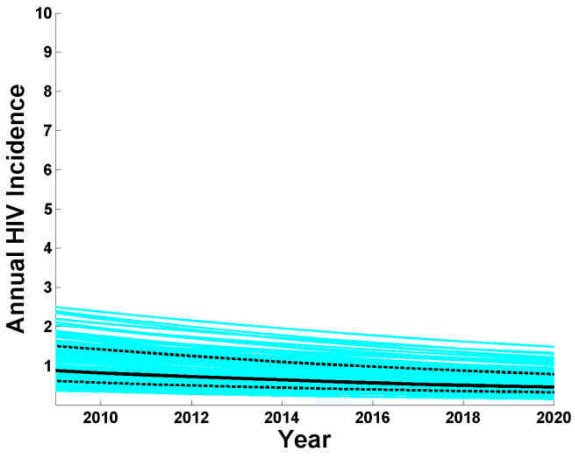
The Western Australian model was used to calculate projections of the expected number of HIV and HCV cases in the future, according to scenarios whereby current syringe distribution levels are maintained or if there are increases or decreases in the provision of syringes through Western Australian NSPs.

Figure 62: Projections of the expected number of HIV cases in Western Australia according to different syringe distribution levels

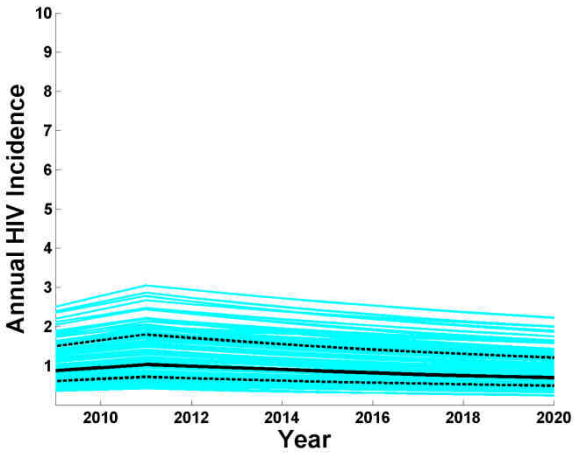
No NSPs



Current NSP distribution



NSP coverage decreases by 25%



NSP coverage increases by 25%

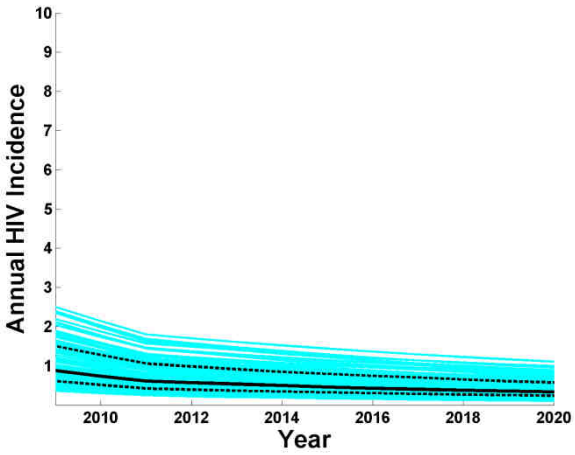
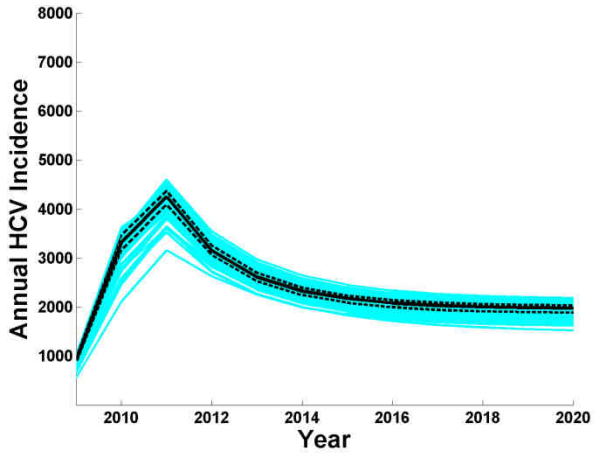
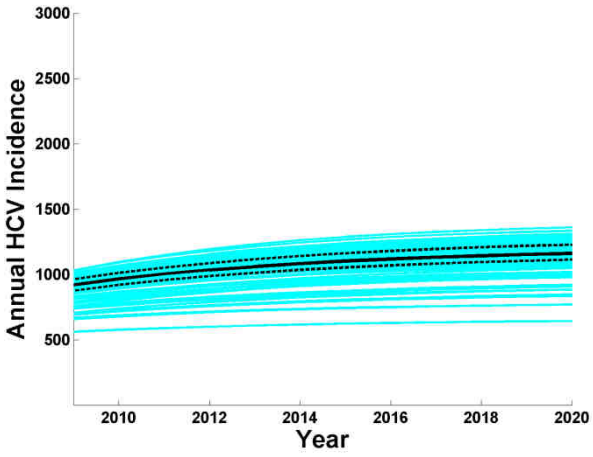


Figure 63: Projections of the expected number of HCV cases in Western Australia according to different syringe distribution levels

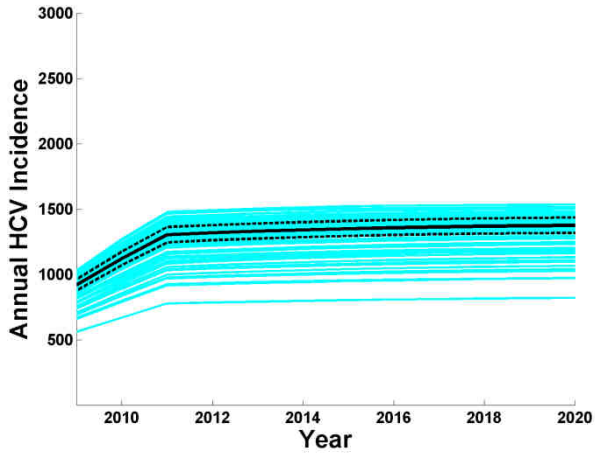
No NSPs



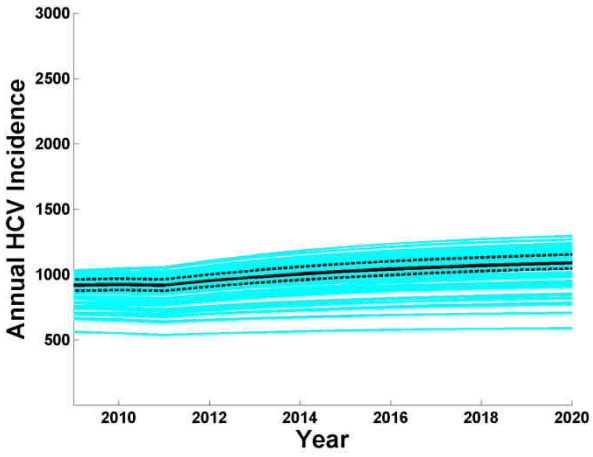
Current NSP distribution



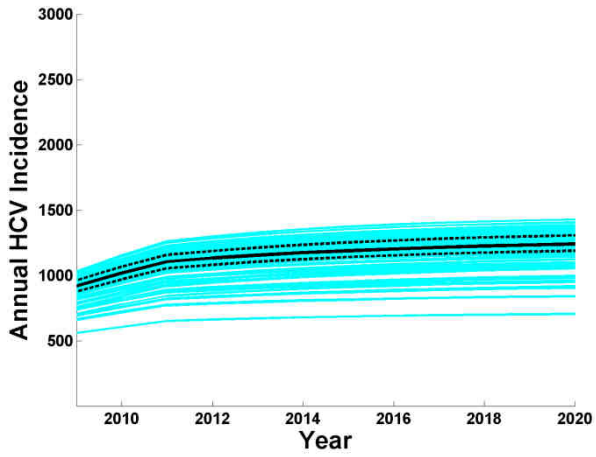
NSP coverage decreases by 25%



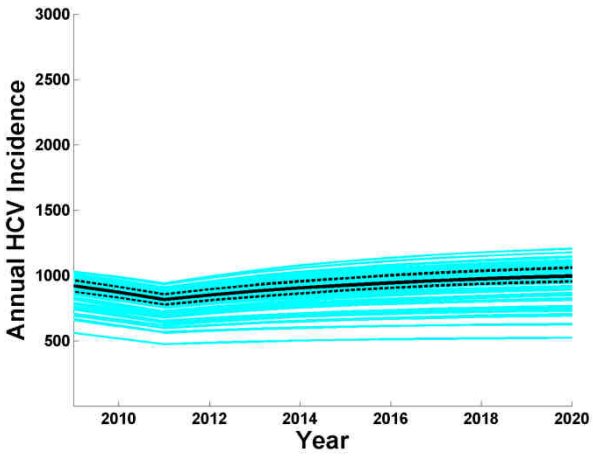
NSP coverage increases by 10%



NSP coverage decreases by 10%



NSP coverage increases by 25%



Economic evaluation of NSPs in Western Australia

The spending of $12.9m in the funding of NSPs in Western Australia from year 2000-2009 has resulted in a saving of $124m in healthcare costs, with more than 19,000 Disability Adjusted Life Years saved with a net financial saving of $111m. A summary of the return on investment of NSP funding in Western Australia is shown in Table 38. The mathematical and economic modelling estimated that if NSPs are continued at the same level of funding in Western Australia for the next ten years, $520m of net financial savings will accrue ($456m discounted at 3%) and for twenty years $1,060m ($804m discounted at 3%). The lifetime net present value of investment in NSPs that took account of all healthcare costs and savings (but not costs associated with productivity losses) would be $5.63bn ($1.97bn discounted at 3%).

Table 38: Return on Investment of NSP funding in Western Australia (2000-2009)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Healthcare costs saved $m (IQR)	11 (10-12)	11 (10-12)	11 (10-13)	11 (10-13)	11 (11-13)	12 (11-14)	13 (12-15)	14 (12-16)	15 (13-18)	16 (14-20)
NSP funding $m (median)	1	1	1	1	1	1	1	1	1	1
Net cost savings $m (median)	10	10	10	10	10	11	11	12	13	15
DALY gain (median)	1,460	1,643	1,745	1,815	1,873	1,947	2,055	2,180	2,323	2,487

Please note that any inconsistencies between the figures presented in the above text and table are due to rounding. Additionally, the results for each jurisdiction are provided to assist in assessment of local return on investment. The small numbers in some jurisdictions may distort parameter uncertainties and should not be used to compare one jurisdiction with another.

Epidemiological and economic evaluation of NSPs for Aboriginal and Torres Strait Islanders

The proportion of NSP survey respondents that were Aboriginal and Torres Strait Islanders was used to estimate the number of needles and syringes distributed to this population. Other available data for this population subgroup were also used (see Appendix B).

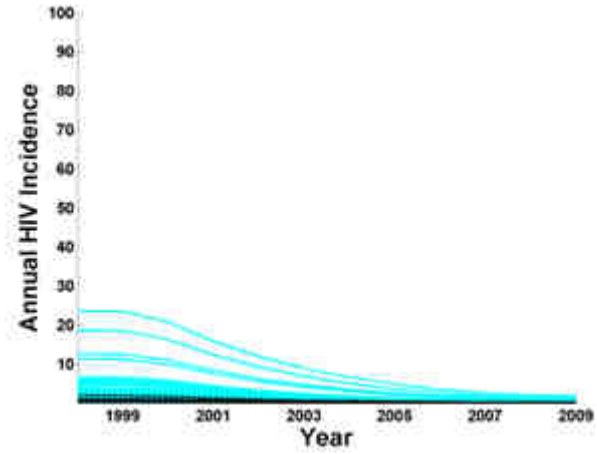
The number of IDUs who are Aboriginal and Torres Strait Islanders has been steadily increasing over the last decade. It is not precisely known how many needles and syringes are distributed through NSPs to this population group, but it is estimated that approximately 7.5-9% of all NSP clients are Aboriginal and Torres Strait Islander people. The average frequency of injecting among Aboriginal and Torres Strait Islander people who are IDUs has been decreasing over the last decade, as has the average rate of sharing. Despite this, the prevalence of HCV among Aboriginal and Torres Strait Islander IDUs is estimated to be steadily increasing (probably due to the increasing population). It is known that the rate of HIV in this population is low with less than 1% of HIV detected over NSP survey collection period 1995-2007.

Evaluating current NSPs

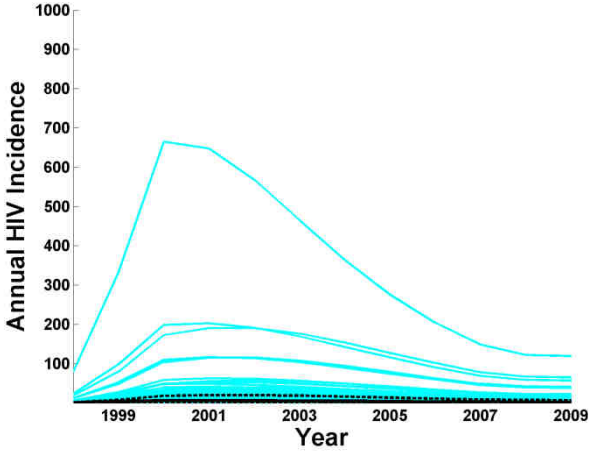
The epidemiological transmission model for HIV and HCV was applied to the population of Aboriginal and Torres Strait Islander IDUs. The model estimated the expected number of HIV and HCV cases among Aboriginal and Torres Strait Islanders with and without NSP distribution of sterile injecting equipment (Figure 64). The estimated number of infections averted is presented in Figure 65. An estimated 39 (0-140) HIV infections and 4,241 (4,057-4,841) HCV infections have been averted in Aboriginal and Torres Strait Islanders due to NSPs.

Figure 64: Estimated HIV and HCV incidence among Aboriginal and Torres Strait Islanders with and without NSPs

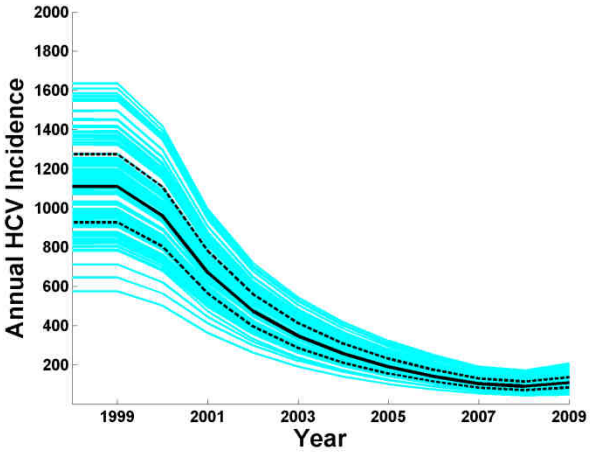
HIV cases with NSPs



HIV cases without NSPs



HCV cases with NSPs



HCV cases without NSPs

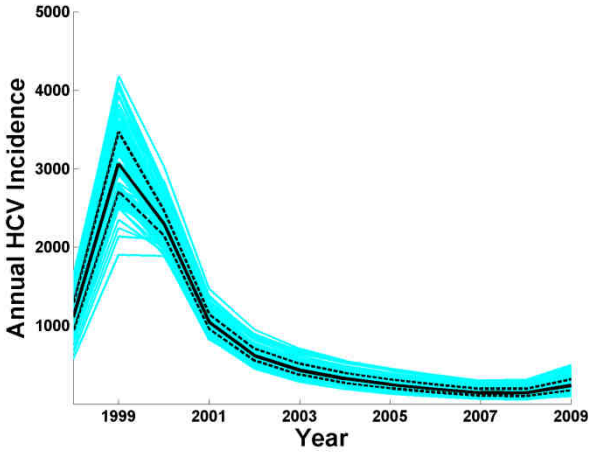
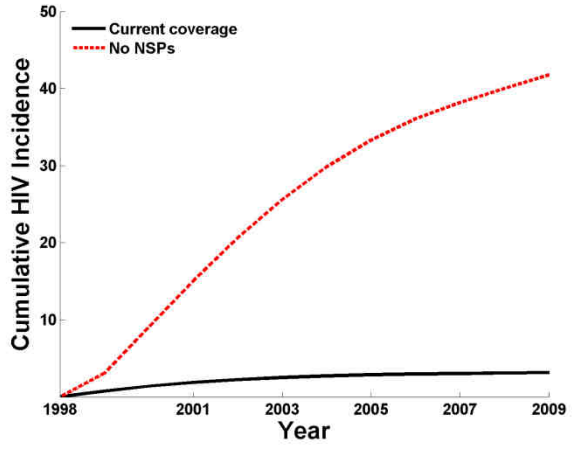
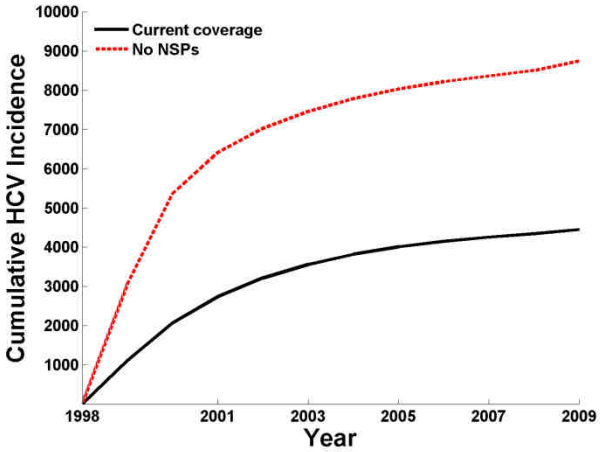


Figure 65: Estimated cumulative number of HIV and HCV cases averted among Aboriginal and Torres Strait Islanders due to NSPs

HIV



HCV

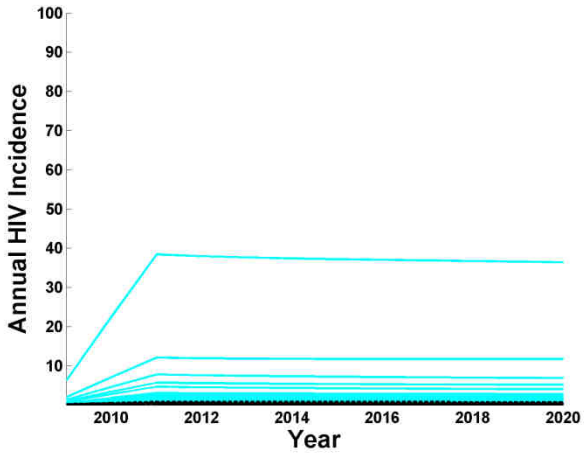


Epidemic projections in Aboriginal and Torres Strait Islanders

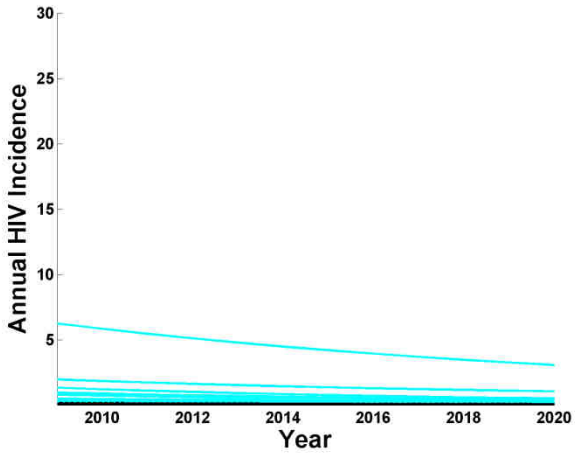
The Aboriginal and Torres Strait Islander model was used to calculate projections of the expected number of HIV and HCV cases in the future, according to scenarios whereby current syringe distribution levels are maintained or if there are increases or decreases in the provision of syringes to Aboriginal and Torres Strait Islander people through NSPs.

Figure 66: Projections of the expected number of HIV cases among Aboriginal and Torres Strait Islanders according to different syringe distribution levels

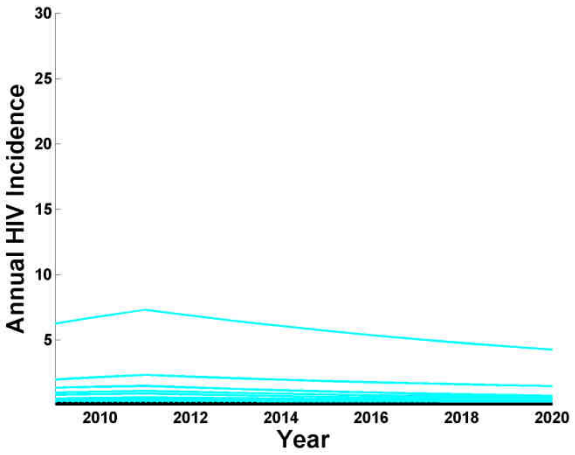
No NSPs



Current NSP distribution



NSP coverage decreases by 25%



NSP coverage increases by 25%

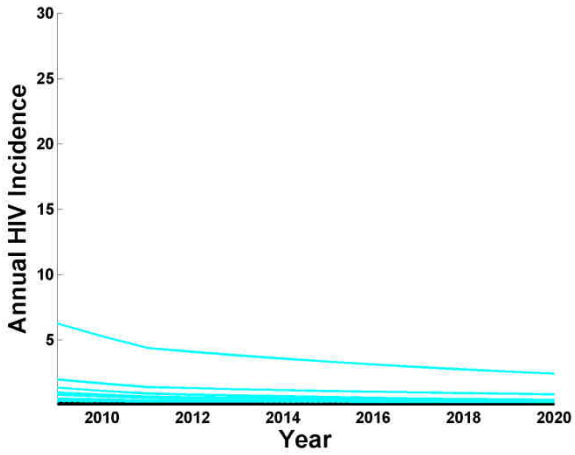
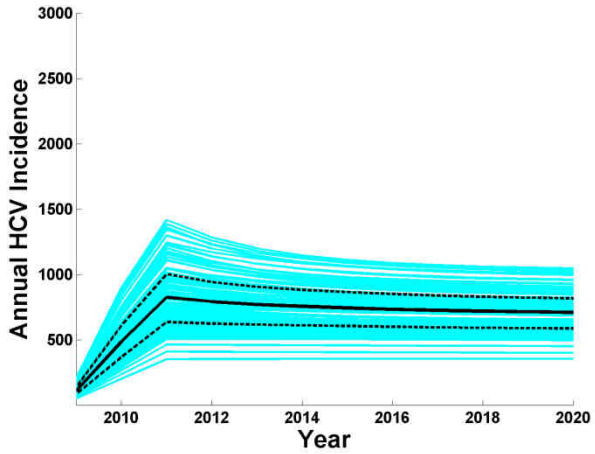
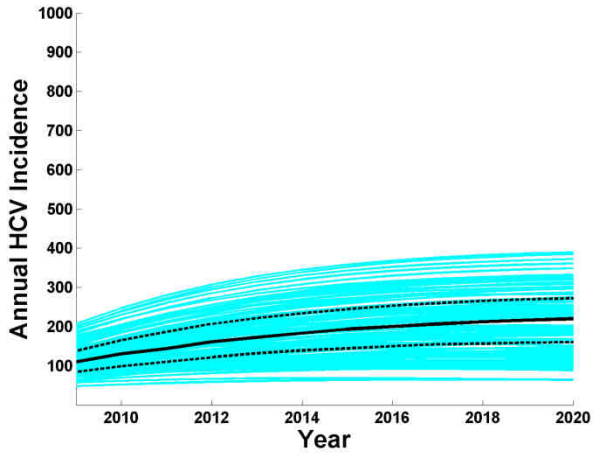


Figure 67: Projections of the expected number of HCV cases among Aboriginal and Torres Strait Islanders according to different syringe distribution levels

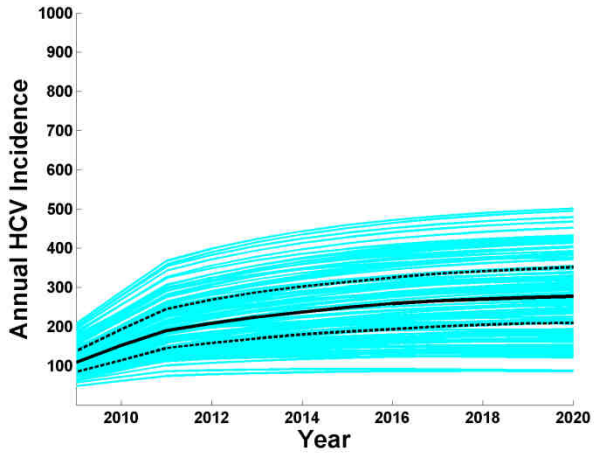
No NSPs



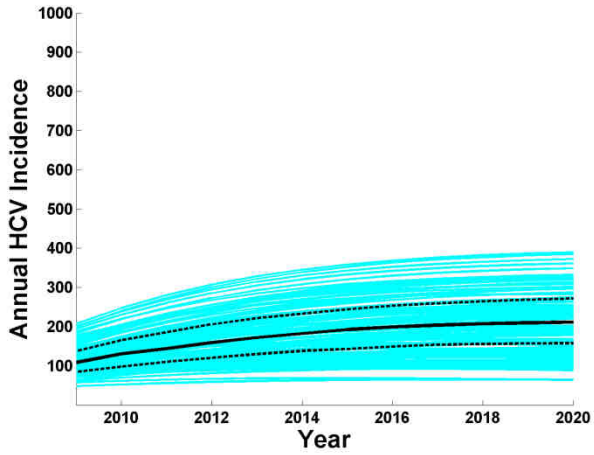
Current NSP distribution



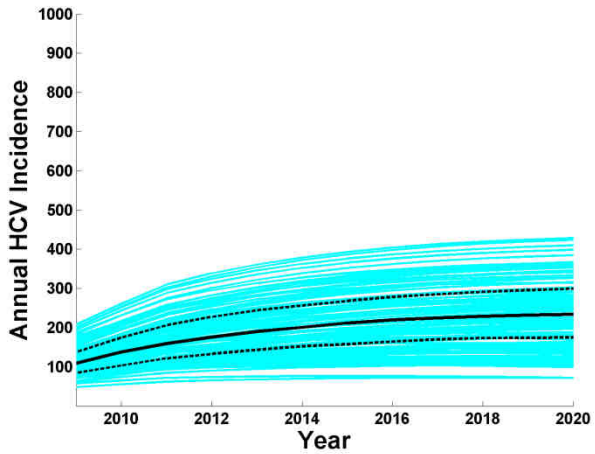
NSP coverage decreases by 25%



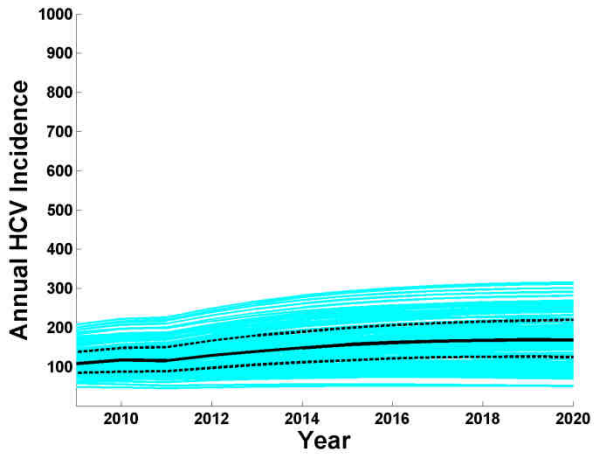
NSP coverage increases by 10%



NSP coverage decreases by 10%



NSP coverage increases by 25%



Discussion

The spending of $27 million per year (total $243m) in NSPs from 2000 to 2009 has resulted in net cost-savings of $1.28bn due to the prevention of HCV and HIV. During the same time period more than 140,000 DALYs would have been saved. Projections that continue the program to 2019 or 2029 suggest that continued substantial savings of costs and gains in years of life would occur for a similar level of funding of NSPs. The majority of savings relate to healthcare for HCV, although the program would still be cost-effective if only HIV disease was considered. Expansion of the program to 150% of the current level with additional spending of $13m per year would lead to further savings of $5.5m per year with evidence of a decreasing marginal return on further spending. Decreased funding from current levels would be associated with increases in HIV and HCV infections, with associated loss of health and life. The reduced return on investment would exceed any savings associated with reduced spending on NSPs.

The inclusion of patient and carer cost-offsets increases the net present value of current provision of NSPs to $2.48bn (for every one dollar invested $12 are returned in healthcare cost savings). If productivity gains associated with the prevention of HCV and HIV were included, $5.85bn of financial savings to society would have occurred from 2000 to 2009 (for every one dollar invested, $27 is returned in healthcare cost savings). If the costs of IRID prevented are included, NSPs could provide additional cost-savings of $20m per year. The costs of secondary HIV and HCV infections prevented would also add 30% more savings from HIV healthcare costs averted and 10% more savings related to HCV costs.

The economic analyses of the results of the epidemiological transmission model suggest that spending on NSPs has provided substantial healthcare cost savings to government related to the prevention of HCV and HIV in the past decade. These cost savings have been associated with substantial gains in quality and quantity of life in the population of NSPs clients. For every ten dollars spent on the activities of NSPs currently, nearly forty additional dollars will be returned and approximately two days of disability-adjusted life gained.

Projections into the future suggest that maintenance of current levels of NSPs funding will continue to provide substantial and increasing healthcare cost savings and gains in life years. Increases in the funding and provision of NSPs would avert additional HCV and HIV infections with further increased cost savings. However, the marginal return on investment would reduce as funding increased to 200%, due to saturation of the market.

The majority of the cost savings and gains in life years relate to the prevention of HCV because more people are prevented from acquiring HCV than HIV in the population at risk. However prevention of HIV alone by current levels of NSPs was cost-effective in the short-term and cost-saving in the long-term.

The previous Return on Investment report of NSP funding from 1991-2000 showed healthcare cost savings equivalent to $494m in year 2008 prices for the period of 1991-2000 [24], while our study reports higher levels of cost-savings: $1.03bn for an expenditure of $243m over the period 2000 to 2009. The previous study reported lifetime net present value of $4.62bn (discounted at 3%) whereas our study shows a net present value of $8.41bn (discounted 3%) over a lifetime. The two studies used different methods and took place at different times, so direct comparison of results should be taken with some caution: first, costs, complexity and duration of antiretroviral treatments have increased substantially in recent years as people stay alive longer on more potent, durable but expensive regimens. In our analysis, the cost of current ARV regimens is two to three times greater now than in the previous Return on Investment report. Similarly, our assumptions about the cost of HCV and HIV healthcare are considerably higher than the previous report, since we included more detailed activity-based costing including data from national databases on hospitalisation. The previous Return on Investment analysis used costs from a pre-antiretroviral era and adapted to current prices, so might have underestimated the complexity and duration of current disease, whereas the current study involved a thorough investigation and costing of activities and current treatments in Australia. The previous Return on Investment study considered patient healthcare costs in the primary analysis, whereas we omitted these in the primary analysis due to a lack of recent robust data. Second, differences in the methods used for modelling the population benefit of NSPs are likely to alter the effect of NSPs on reducing acquisition of HIV and HCV. In the first Return on Investment study, an ecological analysis of NSPs was conducted to estimate their likely benefit in Australia, whereas this study involved the development of a transmission mathematical model informed by Australian IDUs behavioural data and an attempt to describe the mechanisms of viral transmission and prevention due to the distribution of sterile injecting equipment. However, if the same assumptions and costs were to be applied to both methodologies similar outcome results would be expected. A summary of the major differences in methods between the two studies is shown in Table 39.

Table 39: Summary of differences between first and second Return on Investment reports

	ROI I	ROI II
Population model	Statistical back-projections coupled with ecological analysis of NSPs and disease progression model	Epidemic mathematical transmission model of infection and disease progression formulated as system of differential equations
Time horizon	1990-1999 1990-2075	2000-2009 2010-2019 2010-2029 2010-2059 2010-2079
Discounting primary analysis	5%	3%
Cost of ARVs for HIV	$4,000-$10,000	$14,000-$27,000
Primary analysis	Healthcare, government and patient	Healthcare, government

Comparing jurisdictions

It should be noted that each jurisdiction was modelled separately using local parameters and data and a national model was analysed separately. Location-specific behavioural, epidemiological and NSP funding data were utilised for each analysis. Since there are limitations in some data with respect to representativeness, potential for sampling biases, and uncertainty in some model assumptions an uncertainty analysis was carried out for each epidemiological model. This involved establishing relatively wide ranges of plausible values (confidence intervals) around available data for all input parameters for each jurisdiction, sampling 100 unique parameter combinations from these ranges for each model analysis, and then running the epidemiological model 100 times. Uncertainty in the input was translated to uncertainty in output, including the number of HIV and HCV infections expected with and without NSPs. Summary statistics of the range of outputs were analysed for each jurisdiction. Due to this process, the national model that used average input parameters based on cumulative sources of input data (with greater sample sizes) across jurisdictions provides a

more accurate estimate of the national epidemiological impact of NSPs and return on investment than summing the epidemiological impacts and financial returns from each jurisdiction. The latter approach would accumulate numerous output uncertainties to yield less precise estimates. Regardless, the sum of epidemiological and economic estimates over all jurisdictions was highly consistent with the average levels obtained from the national analysis.

Costs of NSP services for all jurisdictions were obtained through responses to a questionnaire given to all state and territory health departments. Data were elicited from jurisdictional contacts on budgets and costs associated with NSPs and their associated interventions. Although each jurisdiction received the same questionnaire, the level of detail of data provided varied markedly between jurisdictions. Some jurisdictions provided a basic summary of expenditure on NSP consumables and support, some provided additional costing data and specified detailed budgets of all direct state-sponsored expenditure in the sector, while others provided incomplete and limited data such that extrapolations had to be made. Certain supporting budgetary items, such as workforce development projects and transportation, were included in total costs of NSPs reported for some jurisdictions but not for others. Where possible, consistent and comparable budget items of NSP expenditure were used for all jurisdictions, but it must be acknowledged that recognition of the cost of services within jurisdictions varied between them because of different budgetary and administrative processes. These differences necessarily translated into the economic analyses performed in this study. The interpretation of results for each jurisdiction should be made in the context of the costs included and excluded in the analysis for the specific jurisdiction.

Therefore, the comparison of cost-savings between different jurisdictions is subject to these model and cost-related variations. These variations may be accentuated in the longer time horizons, especially for the larger jurisdictions, due to wide parameter and model uncertainties. The results for each jurisdiction are provided to assist in assessment of local return on investment and should not be used to compare one jurisdiction with another. Despite this cautionary note it is anticipated that some may be inclined to compare results between jurisdictions. In doing so, it is not appropriate to scrutinize relatively modest quantitative differences between jurisdictions. However, some broad conclusions can be made in comparing jurisdictional results. Firstly, NSPs were found to be cost-saving over 2000-2009 in seven of eight jurisdictions and very cost-effective in the other jurisdiction. Over the longer term, NSPs are highly cost-saving in all jurisdictions. For all analyses, the majority of the cost savings were found to be associated with HCV-related outcomes but

when only HIV-related outcomes were considered the investment was still highly cost-effective or cost-saving.

As expected, the estimated number of HIV and HCV infections averted and healthcare costs saved were greatest in the largest jurisdictions and the degree of epidemiological and economic savings was associated with the size of the jurisdiction. Compared with other jurisdictions, New South Wales has a greater estimated number of IDUs, a greater financial investment has been made over the last 10 years, and this has resulted in the largest financial return. This is followed by Queensland and Victoria. Other states and territories had similar *relative* returns on investment to the larger jurisdictions, but the absolute magnitudes of epidemiological impacts of NSPs and financial savings are scaled lower approximately in proportion to the IDU population size and magnitude of investment. There was roughly the same ratio of number of distributed needles and syringes to estimated IDU population size across all jurisdictions, at ~200 needles/syringes per IDU (Table 6); but it was slightly lower in New South Wales (157.6) and slightly higher in Victoria (236.0). Similarly, the expenditure per IDU was similar across jurisdictions (at approximately $120 per IDU) but was lower in Queensland (at approximately $69 per IDU).

Comparison of results between Queensland and Victoria may appear paradoxical in contrast to comparisons between other jurisdictions. It is important to reiterate that differences in the degree of certainty in epidemiological input data for these states along with differences in the expenditures associated with NSPs that were reported by the health authorities of Queensland and Victoria means that direct and detailed comparisons are not appropriate. In broad terms, Queensland and Victoria have similar population sizes of IDUs and the average number of shared injections per IDU is similar in both jurisdictions, although average injecting frequency is slightly higher for Victorian IDUs. But the baseline epidemiology differs between the states. HIV prevalence is relatively low among IDUs in all jurisdictions. Although the National HIV Registry would be the ideal source for determining the extent of HIV infections in each jurisdiction it is blurred by the fact that male homosexual and injecting exposure are combined and the registry records diagnoses and not prevalence. The NSP surveys [54] provide direct and periodic cross-sectional HIV prevalence estimates and were used in this study. These estimates suggest that HIV prevalence is higher among Queensland IDUs than among Victorian IDUs which may not be true. However, this had little impact on the economic analysis of this study as the majority of the total cost-savings were found to be associated with HCV-related outcomes and not HIV-related outcomes. The prevalence of HCV among IDUs, based on the NSP surveys [54], increased significantly over

the last 10 years in both jurisdictions and was at a substantially greater level in Victoria (increasing from ~60% to ~70%) than in Queensland (increasing from ~40% to ~60%). There was an increasing prevalence of HCV in both jurisdictions despite the presence of NSPs during this period and there was a greater prevalence in Victoria despite greater per-capita distribution of needles and syringes in Victoria. The current analysis suggests that if NSPs were not in place then (~30%) more HCV infections would have been averted in Queensland than in Victoria, and ~15% more DALYs saved. This is because there are a greater number of susceptible IDUs in Queensland with the potential to become infected with hepatitis C. The infection levels in Victoria would saturate sooner than in Queensland if NSPs were absent due to the underlying epidemiology. Thus, it is important to note that the relative benefits of NSPs depend on the unique epidemiology in each setting. Further, Victoria distributed approximately 45% more needles and syringes than Queensland but overall reported expenditure for NSPs in Victoria was approximately 77% greater than expenditure for NSPs in Queensland. Victoria incorporated greater costs in the reported financial investment in NSPs. This effectively increased the total average cost per needle/syringe distributed. Because of the differences in reported expenditure direct comparisons of return on investment between jurisdictions should not be carried out. In both Queensland and Victoria, similar to other jurisdictions, very large epidemiological benefits and financial savings can be attributed directly to NSPs. Investment in NSPs in both Queensland and Victoria were highly cost-saving over the past 10 years and are expected to continue to be very cost-saving into the future.

Limitations

There are several limitations to this modelling approach. While assumptions of this analysis were based on the best available data, these data are based on non-random samples or case notifications. Different prospective observational studies, using different methods and sampling techniques, were explored where possible to obtain robust assumptions. Furthermore, wide-ranging uncertainty analyses (defining ranges of uncertainty around key assumptions) were performed to provide a sense of the robustness of results. The sample sizes for variables in some jurisdictions are small, such that trends in data over time were difficult to ascertain. There is a lack of data for some factors, such as rates of HIV treatment among active IDUs. However, the model was calibrated to current levels of HIV transmission, and so the results are broadly applicable as long as current rates of HIV treatment in active IDUs remain stable.

All models are abstract simplifications of reality and do not incorporate much of the large heterogeneity that exists between people. This mathematical transmission model was a population-based system of ordinary differential equations. An agent-based computer micro-simulation model would be required to capture networks of IDUs and to incorporate greater variation in behaviour between individuals. However, the model used in this analysis is a significant advancement over previous models of HIV and HCV epidemics among IDUs in Australia (or overseas) and over the methodology used in the previous return on investment analysis [24]. As with all models, assumptions should be reviewed critically, and results interpreted cautiously.

Our economic analyses also have a number of limitations. First, we assumed that individuals in each health state of HIV or HCV had homogenous use of healthcare and medications. If the economic model had been incorporated into the population model, we could have sampled stochastically to generate uncertainty boundaries around our cost estimates. However, our method did not allow this and we are aware that this limits our ability to deal with heterogeneity and uncertainty in cost. Second, we costed HIV and HCV healthcare on an activity basis without primary data on utilisation. To reduce the risks associated with this, we aimed to be conservative in our assumptions with extensive reference to clinical expertise and indirect data. Third, we only used patient/carer cost and productivity gains in secondary analyses and may have underestimated the potential health sector and societal benefit of NSPs. On the other hand, our approach reflected the lack of reliable recent local data on patient/carer costs and workforce participation of NSP clients and people living with HCV. In our productivity analysis, we used the Friction Cost approach rather than the Human Capital approach because this approach is recommended by local and international funding agencies and because it reduces the risk of amplifying any uncertainty in the estimates of productivity gains excessively. Finally, in the analyses of increasing or decreasing funding, we assumed that all costs were variable in the short-term, which is unlikely in reality as infrastructure and wind-down/start-up costs would create ‘lumpiness’ in cost. Our analyses of increases and decreases in funding were included to illustrate that NSP funding could be increased substantially without reduction of cost-savings.

It is important to note that our analysis was based on the effectiveness of NSPs in averting HIV and HCV infections among IDUs only and not on the many other benefits of NSPs, such as avoided mental health episodes and injecting related injury, psychosocial benefits, overdose education and prevention. Thus, our analysis is highly conservative of the true return on investment associated with NSPs.

Changes to NSPs

We have clearly demonstrated that NSPs are not only cost-effective but cost-saving. There is significant financial return for the investment made in these programs. Our analysis suggests that it is appropriate from a health sector (government) perspective to consider further expansion of NSPs in all Australian jurisdictions. The quantum of additional resources required to increase syringe distribution depends on the methods employed to achieve this aim. Expansion of opening hours and the establishment of new NSP outlets would require significant additional resources and these measures would most likely be necessary to achieve a large increase in syringe distribution. However, other measures to increase syringe distribution, such as the relaxation of restrictions on the quantity and range of syringes freely available to NSP clients, the removal of impediments to allow secondary exchange by IDUs, and the installation of additional syringe vending machines or more mobile services, could all be implemented at relatively low cost [55]. In Australia, the costs associated with procurement of needles and syringes are estimated at approximately one quarter of total NSP service budgets. If the above-mentioned low cost measures were implemented across Australia, a 10% increase in syringe distribution could theoretically be achieved with a modest ~2% increase in the total NSP budget. The key issue is determining how much extra demand exists for NSP services and the feasibility of meeting the demand.

On the other hand decreased funding in NSPs of just 10% could cost more in the next decade in HIV and HCV infections, with loss of health and life and associated extra healthcare costs leading to a reduction in the return on investment greater than the immediate NSP expenditure savings.

The results of this study support the need for a range of evidence-based public health responses to prevent both primary and secondary HIV and HCV transmission among IDUs. These include biomedical and behavioural prevention interventions which target injecting risk behaviours, interventions designed to encourage early uptake of treatment, and increasing access to HCV treatment. However, while HIV remains low and stable among IDUs in Australia, even relatively minor reductions in current levels of NSP coverage could result in an important increase in incident infections. The situation is more severe for HCV, where the background prevalence is high and increased viral infectivity implies that large control is very unlikely.

NSPs remain a key component of HIV and HCV prevention and current gaps in coverage continue to sustain the epidemic. These results offer strong supportive evidence of the large

epidemiological benefits associated with expanding NSP services. This should also include the establishment of NSPs in settings where there is demand and where they currently do not exist and considering alternative ways of supplying clean injecting equipment, such as extending operating hours of NSPs, removing impediments to secondary exchange, and increasing availability of syringe dispensing machines. Scaling up the distribution of sterile syringes could result in significant reductions in HCV transmission among IDUs, averting considerable morbidity and mortality and decreasing associated costs.

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Appendix A: Development of epidemic mathematical transmission model

An epidemic mathematical transmission model of HIV and HCV among Australian IDUs was formulated to dynamically describe the change in the number of people in the population over time according to disease states. The model considered heterogeneity in injecting behaviour reported by the Illicit Drug Reporting System (IDRS) [56-62]: IDUs who did not inject in the last month, injected weekly or less, injected more than weekly, injected once daily, injected two to three times per day, and injected more than three times per day. The frequency of sharing injecting equipment, number of people with whom equipment is shared, number of times each syringe is used before it is disposed, and frequency with which syringes and other injecting equipment (e.g. spoons, tourniquets, etc) are cleaned before reuse, and the efficacy of cleaning equipment contaminated with HIV or HCV were all factored into the model's calculation of the per capita rate of IDUs becoming infected. The model also tracked the entry of new injectors into the population and the rate of ceasing injecting behaviour, while also matching the assumed dynamic number of IDUs in the population over time. Drug-related, disease-related, and background death rates were also included. All parameter values were estimated based on exhaustive searching of the relevant literature and available data from Australian reports and databases (see Table B.1).

Data were also stratified by each Australian state and territory as well as Aboriginal and Torres Strait Islander populations. The numbers of IDUs in each jurisdiction were included, based on various indicators, along with the dynamic number of sterile syringes distributed by NSPs to these populations over time. We considered different syringe coverage rates within the IDU populations.

Force of infection and analysis of 'static' incidence

Based on these factors, we formulated a mathematical expression for the 'force of infection', which refers to the dynamic rate at which susceptible individuals become infected. The force of infection used in this analysis was developed by first considering a static and homogeneous population of N IDUs and was then adapted to include heterogeneous and dynamic features. In a homogenous population, if each IDU injects an average of n times per year, a proportion, s, of IDUs share their syringes with others in a proportion, q, of their injections, and sharing occurs in groups of m people, then the total number of 'sharing

events' in the population per year is $\frac{Nnsq}{m}$. The total number of expected transmissions will be this number multiplied by the average number of transmissions per 'sharing event'.

If the prevalence in the population is *P*, then the probability of *r* infected people in a sharing group of size m is $\binom{m}{r} P^r (1-P)^{m-r}$, using standard binomial theory. If the group members inject using the shared syringe in random order, then an average of $\frac{m-r}{r+1}$ uninfected people will inject before the first infected person (and between each infected person). Therefore, in each sharing event an average of $m - \frac{m-r}{r+1} - r = \frac{rm-r^2}{r+1}$ uninfected people will use a syringe after an infected person has used it. If a shared syringe is used δ_S times before disposal then m/δ_S syringes are used in each 'sharing event' and the average number of uninfected people in the group to use the same syringe after an infected person becomes $\frac{rm-r^2}{r+1}\frac{\delta_S}{m}$. If the probability of infection from a contaminated syringe per use is β, but transmission is reduced by an effectiveness of ε_C through syringe cleaning and cleaning occurs before a proportion, p_c, of shared injections, then each susceptible person could acquire infection with probability $(1-p_C\varepsilon_C)\beta$ if using a contaminated syringe. Therefore, the expected number of transmissions in a given sharing group (or probability of a transmission occurring) is

$$\frac{\delta_S\beta(1-p_c\varepsilon_c)}{m}\sum_{r=1}^{m-1}\binom{m}{r}P^r(1-P)^{m-r}\frac{rm-r^2}{r+1}.$$

Then the total number of transmissions expected each year, or incidence (*I*), is

$$I=\frac{Nnsq\delta_S\beta(1-p_c\varepsilon_c)}{m^2}\sum_{r=1}^{m-1}\binom{m}{r}P^r(1-P)^{m-r}\frac{rm-r^2}{r+1}. \qquad (1)$$

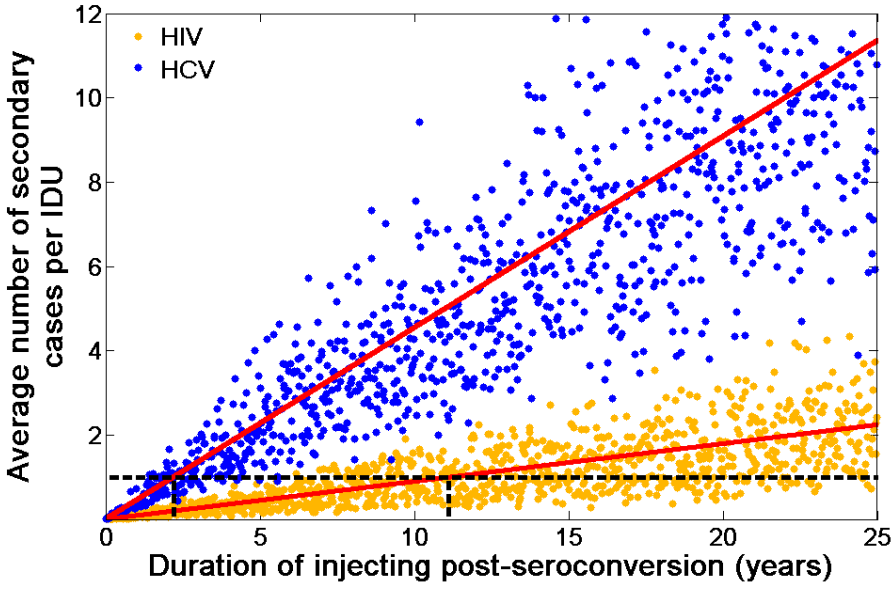
The reader is referred to [63] for details of thorough analyses of this static expression, applied to Australian IDUs. Below are summary results from these analyses.

The expected reproduction ratio, *R*, per IDU was calculated for HIV and HCV as a function of the average duration of injecting post-seroconversion (Figure A.1): if each IDU injects for an average of *D* years after seroconversion, then the average number of secondary cases per IDU is

$$R = \frac{Dnq\delta_s\beta(1-p_c\varepsilon_c)}{m^2 P}\sum_{r=1}^{m-1}\binom{m}{r}P^r(1-P)^{m-r}\frac{rm-r^2}{r+1}. \qquad (2)$$

An epidemic is sustained if R is greater than one [64], implying that each infected person is associated with at least one secondary transmission on average. It was found that the threshold duration of injecting post-seroconversion required to sustain an epidemic is 11.6 (7.0-22.4, IQR) years for HIV and 2.3 (1.8-3.2, IQR) years for HCV (Figure A.1). Based on behavioural data [54, 65] it is reasonable to assume that the average duration of injecting post-HCV seroconversion is ~ten years. This is considerably greater than the threshold of 2.3 years required to control HCV incidence. In contrast, the duration of injecting for HIV-infected IDUs, post-seroconversion, is assumed to be much less than for HCV (less than ten years) and thus less than the critical 11.6 years required to control HIV incidence.

Figure A.1: The average number of secondary cases of HIV (orange) and HCV (blue) transmission per IDU versus the duration of injecting post-seroconversion. The solid lines refer to median simulations and the dashed line refers to one secondary infection.

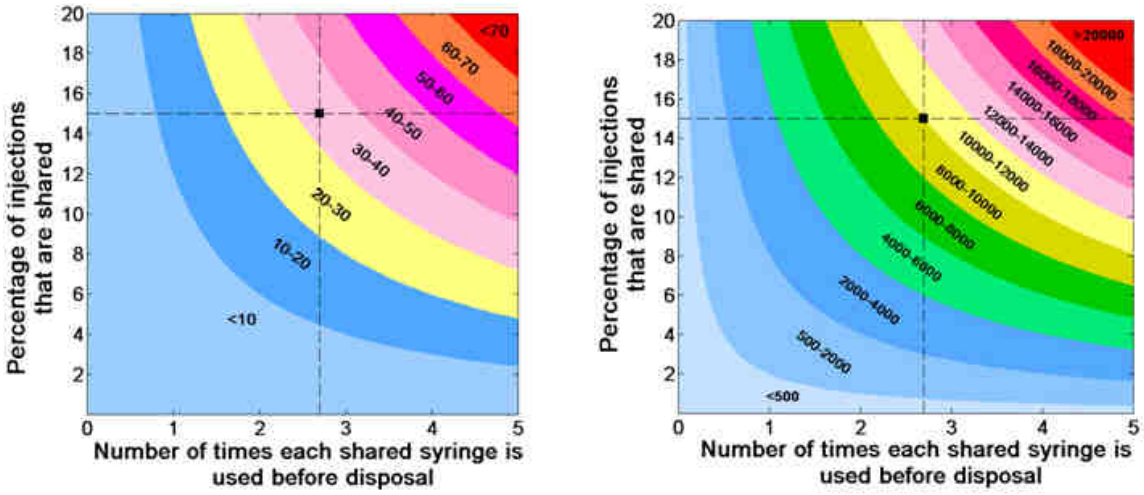


To identify factors that could provide effective targets for intervention a sensitivity analysis was conducted, by means of calculating partial rank correlation coefficients [40] between incidence and the sampled model parameters (results not shown). It was determined that the number of times each syringe is used before disposal is the most sensitive behavioural factor in determining the incidence of both HIV and HCV infection, followed by the percentage of injections that are shared. Therefore, the expected change in incidence for HIV and HCV was

investigated in relation to the frequency of shared injections and the average number of times each syringe is used (Figure A.2).

Figure A.2: The simulated number of annual (a) HIV and (b) HCV transmissions among IDUs in Australia versus the percentage of injections that are shared and the average number of times each syringe is used before disposal. The dashed lines refer to current levels of sharing and syringe use.

(a) **(b)**



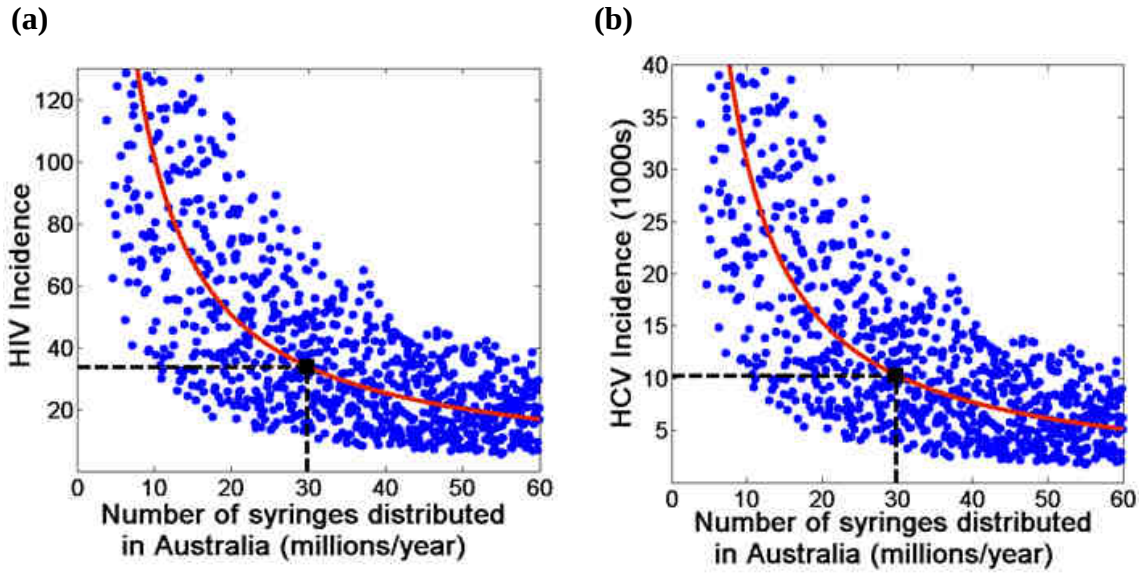
The number of times each syringe is used may be decreased by greater dissemination of sterile syringes through NSPs. The number of syringes distributed through NSPs has remained relatively constant over the last decade (see Table B.1), suggesting that saturation levels have been reached. However, there is also reason to believe that there are opportunities for public sector NSP services to increase client reach. It is difficult to estimate the proportion of all IDUs that access NSPs, however, the recent National Drug Strategy Household Survey revealed that only 51% of those who had injected in the last 12 months usually obtained their injecting equipment from public sector NSPs [66]. Structural and policy factors may limit access to current NSP services. With the exception of pharmacy-based services, few NSPs operate into the evening or are open on weekends. Whilst syringe dispensing machines operate 24 hours a day, these not are operational throughout Australia. There are also limits on the quantity and range of syringes freely available at some NSP services. Secondary exchange of sterile needles and syringes (from one IDU to another) is prohibited in most states and territories, and there are some locations where there is demand for NSP, but where services are not well developed. These factors suggest that syringe distribution in Australia is limited by supply rather than demand, and that increased coverage is possible.

If K syringes are distributed each year and a proportion ω of all syringes are not used, then the number of syringes distributed that are used is $P(1-\omega)$. The number of syringes used for individual injecting episodes among non-sharing IDUs is $\frac{nN(1-s)}{\delta_p}$. Similarly, the total number of syringes used for individual injecting among all sharing IDUs is $\frac{n(1-q)sN}{\delta_p}$ and the total number of syringes used in sharing events is $\frac{nqsN}{\delta_s}$. Therefore,

$$K(1-\omega)=\frac{nN(1-s)}{\delta_p}+\frac{n(1-q)sN}{\delta_p}+\frac{nqsN}{\delta_s}=\frac{nN}{\delta_p\delta_s}\left[\delta_s-sq\left(\delta_s-\delta_p\right)\right] \qquad (3)$$

defines a relationship between the total number of syringes distributed and the use of syringes in this mathematical model (equation 2). Changes in the number of syringes distributed are likely to change any, or all, of the following factors in a way that is consistent with equation 3: the proportion of syringes that remain unused (ω), the proportion of injections that are shared (q), or the average number of times each syringe is used (in shared (δ_S) or individual (non-shared) injections (δ_P)). Changes to ω and δ_P will not influence transmission levels but changes to q and δ_S could potentially result in large reductions in incidence. It could be speculated that increased syringe coverage is most likely to influence a decrease in the number of injections per syringe (for both personal and shared syringes). Therefore, equation 3 was used to estimate the change in the average number of injections per syringe used in both individual and shared injections, assuming the same percentage increase or decrease for both, according to a change in the total number of syringes distributed. The new values for the usage per syringe (δ_P and δ_S) were then used in equation (1), and all other parameters were sampled independently from their original distributions as defined in Table B.1. This was used to estimate the expected incidence of HIV and HCV based on changes in syringe distribution (Figure A.3). It should be noted that very large increases in syringe distribution are likely to be infeasible and unrealistic. It is also important to acknowledge that other relationships between incidence and syringe distribution could be expected if syringe distribution affected other factors in equation 3. However, Figure A.3 does demonstrate that it greater NSP distribution of syringes may lead to reductions in incident cases of HIV and HCV and that if there was a decline in syringe distribution through NSPs then significant increases in incidence could be expected. It is likely that the provision of NSP services has contained the HIV epidemic among IDUs.

Figure A.3: Scatter plots of the simulated number of annual (a) HIV and (b) HCV transmissions among IDUs in Australia versus the number of sterile syringes distributed in Australia are shown, assuming that syringe distribution changes the average number of times each syringe is used before disposal. The blue dots are results from 1000 simulations, the red curves represent the median parameter values, and the black dashed lines refer to current levels of syringe distribution.



Dynamic transmission model

The model used in the analyses of this report extends the 'static' mathematical expression (equations 1 to 3) by including time-dependent parameter estimates for all demographic parameters and simulating the dynamic model-based prevalence of HIV and HCV in the population. Various assumptions about the role NSPs and syringe distribution among heterogeneous groups of IDUs were also considered.

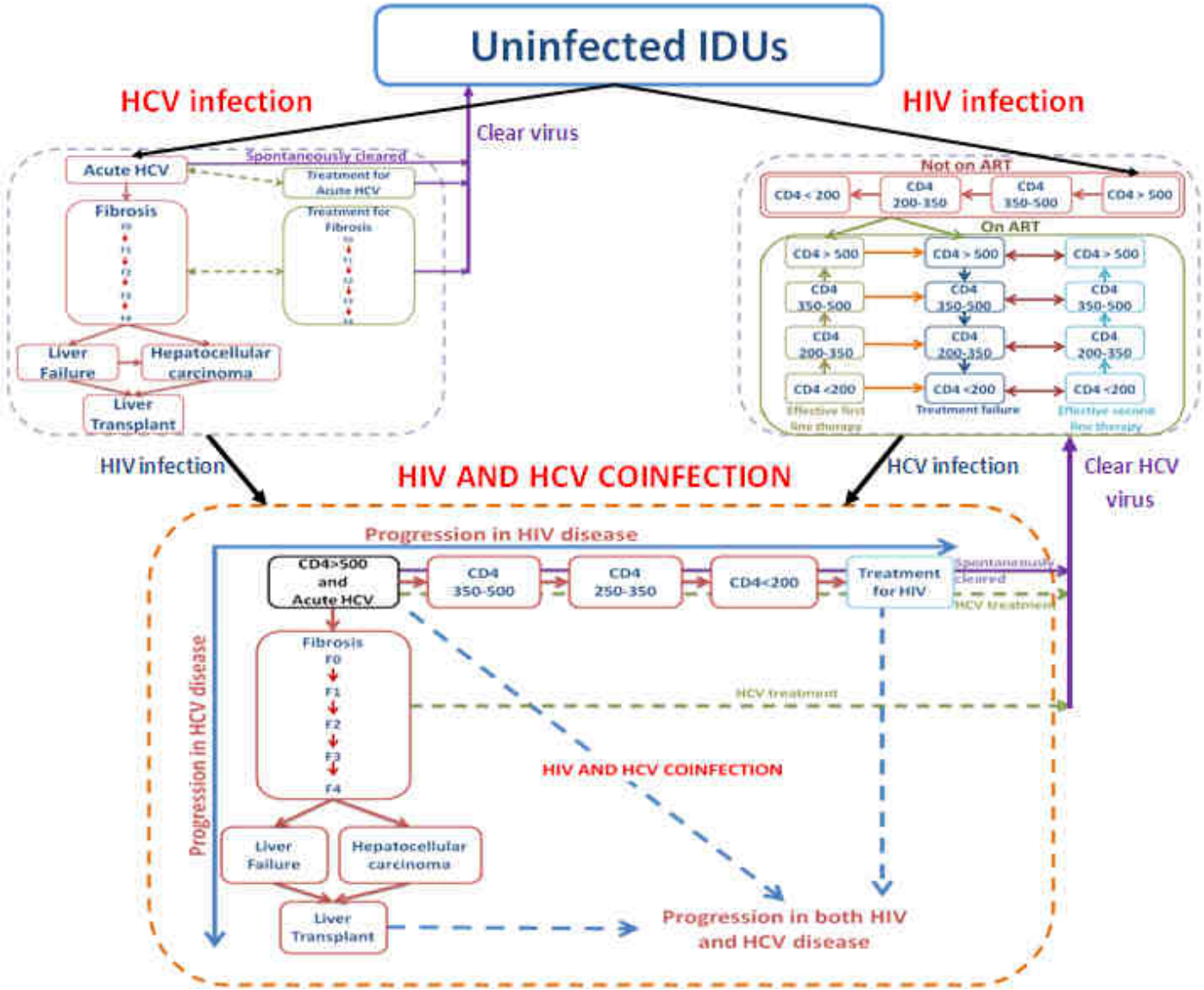
Furthermore, an extensive natural history model of HIV and HCV monoinfection or coinfection was developed to dynamically track the number of people in each HIV and HCV health state. A schematic diagram of compartments of the HIV and HCV transmission model for IDUs in Australia is presented in Figure A.4. The change in the number of people in each compartment was tracked mathematically by formulating a system of 473 ordinary differential equations, one for each compartment. One compartment represents IDUs who are not infected with HIV or HCV. Fifteen compartments represent IDUs who are monoinfected with HCV: in acute stage, fibrosis stages F0, F1, F2, F3, F4, and for each of these, whether they are untreated or receiving treatment. People infected with HCV who have advanced

fibrosis can progress to clinical outcomes of liver failure, hepatocellular carcinoma, or may receive a liver transplant. It is assumed that individuals that progress to these three clinical outcomes no longer inject drugs.

Sixteen compartments represent IDUs who are monoinfected with HIV: individuals who become HIV-infected are initially untreated and are assumed to have a $CD4^+$ T cell count above 500 cells per μl, then will progress in their disease through categories according to $CD4^+$ T cell levels (350-500 cells per μl, 200-350 cells per μl, and <200 cells per μl); HIV-infected individuals may initiate antiretroviral therapy (for each $CD4^+$ T cell category the number of individuals on effective first-line treatment, treatment failure, or effective second-line treatment are also tracked). This model also tracks potential co-infection of HIV and HCV, including all possible combinations of HIV and HCV disease states; however, it is assumed that HIV-infected individuals with CD4 counts less than 350 cells per μl and on antiretroviral therapy will not also receive treatment for their HCV infection at the same time.

Thus, 205 ordinary differential equations are used to describe the co-infection of HIV and HCV among IDUs. This model also tracks the disease progression of individuals who have stopped injecting drugs but are infected with HIV and/or HCV. The number of equations is then doubled, plus the equation for uninfected but susceptible IDUs, leading to a total of 473 ordinary differential equations, one for each model compartment, to describe the number of people in each health state. The flows in the number of people between these compartments are due to biological, behavioural, clinical, or epidemiological parameters (specified in detail in Appendix B).

Figure A.4: Schematic diagram of compartments of the HIV and HCV transmission model for IDUs in Australia



The mathematical description of the model is below:

Uninfected IDUs

$$\overbrace{\frac{dS}{dt}}^{\text{Change in uninfecteds}} = \overbrace{\pi}^{\text{Entry into population}} - \left(\overbrace{\lambda_{HIV}}^{\text{Force of HIV infection}} + \overbrace{\lambda_{HCV}}^{\text{Force of HCV infection}} + \overbrace{\mu}^{\text{Background death}} + \overbrace{\mu_D}^{\text{Drug-related death}} + \overbrace{\xi}^{\text{Exit rate}} \right) S$$

$$+ \overbrace{\gamma_A^M \nu_A^M I_A^{MT}}^{\text{Viral clearance from treatment (acute)}} + \overbrace{\gamma_{F0}^M \nu_F^M I_{F0}^{MT}}^{\text{Viral clearance from treatment (F0)}} + \overbrace{\gamma_{F1}^M \nu_F^M I_{F1}^{MT}}^{\text{Viral clearance from treatment (F1)}} + \overbrace{\gamma_{F2}^M \nu_F^M I_{F2}^{MT}}^{\text{Viral clearance from treatment (F2)}}$$

$$+ \overbrace{\gamma_{F3}^M \nu_F^M I_{F3}^{MT}}^{\text{Viral clearance from treatment (F3)}} + \overbrace{\gamma_{F4}^M \nu_F^M I_{F4}^{MT}}^{\text{Viral clearance from treatment (F4)}} + \overbrace{\psi_M I_A^M}^{\text{Spontaneous viral clearance (acute)}}$$

HCV-infected individuals

$$\overbrace{\frac{dI_A^M}{dt}}^{\text{Change in acute infecteds}} = \overbrace{\lambda_{HCV} S}^{\text{New infections}} + \overbrace{\left(1-\gamma_A^M\right)\nu_A^M I_A^{MT}}^{\text{Cease treatment (acute)}} - \left(\overbrace{\mu}^{\text{Background death}} + \overbrace{\mu_D}^{\text{Drug-related death}} + \overbrace{\xi}^{\text{Exit rate}} \right.$$

$$\left. + \overbrace{\lambda_{HIV}}^{\text{Force of HIV infection}} + \overbrace{\tau_A^M}^{\text{Progress to F0}} + \overbrace{\eta_A}^{\text{Commence treatment (acute)}} \right) I_A^M$$

$$\overbrace{\frac{dI_{F0}^M}{dt}}^{\text{Change in F0 infecteds}} = \overbrace{\tau_A^M I_A^M}^{\text{Progress from acute}} + \overbrace{(1-\gamma_{F0}^M)\nu_F^M I_{F0}^{MT}}^{\text{Cease treatment (F0)}} - \left(\overbrace{\mu}^{\text{Background death}} + \overbrace{\mu_D}^{\text{Drug-related death}} + \overbrace{\xi}^{\text{Exit rate}} \right.$$

$$\left. + \overbrace{\lambda_{HIV}}^{\text{Force of HIV infection}} + \overbrace{\eta_{F0}}^{\text{Commence treatment (F0)}} + \overbrace{\tau_{F0}^M}^{\text{Progress to F1}} \right) I_{F0}^M$$

$$\overbrace{\frac{dI^M_{F1}}{dt}}^{\text{Change in F1 infecteds}} = \overbrace{\tau^M_{F01} I^M_{F0}}^{\text{Progress from F0}} + \overbrace{(1-\gamma^M_{F1})\nu^M_F I^{MT}_{F1}}^{\text{Cease treatment (F1)}} - \left(\overbrace{\mu}^{\text{Background death}} + \overbrace{\mu_D}^{\text{Drug-related death}} + \overbrace{\xi}^{\text{Exit rate}} + \overbrace{\lambda_{HIV}}^{\text{Force of HIV infection}} + \overbrace{\eta_{F1}}^{\text{Commence treatment (F1)}} + \overbrace{\tau^M_{F1}}^{\text{Progress to F2}} \right) I^M_{F1}$$

$$\overbrace{\frac{dI^M_{F2}}{dt}}^{\text{Change in F2 infecteds}} = \overbrace{\tau^M_{F1} I^M_{F1}}^{\text{Progress from F1}} + \overbrace{(1-\gamma^M_{F2})\nu^M_F I^{MT}_{F2}}^{\text{Cease treatment (F2)}} - \left(\overbrace{\mu}^{\text{Background death}} + \overbrace{\mu_D}^{\text{Drug-related death}} + \overbrace{\xi}^{\text{Exit rate}} + \overbrace{\lambda_{HIV}}^{\text{Force of HIV infection}} + \overbrace{\eta_{F2}}^{\text{Commence treatment (F2)}} + \overbrace{\tau^M_{F2}}^{\text{Progress to F3}} \right) I^M_{F2}$$

$$\overbrace{\frac{dI^M_{F3}}{dt}}^{\text{Change in F3 infecteds}} = \overbrace{\tau^M_{F2} I^M_{F2}}^{\text{Progress from F2}} + \overbrace{(1-\gamma^M_{F3})\nu^M_F I^{MT}_{F3}}^{\text{Cease treatment (F3)}} - \left(\overbrace{\mu}^{\text{Background death}} + \overbrace{\mu_D}^{\text{Drug-related death}} + \overbrace{\xi}^{\text{Exit rate}} + \overbrace{\lambda_{HIV}}^{\text{Force of HIV infection}} + \overbrace{\eta_{F3}}^{\text{Commence treatment (F3)}} + \overbrace{\tau^M_{F3}}^{\text{Progress to F4}} \right) I^M_{F3}$$

$$\overbrace{\frac{dI^M_{F4}}{dt}}^{\text{Change in F4 infecteds}} = \overbrace{\tau^M_{F3} I^M_{F3}}^{\text{Progress from F3}} + \overbrace{(1-\gamma^M_{F4})\nu^M_F I^{MT}_{F4}}^{\text{Cease treatment (F4)}} - \left(\overbrace{\mu}^{\text{Background death}} + \overbrace{\mu_D}^{\text{Drug-related death}} + \overbrace{\xi}^{\text{Exit rate}} + \overbrace{\lambda_{HIV}}^{\text{Force of HIV infection}} + \overbrace{\eta_{F4}}^{\text{Commence treatment (F4)}} + \overbrace{\tau^M_{F4LF}}^{\text{Progress to liver failure}} + \overbrace{\tau^M_{F4HCC}}^{\text{Progress to HCC}} \right) I^M_{F4}$$

$$\overbrace{\frac{dI_A^{MT}}{dt}}^{\text{Change in acute infecteds on treatment}} = \overbrace{\eta_A I_A^M}^{\text{Commenced treatment (acute)}} - \left(\overbrace{\mu}^{\text{Background death}} + \overbrace{\mu_D}^{\text{Drug-related death}} + \overbrace{\xi}^{\text{Exit rate}} + \overbrace{\lambda_{HIV}}^{\text{Force of HIV infection}} + \overbrace{(1-\gamma_A^M)\nu_A^M}^{\text{Cease treatment (F4)}} + \overbrace{\gamma_A^M \nu_A^M}^{\text{Viral clearance on treatment (acute)}} + \overbrace{\tau_A^{MT}}^{\text{Progress to F0 during treatment}} \right) I_A^{MT}$$

$$\overbrace{\frac{dI_{F0}^{MT}}{dt}}^{\text{Change in F0 infecteds on treatment}} = \overbrace{\tau_A^{MT} I_A^{MT}}^{\text{Progress from acute during treatment}} + \overbrace{\eta_{F0} I_{F0}^M}^{\text{Commenced treatment (F0)}} - \left(\overbrace{\mu}^{\text{Background death}} + \overbrace{\mu_D}^{\text{Drug-related death}} + \overbrace{\xi}^{\text{Exit rate}} + \overbrace{\lambda_{HIV}}^{\text{Force of HIV infection}} + \overbrace{(1-\gamma_{F0}^M)\nu_F^M}^{\text{Cease treatment (F0)}} + \overbrace{\gamma_{F0}^M \nu_F^M}^{\text{Viral clearance on treatment (F0)}} + \overbrace{\tau_{F0}^{MT}}^{\text{Progress to F1 during treatment}} \right) I_{F0}^{MT}$$

$$\overbrace{\frac{dI_{F1}^{MT}}{dt}}^{\text{Change in F1 infecteds on treatment}} = \overbrace{\tau_{F0}^{MT} I_{F0}^{MT}}^{\text{Progress from F0 during treatment}} + \overbrace{\eta_{F1} I_{F1}^M}^{\text{Commenced treatment (F1)}} - \left(\overbrace{\mu}^{\text{Background death}} + \overbrace{\mu_D}^{\text{Drug-related death}} + \overbrace{\xi}^{\text{Exit rate}} + \overbrace{\lambda_{HIV}}^{\text{Force of HIV infection}} + \overbrace{(1-\gamma_{F1}^M)\nu_F^M}^{\text{Cease treatment (F1)}} + \overbrace{\gamma_{F1}^M \nu_F^M}^{\text{Viral clearance on treatment (F1)}} + \overbrace{\tau_{F1}^{MT}}^{\text{Progress to F2 during treatment}} \right) I_{F1}^{MT}$$

$$\overbrace{\frac{dI_{F2}^{MT}}{dt}}^{\text{Change in F2 infecteds on treatment}} = \overbrace{\tau_{F1}^{MT} I_{F1}^{MT}}^{\text{Progress from F1 during treatment}} + \overbrace{\eta_{F2} I_{F2}^M}^{\text{Commenced treatment (F2)}} - \left(\overbrace{\mu}^{\text{Background death}} + \overbrace{\mu_D}^{\text{Drug-related death}} + \overbrace{\xi}^{\text{Exit rate}} + \overbrace{\lambda_{HIV}}^{\text{Force of HIV infection}} + \overbrace{(1-\gamma_{F2}^M)\nu_F^M}^{\text{Cease treatment (F2)}} + \overbrace{\gamma_{F2}^M \nu_F^M}^{\text{Viral clearance on treatment (F2)}} + \overbrace{\tau_{F2}^{MT}}^{\text{Progress to F3 during treatment}} \right) I_{F2}^{MT}$$

$$\overbrace{\frac{dI_{F3}^{MT}}{dt}}^{\text{Change in F3 infecteds on treatment}} = \overbrace{\tau_{F2}^{MT} I_{F2}^{MT}}^{\text{Progress from F2 during treatment}} + \overbrace{\eta_{F3} I_{F3}^{M}}^{\text{Commenced treatment (F3)}} - \left(\overbrace{\mu}^{\text{Background death}} + \overbrace{\mu_D}^{\text{Drug-related death}} + \overbrace{\xi}^{\text{Exit rate}} + \overbrace{\lambda_{HIV}}^{\text{Force of HIV infection}} + \overbrace{(1-\gamma_{F3}^{M})\nu_F^{M}}^{\text{Cease treatment (F3)}} + \overbrace{\gamma_{F3}^{M}\nu_F^{M}}^{\text{Viral clearance on treatment (F3)}} + \overbrace{\tau_{F3}^{MT}}^{\text{Progress to F4 during treatment}} \right) I_{F3}^{MT}$$

$$\overbrace{\frac{dI_{F4}^{MT}}{dt}}^{\text{Change in F4 infecteds on treatment}} = \overbrace{\tau_{F3}^{MT} I_{F3}^{MT}}^{\text{Progress from F3 during treatment}} + \overbrace{\eta_{F4} I_{F4}^{M}}^{\text{Commenced treatment (F4)}} - \left(\overbrace{\mu}^{\text{Background death}} + \overbrace{\mu_D}^{\text{Drug-related death}} + \overbrace{\xi}^{\text{Exit rate}} + \overbrace{\lambda_{HIV}}^{\text{Force of HIV infection}} + \overbrace{(1-\gamma_{F4}^{M})\nu_F^{M}}^{\text{Cease treatment (F4)}} + \overbrace{\gamma_{F4}^{M}\nu_F^{M}}^{\text{Viral clearance on treatment (F4)}} \right) I_{F4}^{MT}$$

$$\overbrace{\frac{dI_{LF}^{M}}{dt}}^{\text{Change in liver failure infecteds}} = \overbrace{\tau_{F4LF}^{M} I_{F4}^{M}}^{\text{Progress from F4}} - \left(\overbrace{\mu}^{\text{Background death}} + \overbrace{\mu_{LF}}^{\text{Liver failure related death}} + \overbrace{\xi_L}^{\text{Leaving population with liver disease}} + \overbrace{\tau_{LFHCC}}^{\text{Progress to HCC}} + \overbrace{\tau_{LFLT}}^{\text{Progress to LT}} \right) I_{LF}^{M}$$

$$\overbrace{\frac{dI_{HCC}^{M}}{dt}}^{\text{Change in HCC infecteds}} = \overbrace{\tau_{F4HCC}^{M} I_{F4}^{M}}^{\text{Progress from F4}} + \overbrace{\tau_{LFHCC}^{M} I_{LF}^{M}}^{\text{Progress from LF}} - \left(\overbrace{\mu}^{\text{Background death}} + \overbrace{\mu_{HCC}}^{\text{HCC related death}} + \overbrace{\xi_L}^{\text{Leaving population with liver disease}} + \overbrace{\tau_{HCCLT}}^{\text{Progress to LT}} \right) I_{HCC}^{M}$$

$$\overbrace{\frac{dI_{LT}^{M}}{dt}}^{\text{Change in Liver transplants}} = \overbrace{\tau_{LFLT}^{M} I_{LF}^{M}}^{\text{Progress from liver failure}} + \overbrace{\tau_{HCCLT}^{M} I_{HCC}^{M}}^{\text{Progress from HCC}} - \left(\overbrace{\mu}^{\text{Background death}} + \overbrace{\mu_{LT}}^{\text{Liver transplant related death}} + \overbrace{\xi_L}^{\text{Leaving population with liver disease}} \right) I_{LT}^{M}$$

HIV-infected individuals

$$\overbrace{\frac{dI^{M}_{500}}{dt}}^{\text{Change in infecteds (CD4>500)}} = \overbrace{\lambda_{HIV} S}^{\text{New infections}} + \overbrace{\psi_C I^{A}_{500}}^{\text{Spontaneous HCV clearance (acute coinfecteds)}} - \left(\overbrace{\mu}^{\text{Background death}} + \overbrace{\mu_D}^{\text{Drug-related death}} + \overbrace{\xi}^{\text{Exit rate}} + \overbrace{\mu_{500}}^{\text{HIV-related death (CD4>500)}} + \overbrace{\lambda_{HCV}}^{\text{Force of HCV infection}} + \overbrace{\tau^{M}_{500}}^{\text{Progress to 350<CD4<500}} + \overbrace{\eta^{D}_{500}}^{\text{Commence 1st line treatment (CD4>500, Detectable viral load)}} + \overbrace{\eta^{U}_{500}}^{\text{Commence 1st line treatment (CD4>500, Undetectable viral load)}} \right) I^{M}_{500}$$

$$\overbrace{\frac{dI^{M}_{350\_500}}{dt}}^{\text{Change in infecteds (350<CD4<500)}} = \overbrace{\tau^{M}_{500} I^{M}_{500}}^{\text{Progress from CD4>500}} + \overbrace{\psi_C I^{A}_{350\_500}}^{\text{Spontaneous HCV clearance (acute, 350<CD4<500)}} - \left(\overbrace{\mu}^{\text{Background death}} + \overbrace{\mu_D}^{\text{Drug-related death}} + \overbrace{\xi}^{\text{Exit rate}} + \overbrace{\mu_{350\_500}}^{\text{HIV-related death (350<CD4<500)}} + \overbrace{\lambda_{HCV}}^{\text{Force of HCV infection}} + \overbrace{\tau^{M}_{350\_500}}^{\text{Progress to 200<CD4<350}} + \overbrace{\eta^{D}_{350\_500}}^{\text{Commence 1st line treatment (350<CD4<500, Detectable Viral Load)}} + \overbrace{\eta^{U}_{350\_500}}^{\text{Commence 1st line treatment (350<CD4<500, Undetectable Viral Load)}} \right) I^{M}_{350\_500}$$

$$\overbrace{\frac{dI^{M}_{200\_350}}{dt}}^{\text{Change in infecteds (200<CD4<350)}} = \overbrace{\tau^{M}_{350\_500} I^{M}_{350\_500}}^{\text{Progress from 350<CD4<500}} + \overbrace{\psi_C I^{A}_{200\_350}}^{\text{Spontaneous HCV clearance (acute, 200<CD4<350)}} - \left(\overbrace{\mu}^{\text{Background death}} + \overbrace{\mu_D}^{\text{Drug-related death}} + \overbrace{\xi}^{\text{Exit rate}} + \overbrace{\mu_{200\_350}}^{\text{HIV-related death (200<CD4<350)}} + \overbrace{\lambda_{HCV}}^{\text{Force of HCV infection}} + \overbrace{\tau^{M}_{200\_350}}^{\text{Progress to CD4<200}} + \overbrace{\eta^{D}_{200\_350}}^{\text{Commence 1st line treatment (200<CD4<350, Detectable Viral Load)}} + \overbrace{\eta^{U}_{200\_350}}^{\text{Commence 1st line treatment (200<CD4<350, Undetectable Viral Load)}} \right) I^{M}_{200\_350}$$

$$\overbrace{\frac{dI^{M}_{200}}{dt}}^{\text{Change in infecteds (CD4<200)}} = \overbrace{\tau^{M}_{200\_350} I^{M}_{200\_350}}^{\text{Progress from 200<CD4<350}} + \overbrace{\psi_{C} I^{A}_{200}}^{\text{Spontaneous HCV clearance (acute, CD4<200)}} - \left(\overbrace{\mu}^{\text{Background death}} + \overbrace{\mu_{D}}^{\text{Drug-related death}} + \overbrace{\xi}^{\text{Exit rate}} + \overbrace{\mu_{200}}^{\text{HIV-related death (CD4<200)}} + \overbrace{\lambda_{HCV}}^{\text{Force of HCV infection}} + \overbrace{\eta^{D}_{200}}^{\text{Commence 1st line treatment (CD4<200, Detectable Viral Load)}} + \overbrace{\eta^{U}_{200}}^{\text{Commence 1st line treatment (CD4<200, Undetectable Viral Load)}} \right) I^{M}_{200}$$

$$\overbrace{\frac{dI^{M}_{500_{1st}}}{dt}}^{\text{Change in infecteds (CD4>500) during 1st treatment}} = \overbrace{\eta^{U}_{500} I^{M}_{500}}^{\text{Commenced 1st line therapy (CD4>500, Undetectable Viral Load}} + \overbrace{\psi_{C} I^{A}_{500_{1st}}}^{\text{Spontaneous HCV clearance (acute, CD4>500)}} + \overbrace{\omega^{U}_{350\_500} I^{M}_{350\_500_{1st}}}^{\text{Viral supression during 1st line therapy (350<CD4<500)}} - \left(\overbrace{\mu}^{\text{Background death}} + \overbrace{\mu_{D}}^{\text{Drug-related death}} + \overbrace{\xi}^{\text{Exit rate}} + \overbrace{\mu_{500}}^{\text{HIV-related death (CD4>500)}} + \overbrace{\lambda_{HCV}}^{\text{Force of HCV infection}} + \overbrace{\phi_{500}}^{\text{Viral rebound (CD4>500)}} \right) I^{M}_{500_{1st}}$$

$$\overbrace{\frac{dI^{M}_{350\_500_{1st}}}{dt}}^{\text{Change in infecteds (350<CD4<500) during 1st treatment}} = \overbrace{\eta^{U}_{350\_500} I^{M}_{350\_500}}^{\text{Commenced 1st line therapy (350<CD4<500, Undetectable Viral Load}} + \overbrace{\psi_{C} I^{A}_{350\_500_{1st}}}^{\text{Spontaneous HCV clearance (acute, 350<CD4<500)}} + \overbrace{\omega^{U}_{200\_350} I^{M}_{200\_350_{1st}}}^{\text{Viral supression during 1st line therapy (200<CD4<350)}} - \left(\overbrace{\mu}^{\text{Background death}} + \overbrace{\mu_{D}}^{\text{Drug-related death}} + \overbrace{\xi}^{\text{Exit rate}} + \overbrace{\mu_{350\_500}}^{\text{HIV-related death (350<CD4<500)}} + \overbrace{\lambda_{HCV}}^{\text{Force of HCV infection}} + \overbrace{\phi_{350\_500}}^{\text{Viral rebound (350<CD4<500)}} + \overbrace{\omega^{U}_{350\_500}}^{\text{Viral supression (350<CD4<500)}} \right) I^{M}_{350\_500_{1st}}$$

Change in infecteds (200<CD4<350) during 1st treatment

$$\overbrace{\frac{dI^{M}_{200\_350_{1st}}}{dt}} = \overbrace{\eta^{U}_{200\_350} I^{M}_{200\_350}}^{\text{Commenced 1st line therapy (200<CD4<350, Undetectable Viral Load}} + \overbrace{\psi_{C} I^{A}_{200\_350_{1st}}}^{\text{Spontaneous HCV clearance (acute, 200<CD4<350)}} + \overbrace{\omega^{U}_{200} I^{M}_{200_{1st}}}^{\text{Viral supression during 1st line therapy (CD4<200)}} - \left(\overbrace{\mu}^{\text{Background death}} + \overbrace{\mu_{D}}^{\text{Drug-related death}} + \overbrace{\xi}^{\text{Exit rate}} + \overbrace{\mu_{200\_350}}^{\text{HIV-related death (200<CD4<350)}} + \overbrace{\lambda_{HCV}}^{\text{Force of HCV infection}} + \overbrace{\phi_{200\_350}}^{\text{Viral rebound (200<CD4<350)}} + \overbrace{\omega^{U}_{200\_350}}^{\text{Viral supression (200<CD4<350)}} \right) I^{M}_{200\_350_{1st}}$$

Change in infecteds (CD4<200) during 1st treatment

$$\overbrace{\frac{dI^{M}_{200_{1st}}}{dt}} = \overbrace{\eta^{U}_{200} I^{M}_{200}}^{\text{Commenced 1st line therapy (CD4<200, Undetectable Viral Load)}} + \overbrace{\psi_{C} I^{A}_{200_{1st}}}^{\text{Spontaneous HCV clearance (acute, CD4<200)}} - \left(\overbrace{\mu}^{\text{Background death}} + \overbrace{\mu_{D}}^{\text{Drug-related death}} + \overbrace{\xi}^{\text{Exit rate}} + \overbrace{\mu_{200}}^{\text{HIV-related death (CD4<200)}} + \overbrace{\lambda_{HCV}}^{\text{Force of HCV infection}} + \overbrace{\phi_{200}}^{\text{Viral rebound (CD4<200)}} + \overbrace{\omega^{U}_{200}}^{\text{Viral supression (CD4<200)}} \right) I^{M}_{200_{1st}}$$

Change in treatment failure infecteds (CD4>500)

$$\overbrace{\frac{dI^{M}_{500_{Fail}}}{dt}} = \overbrace{\eta^{D}_{500} I^{M}_{500}}^{\text{Commenced 1st line therapy (CD4>500, Detectable Viral Load)}} + \overbrace{\psi_{C} I^{A}_{500_{Fail}}}^{\text{Spontaneous HCV clearance (acute, CD4>500)}} + \overbrace{\phi_{500} I^{M}_{500_{1st}}}^{\text{Viral rebound during 1st line therapy (CD4>500)}} + \overbrace{\phi^{S}_{500} I^{M}_{500_{2nd}}}^{\text{Viral rebound during 2nd line therapy (CD4>500)}} - \left(\overbrace{\mu}^{\text{Background death}} + \overbrace{\mu_{D}}^{\text{Drug-related death}} + \overbrace{\xi}^{\text{Exit rate}} + \overbrace{\mu_{500}}^{\text{HIV-related death (CD4>500)}} + \overbrace{\lambda_{HCV}}^{\text{Force of HCV infection}} + \overbrace{\omega^{D}_{500}}^{\text{Progress to (350<CD4<500)}} + \overbrace{\sigma_{500}}^{\text{Commence 2nd line therapy (CD4>500)}} \right) I^{M}_{500_{Fail}}$$

$$\overbrace{\frac{dI^{M}_{350\_500_{Fail}}}{dt}}^{\substack{Change\ in\\ treatment\ failure\ infecteds\\ (350<CD4<500)}} = \overbrace{\eta^{D}_{350\_500} I^{M}_{350\_500}}^{\substack{Commenced\ 1st\ line\\ therapy\ (350<CD4<500,\\ Detectable\ Viral\ Load)}} + \overbrace{\psi_{C} I^{A}_{350\_500_{Fail}}}^{\substack{Spontaneous\ HCV\\ clearance\\ (acute,\ 350<CD4<500)}} + \overbrace{\phi_{350\_500} I^{M}_{350\_500_{1st}}}^{\substack{Viral\ rebound\\ during\ 1st\ line\ therapy\\ (350<CD4<500)}} + \overbrace{\phi^{S}_{350\_500} I^{M}_{350\_500_{2nd}}}^{\substack{Viral\ rebound\\ during\ 2nd\ line\ therapy\\ (350<CD4<500)}}$$

$$+ \overbrace{\omega^{D}_{500} I^{M}_{500_{Fail}}}^{\substack{Progress\ from\\ CD4>500\ after\\ 1st\ line\ treatment\ failure}} - \left(\overbrace{\mu}^{\substack{Background\\ death}} + \overbrace{\mu_{D}}^{\substack{Drug\text{-}related\\ death}} + \overbrace{\xi}^{\substack{Exit\\ rate}} + \overbrace{\mu_{350\_500}}^{\substack{HIV\text{-}related\\ death\ (350<CD4<500)}} + \overbrace{\lambda_{HCV}}^{\substack{Force\ of\\ HCV\ infection}} \right.$$

$$\left. + \overbrace{\omega^{D}_{350\_500}}^{\substack{Progress\ to\\ (200<CD4<350)}} + \overbrace{\sigma_{350\_500}}^{\substack{Commence\ 2nd\ line\\ therapy\ (350<CD4<500)}} \right) I^{M}_{350\_500_{Fail}}$$

$$\overbrace{\frac{dI^{M}_{200\_350_{Fail}}}{dt}}^{\substack{Change\ in\\ treatment\ failure\ infecteds\\ (200<CD4<350)}} = \overbrace{\eta^{D}_{200\_350} I^{M}_{200\_350}}^{\substack{Commenced\ 1st\ line\\ therapy\ (200<CD4<350,\\ Detectable\ Viral\ Load)}} + \overbrace{\psi_{C} I^{A}_{200\_350_{Fail}}}^{\substack{Spontaneous\ HCV\\ clearance\\ (acute,\ 200<CD4<350)}} + \overbrace{\phi_{200\_350} I^{M}_{200\_350_{1st}}}^{\substack{Viral\ rebound\\ during\ 1st\ line\ therapy\\ (200<CD4<350)}} + \overbrace{\phi^{S}_{200\_350} I^{M}_{200\_350_{2nd}}}^{\substack{Viral\ rebound\\ during\ 2nd\ line\ therapy\\ (200<CD4<350)}}$$

$$+ \overbrace{\omega^{D}_{350\_500} I^{M}_{350\_500_{Fail}}}^{\substack{Progress\ from\\ 350<CD4<500\ after\\ treatment\ failure}} - \left(\overbrace{\mu}^{\substack{Background\\ death}} + \overbrace{\mu_{D}}^{\substack{Drug\text{-}related\\ death}} + \overbrace{\xi}^{\substack{Exit\\ rate}} + \overbrace{\mu_{200\_350}}^{\substack{HIV\text{-}related\\ death\ (200<CD4<350)}} + \overbrace{\lambda_{HCV}}^{\substack{Force\ of\\ HCV\ infection}} \right.$$

$$\left. + \overbrace{\omega^{D}_{200\_350}}^{\substack{Progress\ to\\ CD4<200}} + \overbrace{\sigma_{200\_350}}^{\substack{Commence\ 2nd\ line\\ therapy\ (200<CD4<350)}} \right) I^{M}_{200\_350_{Fail}}$$

Change in treatment failure infecteds (CD4<200)

$$\overbrace{\frac{dI^{M}_{200_{Fail}}}{dt}} = \overbrace{\eta^{D}_{200} I^{M}_{200}}^{\text{Commenced 1st line therapy (CD4<200, Detectable Viral Load)}} + \overbrace{\psi_{C} I^{A}_{200_{Fail}}}^{\text{Spontaneous HCV clearance (acute, CD4<200)}} + \overbrace{\phi_{200} I^{M}_{200_{1st}}}^{\text{Viral rebound during 1st line therapy (CD4<200)}}$$

$$+ \overbrace{\phi^{S}_{200} I^{M}_{200_{2nd}}}^{\text{Viral rebound during 2nd line therapy (CD4<200)}} + \overbrace{\omega^{D}_{200\_350} I^{M}_{200\_350_{Fail}}}^{\text{Progress from 200<CD4<350 after treatment failure}} - \left(\overbrace{\mu}^{\text{Background death}} \right.$$

$$\left. + \overbrace{\mu_{D}}^{\text{Drug-related death}} + \overbrace{\xi}^{\text{Exit rate}} + \overbrace{\mu_{200}}^{\text{HIV-related death (CD4<200)}} + \overbrace{\lambda_{HCV}}^{\text{Force of HCV infection}} + \overbrace{\sigma_{200}}^{\text{Commence 2nd line therapy (CD4<200)}} \right) I^{M}_{200_{Fail}}$$

Change in infecteds (CD4>500) on 2nd line treatment

$$\overbrace{\frac{dI^{M}_{500_{2nd}}}{dt}} = \overbrace{\sigma_{500} I^{M}_{500_{Fail}}}^{\text{Commence 2nd line therapy (CD4>500)}} + \overbrace{\psi_{C} I^{A}_{500_{2nd}}}^{\text{Spontaneous HCV clearance (acute, CD4>500)}} + \overbrace{\omega^{U}_{350\_500} I^{M}_{350\_500_{2nd}}}^{\text{Viral supression during 2nd line therapy from 350<CD4<500}}$$

$$- \left(\overbrace{\mu}^{\text{Background death}} + \overbrace{\mu_{D}}^{\text{Drug-related death}} + \overbrace{\xi}^{\text{Exit rate}} + \overbrace{\mu_{500}}^{\text{HIV-related death (CD4>500)}} + \overbrace{\lambda_{HCV}}^{\text{Force of HCV infection}} + \overbrace{\phi^{S}_{500}}^{\text{Viral rebound during 2nd line therapy (CD4>500)}} \right) I^{M}_{500_{2nd}}$$

Change in infecteds (350<CD4<500) on 2nd line treatment

$$\overbrace{\frac{dI^{M}_{350\_500_{2nd}}}{dt}} = \overbrace{\sigma_{350\_500} I^{M}_{350\_500_{Fail}}}^{\text{Commence 2nd line therapy (350<CD4<500)}} + \overbrace{\psi_{C} I^{A}_{350\_500_{2nd}}}^{\text{Spontaneous HCV clearance (acute, 350<CD4<500)}} + \overbrace{\omega^{U}_{200\_350} I^{M}_{200\_350_{2nd}}}^{\text{Viral supression during 2nd line therapy from 200<CD4<350}} - \left(\overbrace{\mu}^{\text{Background death}} \right.$$

$$\left. + \overbrace{\mu_{D}}^{\text{Drug-related death}} + \overbrace{\xi}^{\text{Exit rate}} + \overbrace{\mu_{350\_500}}^{\text{HIV-related death (350<CD4<500)}} + \overbrace{\lambda_{HCV}}^{\text{Force of HCV infection}} + \overbrace{\phi^{S}_{350\_500}}^{\text{Viral rebound during 2nd line therapy (350<CD4<500)}} + \overbrace{\omega^{U}_{350\_500}}^{\text{Viral supression}} \right) I^{M}_{350\_500_{2nd}}$$

$$\overbrace{\frac{dI^{M}_{200\_350_{2nd}}}{dt}}^{\text{Change in infecteds (200<CD4<350) on 2nd line treatment}} = \overbrace{\sigma_{200\_350} I^{M}_{200\_350_{Fail}}}^{\text{Commence 2nd line therapy (200<CD4<350)}} + \overbrace{\psi_{C} I^{A}_{200\_350_{2nd}}}^{\text{Spontaneous HCV clearance (acute, 200<CD4<350)}} + \overbrace{\omega^{U}_{200} I^{M}_{200_{2nd}}}^{\text{Viral supression during 2nd line therapy from CD4<200}} - \left(\overbrace{\mu}^{\text{Background death}} + \overbrace{\mu_{D}}^{\text{Drug-related death}} + \overbrace{\xi}^{\text{Exit rate}} + \overbrace{\mu_{200\_350}}^{\text{HIV-related death (200<CD4<350)}} + \overbrace{\lambda_{HCV}}^{\text{Force of HCV infection}} + \overbrace{\phi^{S}_{200\_350}}^{\text{Viral rebound during 2nd line therapy (200<CD4<350)}} + \overbrace{\omega^{U}_{200\_350}}^{\text{Viral supression}} \right) I^{M}_{200\_350_{2nd}}$$

$$\overbrace{\frac{dI^{M}_{200_{2nd}}}{dt}}^{\text{Change in infecteds (CD4<200) on 2nd treatment}} = \overbrace{\sigma_{200} I^{M}_{200_{Fail}}}^{\text{Commence 2nd line therapy (CD4<200)}} + \overbrace{\psi_{C} I^{A}_{200_{2nd}}}^{\text{Spontaneous viral clearance (acute, CD4<200)}} - \left(\overbrace{\mu}^{\text{Background death}} + \overbrace{\mu_{D}}^{\text{Drug-related death}} + \overbrace{\xi}^{\text{Exit rate}} + \overbrace{\mu_{200}}^{\text{HIV-related death (CD4<200)}} + \overbrace{\lambda_{HCV}}^{\text{Force of HCV infection}} + \overbrace{\phi^{S}_{200}}^{\text{Viral rebound during 2nd line therapy (CD4<200)}} + \overbrace{\omega^{U}_{200}}^{\text{Viral supression}} \right) I^{M}_{200_{2nd}}$$

The equations above describe the change in the number of people in each health state for HIV and HCV monoinfection. The complete mathematical model also includes equations for each possible HIV and HCV coinfection combination, with the terms of the ordinary differential equations amalgamating the appropriate HIV and HCV terms.

Assumptions for modelling secondary transmissions

The average age at which IDUs in Australia acquire HCV infection is their early to mid 20s [53, 67, 68] and it is likely that IDUs who acquire HIV infection would do so a few years thereafter on average. Approximately p_{MSM}=65% of IDUs with HIV are men who have sex with men, p_{F}=7% are females and the remaining p_{M}=28% are heterosexual males [54]. For IDUs with HCV infection, approximately p_{MSM}=5% of IDUs with HIV are men who have sex with men, p_{F}=32% are females and the remaining p_{M}=63% are heterosexual males [54]. It is assumed that the average number of long-term sexual partners each IDU has after acquiring infection is c_{reg}=3-5. In addition, it is assumed that each heterosexual IDU would have an

average of c_{cas}=5-10 casual short-term sexual partners (each with one penetrative act) after acquiring infection and male homosexual IDUs would have an average of c_{cas}=20-30 casual partners after acquiring infection. Most IDUs who share syringes tend to do so with sexual partners or close friends [69, 70]. Therefore, some of the potential partners are not susceptible to transmission because they are already infected (and probably the primary source for the case in question); this complexity is not considered here. It is assumed that HIV transmission rates are β_{HL}=0.01 for heterosexual transmission for long-term partnerships, β_{ML}=0.1 for male homosexuals for long-term partnerships, and per-act probabilities of HIV transmission during casual partnerships are β_{FM}=0.0005 for female-to-male transmission, β_{MF}=0.001 for male-to-female transmission, and β_{MM}=0.01 for male-to-male transmission during unprotected sex [71-77]. It is assumed that condom usage is q=80% [78], with efficacy of 95% [79-83]. HCV transmission per sexual contact is assumed to be $\beta_{HCV\text{-}a}$=0.1% per act and $\beta_{HCV\text{-}p}$=2% per long-term partnership [84-86].

The average fertility rate in Australia is f=1.93 babies per woman over her lifetime [87] and the median age of all mothers of births is ~31 years [88]. Based on the average age at infection and the relatively similar infection ages for HIV and HCV, it is assumed that 75% of a woman's births occur after she acquires infection [88]. The probability of mother-to-child transmission is $\beta_{HIV\text{-}MTCT}$=2% for HIV (with the use of antiretrovirals and Caesarean section) [89-92] and $\beta_{HCV\text{-}MTCT}$ =5% for HCV [93-95].

Therefore, the average number of secondary infections through sexual transmission or mother-to-child transmission per HIV infection is

$$s_{HIV} = p_{MSM}\left(c_{reg}\beta_{ML} + c_{cas}\beta_{MM}\right) + p_{M}\left(c_{reg}\beta_{HL} + c_{cas}\beta_{MF}\right) + p_{F}\left(c_{reg}\beta_{HL} + c_{cas}\beta_{FM} + 0.75\, f\, \beta_{HIV-MTCT}\right)$$

and the average number of secondary HCV transmissions expected per HCV infection is

$$s_{HCV} = p_{MSM}\left(c_{reg}\beta_{HCV-p} + c_{cas}\beta_{HCV-a}\right) + p_{M}\left(c_{reg}\beta_{HCV-p} + c_{cas}\beta_{HCV-a}\right) + p_{F}\left(c_{reg}\beta_{HCV-p} + c_{cas}\beta_{HCV-a} + 0.75\, f\, \beta_{HCV-MTCT}\right).$$

Substituting parameter estimates leads to 0.44 and 0.11 secondary HIV and HCV cases, respectively, for each primary infection.

Appendix B: Input data and assumptions for epidemic model

Mathematical models of epidemiology heavily rely on the behavioural, social, epidemiological, clinical, and biological data available. They are only as good as the quality of input data provided. For this report, sufficient data was accessible from various sources to inform model inputs. However, it should be noted that if the data are biased, particularly if trends in data over time are not truly reflective of the real world population, then this will directly bias the results and implications of the model. To compensate for potential bias in reported data, uncertainty with some parameters, and intrinsic heterogeneity associated with some factors of our model, we conducted rigorous uncertainty and sensitivity analyses. This involved defining a probability density function for each model parameter, instead of using point estimates, based on plausible ranges established from data published in the international peer-reviewed literature and Australian reports and databases. Exhaustive searching of the literature and other data sources was carried out. All inputs and assumptions of the epidemic model, including justifications and data sources, are provided in Tables B.1 to B.3. Table B.1 lists demographic, epidemiological, and behavioural parameters; Table B.2 lists HIV disease parameters; and Table B.3 lists HCV disease parameters.

Latin Hypercube Sampling [96-102], a type of stratified Monte Carlo sampling, was employed to stratify the defined probability density functions of each parameter (into N=10,000 equiprobable intervals) and the value of each input parameter was randomly chosen for a given simulation of the model. Each input value was used only once in the entire sampling analysis. Thus, we simulated the epidemics of HIV and HCV among Australian IDUs 10,000 times, producing 10,000 epidemic trajectories. Distributions of the outcome variables (e.g. incidence, prevalence, and the number of people in each health state over time) were then produced from the 10,000 model simulations. The appropriateness of each model simulation was determined by comparing (through a standard χ^2 statistic) the model-based incidence and prevalence estimates of HIV and HCV with prevalence and notifications estimates from annual NSP survey data [54] and Australia's surveillance system [6, 23]. A form of Monte Carlo filtering was performed [103, 104]: simulations that were ranked in the top 1,000 best fits over the period 1999-2008 for both HIV and HCV epidemics were then retained and other simulations were excluded from further analysis. Results of the model calibration are shown in the epidemiological impact chapters. Sensitivity analyses were then

conducted to study how the uncertainty in the output of the model can be apportioned to sources of uncertainty in the model inputs [96, 105]. The techniques employed were calculation of partial rank correlation coefficients (PRCCs) [96-99, 106-117], calculation of standardised regression coefficients between model parameters and outcomes [118], and factor prioritisation by reduction of variance (calculating first order sensitivity indices) [119-130]. Sampling of parameter distributions and all sensitivity analyses were performed with the SaSAT software package [131].

Table B.1: Demographic, epidemiological and behavioural parameters

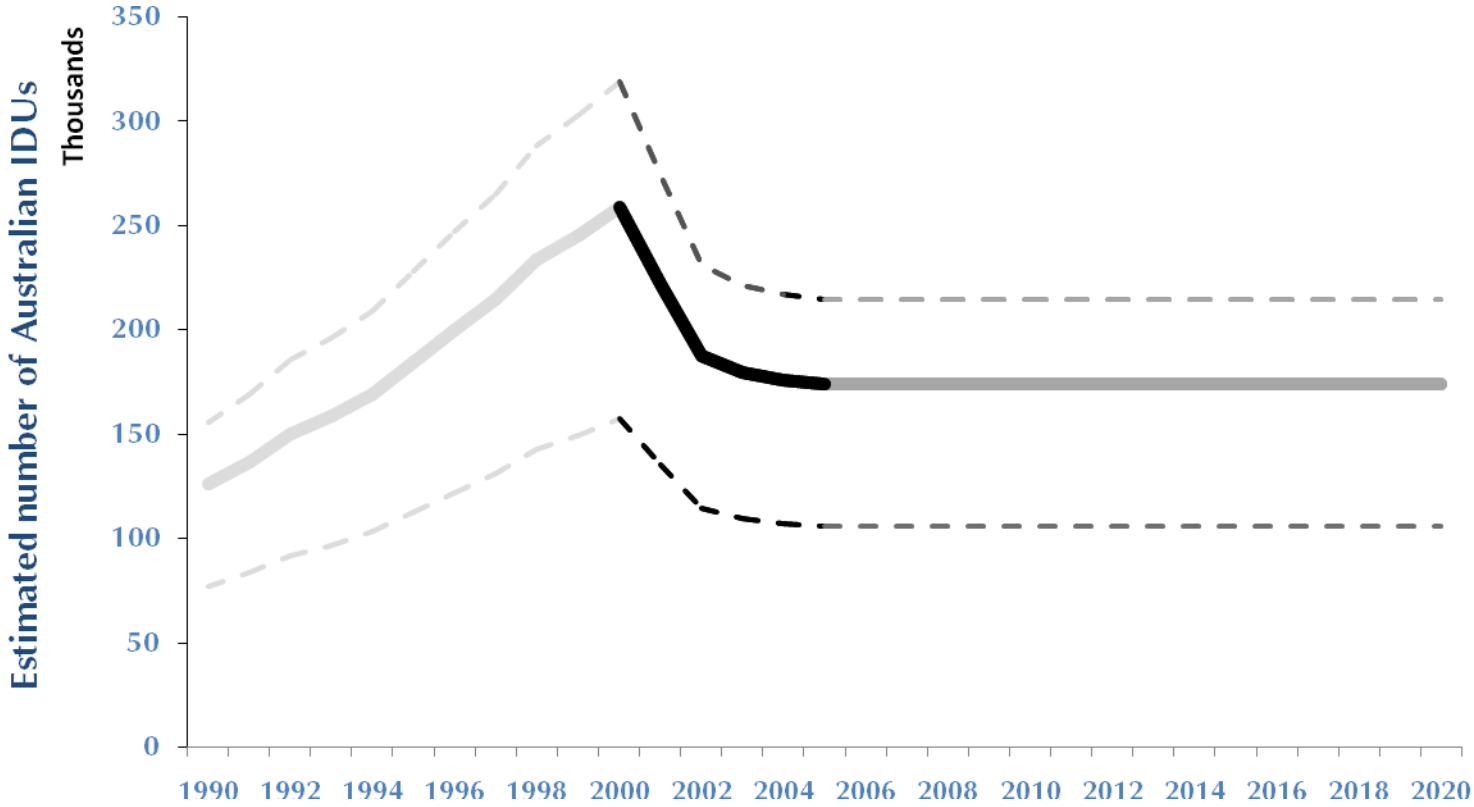
Symbol	Description		Values	References
N	Population size of IDUs	Australia	173,500 (105,000-236,500)	[54, 132], *a*
		ACT, NSW, NT, Qld, SA, Tas, Vic, WA, Indigenous		
P	Total number of syringes distributed per year			*b*
Epidemiology parameters				
p_0^{HIV}	Prevalence of HIV among IDUs	Australia	1.17% (0.90- 1.40%)	*c*
		ACT	0.12% (0.10- 1.10%)	
		NSW	1.49% (1.10- 2.00%)	
		NT	0.72% (0.1 0- 1.10%)	
		Qld	1.64% (1.10- 2.00%)	
		SA	0.86% (0.50- 1.00%)	
		Tas	0.86% (0.10- 4.00%)	
		Vic	0.52% (0.40- 0.60%)	

		WA	0.43% (0.10- 0.80%)	
		Indigenous	1.45% (1.10- 1.93%)	
p_0^{HCV}	Prevalence of HCV among IDUs			d
π	Average rate of people entering IDU population			e
$1/\xi$	Average time of injecting drugs		8-17 years	[54, 133]
$1/\xi_L$	Average time it takes IDUs with liver-related disease to stop injecting		0.5-1 year	Experimental variable
μ	Annual background death rate (not drug-related or disease-related)		0.5-0.7%	f
ω	Percentage of syringes distributed that are not used		0.5-1%	Experimental variable
Behavioural parameters				
m	Average size of a sharing group		2-2.5	Experimental variable
n	Average number of injections per IDU per year (weighted average over all injecting frequency stratifications)			g

s	Proportion of IDUs who share syringes			h
q	Proportion of injections that are shared for IDUs who share syringes	Australia	13-17%	[54]
		ACT	10-14%	
		NSW	10-14%	
		NT	15-19%	
		Qld	11-14%	
		SA	12-16%	
		Tas	10-14%	
		Vic	13-17%	
		WA	16-20%	
		Indigenous	15-25%	Experimental variable
δ_s	Average number of times each shared syringe is used before disposal		2.6-2.8	[54]
δ_p	Average number of times each non-shared syringe is used before disposal		2.1 (1.2-2.9)	i

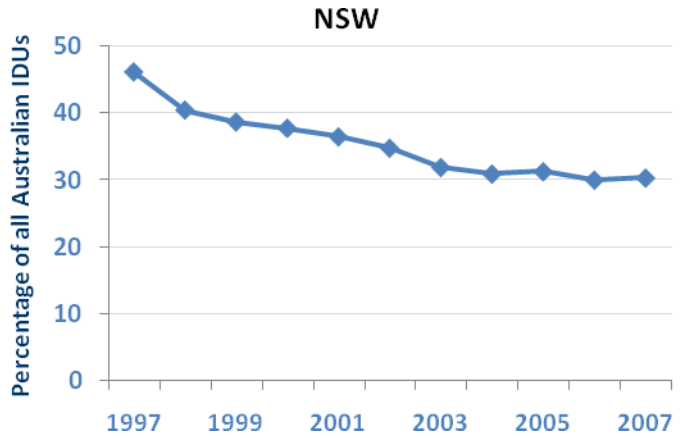
Syringe cleaning parameters				
$p_c^{syringe}$	Proportion of syringes used by multiple people that are cleaned before re-use		5-10%	Experimental variable
p_c^{other}	Proportion of times other equipment (spoons, tourniquets, etc) that is used by multiple people is cleaned before re-use		1-5%	Experimental variable
$\varepsilon_c^{syringe}$	Effectiveness of syringe cleaning	HIV	60-75%	[134-136]
		HCV	25-35%	[137-141]
ε_c^{other}	Effectiveness of cleaning other equipment (spoons, tourniquets etc)	HIV	70-80%	Experimental variable
		HCV	50-70%	

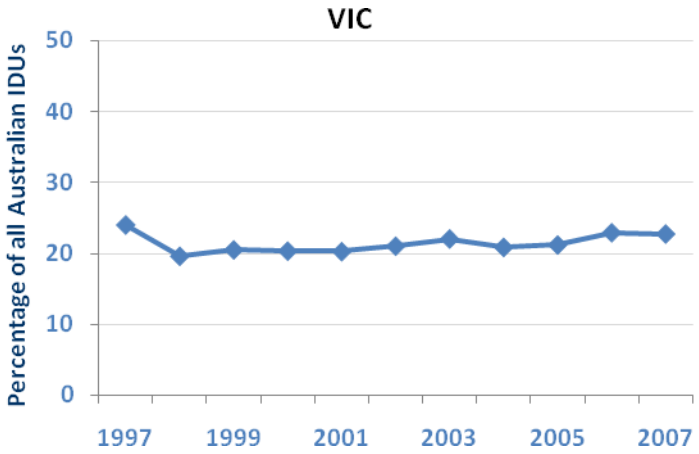
a	Using the same form for the change in the number of IDUs in Australia as that estimated by Law et al. [142], and adjusting slightly to the magnitude recently estimated by Mathers et al. [132], we assume that the IDU population in Australia has changed as shown below (the dashed regions refer to lower and upper bounds of confidence):

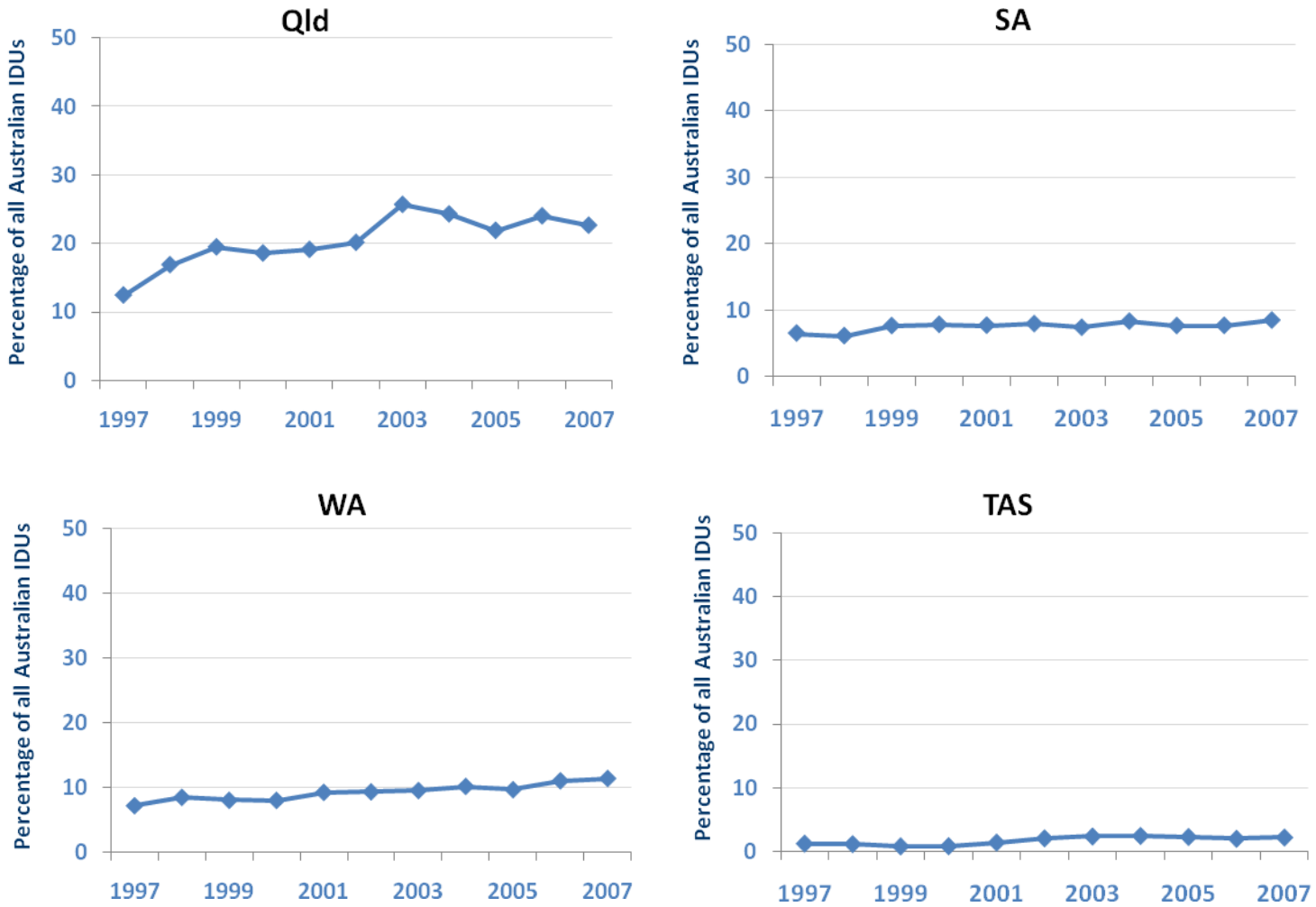


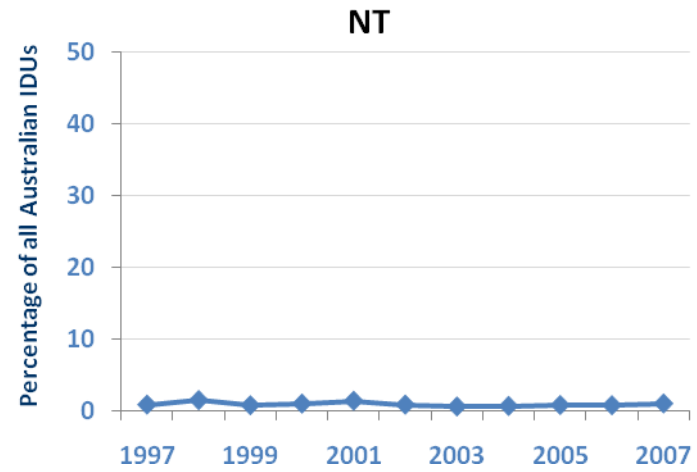
The number of IDUs in each state and territory has changed over time. We use numerous IDU population indicators to estimate the proportion of all Australian IDUs in each jurisdiction. The indicators we use are proportion of regular heroin users [143], proportion of accidental deaths due to opioids among those aged 15-54 years [144], percentage of Australian population in each

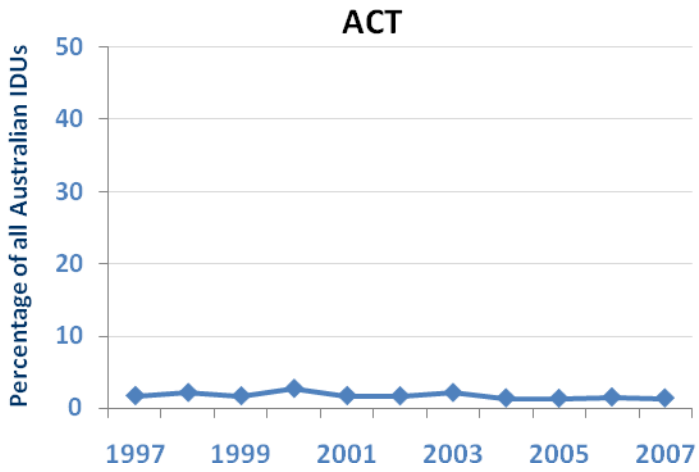
state/territory [145], proportion of national syringes distributed in each state, proportion of national HCV diagnoses in each state/territory through NSPs [54, 146], proportion of all sentenced prisoners convicted of possession or use of drugs in each state/territory [147], proportion of pharmacotherapy clients receiving pharmacotherapy treatment [148], proportion of all drugs consumer and provider arrests [149], and proportion of amphetamine consumer and provider arrests [149]. For the Aboriginal and Torres Strait Islander population, the proportion of NSP survey respondents that were Indigenous was used. The average of these indicators for the proportion of all Australian IDUs that are in each jurisdiction is shown below:

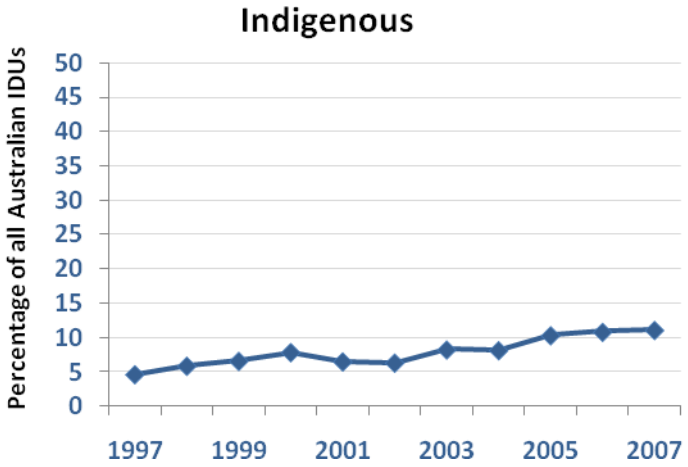




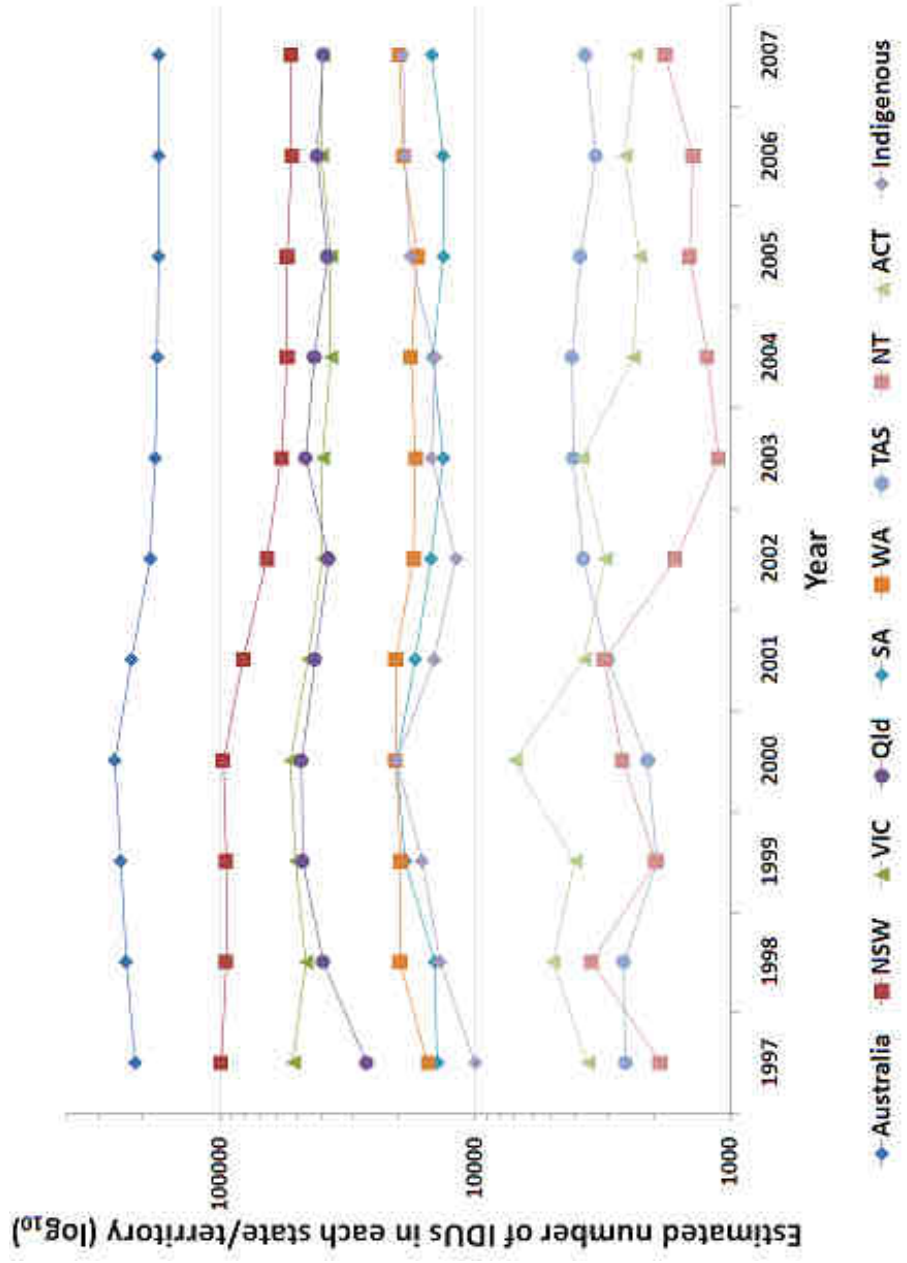

Qld
SA
WA
TAS
Percentage of all Australian IDUs
0
10
20
30
40
50
1997
1999
2001
2003
2005
2007



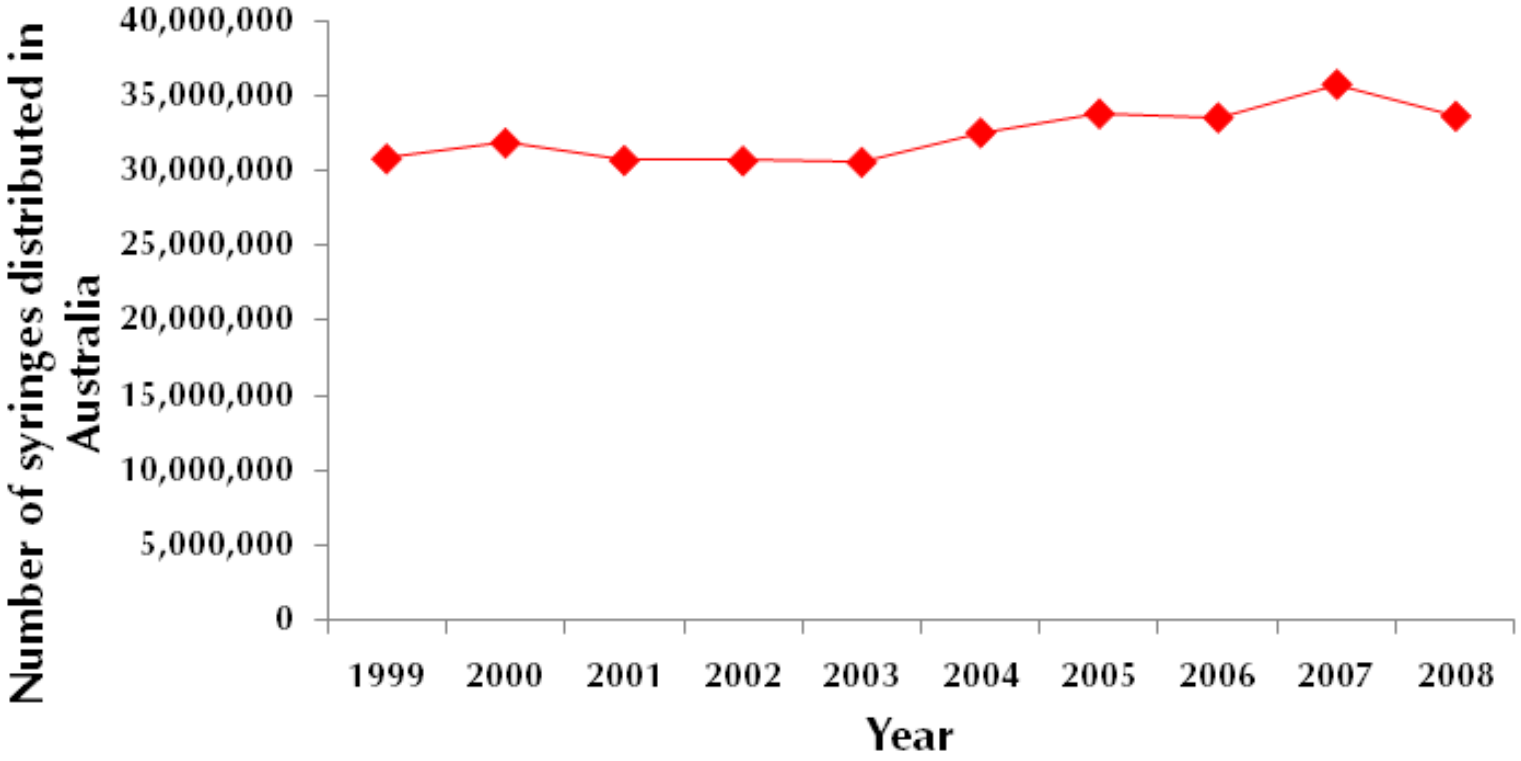




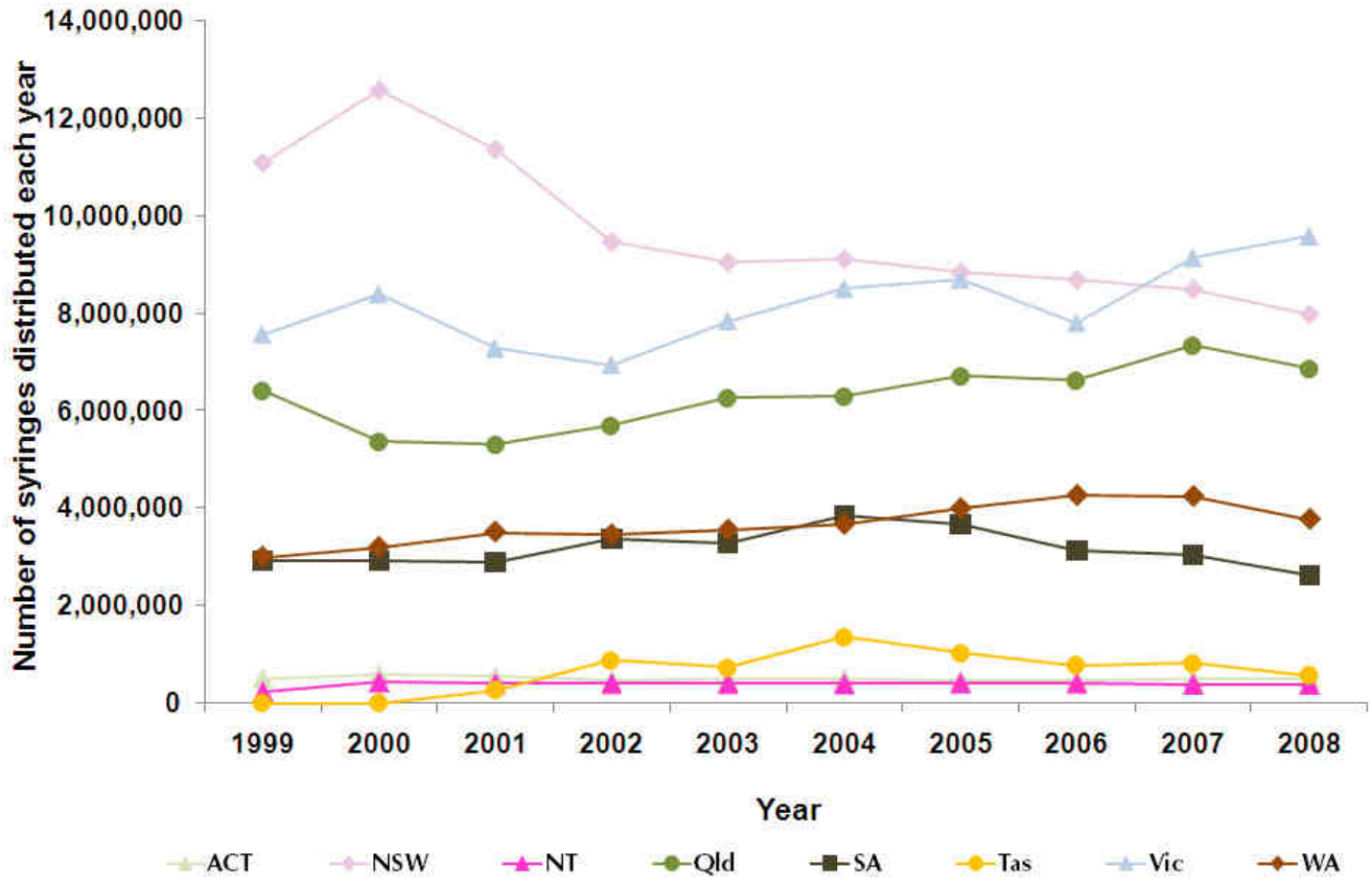
According to the average of these indicators (above) the estimated number of IDUs in Australia, in each state/territory, and in the Indigenous population is shown below:


Estimated number of IDUs in each state/territory (log10)
100000
10000
1000
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Australia
NSW
VIC
Qld
SA
WA
TAS
NT
ACT
Indigenous

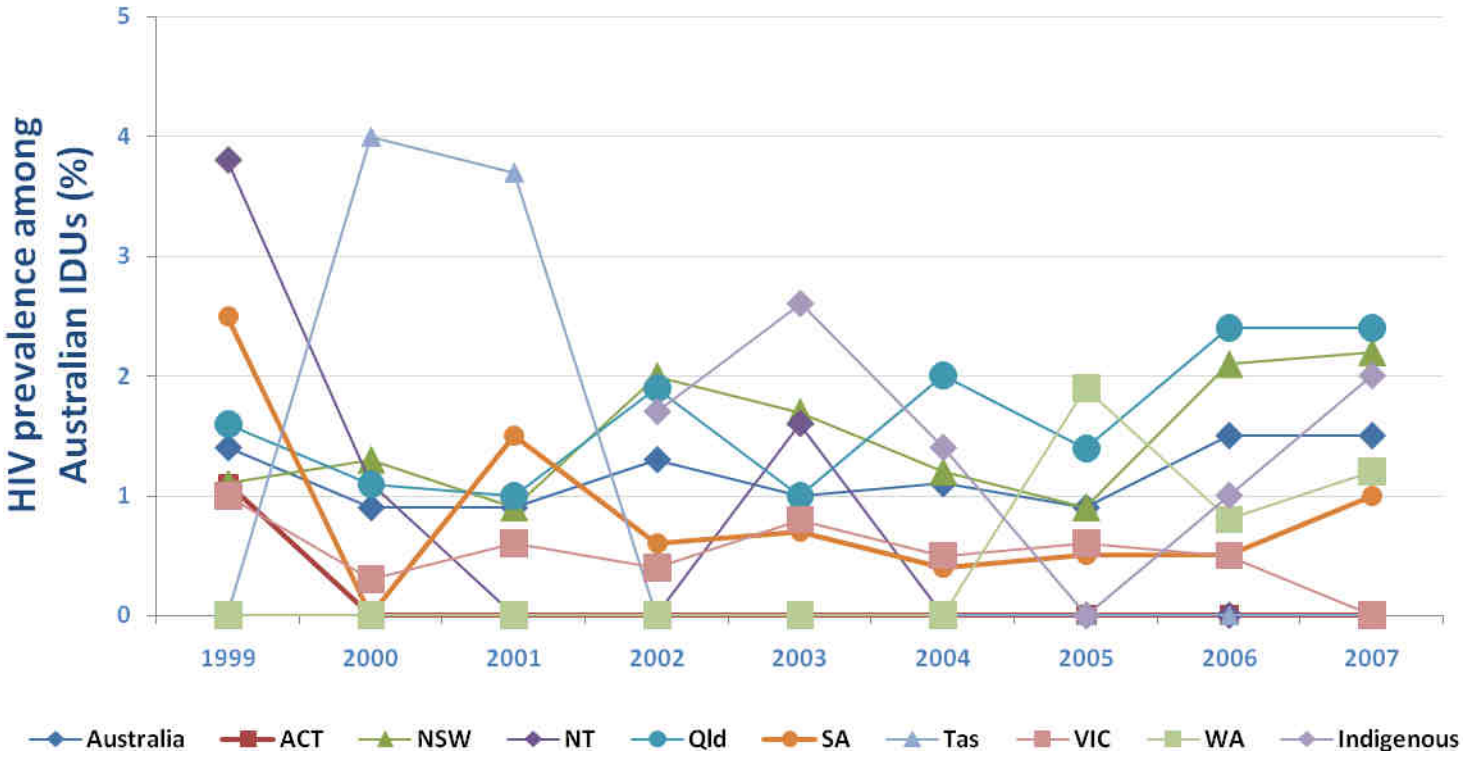
b	The total number of syringes distributed each year in Australia is shown below:

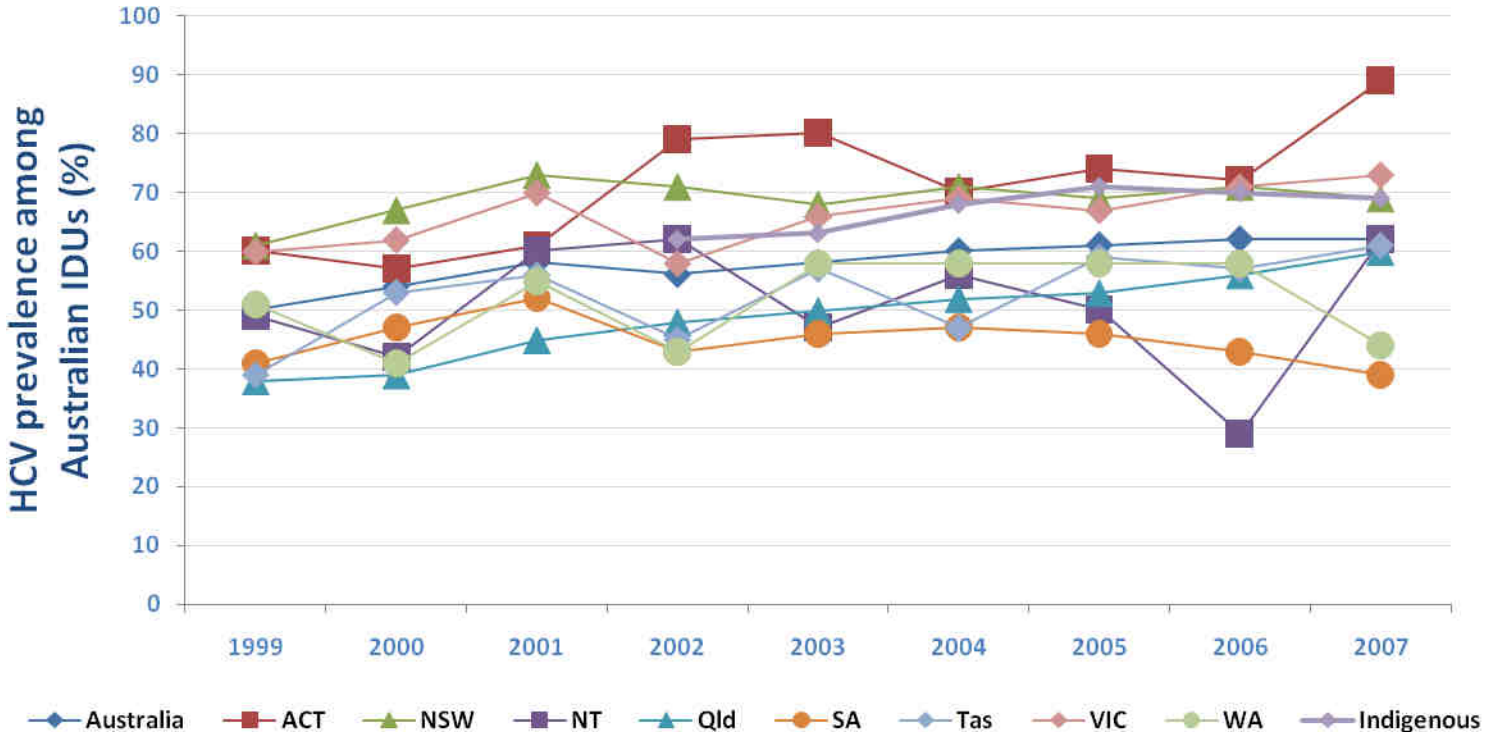


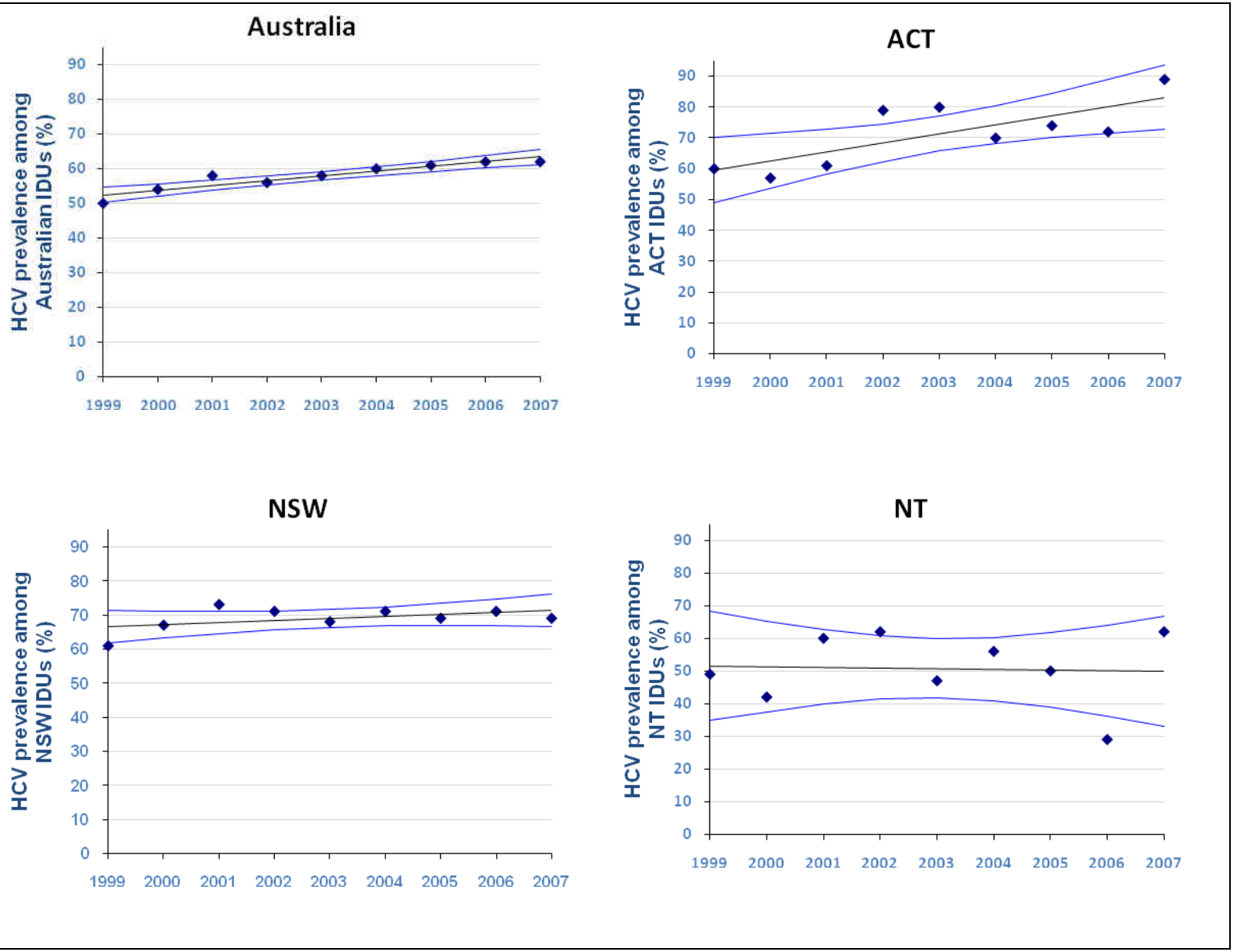
This is split across the state and territory jurisdictions as follows:

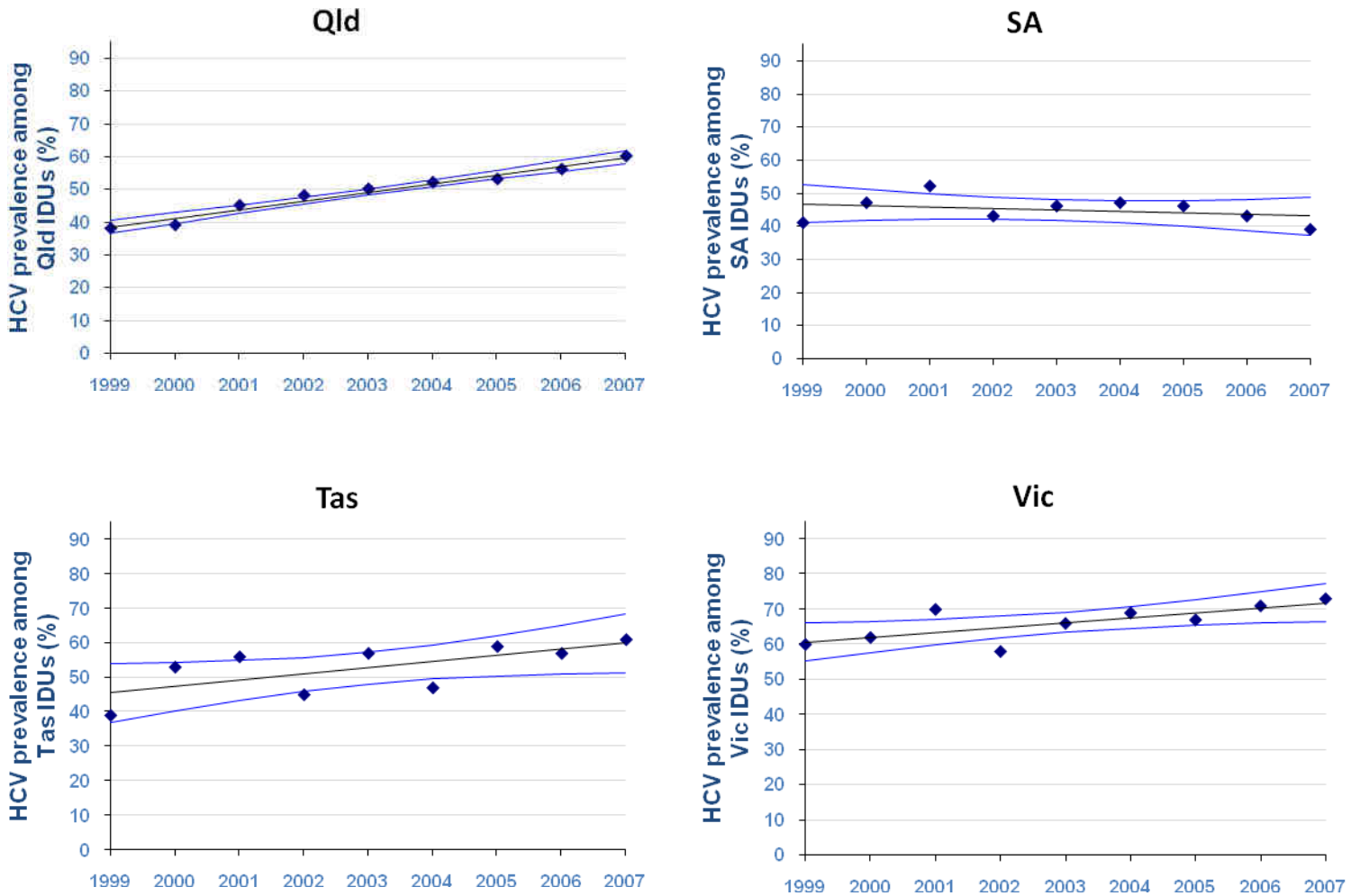


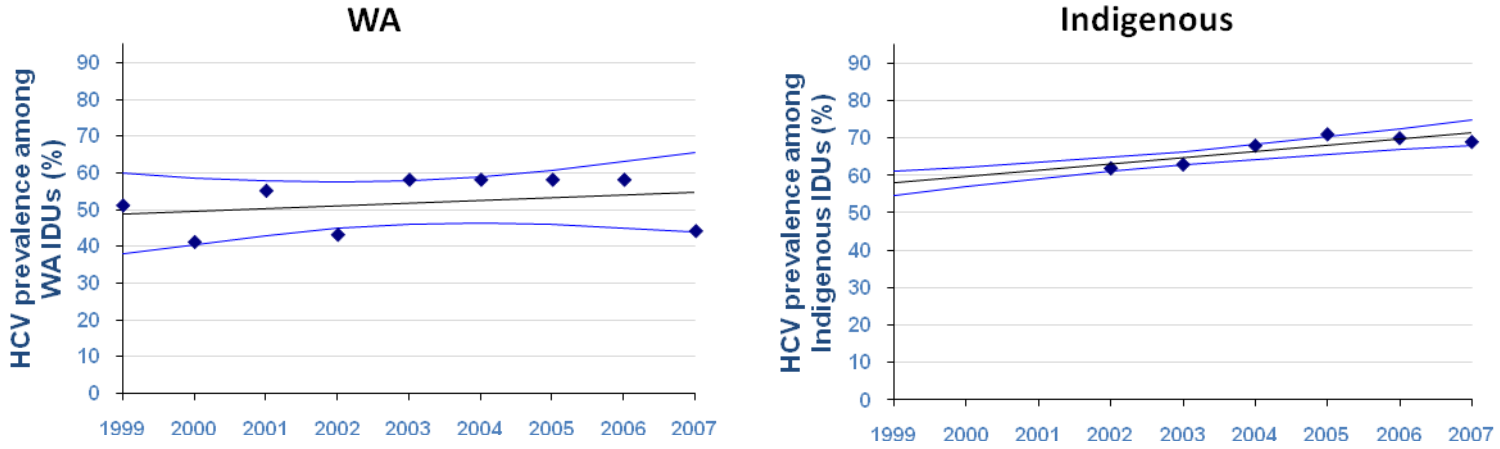
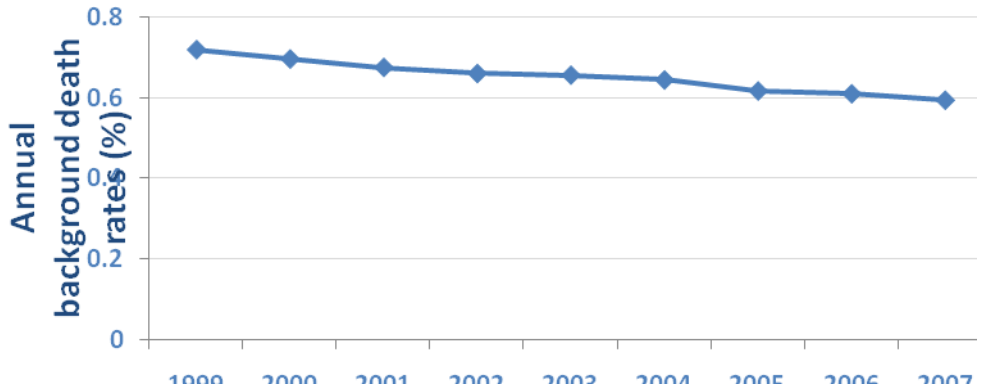
c	Below is a summary of HIV prevalence estimates among IDUs in each state and territory according to NSP survey data [54]. This data is consistent with sentinel and non-sentinel site data. Because of the low number of HIV cases detected, there is considerable variation. But there is no clear trend for changes in prevalence over time. Therefore, we assume constant prevalence and calculate a weighted average (weighted by sample sizes each year) for the prevalence of HIV among IDUs in each state/territory. The weighted averages appear in the main table (lower bounds are adjusted to be at least 0.1%).

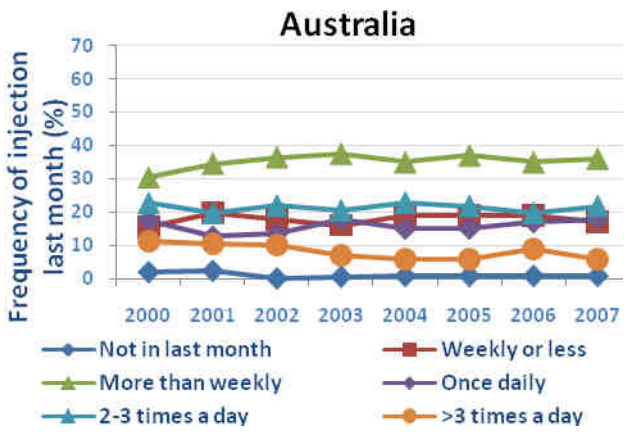
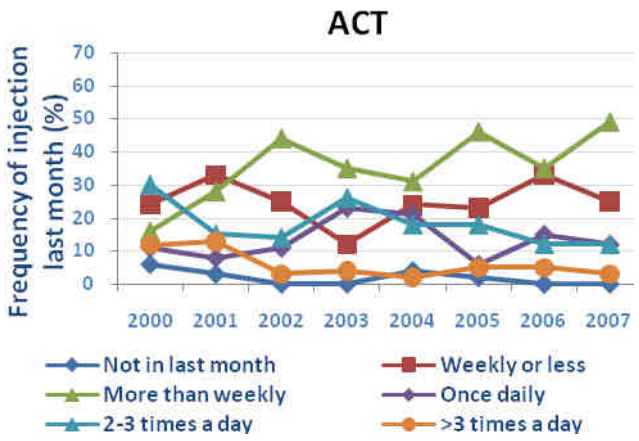


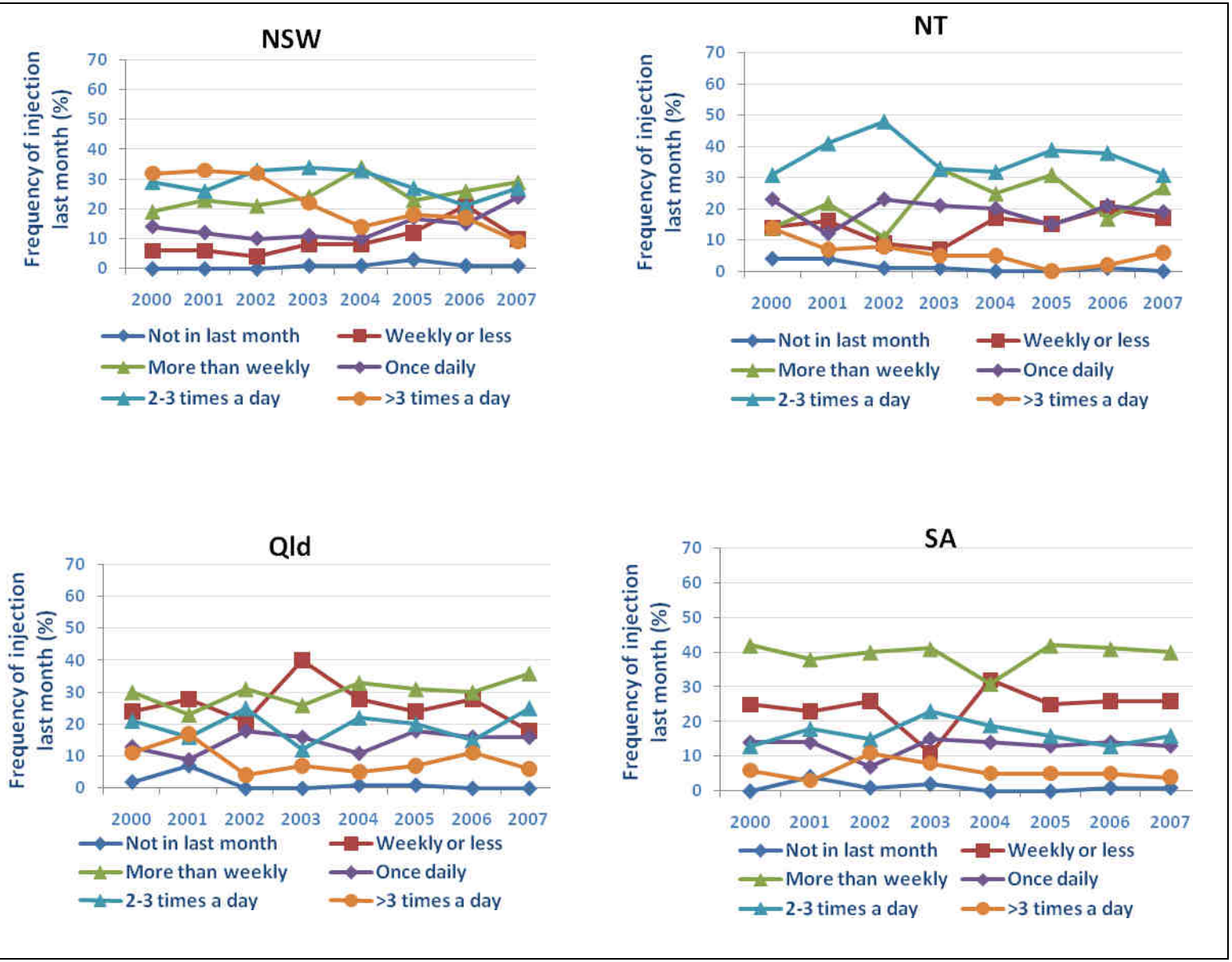
d	Below is a summary of HCV prevalence estimates among IDUs in each state and territory according to NSP survey data [54]. This data is consistent with sentinel and non-sentinel site data.  There appears to be an overall (slightly) increasing trend in HCV prevalence over time. We used regression analysis to determine the best-fitting straight line through the data. Mean and 95% confidence intervals for the trend in prevalence for each state/territory were calculated and are presented in the figures below.

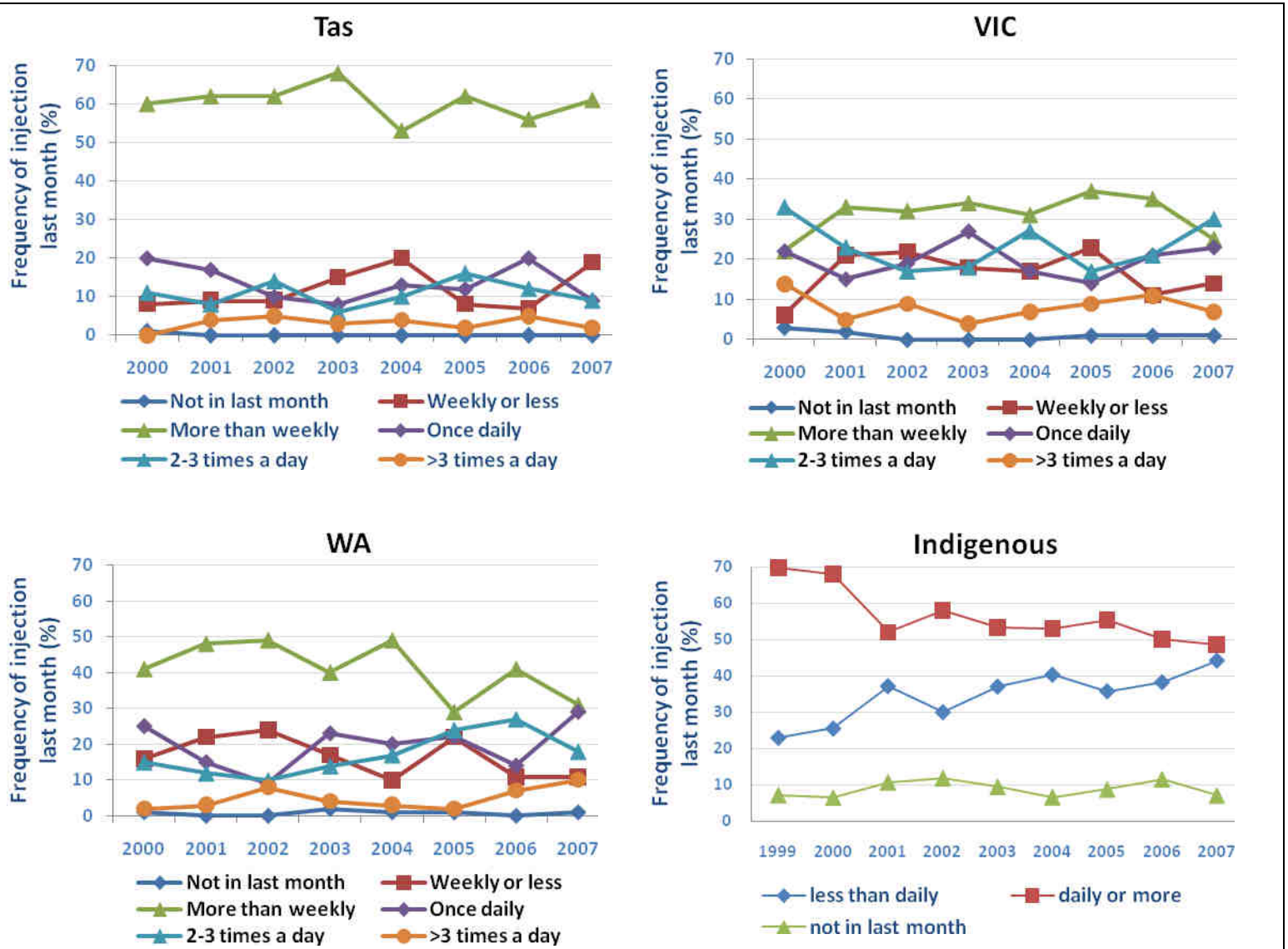

Australia
HCV prevalence among Australian IDUs (%)
ACT
HCV prevalence among ACT IDUs (%)
NSW
HCV prevalence among NSW IDUs (%)
NT
HCV prevalence among NT IDUs (%)
0
10
20
30
40
50
60
70
80
90
1999
2000
2001
2002
2003
2004
2005
2006
2007


Qld
HCV prevalence among Qld IDUs (%)
SA
HCV prevalence among SA IDUs (%)
Tas
HCV prevalence among Tas IDUs (%)
Vic
HCV prevalence among Vic IDUs (%)
0
10
20
30
40
50
60
70
80
90
1999
2000
2001
2002
2003
2004
2005
2006
2007

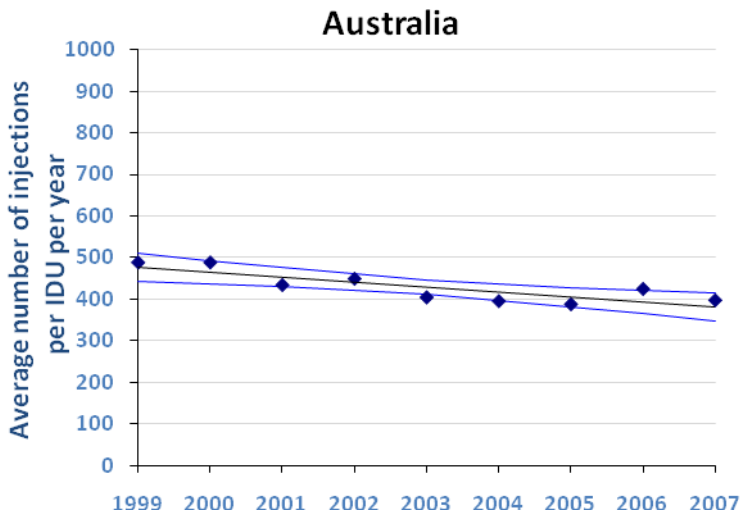
	
e	The rate of entry of new IDUs into the population is determined dynamically based on the exit rate (ξ) and mortality rates to ensure that the total population size matches the assumed size (see footnote *a*).
f	From the Australian Demographic Statistic report [145, 150], the standardised annual death rates among Australians over time is shown below: 

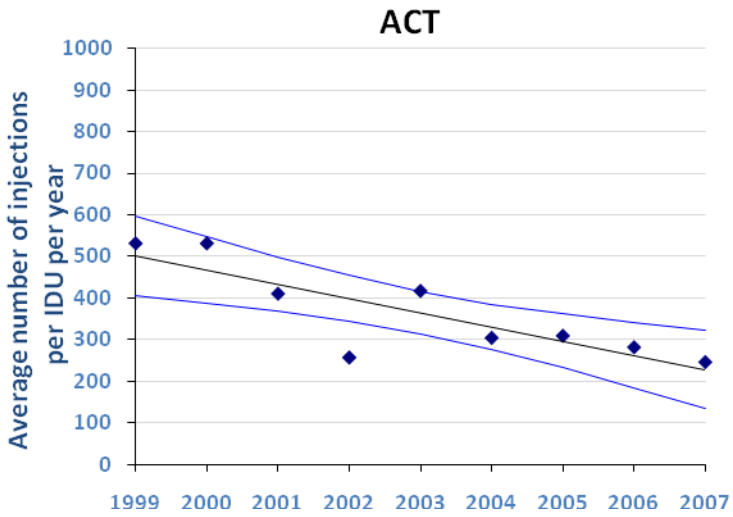
	The annual background death rate is around 0.6-0.7%. From the D:A:D study [151], the CVD, liver disease, renal or non-AIDS related death rate was estimated to be 0.5 (0.488-0.59%) per year. The illicit drug use expert group conducted a systematic review of mortality rates among IDUs [152] and reported that Australia had the lowest mortality rate of any world region, where data were available, and their mortality rate estimate was 0.86% (0.83-0.89%) per year [152]. The Victorian Injecting Cohort Study (VICS) estimated the overall annual mortality rate among IDUs as 0.83% (0.56-1.21%) [133]. This includes drug overdose mortality and additional drug-related mortality rates. Therefore, we assume a range of 0.86% (0.56-1.21%) per year, to cover all possible uncertainty. Several longitudinal studies also estimated the rates of mortality of patients who commence opioid maintenance treatment [153, 154]. The overall mortality rate among those patients was 0.88% among patients who receive the treatment with drug-overdose mortality rate of 0.35% and AIDS-related mortality rate of 0.059%. Therefore, we assume 0.5-0.7% for an annual background death rate.
g	From the Illicit Drug Reporting System (IDRS) [56-62], the proportions of IDUs who did not inject in the last month, injected weekly or less, injected more than weekly, injected once daily, injected two to three times per day, and injected more than three times per day were estimated over time as shown below:  

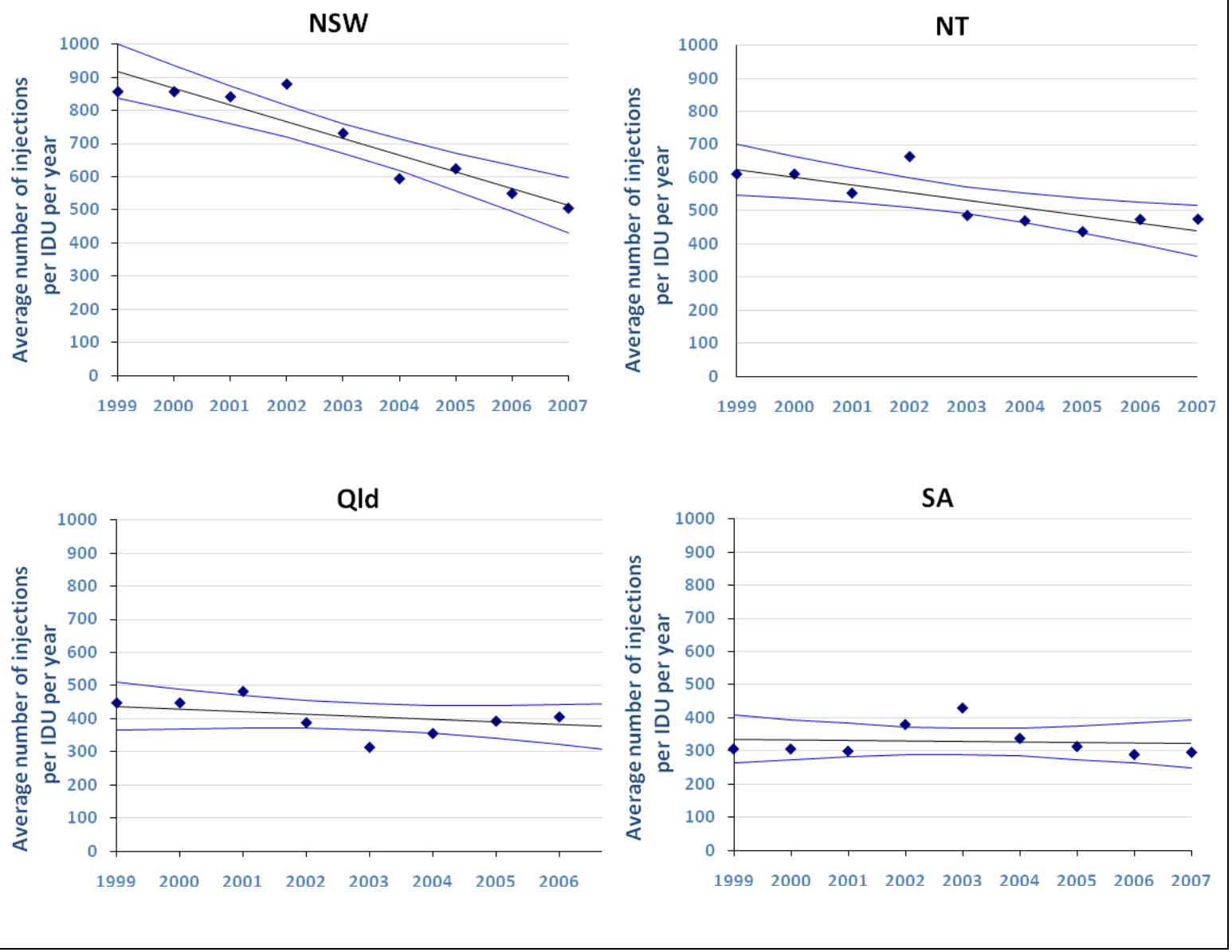

NSW
Frequency of injection last month (%)
70
60
50
40
30
20
10
0
2000 2001 2002 2003 2004 2005 2006 2007
Not in last month
Weekly or less
More than weekly
Once daily
2-3 times a day
>3 times a day
NT
Frequency of injection last month (%)
70
60
50
40
30
20
10
0
2000 2001 2002 2003 2004 2005 2006 2007
Not in last month
Weekly or less
More than weekly
Once daily
2-3 times a day
>3 times a day
Qld
Frequency of injection last month (%)
70
60
50
40
30
20
10
0
2000 2001 2002 2003 2004 2005 2006 2007
Not in last month
Weekly or less
More than weekly
Once daily
2-3 times a day
>3 times a day
SA
Frequency of injection last month (%)
70
60
50
40
30
20
10
0
2000 2001 2002 2003 2004 2005 2006 2007
Not in last month
Weekly or less
More than weekly
Once daily
2-3 times a day
>3 times a day

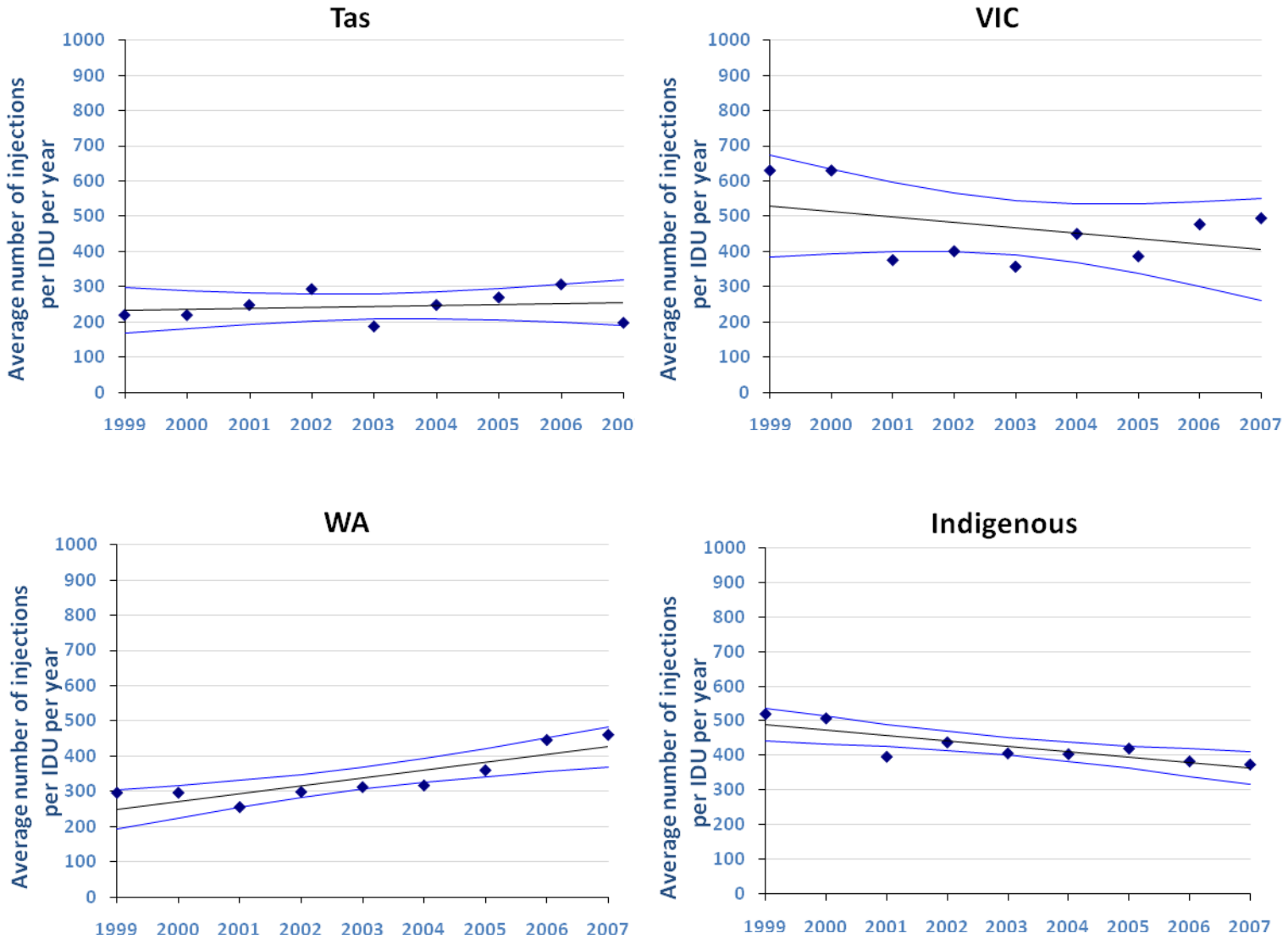

Tas
Frequency of injection last month (%)
70
60
50
40
30
20
10
0
2000 2001 2002 2003 2004 2005 2006 2007
Not in last month
Weekly or less
More than weekly
Once daily
2-3 times a day
>3 times a day
VIC
Frequency of injection last month (%)
70
60
50
40
30
20
10
0
2000 2001 2002 2003 2004 2005 2006 2007
Not in last month
Weekly or less
More than weekly
Once daily
2-3 times a day
>3 times a day
WA
Frequency of injection last month (%)
70
60
50
40
30
20
10
0
2000 2001 2002 2003 2004 2005 2006 2007
Not in last month
Weekly or less
More than weekly
Once daily
2-3 times a day
>3 times a day
Indigenous
Frequency of injection last month (%)
70
60
50
40
30
20
10
0
1999 2000 2001 2002 2003 2004 2005 2006 2007
less than daily
daily or more
not in last month

We assume that IDUs who did not inject in the last month inject an *average* of once every two months; those who inject weekly or less inject an *average* of once every fortnight; those who inject more than weekly inject once every five days on *average*; IDUs who inject two to three times per day inject an *average* of 2.5 times per day; and those who inject more than three times each day inject an *average* of four to five times per day. Among Aboriginal and Torres Strait Islander IDUs, we assume that those who did not inject during the last month inject an *average* of once every two months; those who inject less than daily inject an *average* of once every ten days; and those who inject daily or more inject an *average* of two times per day. Based on those estimates, we calculated the average number of injections per IDU per year as a weighted average. Mean and 95% confidence intervals for the trend in injecting frequency for each state/territory was calculated as follows:

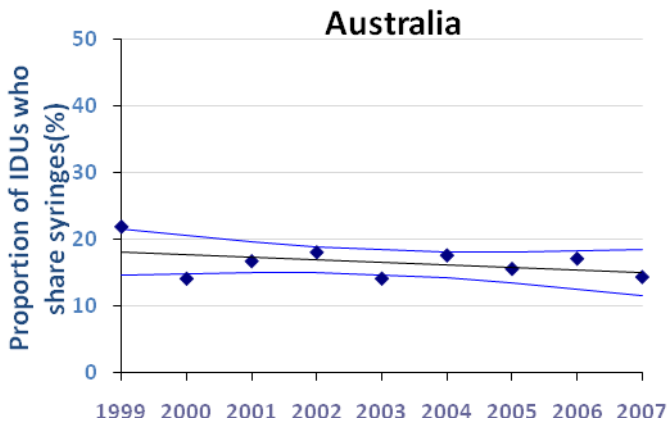


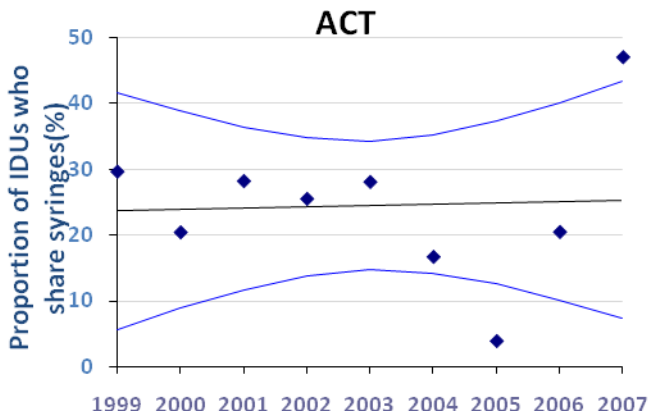


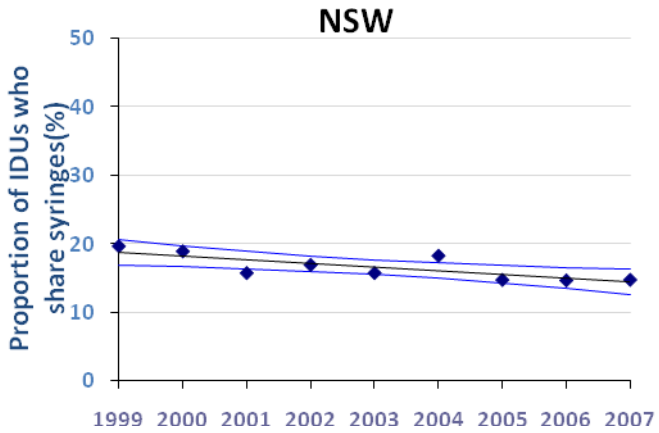

NSW
NT
Qld
SA
Average number of injections per IDU per year
0
100
200
300
400
500
600
700
800
900
1000
1999
2000
2001
2002
2003
2004
2005
2006
2007

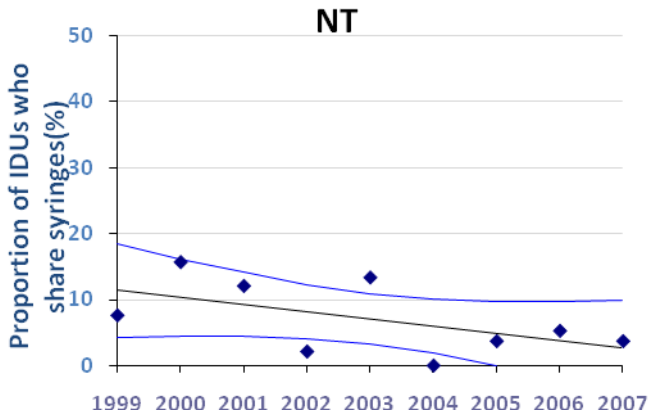

Tas
VIC
WA
Indigenous
Average number of injections per IDU per year
0
100
200
300
400
500
600
700
800
900
1000
1999
2000
2001
2002
2003
2004
2005
2006
2007

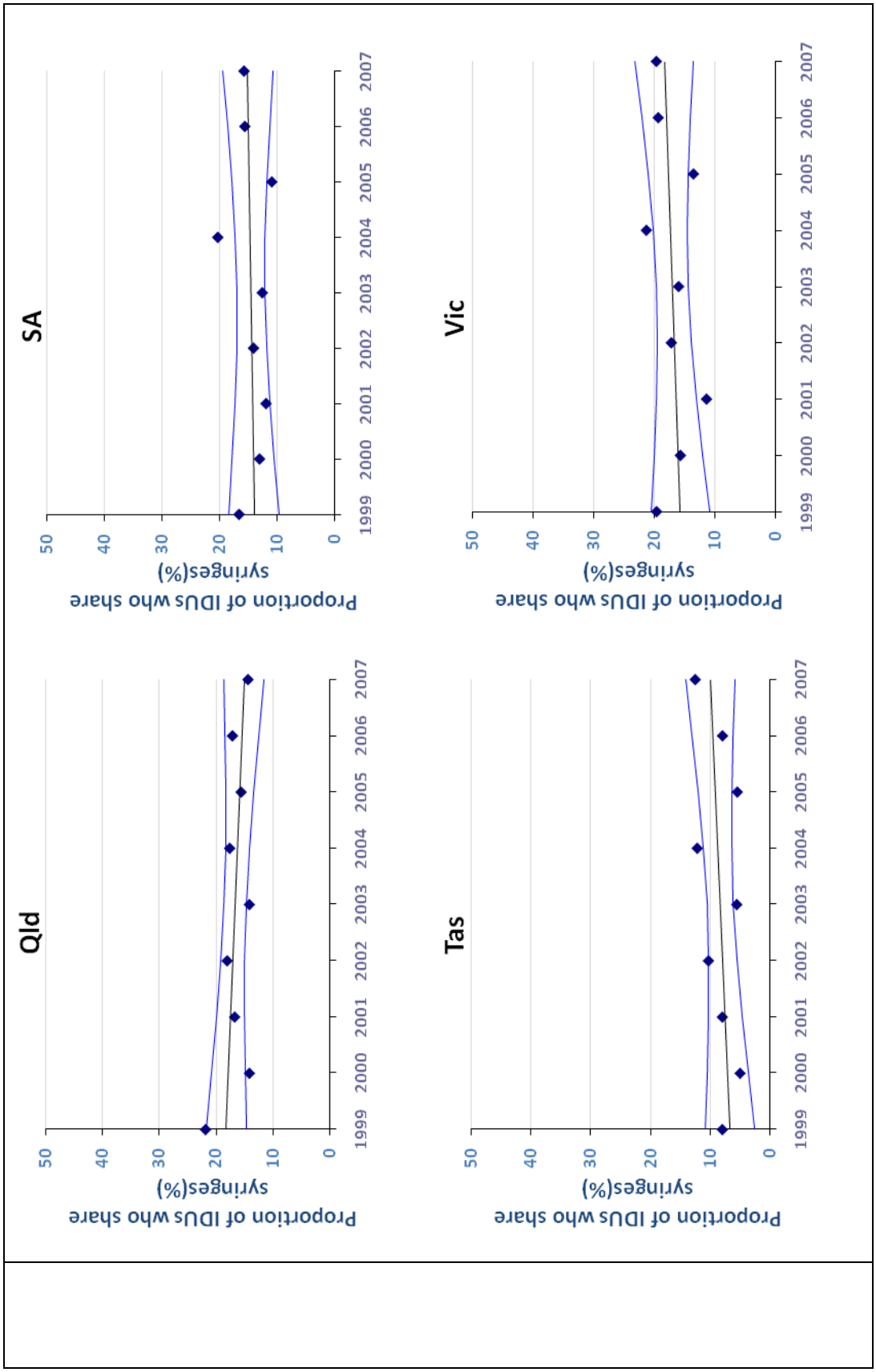
h	Sharing rates for each state/territory were obtained from the Australian NSP Survey [54]. Regression analysis determined the mean and 95% confidence intervals for the trend in sharing rates over time:










SA
Vic
Qld
Tas
Proportion of IDUs who share syringes(%)
0
10
20
30
40
50
1999
2000
2001
2002
2003
2004
2005
2006
2007

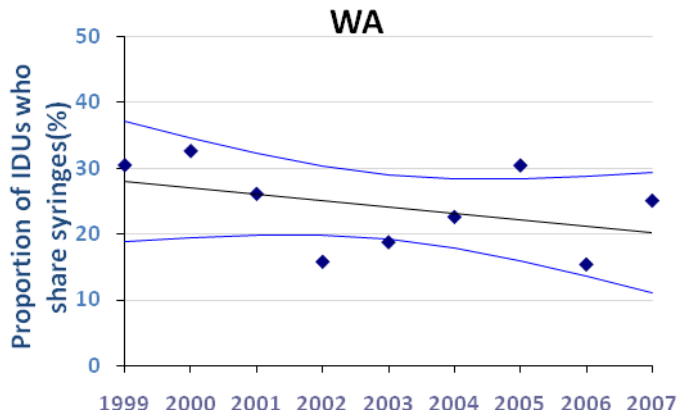
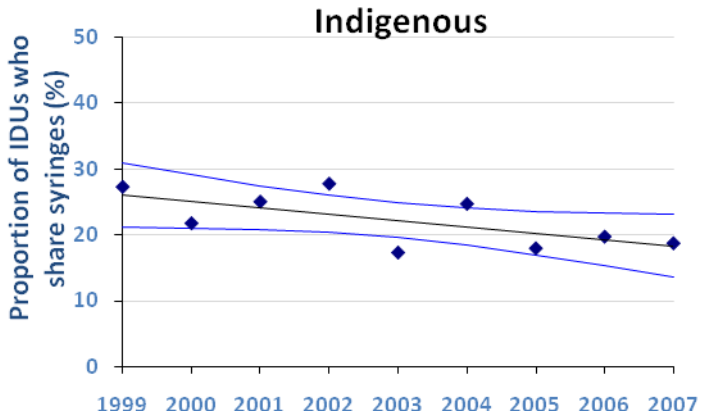
	 
i	We estimate the number of times each syringe is used for non-shared injections according to the following mathematical argument which is also based on syringe distribution and behaviour data. If P syringes are distributed each year and a proportion ω of all syringes are not used, then $P(1-\omega)$ syringes are used. If a syringe is used δ_p times before disposal for personal (unshared) injections, then the number of syringes used for individual injecting episodes among non-sharing IDUs is $nN(1-s)/\delta_p$. Similarly, the total number of syringes used for individual injecting among all sharing IDUs is $n(1-q)sN/\delta_p$ and the total number of syringes used in sharing events is $nqsN/\delta_s$. Therefore, $P(1-\omega) = nN(1-s)/\delta_p + n(1-q)sN/\delta_p + nqsN/\delta_s = nN\left[\delta_s - sq\left(\delta_s - \delta_p\right)\right]/\delta_p\delta_s$ defines a relationship between the total number of syringes distributed and the use of syringes. Changes in the number of syringes distributed are likely to change any, or all, of the following factors: the proportion of syringes that remain unused (ω), the proportion of injections that are shared (q), or the average number of times each syringe is used (in shared (δ_S) or individual (non-shared) injections (δ_P)). Substituting the known values and solving for δ_p leads to an average of 2.1 (1.2, 2.9) uses of non-shared syringes.

Table B.2: HIV disease parameters

Symbol	Description	Values	References
Transmission			
β_{HIV}	Transmission probability of HIV per injection with a contaminated syringe	0.6-0.8%	[155, 156], *a*
Disease progression of undiagnosed individuals without treatment			
$1/\tau_{CD4>500}$	Average time for **undiagnosed (without ART)** HIV-infected individuals to progress from CD4 count **>500** to CD4 count **350-500**	4.09 (3.79-4.42) years	[157], *b*
$1/\tau_{350<CD4<500}$	Average time for **undiagnosed (without ART)** HIV-infected individuals to progress from CD4 count **350-500** to CD4 count **200-350**	1.96 (1.81-2.13) years	
$1/\tau_{200<CD4<350}$	Average time for **undiagnosed (without ART)** HIV-infected individuals to progress from CD4 count **200-350** to CD4 count **<200**	1.96 (1.81-2.13) years	
Disease progression of HIV-infected individuals on treatment (detectable viral load)			
$1/\omega^{D}_{CD4>500}$	Average time for HIV-infected individuals **on ART** with **detectable viral load** to progress from CD4 count **>500** to CD4 count **350-500**	10.99 (1.32-12.00) years	[158] , *c*

$1/\omega^{D}_{350<CD4<500}$	Average time for HIV-infected individuals **on ART** with **detectable viral load** to progress from CD4 count **350-500** to CD4 count **200-350**	6.38 (0.48-8.00) years	
$1/\omega^{D}_{200<CD4<350}$	Average time for HIV-infected individuals **on ART** with **detectable viral load** to progress from CD4 count **200-350** to CD4 count **<200**	8.88 (0.51-10.00) years	
Disease progression on treatment (undetectable viral load)			
$1/\omega^{U}_{CD4<200}$	Average time for HIV-infected individuals **on ART** with **undetectable viral load** to progress from CD4 count **<200** to CD4 count **200-350**	2.80 (2.33-3.58) years	[159] , *d*
$1/\omega^{U}_{200<CD4<350}$	Average time for HIV-infected individuals **on ART** with **undetectable viral load** to progress from CD4 count **200-350** to CD4 count **350-500**	1.42 (0.90-3.42) years	
$1/\omega^{U}_{350<CD4<500}$	Average time for HIV-infected individuals **on ART** with **undetectable viral load** to progress from CD4 count **350-500** to CD4 count **>500**	2.20 (1.07-7.28) years	
Commencement of treatment			
$\eta^{D/U}_{CD4>500}$	Proportion of individuals with CD4 count **>500** that commence treatment for HIV each year	0.2	Experimental variable
$\eta^{D/U}_{350<CD4<500}$	Proportion of individuals with CD4 count **350-500** that commence treatment for HIV each year	0.5	

$\eta^{D/U}_{200<CD4<350}$	Proportion of individuals with CD4 count **200-350** that commence treatment for HIV each year	0.75-0.85	
$\eta^{D/U}_{CD4<200}$	Proportion of individuals with **CD4** count **<200** that commence treatment for HIV each year	0.85-0.95	
Stopping treatment (detectable viral load)			
ϕ_S	Percentage of individuals on ART who cease therapy each year	1-5%	e
Response to treatment (undetectable viral load)			
ϕ	Percentage of individuals on ART to experience viral rebound per year	3-6%	[160]
Response to treatment (detectable viral load)			
$1/\sigma_{200<CD4<350}$	Average time after treatment failure for individuals with CD4 count > **200** to go on second line ART	6-18 months	Experimental variable
$1/\sigma_{CD4<200}$	Average time for individuals on ART with CD4 count **<200** to go on second-line ART	2-3 months	
Mortality Rates (Detectable Viral Load)			
$\mu^{D}_{CD4>500}$	HIV-related death rate for patients with CD4 count >500 cells per μL and detectable viral load	0.051% (0.035-0.068%)	[151]

$\mu^{D}_{350<CD4<500}$	HIV-related death rate for patients with CD4 count 350-500 cells per μL and detectable viral load	0.128% (0.092-0.164%)	[151]
$\mu^{D}_{200<CD4<350}$	HIV-related death rate per 100 person-years for patients with CD4 count 200-350 cells per μL and detectable viral load	1.0% (0.2-2.0)%	[151, 158]
$\mu^{D}_{CD4<200}$	HIV-related death rate per 100 person-years for patients with CD4 count <200 cells per μL and detectable viral load	4.08 (0.30-7.86)%	
Mortality Rates (Undetectable Viral Load)			
$\mu^{U}_{CD4<200}$	HIV-related death rate for patients with CD4 count <200 cells per μL and undetectable viral load	Same as $\mu^{D}_{CD4<200}$	Experimental variable
$\mu^{U}_{200<CD4<350}$	HIV-related death rate for patients with CD4 count 200-350 cells per μL and undetectable viral load	Same as $\mu^{D}_{200<CD4<350}$	
$\mu^{U}_{350<CD4<500}$	HIV-related death rate for patients with CD4 count 350-500 cells per μL and undetectable viral load	Same as $\mu^{D}_{350<CD4<500}$	
$\mu^{U}_{CD4>500}$	HIV-related death rate for patients with CD4 count >500 cells per μL and undetectable viral load	Same as $\mu^{D}_{CD4>500}$	

<table>
<tr><td>a</td><td>Numerous studies have estimated the transmission risk of HIV in an occupational setting due to needlestick injury [161-167]. A model-based analysis evaluating population-level data in New Haven estimated the risk as ~0.7% [168]. Few studies have directly estimated the probability of HIV transmission per injection by IDUs using a contaminated syringe. In a long-term cohort study among injecting drug users in Bangkok, Thailand, a probability of transmission per exposure with a contaminated syringe was estimated to be 0.6% (0.4-0.9%) [156]. A review and meta-analysis suggested that the probability of transmission following a needlestick exposure is 0.23% (0-0.46%) and the infectivity per intravenous drug injection had a median of 0.8% (ranging 0.63%-2.4%) [155]. Estimates from studies based on occupational exposure tend to have lower transmission risk than estimates of risk by intravenous drug injection. Based on the injecting drug studies, we assume that the probability of transmission per drug injection with a contaminated syringe ranges from 0.6 to 0.8%.</td></tr>
<tr><td>b</td><td>A summary of the relation between HIV-1 RNA concentration and decline in $CD4^+$ count from the prospective study by Mellors et al. [157] is given below:
<table>
<tr><th>Plasma HIV-1 RNA concentration (copies/mL)</th><th>Mean decrease in $CD4^+$ T cell count per year (cells/μL)</th></tr>
<tr><td>≤ 500</td><td>-36.3 (-30.4,-42.3)</td></tr>
<tr><td>501-3,000</td><td>-44.8 (-39.1,-50.5)</td></tr>
<tr><td>3,001-10,000</td><td>-55.2 (-50.7,-59.8)</td></tr>
<tr><td>10,001-30,000</td><td>-64.8 (-59.6,-70.0)</td></tr>
<tr><td>> 30,000</td><td>-76.5 (-70.5,-82.9)</td></tr>
</table></td></tr>
</table>

With this data, and assuming that the average viral load is ~$10^{4.87}$ copies per mL for people without treatment, the $CD4^+$ T cell count decreases by an average of 76.5 (70.5, 82.9) every year.

To progress through the >500 CD4 cell category, we assume that the average CD4 count is 800 cells/μL after the 2-month acute phase of HIV infection and then declines at the constant rate of 76.5 (70.5, 82.9) cells/μL each year. Then the average time to progress through this compartment is 2/12 + 300/(76.5 (70.5, 82.9)) years; that is 4.09 (3.79, 4.42) years.

To progress through the 350-500 and 200-350 CD4 cell categories, we assume an average loss of 150 CD4 cells. Then the average time to progress through this compartment is 150/(76.5 (70.5, 82.9)) years; that is 1.96 (1.81, 2.13) years.

c

The relationship between the $CD4^+$ T cell slope, and the patient HIV-1 RNA concentration, treatment information and demographic characteristics has been estimated by the PLATO Collaboration [158] and led to the following regression coefficients:

	Change (95% CI) in CD4 count slope (cells per μL per year)-multivariate analysis
Current CD4 count per 100 cells per μL	2.2 (-2.3, 6.6)
Current viral load, per $\log_{10}$ copies per mL	-25.0 (-29.0, -20.0)
Age, per ten years	-6.7 (-12.0, -1.2)
Infection via injecting drug use	-2.7 (-21.0, 16.0)
Number of drugs, per additional drug	4.8 (0.22, 9.4)
Receiving ART (NNRTI)	-23.0 (-35.0, -11.0)

Based on this published data [158] the average change in $CD4^+$ T cells for people failing therapy is estimated.
For people on treatment with detectable viral load, we assume their viral load is $10^{3.5}$ with median age of 35 years [54].

To progress through the >500 CD4 count category we assume an average loss of 250 CD4 count in this interval; then the average CD4 cell slope is

123 (82,164) - 6.7 (12.0, 1.2)*3.5 - 2.7 (21.0, -16.0)*1– 25 (29.0, 20.0)*3.5 + 2.2 (-2.3, 6.6)*10 + 4.8 (0.22, 9.4)*3 – 23 (-35.0, 11.0)*1. That is, an average CD4 slope of 22.75 (-69.84, 189.0) cells per μL per year. Therefore, the average time to progress through this compartment is 10.99 (1.32, 15[#]) years.

To progress through the 350-500 CD4 count category, we assume an average loss of 75 CD4 count in this interval; then the average CD4 cell slope is 123 (82,164) - 6.7 (12.0, 1.2)*3.5 - 2.7 (21.0, -16.0)*1– 25 (29.0, 20.0)*3.5 + 2.2 (-2.3, 6.6)*5 + 4.8 (0.22, 9.4)*3 – 23 (-35.0, 11.0)*1. That is, an average CD4 slope of 11.75 (-58.34, 156) cells per μL per year. Therefore, the average time to progress through this compartment is 6.38 (0.48, 8.00[#]) years.

To progress through the 200-350 CD4 count category, we assume an average loss of 75 CD4 count in this interval; then the average CD4 cell slope is 123 (82,164) - 6.7 (12.0, 1.2)*3.5 - 2.7 (21.0, -16.0)*1– 25 (29.0, 20.0)*3.5 + 2.2 (-2.3, 6.6)*3.5 + 4.8 (0.22, 9.4)*3 – 23 (-35.0, 11.0)*1. That is, an average CD4 slope of 8.45 (-54.89, 146.1) cells per μL per year. Therefore, the average time to progress through this compartment is 8.88 (0.51, 10.00[#]) years. [#]: upper bound assumption.

d Below is a summary of data from [159] for changes in CD4 count over time among people who are on effective cART.

CD4 count at initiation of cART (cells per μL)	**Time since starting cART (years)**	**Current CD4 (cells per μL) means (95% CI)**
≤200	<1	76 (53-99)
	1-3	69 (63-76)
	3-5	50 (36-69)
	>5	32 (18-46)
201-350	<1	129 (91-166)
	1-3	50 (25-74)
	3-5	47 (24-69)
	>5	23 (2-44)
>350	<1	90 (37-144)
	1-3	50 (18-82)

<table>
<tr><td></td><td>
<table>
<tr><td></td><td>3-5</td><td>17 (-17-51)</td></tr>
<tr><td></td><td>>5</td><td>21 (-12-54)</td></tr>
</table>
We use this data to estimate the average time to progress through our CD4 categories whilst on effective cART. For people with undetectable viral load:

For CD4 count increases from 0 to 200 cells per μL, average increases of 76 (53-99) cells per μL can be expected during the first year and then 69 (63-76) cells per μL during the second and third years. Therefore, it can be expected to take 2.80 (2.33-3.58) years to progress through this category.
For CD4 count increases from 200 to 350 cells per μL, we have a 150 CD4 count increase. In this interval, the CD4 count increases by 129 (91-166) cells per μL during the first year and then 50 (25-74) CD4 count during the second year. Therefore, it can be expected to take 1.42 (0.9-3.42) years to progress through this category.
For CD4 count increases from 350 to 500 cells per μL, then we have a 150 CD4 count increase. In this interval, the CD4 count increases by 90 (37-144) cells per μL during the first year and then 50 (18-82) cells per μL during the second year. Therefore, it can be expected to take 2.20 (1.07-7.28) years to progress through this category.

EuroSIDA study [169] investigated that the HCV serostatus does not influence CD4 recovery among patients on ART. It was found that there was no difference in CD4 gain among HIV/HCV coinfected and HIV monoinfected patients after starting ART. Therefore we assume the same recovery rate for HIV/HCV coinfected patient as HIV monoinfected patient.</td></tr>
<tr><td>e</td><td>15.4/100 person years is the average rate of stopping one regime due to toxicity but the vast majority usually start another regime [170]. Very few people who commence ART stop altogether (expert opinion). Therefore, we take the absolute rate of completely stopping therapy to range from 1-5% per year as an experimental variable.</td></tr>
</table>

Table B.3: HCV disease parameters

Symbol	Description		Values	References
Transmission				
β_{HCV}	Transmission probability of hepatitis C per injection with a contaminated syringe		1.5-4%	[167, 171-177], *a*
Disease progression without treatment				
$1/\tau_A$	Average time for untreated HCV infected individuals to progress from **acute** infection to the first stage of fibrosis (**F0)**		4-8 months	[178, 179]
$1/\tau_{F0\text{-}F1}$	Average time from fibrosis stage **F0** to **F1 [**Annual transition probability]	HCV monoinfection	8.62 (0.23-16.95) years [0.116 (0.059-0.228)]	[180, 181]
		HCV coinfection with HIV	8.20 (6.54-10.20) years [0.122 (0.098-0.153)]	
$1/\tau_{F1\text{-}F2}$	Average time from fibrosis stage **F1** to **F2 [**Annual transition probability]	HCV monoinfection	11.76 (9.09-15.38) years [0.085 (0.065-0.110)]	[180, 181]
		HCV coinfection with HIV	8.70 (7.14-10.53) years [0.115 (0.095-0.140)]	
$1/\tau_{F2\text{-}F3}$	Average time from fibrosis stage **F2** to **F3 [**Annual transition probability]	HCV monoinfection	11.76 (6.80-20.41) years [0.085 (0.049-0.147)]	[180, 181]
		HCV coinfection with HIV	8.06 (6.29-10.31) years [0.124 (0.097-0.159)]	
$1/\tau_{F3\text{-}F4}$	Average time from fibrosis stage **F3** to **F4**	HCV monoinfection	7.69 (3.13-18.87) years [0.130 (0.053-0.319)]	[180, 181]

	[Annual transition probability]	HCV coinfection with HIV	8.70 (7.41-10.20) years [0.115 (0.098-0.135)]	
$1/\tau_{F4\text{-}LF}$	Average time from **F4** to **liver failure** **[**Annual transition probability]		18.18 (10.87-25.0) years [0.055 (0.040-0.092)]	[182-198], *b*
$1/\tau_{F4\text{-}HCC}$	Average time from **F4** to **hepatocellular carcinoma** **[**Annual transition probability]		32.26 (26.32-41.67) years [0.031 (0.024-0.038)]	
$1/\tau_{LF\text{-}HCC}$	Average time from **liver failure** to **hepatocellular carcinoma** **[**Annual transition probability]		14.71 (10.10-24.39) years [0.068 (0.041-0.099)]	[198, 199]
$1/\tau_{LF\text{-}LT}$	Average time from **liver failure** until **liver transplant** **[**Annual transition probability]		30.30 (20.41-58.82) years [0.033 (0.017-0.049)]	[200]
$1/\tau_{HCC\text{-}LT}$	Average time until **liver transplant** for individuals with **hepatocellular carcinoma [**Annual transition probability]		10.0 (5.56-20.0) years [0.1 (0.05-0.18)]	[201], *c*
$1/\mu_{LF\text{-}LD}$	Average time until **liver-related death** for individuals with **liver failure** **[**Annual transition probability]		7.25 (4.95-13.51) years [0.138 (0.074–0.202)]	[187]
$1/\mu_{LT\text{-}LD}$	Average time until **liver-related death** for individuals who have received a **liver transplant** **[**Annual transition probability]	First year	5.92 (4.76-7.87) years [0.169 (0.127-0.210)]	[202, 203], *d*
		After first year	29.41 (23.26-41.67) years [0.034 (0.024-0.043)]	

$1/\mu_{HCC\text{-}LD}$	Average time until **liver-related death** for individuals with **hepatocellular carcinoma [**Annual transition probability]			1.65 (1.48-1.83) years [0.605 (0.545-0.676)]	[191]
Commencement of treatment					
	Proportion treated for a**cute/early** HCV infection	HCV monoinfection		0.002-0.003	[23, 201]
		HCV coinfection with HIV		0.07-0.13	
$\frac{1}{\eta_A}$	Average time before individuals in a**cute/early** HCV infection commence treatment	HCV monoinfection	Asymptomatic	320 (213-399) days	*e*
			Symptomatic	221 (188-274) days	
		HCV coinfection with HIV	Asymptomatic	234 (161-392) days	
			Symptomatic	181 (146-223) days	
η_F	Proportion of individuals of fibrosis HCV infection to commence treatment per year		F0/1	25-30%	[204]
			F2/3	46-60%	
			F4	15-25%	

Stopping treatment					
$\frac{1}{\nu}$	Average duration of treatment	Acute	HCV monoinfection	0.46 years	[205]
			HCV coinfection with HIV	0.46 years	[205]
		F0-F4	HCV monoinfection	0.69 years	[206, 207]
			HCV coinfection with HIV	0.92 years	[208]
Clearance of virus					
ψ	Proportion of IDUs who spontaneously clear HCV	Acute	HCV monoinfection	0.26 (0.22-0.29)	[209]
			Relative clearance rate due to coinfection compared with monoinfection	0.16-0.88	[210-212]
γ_A	Proportion of HCV-treated individuals who clear the virus due to treatment (sustained virological responders) in a**cute** HCV	HCV monoinfection		0.6-0.9	[213-217]
		HCV coinfection with HIV		Same as monoinfection	[218, 219]

γ_{F0}	Proportion of HCV-treated individuals who clear the virus due to treatment in **F0** phase	HCV monoinfection	0.60 (0.52-0.68)	[207, 220, 221]
		HCV coinfection with HIV	0.38 (0.29-0.48)	[208, 222-225]
γ_F	Proportion of HCV-treated individuals who clear the virus due to treatment in **F1**-**F4** phase	HCV monoinfection	0.56 (0.50-0.61)	[206, 207, 220, 221, 226-230]
		HCV coinfection with HIV	0.38 (0.29-0.48)	[208, 222-225]
a	No study has directly estimated the probability of HCV transmission per injection by IDUs using a contaminated syringe. Numerous studies have estimated the transmission risk of HCV in an occupational setting due to needlestick injury [167, 171-177]. In the absence of other data, we use these studies to estimate transmission risk among IDUs sharing syringes. We reviewed these studies, paying particular attention on long-term cohort studies with larger number of cases, leading to a plausible range of transmission risk per exposure of 1.5-4%.			
b	Pooled estimate from a survey of the literature [182-198]; weighted using sample size.			
c	11 of 111 new HCV-related HCC reported cases in 2007 in Australia received a liver transplant [201]. This leads to a 95% confidence interval of 5-18%.			
d	Our deterministic ordinary differential equation model assumes exponential rates. We determined the best-fitting exponential function over 40 years, leading to an average transition probability of 0.043 (0.0294, 0.0557) per year, which is equivalent to an average time of 23.26 (17.95-34.01).			
e	Based on unpublished data from the Australian Trial in Acute Hepatitis C (ATAHC) study.			

Appendix C: Healthcare costs

Overview

The healthcare cost of HIV and Hepatitis C were identified through the creation of a model of service delivery reflecting current practice by the authors, who included doctors experienced in HIV and HCV. Utilisation data was derived for different health states from the literature and local data by four CD4 strata in HIV and by seven disease states in HCV.

HIV

Identification

The following items of service were identified for people living with HIV: Medical consultations including general practitioners and specialists; Allied Health including psychologists, social workers and dietician; Pathology including Full Blood Examination, CD4 T-cell Lymphocyte phenotype, HIV viral load, blood chemistry including liver enzymes, creatinine, urea, electrolytes, glucose, genotype resistance testing; inpatient hospitalisations; Medications including prophylaxis and associated non-ARV medications. These items were similar to those identified in a pre-ARV era study of Australian health service use by Hurley [231, 232].

Utilisation

The utilisation of each type of service was determined from published data and clinical experience of the authors. Utilisation was the incremental use of health services over and above the use by people of a similar age and gender without HIV. People living with HIV were divided into four health states according to CD4 T cell count >500, 350-499, 200-349 and >200. Antiretroviral costs were calculated separately.

50% of patients are seen by their general practitioner for HIV care in the HIV Futures 5 study [233]. In a study in the United States people with HIV visited outpatients five times a year [234] and in Italy five to six times [235]; in another study in the USA, patients were seen 9.7 times [236]; all studies showed that utilisation rose with lower CD4 cell counts with 20% more visits when the CD4 was less than 350 [237]. In contrast, males in the overall Australian population aged 25-45years claimed two to three standard GP consultations in a year [238, 239]. 8% of people used a clinical psychologist for counselling, 10% saw a social

worker and 5% saw a dietician. Pathology utilisations followed a standard three monthly monitoring for people with a CD4 cell count greater than 500, with a proportion having a genotype resistance test in a year. Medications for prophylaxis of herpes simplex virus, mycobacterium complex and pneumocystis pneumonia commenced when the CD4 cell count was low.

According to epidemiological data, the risk of AIDS is low with higher CD4 cell counts [234] but people may be admitted with serious non-AIDS events. Hospitalisation was rare (1%) in Italy with high CD4 cell counts [235, 240] but higher (11%) in the USA [234, 235, 240, 241]; hospitalisation risk increased in all settings with lower CD4 cell counts [44]. A national hospital admissions database was searched to determine the types of admission with HIV as a primary or secondary diagnosis in Australia by diagnostic related group(DRG) [42] . The assumptions on use of medical and pathology services were consistent with unpublished data from a study of Medicare Benefits Schedule claims by people with HIV 2003-2007 (n=10951) (Anderson unpublished data).

Valuation

Outpatient items were valued from the Medicare Benefits Schedule [43], Prescription Benefits Schedule[242], the Pharmaceutical Benefits Advisory Committee Manual of Resource Items and the Department of Veteran Affairs in 2008 dollars. The unit costs of inpatient admission were estimated by using the proportions of admissions for each type of DRG and the public hospital cost-weights for DRGs, to create a weighted average cost per admission with HIV.

Antiretrovirals

Use of antiretrovirals was determined by clinical advice from one of the authors (JA), an experienced HIV physician and was consistent with the Australian commentary on the US DHHS guidelines [43] with three lines of antiretroviral therapy. Patients were assumed to start ARVs when their CD4 cell count was less than 350 and continue on them indefinitely. In the population model they moved to the next line of therapy when the previous one failed. Antiretrovirals were valued by the Prescription Benefits Schedule [243].

Patient/carer healthcare costs for HCV

The following Table outlines the patient/carer healthcare costs associated with HCV infection.

HCV-related outcome	Annual Cost
Chronic HCV	$2,827
Cirrhosis	$4,212
Treatment	$4,426
Hepatocellular carcinoma	$7,400
Transplant	$13,665

CD4 >500

Description	Number per year	Unit cost	% of pts having	cost per patient	Rationale / Comment
MEDICAL					
General-practitioner consultations	5	$33.55	50%	$82.00	item 23
Specialist consultations	5	$69.75	50%	$145.00	item 116
Clinical Psychologist	12	$119.75	8%	$114.96	CL01 One hour; http://www.dva.gov.au/health/provider/docs/Clinical_Counsellors_Fee_Schedule_1Nov08.pdf
Social Worker	2	$57.55	10%	$11.51	SW01 One hour; http://www.dva.gov.au/health/provider/docs/Social_Workers_Fee_Schedule_1Nov08.pdf
Dietician	2	$80.30	5%	$8.03	DT01 One hour; http://www.dva.gov.au/health/provider/docs/dietitiansnov08.pdf
DIAGNOSTICS					
FBE	4	$17.20	100%	$51.60	Item 66515
CD4 T cell lymphocyte count	4	$105.85	100%	$317.60	Included in item 66515
HIV viral load	4	$181.45	100%	$544.40	
Liver enzymes/renal	4	$17.80	100%	$59.40	
Glucose/lipids	1	$0.00	100%	$14.85	included in item 66500
Resistance test	1	$600.00	10%	$60.00	10-20% viral failure/year
HOSPITALIZATIONS	1	$7,245.40	1%	$114.00	
CD4 >500 TOTAL COST per YEAR				**$1,523.35**	

HIV CD4

CD4 350-499				**cost per patient**	
Description	Number per year	Unit cost	% of pts having	baseline	item
MEDICAL					
General-practitioner consultations (MBS item 23) 50%	5	$33.55	50%	$82.00	item 23
Specialist consultations (MBS item 116) 50%	5	$69.75	50%	$145.00	item 116
Clinical Psychologist	12	$119.75	8%	$114.96	CL01 One hour; http://www.dva.gov.au/health/provider/docs/Clinical_Counsellors_Fee_Schedule_1Nov08.pdf
Social Worker	2	$57.55	10%	$11.51	SW01 One hour; http://www.dva.gov.au/health/provider/docs/Social_Workers_Fee_Schedule_1Nov08.pdf
Dietician	2	$80.30	5%	$8.03	DT01 One hour; http://www.dva.gov.au/health/provider/docs/dietitiansnov08.pdf
DIAGNOSTICS					
FBE	5	$17.20	100%	$64.50	
CD4 T cell lymphocyte count	5	$105.85	100%	$397.00	
HIV viral load	5	$181.45	100%	$680.50	Item 66515
Liver enzymes/renal	5	$17.80	100%	$74.25	Included in item 66515
Glucose/lipids	1	$14.85	100%	$14.85	
Resistance test	1	$600.00	20%	$120.00	
HOSPITALIZATIONS	1	$7,245.40	3%	$342.00	
CD4 350-499 TOTAL COST per YEAR				$2,054.60	

CD4 200-349 TOTAL COST per YEAR

Description	Number per year	Unit cost	% of pts having	cost per patient baseline	Rationale / Comment
MEDICAL					
General-practitioner consultations (MBS item 23) 50%	7	$33.55	50%	$114.80	
Specialist consultations (MBS item 116) 50%	7	$69.75	50%	$203.00	
Clinical Psychologist	12	$119.75	8%	$114.96	CL01 One hour; http://www.dva.gov.au/health/provider/docs/Clinical_Counsellors_Fee_Schedule_1Nov08.pdf
Social Worker	2	$57.55	10%	$11.51	SW01 One hour; http://www.dva.gov.au/health/provider/docs/Social_Workers_Fee_Schedule_1Nov08.pdf
Dietician	2	$80.30	5%	$8.03	DT01 One hour; http://www.dva.gov.au/health/provider/docs/dietitiansnov08.pdf
DIAGNOSTICS					
FBE	6	$17.20	100%	$77.40	
CD4 T cell lymphocyte count	6	$105.85	100%	$476.40	
HIV viral load	6	$181.45	100%	$816.60	Item 66515
Liver enzymes/renal	6	$17.80	100%	$89.10	Included in item 66515
Glucose/lipids	1	$14.85	100%	$14.85	
Resistance test	1	$600.00	20%	$120.00	
HOSPITALIZATIONS	1	$7,245.40	6%	$684.00	
CD4 200-349 TOTAL COST per YEAR				$2,730.65	

CD4 <200

Description	**units per year**	**Unit cost**	**% of pts having**	cost per patient **baseline**	**Rationale / Comment**
MEDICAL					
General-practitioner consultations (MBS item 23) 50%	8	$33.55	50%	$131.20	
Specialist consultations (MBS item 116) 50%	5	$69.75	50%	$145.00	
Clinical Psychologist	12	$119.75	8%	$114.96	CL01 One hour; http://www.dva.gov.au/health/provider/docs/Clinical_Counsellors_Fee_Schedule_1Nov08.pdf
Social Worker	2	$57.55	10%	$11.51	SW01 One hour; http://www.dva.gov.au/health/provider/docs/Social_Workers_Fee_Schedule_1Nov08.pdf
Dietician	2	$80.30	5%	$8.03	DT01 One hour; http://www.dva.gov.au/health/provider/docs/dietitiansnov08.pdf
DIAGNOSTICS					
FBE	6	$17.20	100%	$0.00	65070
CD4 T cell lymphocyte count	6	$105.85	100%	$476.40	
HIV viral load	5	$181.45	100%	$680.50	
Liver enzymes/renal	6	$17.80	100%	$89.10	covered in 66512
Glucose/lipids	1	$0.00	100%	$14.85	covered in 66512
Resistance test	1	$600.00	50%	$300.00	
NON-ARV medications					
Cotrimoxazole	52	$8.93	100%	$331.92	Prophylaxis for PCP
Valtrex /Famvir	12	$213.63	100%	$1,853.40	
Azithromycin	6	$67.82	50%	$203.46	50% will need it as CD4<100
HOSPITALIZATIONS	1	$7,245.40	10%	$1,140.00	
	1	$7,245.40	3%		
	1	$7,245.40	50%		
CD4<200 TOTAL COST per YEAR				**$5,500.33**	

Table: Diagnostic Related Groups for HIV admissions

DRG Code v5	DRG Description	No.	% of total	Average cost per Admission
S65C	HIV-Related Diseases -Cscc	152	4.45%	$5,998
S65B	HIV-Related Diseases +Scc	151	4.42%	$8,862
S65A	HIV-Related Diseases +Ccc	128	3.75%	$20,793
S60Z	HIV, Sameday	58	1.70%	$721
T63B	Viral Illness A<60 -Cc	4	0.12%	$1,098
T63A	Viral Illness A>59/+Cc	1	0.03%	$2,044
TO1C	Or Proc Infect & Paras Dis-Cc	1	0.03%	$5,028
S60Z	HIV, Sameday	896	26.23%	$721
S65C	HIV-Related Diseases -Cscc	564	16.51%	$5,998
S65A	HIV-Related Diseases +Ccc	497	14.55%	$20,793
S65B	HIV-Related Diseases +Scc	450	13.17%	$8,862
Q62Z	Coagulation Disorders	174	5.09%	2,555
G11A	Anal & Stomal Procedures +Cscc	81	2.37%	6,423
G44C	Other Colonoscopy, Sameday	70	2.05%	1,177
F74Z	Chest Pain	66	1.93%	1,474
X62A	Poisng/Toxc Eff Drugs A>59/+Cc	62	1.81%	3,651
G45B	Other Gastrpy+N-Mjr Digest Dis	61	1.79%	1,047
TOTAL		3416	100.00%	**$7,245.40**

		Number per year	Unit cost	cost per year
ARV medications				
cost of first line SOC	Truvada	12	$765.10	$9,181.20
	Efavirenz	12	$452.64	$5,431.68
total first line				$14,612.88
Cost of second line SOC	NRTI Abacavir	12	$423.00	$5,076.00
	NRTI	12	$282.00	$3,384.00
	Atazanavir	12	$521.91	$6,262.92
	boosting ritonavir	12	$37.92	$455.01
total second line SOC				**$15,177.93**
Cost of subsequent line				
	Kaletra	12	$685.00	$8,220.00
	Raltegravir	12	$1,146.60	$13,759.20
	Etravirine	12	$483.10	$5,797.20
total third line				**$27,776.40**

Appendix D: Productivity losses and gains

HIV and HCV are diseases that affect the productivity of an individual by reducing both the quantity and quality of years of life. The term productivity costs has been defined as "the costs associated with lost or impaired ability to work or engage in leisure activities due to morbidity and lost economic productivity due to death" by the US Panel on Cost-Effectiveness in Health and Medicine [244].

No studies have attempted to estimate productivity costs associated with HIV infection in Australia. A small number of studies have been conducted overseas, mostly in the pre-ARV era. An analysis of the indirect costs of HIV in the UK in the pre-ARV era that used the human capital approach, found that annual productivity losses ranged from A$2,400 to A$16,600 (1997 prices) depending on clinical state [245]; a prevalence-based estimate from the United States argued that productivity losses resulting from morbidity and premature mortality would rise from US$3.9 billion in 1985 to US$55.6 billion in 1991 [246, 247]; a recent cross-sectional analysis of patients enrolled in the Swiss HIV cohort estimated a mean annual productivity loss per person of A$19,000 based on the human capital approach [243].

The inclusion of productivity losses and gains in economic evaluations that also include QALYs may be double-counting because the utility used in QALYs takes account of disability and losses in quality of life that may reduce employment [248]. However, in the economic evaluation of interventions, it can be valuable in secondary analyses to quantify the additional potential productivity benefits that may accrue by further expenditure, although it may favour interventions that improve the health of sections of the population with higher levels of employment, over those whom, are not participating in the workforce [249].

Rationale for method

The authors used the method developed by Deakin Health Economics because it provided a tractable model with relatively simple data needs that had been developed on behalf of decision-makers at the Victorian government Treasury and used in a series of analyses of prevention in the NHMRC-funded research program, Assessing Cost-Effectiveness of prevention. The method provides for a choice of two approaches to costing productivity losses: in brief, the Human Capital approach assumes that the productivity losses associated with a worker who stops work due to illness or dies, are the average annual wage for their age and gender from the time that they stop work until the age of 65; the Friction Cost approach

assumes that workers can be replaced and new workers trained to perform at the same level as the injured or deceased worker within a period of time (usually 3-12 months) [248, 250].

The Friction Cost approach is recommended or described as theoretically preferable by a number of reimbursement agencies [248, 251]. The Friction cost approach assumes that workers will return to work after a health intervention. This assumption may not hold if recovered workers value non-work life more highly after recovery from a serious illness [251] or have adequate levels of income without the need to work full-time [243].

Method

In this project, the Friction Cost approach was used, with a secondary analysis using the Human Capital approach for illustration. All cost is discounted to present value at a baseline discount rate of 3%, consistent with the US Panel on Cost-Effectiveness in Health and Medicine [248] varied to 0% and 5%, the latter figure consistent with the recommendations of the Prescription Benefits Advisory Committee [252-254]. It was assumed that three months would be required to hire and re-train due to a sick or deceased worker; variations of six months and 12 months were carried out to test this assumption.

The Deakin Health Economics model compares the employment status, participation rate, short-term absenteeism and mortality of people with a disease or intervention with people without the disease or intervention. Data on the workforce participation of people who inject drugs is limited. Studies from the early 1990s reported participation rates of around 30% for injection drug users with and without HCV attending clinics and participating in a coordinated care program [233]. On the other hand, in the HIV Futures V study (n=982) carried out in 2005/6 [255], 47 to 50% of the 271 current or previous injection drug users living with HIV were currently employed compared to 62% of those who did not inject drugs with HIV. Given the better economic conditions that were prevalent until 2008, we decided to assume that a population of injection drug users without HCV or HIV would have a workforce participation rate that was 10% less than the general workforce participation rate for age and gender provided in the National Health Survey of 2004/ 5 [255]. The demography of the comparison and disease populations in the productivity model was assumed to match the age and gender mix of the estimates of injection drug users in Australia with 33% women.

Short-term absenteeism rates in the comparison population were presumed to be similar to the general population rates from the National Health Survey when 3% of the population being absent from work daily in Australia [256]. Coverage by colleagues and employers for

absent workers during sick leave was also assumed to match the general population with 28% of employees not covered by sick leave [257]. Training costs for replacement of sick or deceased workers were derived from the Victorian Department of Treasury and Finance Report where outsourced human resources services were costed at 30% for lower paid staff and 75-100% for higher paid staff [258].

The age-sex structure of the population acquiring HIV and HCV in the productivity model mirrored assumptions made for the uninfected IDU population. Inputs for the participation rate, employment status, unemployment rate and short-term absenteeism in people with HIV by age group was provided by the Australian Research Centre in Sex, Health and Society from the HIV Futures V study [233]. In the Futures V study the overall employment rate was 51%, with some students, retired people and 10.9% unemployment. 6% reported that they were sometimes unable to attend work due to HIV so the absenteeism rate was assumed to double the rate of the comparison population [259]. Age-specific but not gender-specific employment and participation data was used in HIV population in the productivity model.

Extra mortality due to HIV and HCV leading to productivity losses for each incident infection at a specific age was estimated in a series of separate expected value analyses constructed in a simple Markov model in TreeAge with annual cycles and two states alive and dead. Age-specific mortality for HIV-infected and uninfected populations in the ARV-era (2000-2005) without HCV were drawn from a Danish population study [260, 261]. Additional deaths from HIV by 65 years were computed according to the time of infection and included in the model to allow the estimation of mortality-related productivity losses.

Inputs for friction costs involve estimating the workforce participation rate of HCV-infected individuals for the rest of their working life, compared to a cohort of population controls who are not HCV infected, measuring their respective disability, mortality, workplace absenteeism, and employment/work force participation. Survival time and age-specific mortality rates of an HCV-infected population was compared with that of the general population. The proportion of full time and part-time employment was based on a study evaluating the experiences of testing for blood borne viruses and acceptability of different methods of HCV testing among IDUs recruited through primary healthcare and drug treatment services: 61% of the IDUs with chronic hepatitis C reported unemployment [51].

Taxation and welfare effects of productivity losses were not estimated due the lack of data on marital status and eligibility for a disability support pension in the IDU population. Taxation

and welfare may be considered as transfer payments and therefore excluded from economic evaluations from a societal perspective.

The baseline output from the productivity model was the productivity loss per incident infection of HIV and HCV expressed in dollars discounted at 3%, using the Friction Cost approach of replacement in three months with gender specific wage rates. The productivity model was run using the @Risk software package for 4000 simulations to enable the calculation of mean and 95% uncertainty limits. The reference year for costs was 2008.

Results

The baseline mean productivity loss was $21,757 per HIV infection, discounted at 3% with a 95% uncertainty range between $12,322 and $33,939 if the FC period was three months. Using the HC approach the production losses were $493,660 per HIV infection (95% limits 372,306 to 621,463) up to the age of 65 years. An increased time period for recruitment and training of new staff from three months to six months increased the productivity loss to $26,506. Gender free wages increased the productivity loss to $23,222. Using the FC approach, 71% of the cost of productivity loss was due to morbidity, especially in people aged 25-44 years old, reflecting the higher participation rates in the workforce. 29% was related to premature mortality particularly in males infected when aged 35-44. In contrast, using the HC approach, the 50% of productivity cost related to premature mortality. A higher discount rate of 5% reduced the mean loss by FC to $18,167 (95% limits $10,947 to $27,050) and with a zero discount rate the mean loss was $33,619 ($16,325 to $58,151).

Limitations

The method was limited for a number of reasons: First, we did not have direct data on the employment of IDUs around Australia and therefore made a number of assumptions. Secondly injection drug use may be associated with higher or lower workforce participation than in our model which would alter the productivity loss: if IDUs are already not working, then HIV or HCV may make little difference to their employment status. Third, we assumed that the mortality related to HIV would be the same in Australia and Denmark. Since the impact of premature mortality was limited on the result compared to morbidity, it is not likely to have made much difference. Finally a caveat: the results are only relevant to the productivity loss associated with an HIV infection in a population of injection drug users in Australia in the middle of this decade.

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