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.