



Return on Investment in Needle and Syringe Programs in Australia

Summary Report



Commonwealth Department of
Health and
Ageing

**COMMONWEALTH DEPARTMENT OF
HEALTH AND AGEING**

**RETURN ON INVESTMENT IN NEEDLE &
SYRINGE PROGRAMS IN AUSTRALIA**

SUMMARY REPORT

HEALTH OUTCOMES INTERNATIONAL PTY LTD

IN ASSOCIATION WITH

THE NATIONAL CENTRE FOR HIV EPIDEMIOLOGY AND
CLINICAL RESEARCH

AND

PROFESSOR MICHAEL DRUMMOND, CENTRE OF HEALTH
ECONOMICS, YORK UNIVERSITY

© Commonwealth of Australia 2002

ISBN 0 642 82117 8

This work is copyright. Apart from any use as permitted under the *Copyright Act 1968*, no part may be reproduced by any process without prior written permission from the Commonwealth available from the Department of Communications, Information Technology and the Arts. Requests and inquiries concerning reproduction and rights should be addressed to the Manager, Copyright Services, Info Access, GPO Box 1920, Canberra ACT 2601

Publication approval number: 3123

Publications Production Unit (Public Affairs, Parliamentary and Access Branch)
Commonwealth Department of Health and Ageing

CONTENTS

1	INTRODUCTION	1
1.1	BACKGROUND	1
1.2	METHODOLOGY.....	1
1.3	ACKNOWLEDGEMENT	2
2	AN OVERVIEW OF NEEDLE AND SYRINGE PROGRAMS (NSPs)	3
2.1	OVERVIEW OF NEEDLE AND SYRINGE PROGRAMS	3
2.2	OPERATIONS OF NEEDLE AND SYRINGE PROGRAMS.....	4
3	EFFECTIVENESS OF NSPs FOR PREVENTING TRANSMISSION OF HIV AND HCV INFECTION.....	5
3.1	METHODOLOGY.....	5
3.2	HIV SEROPREVALENCE.....	6
3.3	HCV SEROPREVALENCE	7
3.4	DISCUSSION.....	8
3.5	ESTIMATES OF INJECTING DRUG USERS LIVING WITH HIV/AIDS	9
3.6	ESTIMATES OF INJECTING DRUG USERS WITH HCV AND HCV-RELATED DEATHS	10
4	FINANCIAL EFFECTS OF NSPs	11
4.1	BACKGROUND	11
4.2	EXPENDITURE ON NSPs.....	11
4.3	TREATMENT COSTS AVOIDED.....	12
4.4	RETURN ON INVESTMENT.....	14
4.5	DISCUSSION.....	16
5	QUALITY OF LIFE (QoL) EFFECTS OF NSPs	18
5.1	INTRODUCTION.....	18
5.2	LIFE YEARS GAINED.....	18
5.3	QUALITY ADJUSTED LIFE YEARS GAINED	19
6	CONCLUSION	21
APPENDICES		
Appendix A	References.....	22

1 INTRODUCTION

1.1 BACKGROUND

In 2000, the Department of Health and Ageing engaged Health Outcomes International Pty Ltd (HOI) in association with the National Centre for HIV Epidemiology and Clinical Research (NCHECR) to undertake a study into the economic effectiveness (or financial return on investment) of needle and syringe programs (NSPs) in Australia.

The study updates and expands a study previously undertaken by Hurley, Jolley and Kaldor which investigated the effectiveness and cost effectiveness of needle and syringe programs in relation to HIV/AIDS (see 'The effectiveness and cost-effectiveness of needle and syringe exchange programs' in *An Economic Evaluation of Aspects of the Australian HIV/AIDS Strategies*, Technical Appendix 2 to *Valuing the past...investing in the future - Evaluation of the National HIV/AIDS Strategy 1993-94 to 1995-96*).

The study seeks to analyse the effectiveness of needle and syringe programs in preventing transmission of HIV, and hepatitis C (HCV) in Australia from 1991 (that is from when NSPs were well established in all jurisdictions except Tasmania) to the end of 2000. The study then uses these findings to calculate the return on investment from NSPs from 1991 to 2000. Specifically the aims of the study were to:

- Estimate the effectiveness of NSPs in relation to preventing transmission of HIV as well as hepatitis B and hepatitis C;
- Calculate the return on investment in NSPs from 1991 to the present; and
- Provide contemporary research on the effectiveness and efficiency of the NSPs in order to assist stakeholders and governments to demonstrate the role of NSPs as a core population health activity, and to support further investment in NSPs if necessary.

For several reasons the project examined effectiveness in relation to prevention of HIV and hepatitis C, but not hepatitis B. First, epidemiological data were more readily accessible for HIV and hepatitis C, in particular in the Australian setting. Second, the vast majority (possibly greater than 95%) of injecting drug users exposed to hepatitis B do not develop chronic infection, and are therefore not at risk of major hepatitis B-related morbidity and mortality. Third, there is greater uncertainty in relation to the natural history of chronic hepatitis B. The exclusion of hepatitis B from the analysis therefore represents a conservative approach, and may underestimate, to some extent, the total costs of treatment avoided.

1.2 METHODOLOGY

The study comprised two discrete stages. The first related to the development of an agreed methodology that examined the international evidence base and data from within Australia to support the study, and from that evidence, to develop an approach that maximised the use of available data.

The second stage of the study was the implementation of the approved methodology, the outcomes of which are presented in this report. The key components of the methodology were:

- An ecological study of the effect of NSPs on HIV and HCV, based on the international literature together with a range of related information and data from within Australia.
- Collection of data on the costs of operating NSPs in all Australian jurisdictions.
- Collection of data on the lifetime costs of treatment of HIV and HCV in the current clinical environment.
- Determination of Quality of Life (QoL) values for persons with HIV and HCV.

-
- Development and application of an economic model to evaluate the return on investment in NSPs.
 - Determination of the quality of life impacts of NSPs on HIV and HCV.
 - Preparation of draft and final reports presenting our findings.

In applying the findings of the impact of NSPs on HIV and HCV in Australia, we have assumed that NSPs have had no effect on the size of the injecting drug user population (i.e. that NSPs do not increase drug use). Whilst acknowledging the debate that exists on this subject, the available evidence from Australia and overseas has not demonstrated that NSPs have resulted in an increase in drug use, and hence our assumption is reasonable (See Guydish et al (1993), Watters et al (1994), Wolk et al (1990) and Schoenbaum et al (1996)).

1.3 ACKNOWLEDGEMENT

Throughout the course of the study, a number of individuals and organisations across Australia have contributed information, data, advice and other forms of assistance to the researchers. Their contribution is gratefully acknowledged.

2 AN OVERVIEW OF NEEDLE AND SYRINGE PROGRAMS (NSPs)

2.1 OVERVIEW OF NEEDLE AND SYRINGE PROGRAMS

Needle and Syringe Programs have been an important part of Australia's HIV/AIDS and Hepatitis C Strategies. NSPs are a public health measure funded to reduce the spread of blood borne viral infections such as HIV and hepatitis C among injecting drug users and are supported by the National Drug Strategy's harm reduction framework. They provide a range of services that include provision of injecting equipment and disposal facilities, education and information on reducing drug-related harms, referral to drug treatment, medical care and legal and other social services. Equipment provided includes needles and syringes, swabs, vials of sterile water and 'sharps bins' for the safe disposal of used injection equipment. The aim of providing sterile injecting equipment is to prevent the shared use of injecting equipment, which can lead to the transmission of blood borne viral infections. Staff also address the potential for transmission of infection via sexual contact by providing condoms and safer sex education. By engaging injecting drug users in health services, those who continue to use drugs are likely to incur less harm to themselves and society. NSPs are also an important point for collection of used injecting equipment.

There are different models of Needle and Syringe Programs operating in Australia and, depending on the jurisdiction, the proportions of these that are government run and non-government run vary. Furthermore, of the NSPs operating in the non-government sector, a number of these are 'peer-based' NSPs. Peer-based NSPs can be distinguished by the employment of past or current drug users in the development and provision of NSP services. It is widely understood that peer-based services have had a significant and positive impact on the delivery and acceptability of NSPs to injecting drug users.

Broadly, the following NSP service models exist throughout Australia:

Primary outlets are stand-alone agencies that are specifically established to provide injecting equipment, sometimes along with primary medical care. Staff provide these specific services in a non-judgmental manner and develop a rapport with individuals who are otherwise hard to reach.

Secondary outlets offer needle distribution or exchange as one of a range of other health or community services. Typical secondary outlets include hospital Accident and Emergency Departments and Community Health Centres.

Mobile services are distribution and exchange services provided by vehicle or on foot.

Outreach services have workers who move around from place to place to extend the reach of the service, often out of hours.

Vending machines dispense needle and syringe packs containing several 1ml syringes for a small fee. These machines are monitored and restocked by Needle and Syringe Program staff.

As Needle and Syringe Programs need to be accessible, they tend to be located in relatively public places. Various government-sponsored pharmacy schemes operate throughout Australia. Generally the schemes provide 1ml syringes, which can either be purchased, or, in NSW, exchanged free on return of a pack with used syringes. In addition to those participating in the government-sponsored schemes, other pharmacies sell needles and syringes and other equipment used for injecting on a commercial basis.

Over 40 countries operate Needle and Syringe Programs including: Australia, Belgium, Brazil, Bulgaria, Canada, China, Croatia, Czech Republic, Denmark, Estonia, Finland, Germany, Greece, Hungary, India, Kazakhstan, Latvia, Luxembourg, Nepal, Netherlands, Norway, Philippines, Poland, Portugal, Slovak Republic, Salvador, Slovenia, Thailand, Ukraine, United Kingdom and the United States of America.

2.2 OPERATIONS OF NEEDLE AND SYRINGE PROGRAMS

While Needle and Syringe Programs operate in all Australian States and Territories, their type, level of activity and funding arrangements differ considerably between jurisdictions. As part of this study, State and Territory health authorities provided details of the level of government expenditure and consumer fees paid for NSP services in recent years, together with estimates of the number of needles and syringes distributed. A summary of the data reported is presented in Table 2.1. It should be noted that in several instances, estimates have been imputed based on data provided by health authorities and the analysis of trends within each State/Territory.

The information presented in the table excludes expenditure on, and needles and syringes sold through pharmacies that sell these products on a commercial basis and are separate from government-auspiced NSPs. Reliable data on these services are not available across all jurisdictions, and consequently they have been excluded from the analysis presented in this report. However, in order to test the possible effect of their inclusion in the financial analysis, sensitivity analysis presented later in this report considers the impact of higher levels of costs of operating NSPs without any increase in benefit.

Table 2.1 Expenditure and needles distributed by NSPs by State/Territory, 1999/2000 ⁽¹⁾

	Government Expenditure (\$'000)	Consumer Expenditure (\$'000)	Total Expenditure (\$'000)	Needles Distributed (000)
ACT	\$531	\$8	\$539	593
NSW	\$9,827	\$463	\$10,290	11,566
NT	n.a.	-	n.a.	604 ²
Qld	\$1,678	-	\$1,678	5,300
SA	\$787	\$43	\$830	3,018
Tas	\$484	\$138 ²	\$622	1,381 ²
Vic	\$4,767	-	\$4,767	6,177
WA	\$1,227	\$2,349 ²	\$3,576	3,209
Total¹	\$19,673	\$3,001	\$22,674	31,848

¹ Data relates to government-auspiced NSPs only. Excludes expenditure on needle and syringes sold through pharmacies on a commercial basis.

² Includes figures imputed from data provided by State/Territory health authorities.

3 EFFECTIVENESS OF NSPs FOR PREVENTING TRANSMISSION OF HIV AND HCV INFECTION

3.1 METHODOLOGY

In this study, NCHECR repeated the ecological study of change in HIV prevalence in cities with and without NSPs because several countries have introduced NSPs since the previous study (Hurley et al. 1997). The study also used a similar methodology to assess the effectiveness of NSPs for prevention of HCV infection.

The ecological study design was used to compare HIV and HCV infection among injecting drug users in countries with and without NSPs. Data recorded on HIV and HCV infection included both seroprevalence and seroincidence studies. NSPs were defined as programs distributing needles and syringes, either free or with minimal charge, irrespective of whether they operated from a fixed or mobile site, whether return of a used syringe was mandatory, or the range of other HIV and HCV prevention and treatment services provided.

Several sources were used to identify published reports of HIV and HCV prevalence and incidence among injecting drug users and the implementation of NSPs. All studies with sample size of at least 50 were included. Cities with HIV prevalence studies were only included if HIV was measured among injecting drug users in two or more calendar years. Studies of HIV or HCV among incarcerated injecting drug users were excluded because very few countries provide NSPs during imprisonment. Analysis compared change in HIV and HCV prevalence between cities with and without NSPs at the time of the surveys. For HIV prevalence, city-specific change in prevalence was used in the analysis. For HCV prevalence, however, it was not possible to use city-specific change because relatively few cities had more than one estimate of prevalence.

For each city, the annual rate of change of HIV seroprevalence was estimated by fitting a regression line on a logit scale, with calendar years centred to 1990. The annual rate of change of HIV seroprevalence was also estimated using regressions weighting the comparison of cities with and without NSPs according to one over the variance of the regression estimator (Hurley et al. 1997). The effect of NSPs was assessed by comparing the annual rate of change in HIV seroprevalence in cities that had ever introduced NSPs with cities that had never introduced NSPs. Analyses of HIV seroprevalence were performed comparing all cities, and also in the subset of cities which had an initial HIV seroprevalence of less than 10%, and had results from at least three surveys available over at least three years. Analyses were repeated using regressions weighted according to survey sample size, and also excluding cities in developing countries.

A random effects regression model was used for analyses of HCV seroprevalence because few cities had data points before and after NSPs were introduced, and to allow appropriately for within and between city effects. The effect of NSPs on HCV prevalence was estimated using all data from all cities, excluding studies that used blood stored since 1981, and for cities that introduced NSPs between the first and last available study. A random effects regression model was also used to estimate the effect of NSPs on HCV prevalence using data available for people reporting less than three years of drug injection.

Two sets of analyses were performed to assess the effect of NSPs on HCV incidence. In the first set of analyses, random effects and GEE negative-binomial models were used to compare cohorts in cities with and without NSPs, allowing for within and between city effects in the analysis and for over-dispersion effects. In the second analysis, an overall incidence rate was calculated for each city by summing the numbers of incident infections and person-years of follow-up. Straightforward negative-binomial regression models were then used to compare cities with and without NSPs.

3.2 HIV SEROPREVALENCE

For HIV, there were 778 calendar years of data from 103 cities with HIV seroprevalence measurements from more than one year and information on NSP implementation. Studies were from 67 cities without NSP, 23 cities that implemented NSP between the first and last study, and 13 cities that already had NSP when the studies were carried out.

The overall comparison of annual rates of change of HIV seroprevalence in cities that never introduced NSPs with cities that did introduce NSPs are summarised in Table 3.1.

Table 3.1 Estimated annual rate of change in HIV seroprevalence according to weighting of analysis and sample selection for cities without and with NSPs

Weighting of analysis/ Sample selection	Cities without NSPs	Cities with NSPs
No weighting of analysis		
All cities		
Number	63	36
Mean	8.1%	-18.6%
(95% CI)	(-2.8%, 20.1%)	(-42.6%, 15.3%)
Mean difference (95%CI)	-24.7% (-43.8%, 0.5%), p=0.057	
Cities with initial HIV prevalence <10%, three calendar years of data		
Number	19	25
Mean	28.6%	-4.0%
95% CI	(-4.9%, 73.8%)	(-28.5%, 29.0%)
Mean difference (95%CI)	-25.3% (-50.8%, 13.3%), p=0.165	
Weighting of analysis		
All cities		
Number	63	36
Mean	5.1%	-29.2%
(95% CI)	(1.4%, 9.1%)	(-30.8%, -27.6%)
Mean difference (95%CI)	-32.7% (-37.5%, -27.6%), p<0.001	
Cities with initial HIV prevalence <10% and three calendar years of data		
Number	19	25
Mean	32.1%	7.8%
95% CI	(22.1%, 42.8%)	(-4.8%, 22.0%)
Mean difference (95%CI)	-18.4% (-32.0%, -2.0%), p=0.030	

The analysis found that cities that introduced NSPs had a mean annual 18.6% decrease in HIV seroprevalence, compared with a mean annual 8.1% increase in HIV seroprevalence in cities that had never introduced NSPs (mean difference -24.7% [95% CI: -43.8%, 0.5%], p=0.06). An analysis which weighted each city by one over the variance of the fitted regression line estimated the mean difference in annual rates of change in HIV-seroprevalence between cities with and without NSPs to be -32.7% [95% CI: -37.5% to -27.6%] p<0.001. In cities with an initial HIV prevalence less than 10% and with sero-surveys over a period of at least three years, the mean annual decrease in HIV prevalence was 4.0% in cities that introduced NSPs, compared with a mean annual

28.6% increase in cities without NSPs (mean difference –25.3% [95% CI: -50.8%, 13.3%], p=0.2). In these cities, the weighted analysis estimated the mean difference to be –18.4% [95% CI: -32.0% to –2.0%] p=0.030. Because the unweighted results are qualitatively very similar and, for all cities, the point estimate is smaller than the weighted analysis, estimates of NSP effectiveness were based on the unweighted analysis, representing a more conservative approach.

3.3 HCV SEROPREVALENCE

For HCV, there were 190 calendar years of HCV seroprevalence data from 101 cities. Data were from 41 cities without NSP, 9 cities that implemented NSP between the first and last study, and 51 cities that already had NSP when the studies were carried out. There were 71 cities with data available for one calendar year, 13 cities with data for two calendar years and 17 cities with data for three or more calendar years. In the 30 cities with HCV seroprevalence data available for more than one year, 60% had already implemented NSPs before the first year of measurement and 30% introduced NSP between the first and last year of measurement.

Median HCV prevalence was 75% (range 24% to 96%) in studies from cities without NSPs and 60% (range 17% to 98%) in cities with NSPs (NPtrend p=0.01). Overall the results indicated little change in HCV prevalence before NSPs were introduced, followed by a decline after the introduction of NSPs (Table 3.2).

Table 3.2 Estimation of the effect of NSPs on HCV prevalence per year using random effects regression

Inclusion criteria	logit(HCV)	Coefficient	Std. Error	p value	95% CI
All cities and all data points					
	Calendar year	-0.008	0.02	0.7	-0.05, 0.04
	Years since NSP	-0.079	0.03	0.003	-0.13, -0.02
	Constant	1.040	0.24	<0.001	0.56, 1.52
	sigma_u	0.5637			
	sigma_e	0.8082			
	rho	0.3275			(fraction of variance due to u_i)
All cities and excluding data points before 1981					
	Calendar year	-0.0460	0.03	0.1	-0.10, 0.12
	Years since NSP	-0.0576	0.03	0.05	-0.11, -0.001
	Constant	92.775	59.3	0.1	-23.5, 209.1
	sigma_u	0.5627			
	sigma_e	0.8084			
	rho	0.3264			(fraction of variance due to u_i)
All nine cities with data points before and after NSP					
	Calendar year	0.0446	0.04	0.2	-0.03, 0.11
	Years since NSP	-0.1317	0.05	0.01	-0.24, -0.03
	Constant	-87.17	70.8	0.2	-226, 51.6
	sigma_u	0.2255			
	sigma_e	0.8245			
	rho	0.0696			(fraction of variance due to u_i)

If HCV prevalence was 75% or 50% respectively before NSPs were introduced, the results correspond to around a 1.5% or 2% decline in HCV prevalence per annum.

There were 48 studies, from 19 cities, with HCV seroprevalence estimated among people reporting less than three years of injecting drug use. Most studies were carried out in cities with NSPs (43 studies from 16 cities). Five studies were carried out in four cities without NSPs. Before and after NSP data were only available from one city. Sample size ranged from 14 to 303, median 53. Relevant results are presented in Tables 3.3 and 3.4.

Table 3.3 Summary of HCV prevalence rates among people reporting less than three years of drug injection according to availability of NSPs

NSP	Number of studies	Mean HCV prevalence	Standard deviation	Median HCV prevalence	Inter-quartile range
No NSP	5	66%	15%	71%	5%
With NSP	43	25%	18%	19%	21%

Table 3.4 Estimation of the effect of NSPs on HCV prevalence among people reporting less than three years of drug injection using random effects regression

HCV prevalence	Coefficient	Std. Error	p value	95% CI
NSP	-37.06	7.75	<0.001	-52.25, -21.86
Constant	64.50	8.41	<0.001	48.01, 80.98
sigma_u	22.74			
sigma_e	8.70			
rho	0.87		(fraction of variance due to u_i)	

Median HCV prevalence was substantially lower in cities with than without NSPs (19% vs 71%; Table 3.3). On average, HCV prevalence in cities with NSPs was 37% lower than in cities without NSPs using random effects regression modelling (mean (sd): 25% (+18%) vs. 66% (+15%), $p < 0.001$; Table 3.4).

3.4 DISCUSSION

On average, HIV seroprevalence decreased in studies of injecting drug users in cities with NSPs whereas in studies from cities without NSPs, HIV seroprevalence increased. Seroprevalence of HCV also decreased annually in studies carried out after NSPs were introduced. HCV prevalence was substantially lower among people reporting less than three years of drug injection in cities with NSPs compared to cities without NSPs. There was also a non-statistically significant protective effect for HCV incidence in cities with NSPs when compared to those without NSPs.

There are several limitations associated with the ecological study design that should be considered when interpreting the findings from these studies. Seroprevalence data used in the analyses were collected according to different protocols and in diverse populations. It is unlikely that estimates of HIV and HCV seroprevalence in cities with NSPs would differ systematically from those in cities without NSPs, so any such sampling bias would underestimate the effectiveness of NSPs. Because cities were selected for analysis by the existence of published HIV and HCV serological surveys, bias may have been introduced by the decision to do a survey in a particular city at a particular time.

Data on NSPs used in the analyses were based on presence or absence of NSPs rather than on the extent and uptake of these services. Given the positive findings, however, it is likely that inclusion of these parameters would result in a dose response effect on HIV and HCV seroprevalence from NSPs. In addition, it is not possible to separate the effects of implementation of NSPs from the other HIV prevention strategies (Benedikt et al. 2000). In

most settings, introduction of NSPs is one component of a broader harm reduction package to reduce the risk of transmission of blood-borne viruses and other harm associated with injecting drug use. Other components include education and counselling, drug dependency treatment strategies such as methadone maintenance therapy, and provision of clean injecting equipment through other outlets in particular pharmacies. Adequate data was not available on individual components of harm reduction strategies to allow an evaluation of the impact of components other than provision of clean injecting equipment (NSPs). Sensitivity analysis has been conducted to determine the outcome of lower rates of NSP effect on HIV.

The excess risk of HIV in people who inject drugs is not due solely to sharing needles, other injecting practices and sexual behaviour patterns increase HIV risk. In contrast to HIV, HCV infection is rarely transmitted through sex. (MacDonald et al. 1996).

It is also possible that HIV seroprevalence may have remained low in some of the cities with NSPs, irrespective of their introduction. HCV infection, however, is universally high among drug injectors. In most countries HCV infection became endemic among this population before there was widespread publicity about transmission of blood borne viruses through injecting practices. Because HCV infection remains asymptomatic for longer than HIV infection, it is also possible that people with HCV infection remain in the population of injectors for longer than those with HIV infection, therefore increasing the prevalence of HCV infection in seroprevalence surveys of injectors.

If NSPs decrease the incidence of HIV and HCV, the rate of increase in seroprevalence will decrease eventually. It is likely that the lower effect of NSP on HCV than HIV seroprevalence can be attributed to the generally higher prevalence of HCV compared to HIV before the introduction of NSPs.

NSPs influence HIV and HCV transmission by increasing use of sterile syringes for injection and lowering the rate of syringe sharing thereby reducing contact with each virus. Some NSPs also provide referrals to drug treatment centres, condoms and education about minimising risk. The difference in rate of change of HIV seroprevalence between cities with and without NSPs and the decrease in HCV prevalence in cities after the introduction of NSPs may not be due solely to NSPs. Nonetheless, the study provides evidence that NSPs reduce the spread of HIV and HCV infection.

3.5 ESTIMATES OF INJECTING DRUG USERS LIVING WITH HIV/AIDS

The results of the analysis of the effect of NSPs on HIV and HCV prevalence internationally were then applied to estimates of the Australian injecting drug user population to estimate the number of cases of HIV and HCV avoided as a result of NSPs over ten years during the 1990s.

Estimates of past HIV incidence and future AIDS incidence as a result of injecting drug use were obtained using back-projection methods. The method uses observed AIDS incidence data (adjusted for reporting delay), and knowledge of the rate at which HIV-infected people progress to AIDS, to reconstruct the likely pattern of past HIV incidence. It is then also possible to estimate future AIDS incidence. Because of the relatively small numbers of AIDS cases reported due to injecting drug use, back-projection analyses were applied to annual AIDS counts.

3.5.1 WITH NSP INTRODUCTION

The number of injecting drug users living with HIV/AIDS is estimated to have peaked in the early 1990s at approximately 470 cases, with a peak in people living with AIDS of less than 100 in the late 1990s. The cumulative number of deaths from HIV/AIDS by 2010 is projected to be approximately 350.

3.5.2 WITHOUT NSP INTRODUCTION

The number of injecting drug users living with HIV/AIDS is estimated to peak in 2000 at approximately 26,000, with a peak in people living with AIDS of almost 3,000 in 2010. The estimated cumulative number of deaths from HIV/AIDS by 2010 is projected to be approximately 5,000.

3.5.3 PREVENTED THROUGH NSP INTRODUCTION

By the year 2000, approximately 25,000 HIV infections are estimated to have been prevented among injecting drug users since the introduction of NSPs in 1988, and by 2010 approximately 4,500 deaths are projected to have been prevented.

3.6 ESTIMATES OF INJECTING DRUG USERS WITH HCV AND HCV-RELATED DEATHS

The modelled estimate of HCV incidence in Australia that has occurred with NSPs corresponds to a gradual increase in HCV prevalence among regular IDUs until the mid- to late-1980s, followed by a gradual decline to around 52% HCV prevalence in 2000. NSPs were first introduced in Australia in late 1987. Hence, NSPs were assumed to have reduced HCV prevalence among IDUs from 1988 onwards. The pattern of HCV prevalence if NSPs had not been introduced was estimated by assuming that HCV prevalence would have remained constant at 1988 levels from 1988 onwards. From this, a pattern of HCV incidence if NSPs had not been introduced was derived. The model also excludes any reduction of HCV through secondary infection routes.

3.6.1 WITH NSP INTRODUCTION

In 2000, the number of injecting drug users living with HCV was estimated to be approximately 200,000 (approximately 150,000 with chronic HCV infection). By 2010 an estimated 11,800 injecting drug users are projected to be living with cirrhosis, and estimated cumulative HCV-related deaths are projected to be 1,800.

3.6.2 WITHOUT NSP INTRODUCTION

In 2000, the number of injecting drug users living with HCV is estimated to be approximately 220,000 (approximately 165,000 with chronic HCV infection). By 2010 an estimated 12,500 injecting drug users are projected to be living with cirrhosis, and estimated cumulative HCV-related deaths are projected to be 1,900.

3.6.3 PREVENTED THROUGH NSP INTRODUCTION

By the year 2000, approximately 21,000 HCV infections are estimated to have been prevented among injecting drug users since the introduction of NSPs in 1988, (of which approximately 16,000 would have developed chronic HCV); while by 2010 approximately 650 fewer injecting drug users are projected to be living with cirrhosis and 90 HCV-related deaths would have been prevented.

4 FINANCIAL EFFECTS OF NSPs

4.1 BACKGROUND

The model used to analyse the financial effects of NSPs examines the direct costs of operating NSPs during the 1990s, and compares those costs to the future financial savings that are anticipated to flow from that investment. These savings relate to the direct costs of treatment of cases of HIV and HCV that would otherwise have occurred until death, had it not been for the existence of NSPs. Because the investment in NSPs occurred over a ten year period, while the savings will continue to accrue into the future until all cases avoided have died, the cashflows associated with both are discounted back to a common reference point, namely the commencement of the investment period. The net value of these two cashflow streams after discounting, known as the Net Present Value, takes into account the fact that a dollar today is valued more highly than a dollar in, say, ten years, and thus converts them to a common dollar equivalent.

In undertaking the analysis, only direct costs and cost offsets have been included.

- Direct costs include the costs of operating NSPs themselves, the infrastructure associated with their development and operation, and the costs of safe disposal of used syringes and needles. Conceptually, direct costs may also include the costs of volunteers and other unpaid workers in NSPs, and in-kind support provided by host agencies. However, the data reported by State and Territory health authorities were not able to identify or quantify this component, and it is therefore excluded from the analysis.
- Direct cost offsets or savings are those related to reduced costs due to the prevention or avoidance of HIV and HCV attributable to NSPs. These have been based on the lifetime costs of treatment of the diseases.

While the major focus of the study is on the public health perspective, it should be recognised that programs of this type may have implications for many other aspects of society that are not reflected in the economic analysis, including indirect costs such as family support, accommodation and income support etc.

4.2 EXPENDITURE ON NSPs

Data on expenditure on NSPs from 1990/91 to 1999/2000 are presented in Table 4.1.

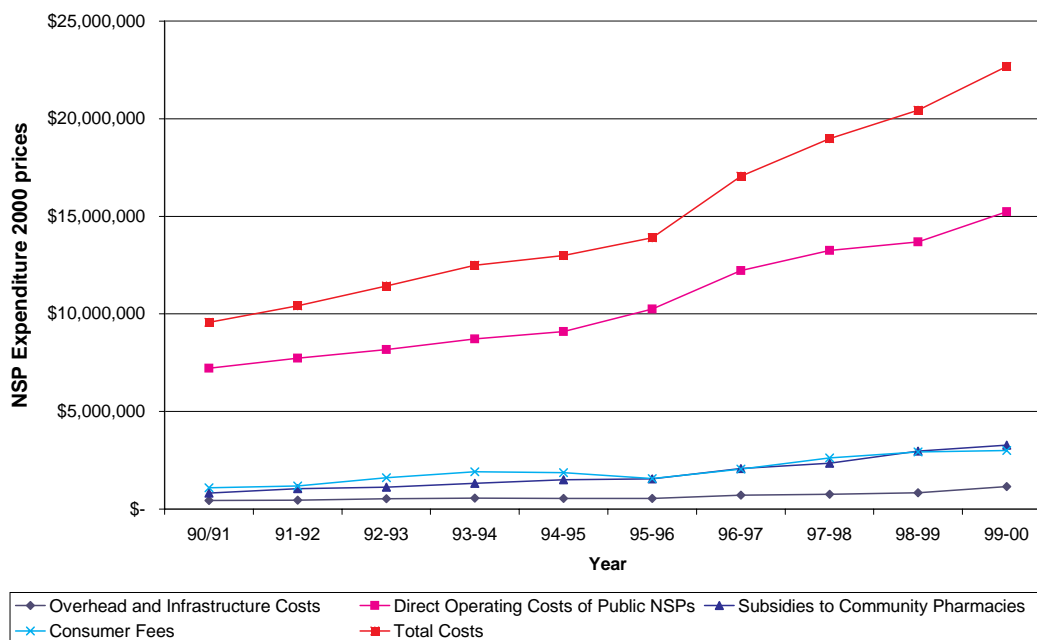
Table 4.1 Expenditure on NSPs, Australia, 1990-91 to 1999-2000 (\$'000) (Year 2000 prices)

1990-1991	1991-1992	1992-1993	1993-1994	1994-1995	1995-1996	1996-1997	1997-1998	1998-1999	1999-2000	Total
Overhead and Infrastructure Costs										
\$441	\$455	\$530	\$560	\$541	\$539	\$714	\$757	\$841	\$1,153	\$6,531
Direct Operating Expenditure on Public NSPs										
\$7,215	\$7,730	\$8,172	\$8,710	\$9,089	\$10,251	\$12,213	\$13,250	\$13,690	\$15,243	\$105,562
Subsidies to Community Pharmacies										
\$826	\$1,045	\$1,129	\$1,318	\$1,497	\$1,551	\$2,079	\$2,347	\$2,975	\$3,278	\$18,045
Consumer Costs										
\$1,091	\$1,183	\$1,608	\$1,905	\$1,865	\$1,555	\$2,043	\$2,625	\$2,930	\$3,001	\$19,807
Total Government Direct Expenditure										
\$8,042	\$8,774	\$9,301	\$10,028	\$10,586	\$11,802	\$14,292	\$15,597	\$16,664	\$18,521	\$123,607
Total Government Expenditure										
\$8,483	\$9,230	\$9,831	\$10,589	\$11,127	\$12,341	\$15,006	\$16,354	\$17,505	\$19,673	\$130,138
Total Expenditure										
\$9,574	\$10,413	\$11,438	\$12,494	\$12,992	\$13,897	\$17,048	\$18,979	\$20,435	\$22,674	\$149,944

Between 1991 and 2000, a total of \$150 million (Year 2000 prices) was expended on NSPs across Australia, comprised of \$130 million (87%) by government, and \$20 million (13%) in consumer expenditure. These data cover expenditure on NSPs operating within the programs managed by State and Territory health authorities. It excludes costs associated with the many retail pharmacies that also sell needles and syringes on a commercial basis, for which reliable data is not available on the number of needles sold or the level of expenditure by consumers.

The trend in expenditure of the period is illustrated in Figure 4.1.

Figure 4.1 Expenditure on NSPs, 1990-91 to 1999-2000 (Year 2000 Prices)



4.3 TREATMENT COSTS AVOIDED

Estimates of the lifetime costs of treatment for HIV and HCV cases avoided are based on past and current treatment regimes by disease stage and applied over the projected lifetime of cases, based on known mortality rates. Standardised costs have been used for each component of health care using year 2000 prices, and cover both community-based costs and inpatient costs. A range of data sources have been used for the identification of standardised unit costs.

4.3.1 HIV TREATMENT COSTS

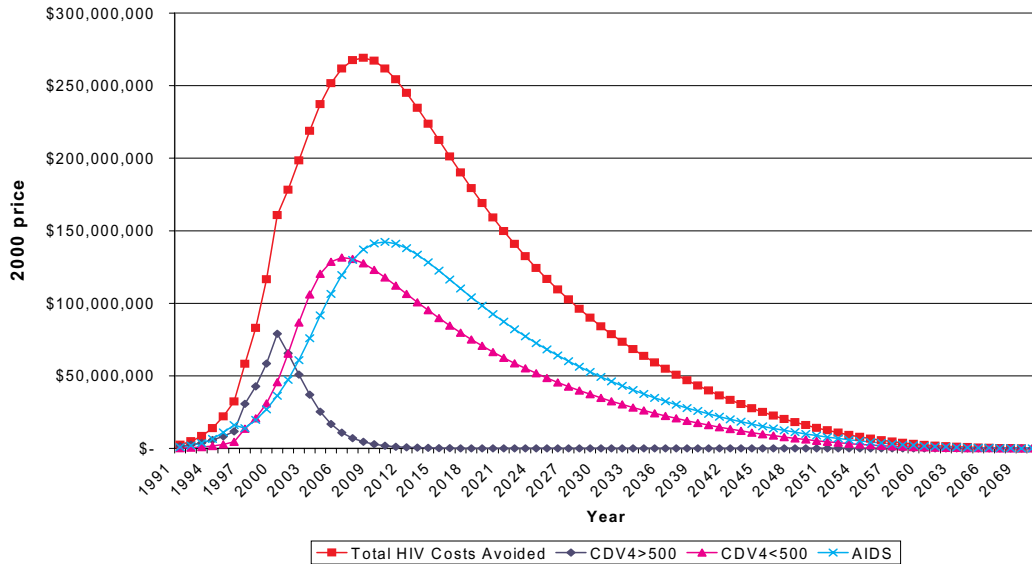
Figure 4.2 illustrates the annual costs of treatment for the diagnosed cases of HIV avoided as a result of the ten year investment in NSPs. Annual treatment costs rise progressively to the year 2008 as patients progress to later stages of the disease, at which time they peak at approximately \$269 million. Thereafter, annual costs decline, brought about mainly by the declining number of patients in the second and third stages of HIV.

Cumulative HIV treatment costs avoided over the lifetime of consumers accumulate throughout the lifetime of survivors, but at a slower rate after about 2008. Total HIV treatment costs avoided over the lifetime of cases are estimated at \$7,025 million (undiscounted). These represent the savings that accrue from a combination of the following:

- Approximately 25,000 cases of HIV avoided, who
- live for an average of about 24 years after infection, and who

- incur average treatment costs of nearly \$14,000 each year of their life after diagnosis.

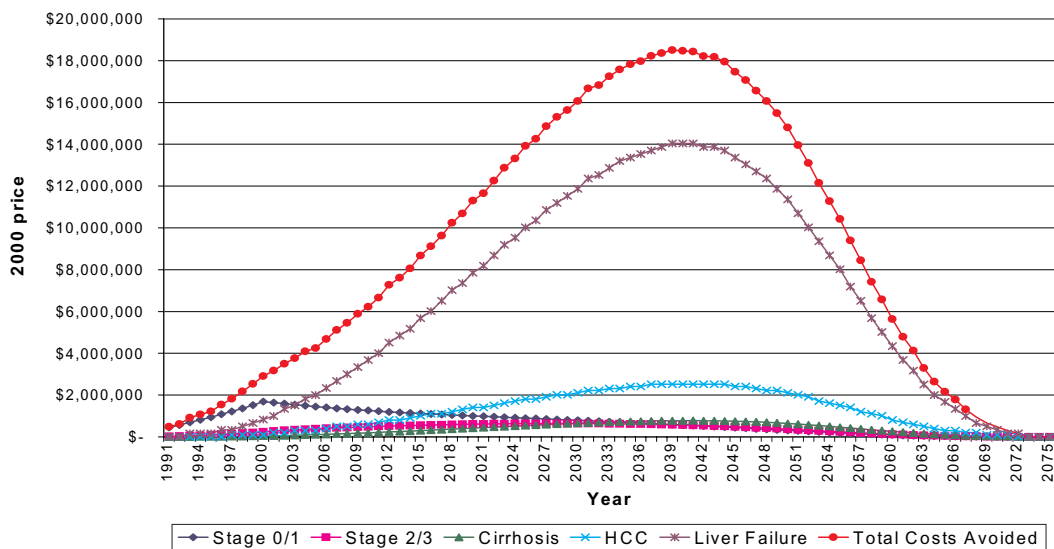
Figure 4.2 Annual costs of treatment of diagnosed cases of HIV avoided by NSPs (Not discounted)



4.3.2 HCV TREATMENT COSTS

Figure 4.3 illustrates the annual costs of treatment for the diagnosed cases of HCV avoided as a result of the ten year investment in NSPs.

Figure 4.3 Annual costs of treatment of diagnosed cases of HCV avoided by NSPs (Not discounted)



Annual treatment costs rise progressively to the year 2040, at which time they peak at approximately \$18.8 million and decline thereafter. The major factor influencing this cost profile is the number of patients who progress to liver failure who, while relatively small in number, have extremely high costs of treatment. Total HCV treatment costs avoided over the lifetime of cases are estimated at \$783 million (undiscounted).

Overall, total treatment costs avoided over the life of the cases of HIV and HCV avoided by NSPs are approximately \$7,808 million (before discounting). The costs of HIV treatment avoided are approximately ten

times those for HCV, which reflects a combination of the number of cases avoided in the first instance, a higher diagnosis rate for HIV than HCV, and higher average annual treatment costs for HIV than for HCV.

4.4 RETURN ON INVESTMENT

The assessment of return on investment from NSPs takes into account the total investment by government and consumers in NSPs during the 1990s, together with anticipated savings resulting from treatment costs avoided for persons who would otherwise have contracted HIV and HCV over their lifetime, were it not for the availability of NSPs during the decade under study.

The calculation of return on investment discounts future cashflows associated with the investment in the NSP program and treatment costs avoided by an agreed discount rate. The discount rate most commonly used in government programs of this nature is 5% per annum. For the purposes of illustration, we have also applied discount rates of 3% and 0%.

4.4.1 HIV IMPACTS

The results of the analysis on return on investment in NSPs to government and in total, having regard to the impacts on HIV alone, are presented in Table 4.2.

Table 4.2 Net Present Value of investment in NSPs for HIV.

Discount Rate	Net Present Value, 1991 (\$million, Year 2000 Prices)	
	Govt Expenditure	All Expenditure
Lifetime Costs of Treatment		
5%	\$2,277	\$2,262
3%	\$3,415	\$3,398
0%	\$6,896	\$6,876
To Year 2000		
5%	\$242	\$227
3%	\$287	\$270
0%	\$373	\$353

The table illustrates that the net savings to government from its investment in NSPs over the lifetime of cases of HIV avoided (after deducting the value of the initial government investment) before discounting are \$6,896 million. Discounting these savings at 5% results in a Net Present Value (NPV) of their investment of \$2,277 million (\$3,415 million at 3% discount rate). When considering the total investment in NSPs (by including consumer expenditure), the equivalent returns are \$6,876 million (undiscounted), \$2,262 million (discount rate of 5%) and \$3,398 million (discount rate of 3%).

The analysis indicates that there have been significant savings accruing to government from the investment in NSPs to date, and that these savings will continue to accrue into the future. This is further illustrated by considering the return achieved to the end of the investment period (i.e. to Year 2000) without taking into account any additional savings that accrue in the future. By the year 2000, government had achieved net savings of \$373 million (after deducting the value of their investment), the NPV of which at a discount rate of 5% is \$242 million (\$287 million at a discount rate of 3%).

4.4.2 HIV AND HCV IMPACTS COMBINED

The return on investment in NSPs to government and in total, having regard to the impacts on HIV and HCV combined, are presented in Table 4.3.

Table 4.3 Net Present Value of investment in NSPs for HIV and HCV combined.

Discount Rate	Net Present Value, 1991 (\$million, Year 2000 Prices)	
	Govt Expenditure	All Expenditure
Lifetime Costs of Treatment		
5%	\$2,402	\$2,386
3%	\$3,653	\$3,637
0%	\$7,678	\$7,658
To Year 2000		
5%	\$255	\$240
3%	\$302	\$285
0%	\$391	\$371

The analysis indicates that the incorporation of HCV into the NPV calculations has further increased the savings accruing to government and in total. This is to be expected, as no additional investment has been required, and some 21,000 cases of HCV are estimated to have been avoided. The impact on savings, however, is significantly lower than for HIV, due to the lower annual costs of treatment for the earlier stages of HCV, and the fact that the higher costs associated with the relatively small proportion of patients who progress to liver failure are deferred until much later and are considerably reduced by discounting.

4.4.3 SENSITIVITY ANALYSIS

In order to test the robustness of the results, sensitivity analysis has been conducted on a number of the variables affecting the outcomes. These are:

- Halving the rate of effect of NSPs on HIV. This analysis seeks to address the issue of the extent to which NSPs contribute to the reduction in HIV as opposed to other concomitant activities.
- Quartering the effect of NSPs on HIV. This analysis further extends the examination of reduced NSP effects on HIV.
- Doubling the level of investment in NSPs over the ten years. This analysis examines the result of increasing the expenditure on NSPs without any increase in effect on HIV. By so doing, it takes into account the potential contribution of the commercial pharmacy market.
- Halving the annual treatment costs for HIV. This analysis considers the results of possible future reductions in the costs of HIV treatment.

The outcomes for each of these variations in isolation are illustrated in Table 4.4, applied only to the impact on HIV, and based on a discount rate of 5% in all scenarios.

The analysis indicates that the outcomes previously presented are most sensitive to the impact of NSPs on HIV incidence. This is to be expected because of the nature of the estimation technique employed, which uses the logit scale as its base. Consequently, halving the rate of effect of NSPs on HIV incidence has a proportionally greater effect on the number of cases avoided over time. Nevertheless, even at the most conservative estimate of effect (one-quarter of the original effect estimate) the return on investment on both government expenditure and

total expenditure on NSPs is positive. This also holds true for variations to the other input variables in the model. The sensitivity analysis indicates that the results presented are robust, and that the return on investment from NSPs is positive in all other tested scenarios.

Table 4.4 Net Present Value of investment in NSPs for HIV – Sensitivity Analysis.

	Net Present Value, 1991 (\$million, Year 2000 Prices)	
	Govt Expenditure	All Expenditure
Lifetime Costs of Treatment		
Original Estimate	\$2,277	\$2,262
Half NSP Effect on HIV	\$333	\$318
Quarter NSP Effect on HIV	\$52	\$37
Double NSP Investment	\$2,180	\$2,151
Half HIV Annual Treatment Costs	\$1,090	\$1,075

The analysis indicates that the outcomes previously presented are most sensitive to the impact of NSPs on HIV incidence. This is to be expected because of the nature of the estimation technique employed. Nevertheless, even at the most conservative estimate of effect (one-quarter of the original effect estimate) the return on investment on both government expenditure and total expenditure on NSPs is positive. This also holds true for variations to the other input variables in the model. The sensitivity analysis indicates that the results presented are robust, and that the return on investment from NSPs is positive in all other tested scenarios.

4.5 DISCUSSION

The study indicates that the return on investment will exceed manyfold the original investment in NSPs, and that the original investment had been fully recouped and surpassed by the end of the investment period, before any future savings are taken into account. The investment in NSPs is justified by the effect on HIV alone, with the effect on HCV providing an additional financial benefit. Sensitivity analysis on the main variables used in the analysis indicates that the results are robust under a range of alternative assumptions and scenarios.

A number of observations are offered about the results presented.

- The factor that has the greatest impact in the financial analysis is the effect of NSPs in reducing the incidence of HIV (and to a lesser extent HCV). As noted previously, however, NSPs typically operate in an environment where a range of public health and other initiatives are in place. It is not possible to isolate the effects of NSPs from other elements in these initiatives. Notwithstanding this point, the sensitivity analysis conducted indicates that even under scenarios where the effect of NSPs on HIV incidence is reduced by 75% of the original estimate, the return on investment from NSPs remains positive.
- The financial analysis has considered only the direct costs and savings associated with NSPs. There is clearly a greater range of other potential financial savings to be derived from a reduction in HIV and HCV, savings that would accrue to governments, patients and their carers as well as wider society.
- Estimates of future treatment costs have been based on current treatment regimes. However, methods and costs of treatment can change very quickly, which may have a significant effect on patients, as well the analysis of return on investment. The sensitivity analysis conducted on the results to date indicates that, even if future treatment costs halve, NSPs would continue to be a sound investment strategy.
- The analysis presented has considered the retrospective investment in NSPs, as well as the direct health care savings accruing from that investment, and assumes that the investment in NSPs ceases in the year 2000. Given the current population of injecting drug users and the level of use of NSP services, together

with the demonstrated effect of NSPs on HIV and HCV, it is clear that an ongoing investment in NSPs will continue to avert the incidence of HIV and HCV, and that savings will continue to accrue. Consequently, the model demonstrates not only that the financial return on investment to date in NSPs has been positive, but also that ongoing investment in NSPs is warranted.

5 QUALITY OF LIFE (QoL) EFFECTS OF NSPs

5.1 INTRODUCTION

Since both HIV and HCV are potentially life-threatening conditions, one of the main benefits from averting infections is the prevention of premature mortality. In addition, given the natural history of progression of these diseases and its effect on quality of life, significant quality of life benefits may also accrue from the avoidance of HIV and HCV.

The most widely used approach for estimating quality of life benefits in economic evaluations is the quality-adjusted life-year (QALY). In this approach, states of health are assigned a health state preference or 'utility' value, on a scale including 1.0 (full health) and 0 (death). The amount of time an individual spends in a given health state is then multiplied by the health state preference value to calculate the quality-adjusted life-years (QALYs) gained. The main advantage of the QALY approach is that it provides one combined measure of the benefits of a program that both extends life and maintains quality of life.

5.2 LIFE YEARS GAINED

The number of life years gained provides a measure of the additional number of years by those persons who would otherwise have been infected with HIV and HCV, but for the effect of NSPs. The effect of NSPs on HIV and HCV is illustrated in Figures 5.1 and 5.2.

Figure 5.1 Life Years Gained for HIV cases avoided

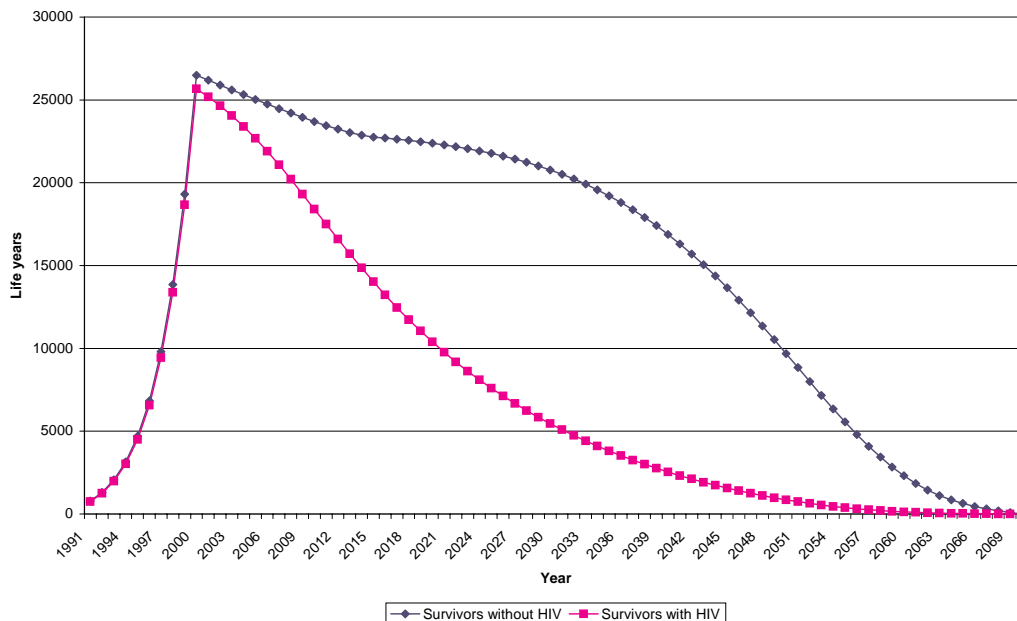
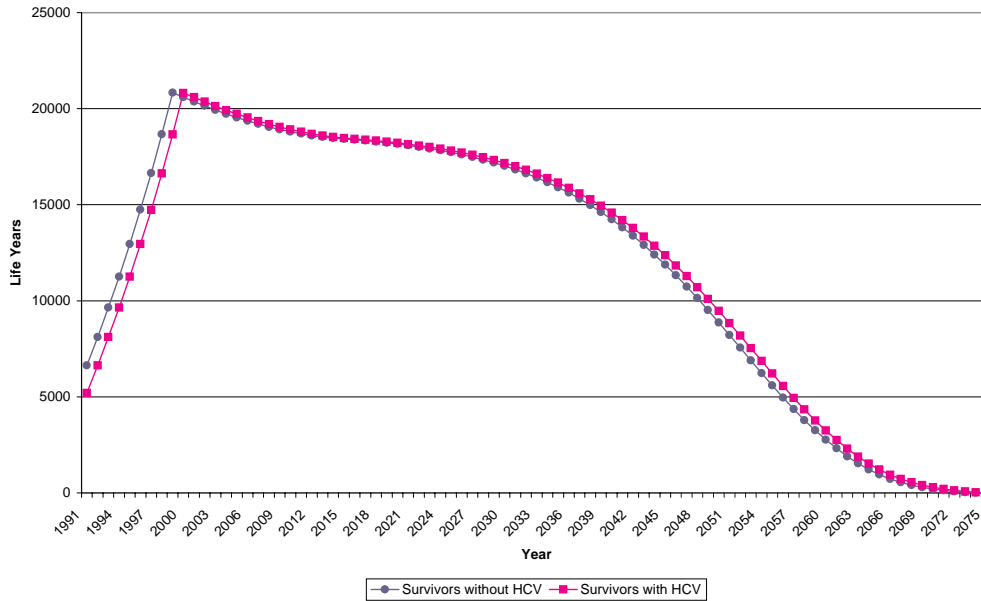


Figure 5.2 Life Years Gained for HCV cases avoided



The effect of NSPs in terms of life years gained is much greater for HIV than for HCV. The 25,000 persons avoiding HIV are expected to gain an additional 588,000 life years (about 23 years each) than if they had contracted HIV. In comparison, the 21,000 persons avoiding HCV are expected to gain only about 1,200 life years over their lifetime. The difference in these outcomes is essentially due to the different mortality rates associated with each disease and their rate of progression through the various stages.

5.3 QUALITY ADJUSTED LIFE YEARS GAINED

The application of an adjustment factor to the number of life years gained to take account of the quality of life effects of these diseases leads to a measure referred to as Quality Adjusted Life Years (QALYs). QALYs gained incorporates both the quantity of life gained, and the quality of life gained by avoiding HIV and HCV. The outcomes of this analysis are presented in Figures 5.3 and 5.4.

Figure 5.3 Life Years and QALYs gained by HIV survivors

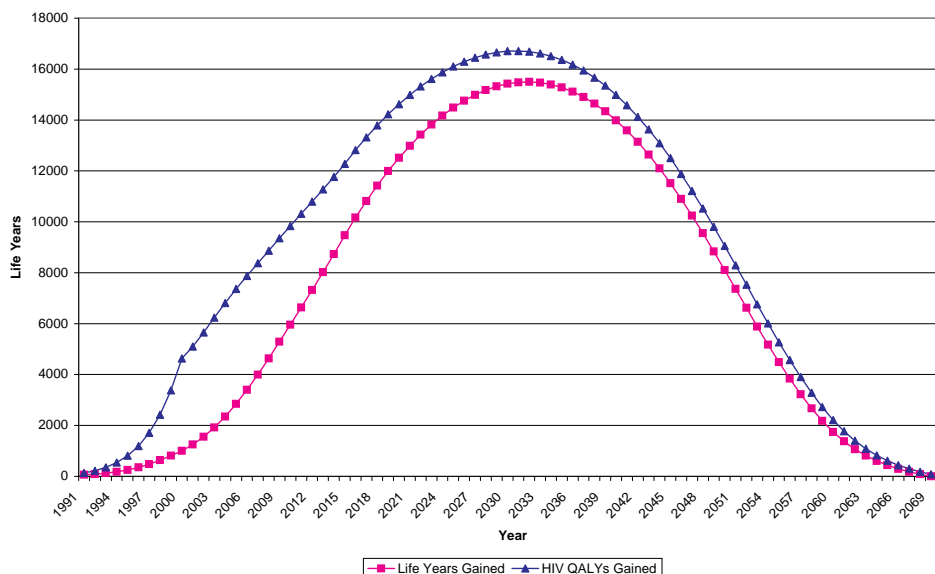
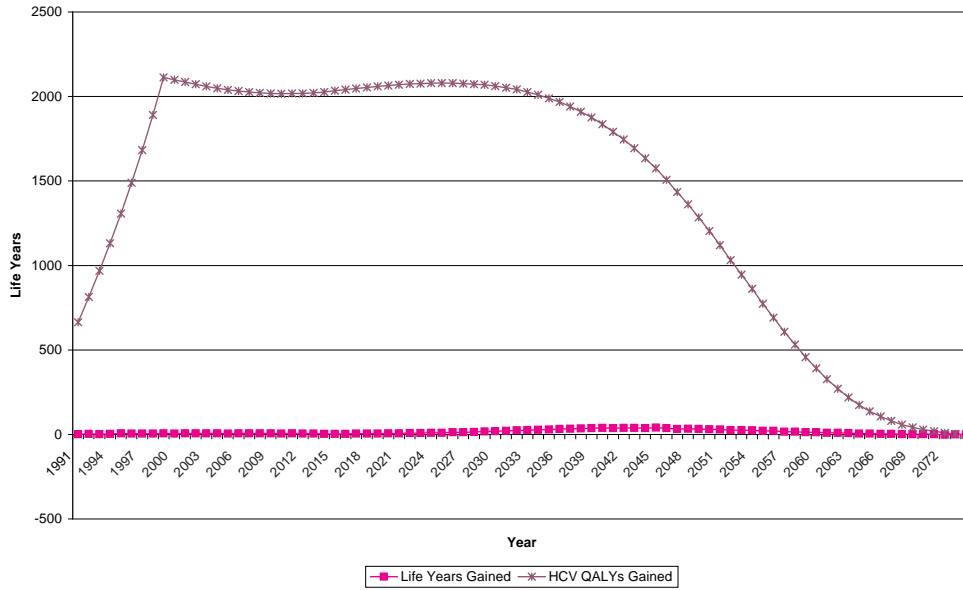


Figure 5.4 Life Years and QALYs gained by HCV survivors



The curves “HIV/HCV QALYs Gained” represent the quality adjusted life years for persons who would have had HIV/HCV, but for the effect of NSPs. The gap between these curves and the curves “Life Years Gained” represents the quality effect of HIV and HCV on their lives. The 25,000 persons avoiding HIV are expected to gain an additional 715,000 quality adjusted life years than if they had contracted the disease. In comparison, the 21,000 persons avoiding HCV are expected to gain about 120,000 quality adjusted life years over their lifetime. The difference between the two groups is largely attributable to the greater effect of HIV on the “quantity” of life compared to HCV, rather than the “quality” effect.

Applying the same discount rates used in the financial analysis (viz 5%, 3% and 0%) to QALYs gained results in the figures shown in Table 5.1

Table 5.1 Net Present Value of QALYs gained for HIV and HCV

Discount Rate	Net Present Value, 1991 (QALYs)		
	HIV	HCV	HIV & HCV
5%	138,072	32,207	170,279
3%	248,364	50,041	298,406
0%	715,245	119,992	835,237

The analysis of the effects of HIV and HCV on both the quantity of life and the quality of life of persons with these diseases adds a further dimension to the assessment of the effect of NSPs among injecting drug users. The benefits demonstrated for consumers in terms of the number of lives saved, the number of life years gained, and the improved quality of life are additional to the direct financial benefits to governments previously identified.

6 CONCLUSION

The study into the effect of NSPs on HIV and HCV, and the consequent return on investment from these programs has reinforced the original findings by Hurley, Jolley and Kaldor. The results demonstrate that NSPs are effective in reducing the incidence of both diseases and that they represent an effective financial investment by government.

From a financial perspective, we have considered only the direct costs of treatment saved by the avoidance of HIV and HCV. Such an approach is inherently conservative, and it is likely that there are further financial benefits derived from the investment in NSPs not included in our findings. As such, the savings we have demonstrated, if anything, understate the total financial benefits to government and members of the community.

When considering the effect of NSPs on the lives of those immediately affected by their operation, namely injecting drug users, the study again demonstrates that NSPs have a positive impact. This has been measured in terms of avoidance of deaths, gains in the duration of life and improvements in the quality of life of injecting drug users. Such benefits are additional to the financial benefits demonstrated.

The study has considered the investment in NSPs during the 1990s, at which time we have assumed that the investment ceased. The consideration of effect has been limited to the future benefits accruing from the cases of HIV and HCV avoided during the investment period. Continued investment will result in further savings.

The results demonstrate that, across all measures of effect used in the study, NSPs have yielded a significant public health benefit, and that continued investment will result in further financial savings to government and improvements in both the quantity and quality of life of injecting drug users accessing NSPs.

APPENDIX A

REFERENCES

ABS (Australia Bureau of Statistics)(1995). Deaths, Australia 1994. ABS Catalogue No. 3302.0. AGPS, Canberra, 1995.

Alcades P, Munoz A, Vlahov D and Freidlan GH (1993). *Incubation period of human immunodeficiency virus*. Epidemiol Rev, 15: 303-318

Becker NG, Watson LF and Carlin JB (1991). *A method of non-parametric back-projection and its application to AIDS data*. Stat Med, 10: 1527-1542

Bennett WG, Inoue Y, Beck JR, et al (1997). *Estimates of the cost-effectiveness of a single course of interferon-alpha2B in patients with histologically mild chronic hepatitis C*. Ann Intern Med, 127: 855-865.

Bonkovsky HL, Woolley JM and the Consensus Interferon Study Group (1999). *Reduction of health-related quality of life in chronic hepatitis C and improvement with interferon therapy*. Hepatology, 29: 264-270.

Bruneau J, Lamothe F, Franco E, et al (1997). *High rates of HIV infection among injecting drug users participating in needle exchange programs in Montreal: results of a cohort study*. Am J Epidemiol, 145: 994-1002.

Des Jarlais DC, Hagan H, Friedman S, et al (1995). *Maintaining low HIV seroprevalence in populations of injecting drug users*. JAMA, 274: 1226-1231.

Drucker E, Lurie P, Wodak A and Alcades P (1998). *Measuring harm reduction: the effects of needle and syringe exchange programs and methadone maintenance on the ecology of HIV*. AIDS, 12 (Suppl A): S217-S230.

Drummond et al (1997). *Methods for the Economic Evaluation of Health Care Programmes*, 2nd edition, Oxford University Press

English D, Holman CDJ, Milne E, et al (1995). *The quantification of drug caused morbidity and mortality in Australia, 1995 edition*. Commonwealth Department of Human Services and Health, Canberra, 1995.

Fattovich G, Giustina G, Degos F, et al (1997). *Morbidity and mortality in compensated cirrhosis type C: a retrospective follow-up study of 384 patients*. Gastroenterol, 112: 463-472.

Freeman A, Dore GJ, Law MG, Thorpe M, Von Overbeck J, Lloyd A, Marinou G and Kaldor JM (2001). *Estimating progression to cirrhosis in chronic hepatitis C*. Hepatology, 34: 809-816.

Gulich AE, Wan X, Law MG, Coates M and Kaldor JM (1999). *Risk of cancer in people with AIDS*. AIDS, 13: 839-843.

Guydish J, Bucardo J, Young M, Woods W, Grinstead O and Clark W (1993). *Evaluating needle exchange: Are there negative effects?* AIDS, 7: 871-876.

Hagan H, McGough JP, Thiede H, et al (1999). *Syringe exchange and risk of infection with hepatitis B and C viruses*. Am J Epidemiol, 149: 203-213.

Hall WD, Ross JE, Lynskey MT, Law MG and Degenhardt LJ (2000). *How many dependent heroin users are there in Australia?* Med J Aust, 173: 528-531.

Holtgrave DR and Pinkerton SD (1997). *Updates of cost of illness and quality of life estimates for use in economic evaluations of HIV prevention programs*. JAIDS, 16: 54-62.

-
- Hurley SF, Jolley DJ and Kaldor JM (1997). *Effectiveness of needle-exchange programmes for prevention of HIV infection*. *Lancet*, 349: 1797-1800.
- Hurley SF, Kaldor JM, Carlin JB, et al (1995). *The usage and costs of health services for HIV infection in Australia*. *AIDS*, 9: 777-785.
- Law MG on behalf of the Hepatitis C Virus Projections Working Group (1999). *Modelling the hepatitis C virus epidemic in Australia*. *J Gastro Hepatol*, 14:1100-1107.
- MacDonald M, Crofts N and Kaldor J (1996). *Transmission of hepatitis C: Rates, routes and cofactors*. *Epidemiol Rev*, 18: 137-148.
- Marschner IC and Watson LF (1992). *An improved EMS algorithm for back-projection of AIDS incidence data*. Research Report 92/1, Department of Statistics, La Trobe University, Melbourne.
- NCHECR (2001). *HIV/AIDS, viral hepatitis and sexually transmissible infections in Australia Annual Surveillance Report 2001*. National Centre in HIV Epidemiology and Clinical Research (Ed), Sydney, 2001.
- Rodger AJ, Jolley D, Thompson SC, Lanigan A and Crofts N (1999). *The impact of diagnosis of hepatitis C virus on quality of life*. *Hepatology*, 30: 1299-1301.
- Rosenberg PS, Gail MH and Carroll RJ (1992). *Estimating HIV prevalence and projecting AIDS incidence in the United States: a model that accounts for therapy and changes in the surveillance definition of AIDS*. *Stat Med*, 11: 1633-1655.
- Schoenbaum EE, Hartel DM and Gourevitch MN (1996). *Needle exchange use among a cohort of injecting drug users*. *AIDS*, 10: 1729-1734.
- Shiell A, Briggs A and Farrell G (1994). *The cost effectiveness of alpha interferon in the treatment of chronic active hepatitis C*. *Med J Aust*, 160: 268-272.
- Tengs, Tammy O, Wallace, Amy, *One Thousand Health-Related Quality-of-Life Estimates*, *Medical Care*, 2000; Vol 38 No. 6: 583-637
- Thorley A (1981). *Longitudinal studies of drug dependence*. In: *Drug problems in Britain: a review of ten years*. Eds: Edwards G, Busch C. Academic Press.
- US Census Bureau & UNAIDS (2000). *HIV/AIDS Surveillance Data Base*. Health Studies Branch, International Programs Center Population Division, US Census Bureau, Washington.
- van Ameijden EJC, van den Hoek JAR and Coutinho RA (1994). *Injecting risk behaviour among drug users in Amsterdam 1986 to 1992, and its relationship to AIDS prevention programs*. *Am J Pub Health*, 84: 275.
- Watters JK, Estilo MJ, Clark GL and Lorvick J (1994). *Syringe and needle exchange as HIV/AIDS prevention for injecting drug users*. *Journal of American Medical Association*, 271: 115-120.
- Wolk J, Wodak A, Guinan JJ, Macaskill P and Simpson JM (1990). *The effect of a needle and syringe exchange on a methadone maintenance unit*. *British Journal of Addiction*, 85. 1445-1450.