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)

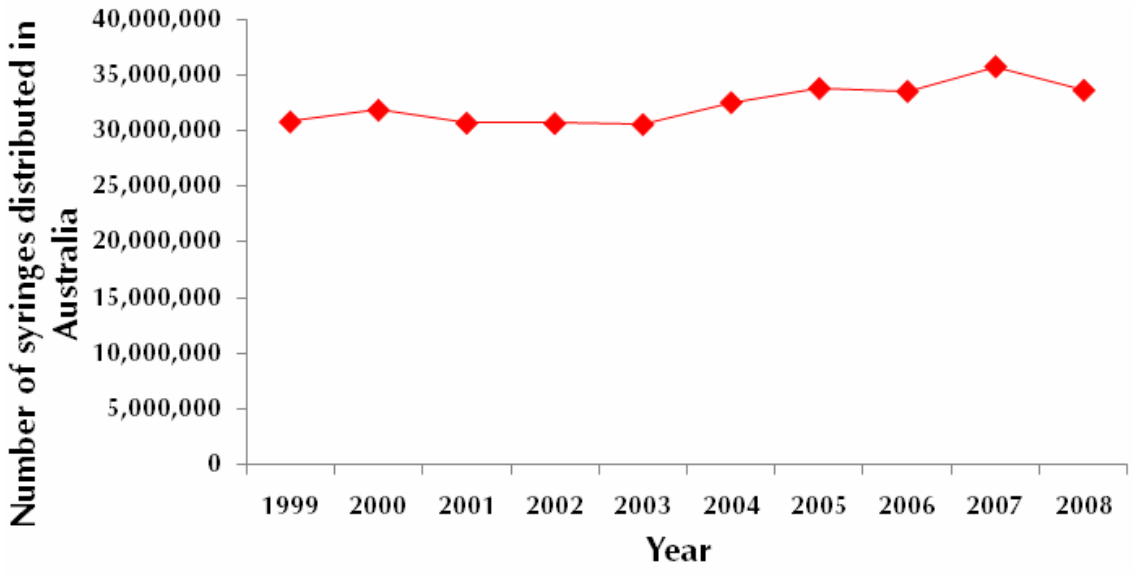
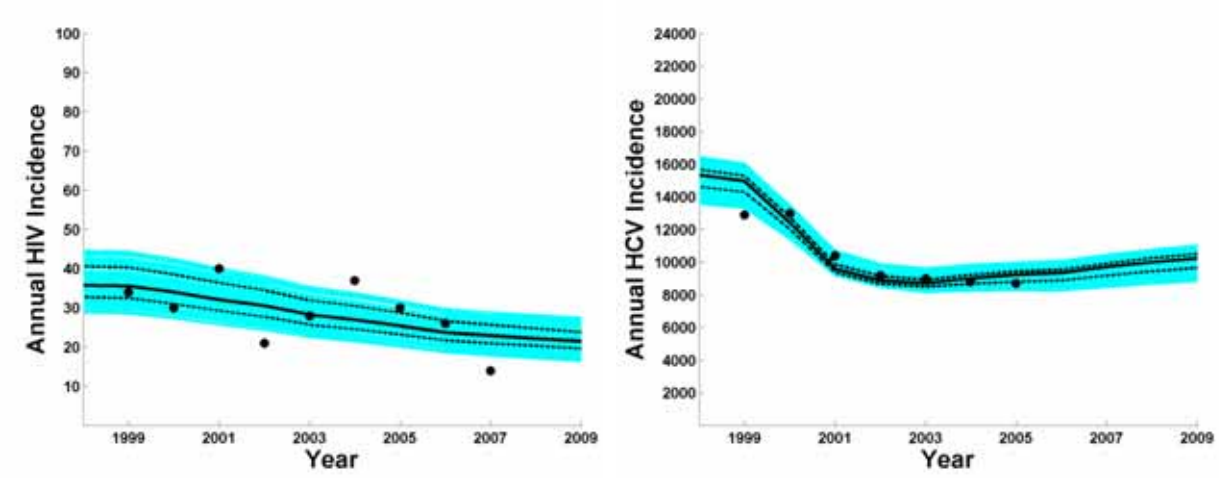


Figure 2: HIV and HCV notifications data among Australian IDUs and 100 model simulations for current NSP coverage (1999-2009)

HIV **HCV**

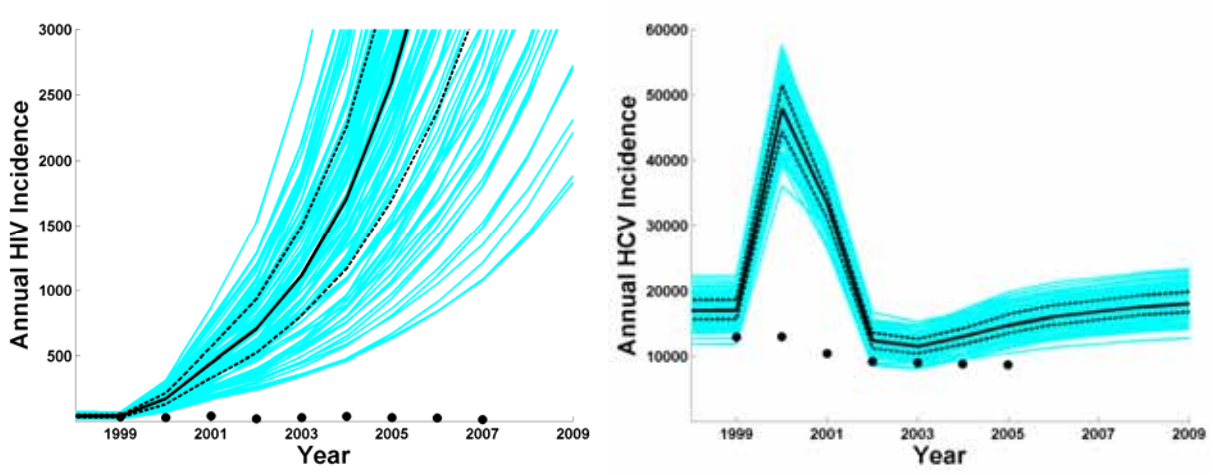


Simulating the past if NSPs had not been in place

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**

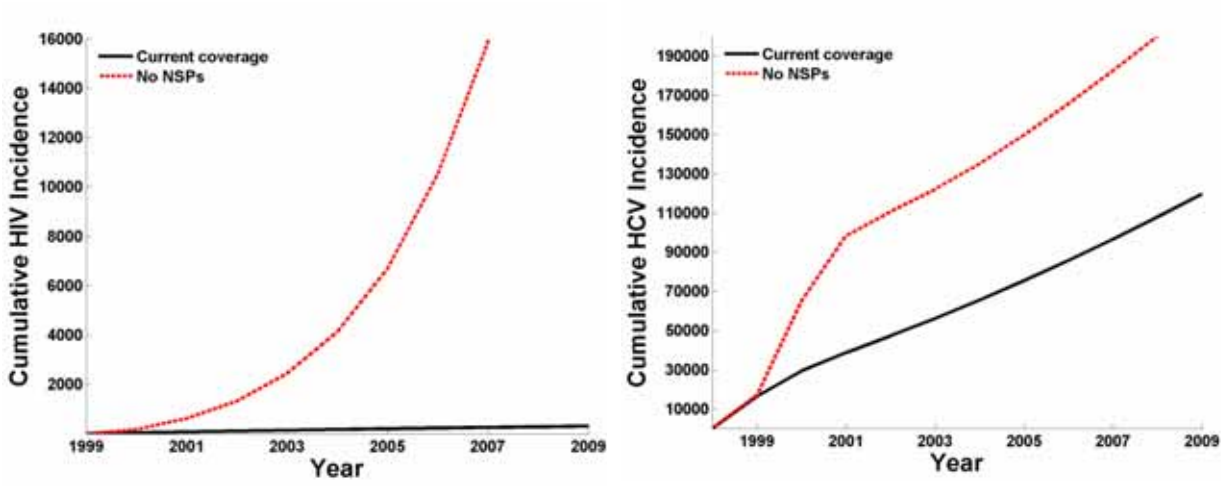


Table 2: Estimated HIV and HCV related outcomes with and without NSPs (medians)

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**

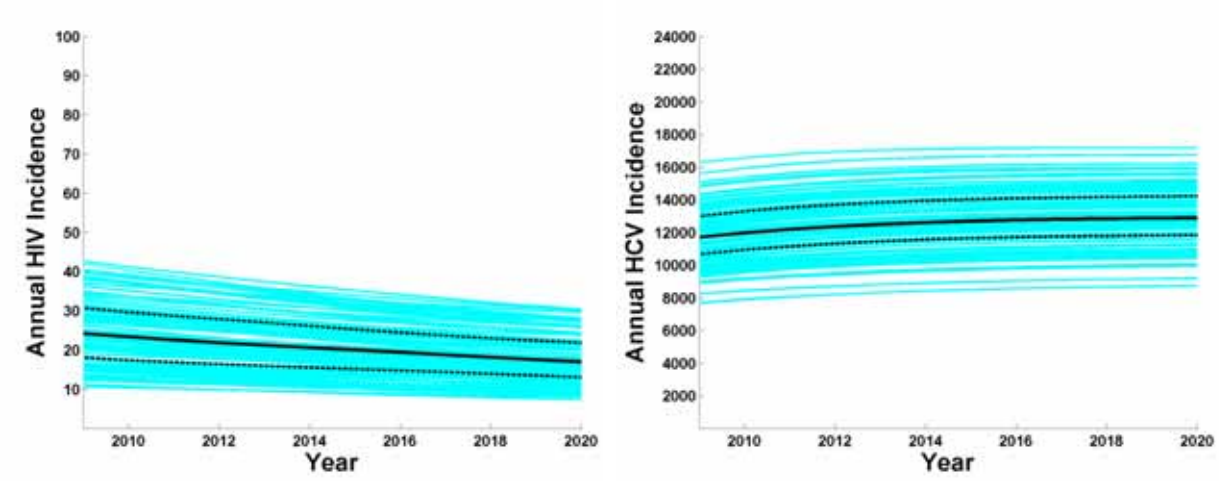


Figure 6: Projected HIV and HCV cases among Australian IDUs if NSPs cease to distribute injecting equipment (2010-2019)

HIV **HCV**

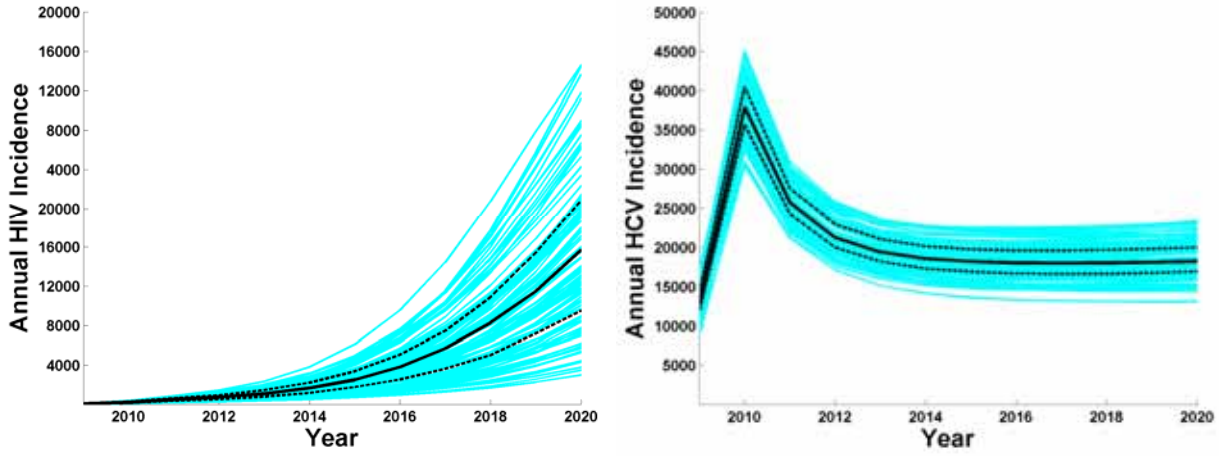


Figure 7: Projected HIV and HCV cases among Australian IDUs if NSPs decrease overall distribution of injecting equipment by 50% (2010-2019)

HIV **HCV**

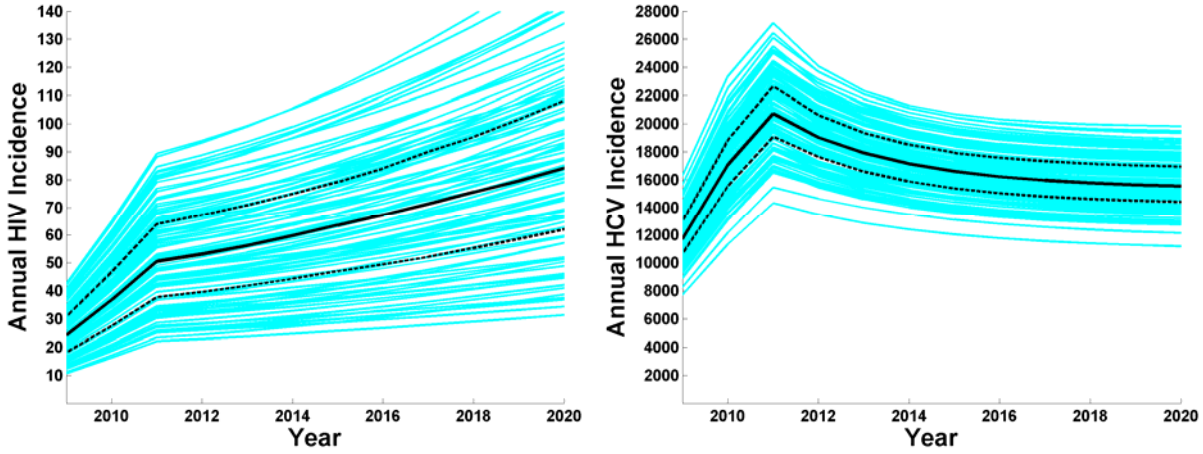


Figure 8: Projected HIV and HCV cases among Australian IDUs if NSPs decrease overall distribution of injecting equipment by 25% (2010-2019)

HIV **HCV**

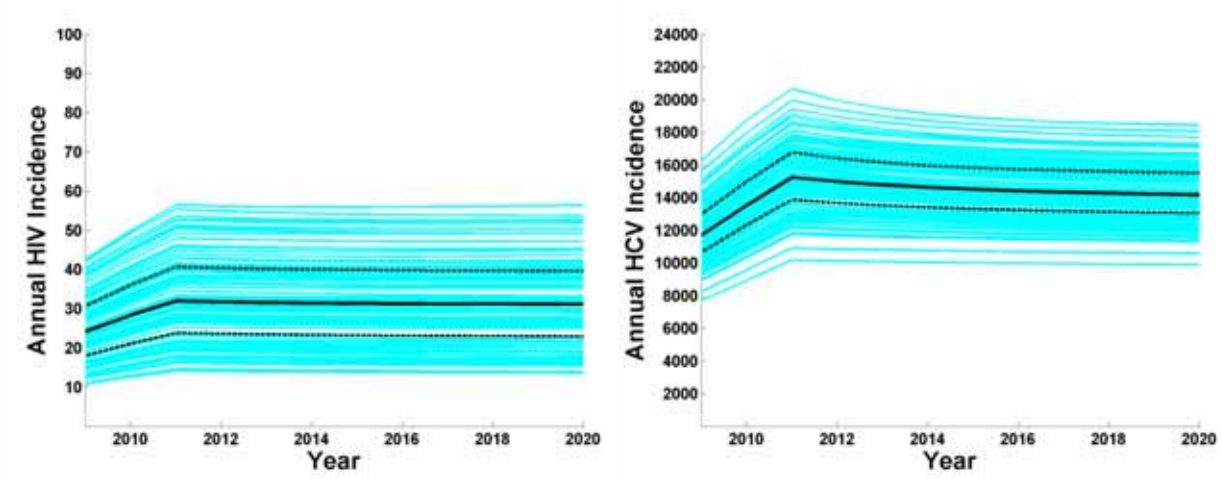


Figure 9: Projected HIV and HCV cases among Australian IDUs if NSPs decrease overall distribution of injecting equipment by 10% (2010-2019)

HIV **HCV**

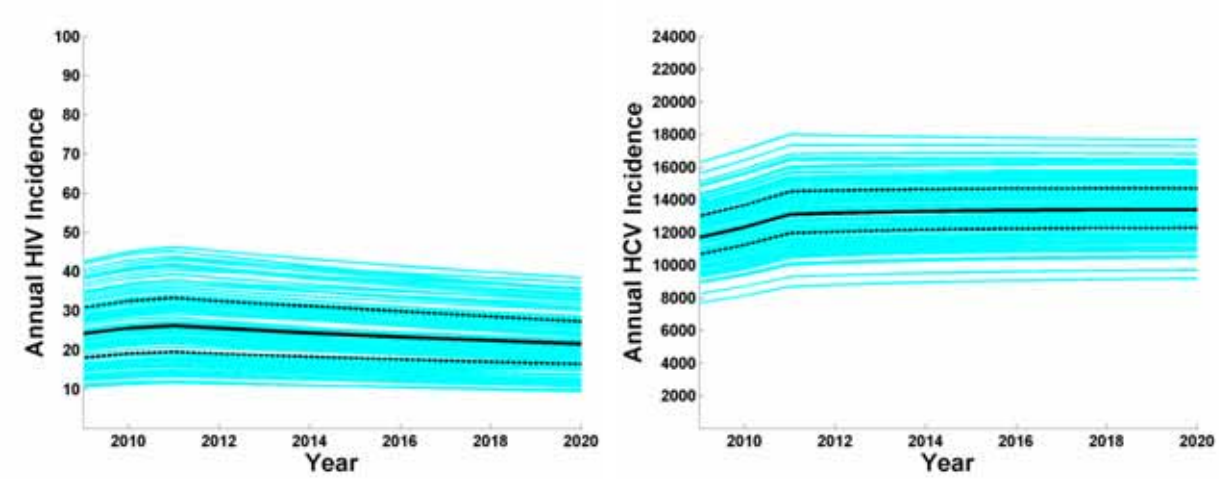


Figure 10: Projected HIV and HCV cases among Australian IDUs if NSPs increase overall distribution of injecting equipment by 10% (2010-2019)

HIV **HCV**

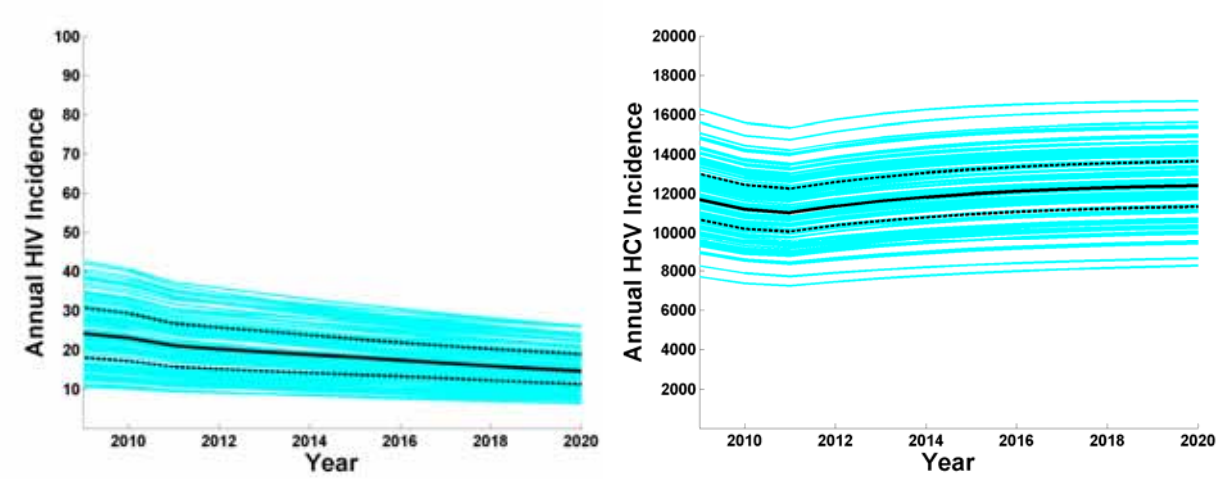


Figure 11: Projected HIV and HCV cases among Australian IDUs if NSPs increase overall distribution of injecting equipment by 25% (2010-2019)

HIV **HCV**

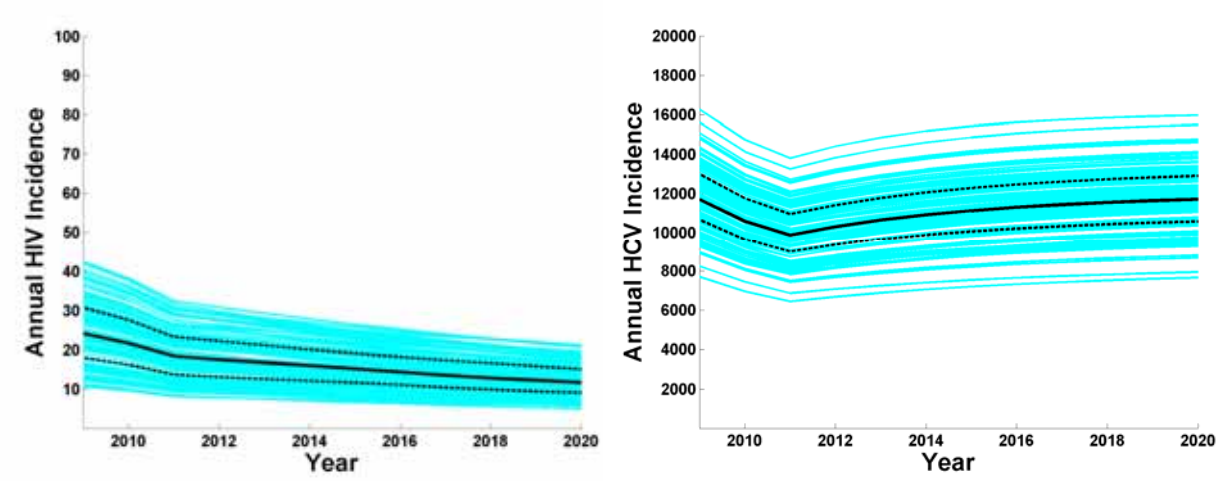
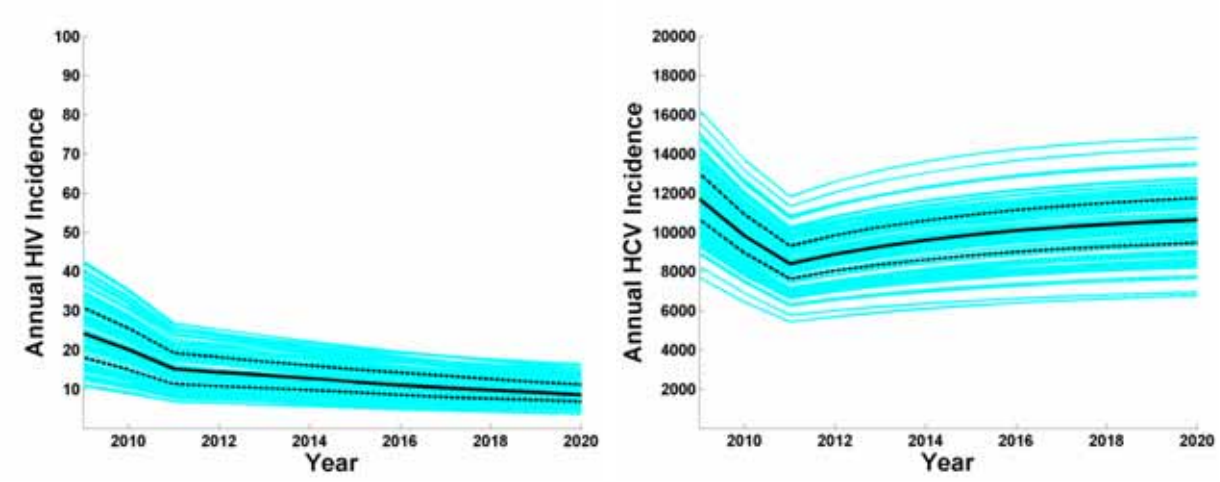


Figure 12: Projected HIV and HCV cases among Australian IDUs if NSPs increase overall distribution of injecting equipment by 50% (2010-2019)

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)

HIV **HCV**

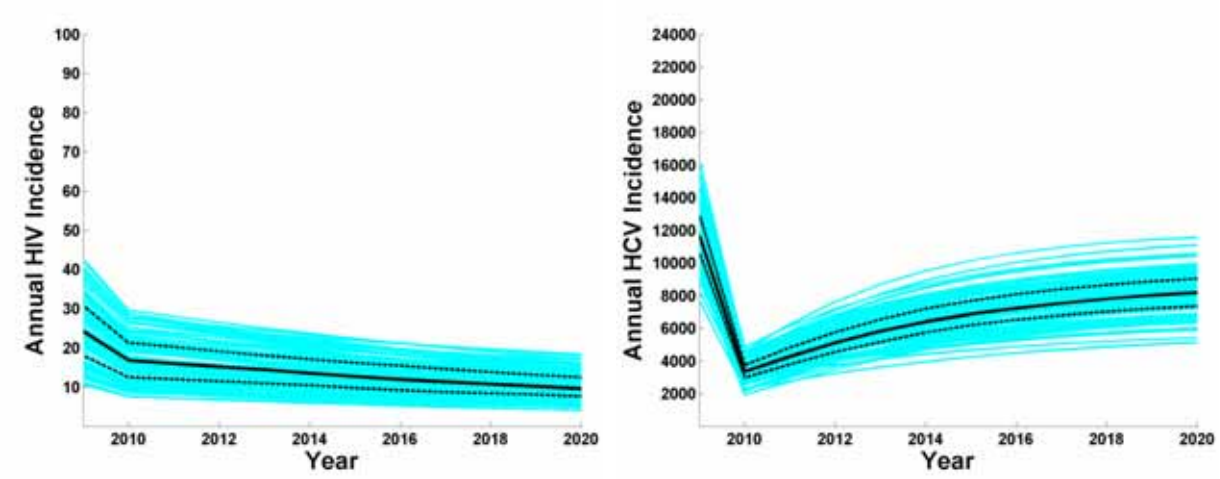


Figure 14: Projected HIV and HCV cases among Australian IDUs if the size of the IDU population decreases by 10% (2010-2019)

HIV **HCV**

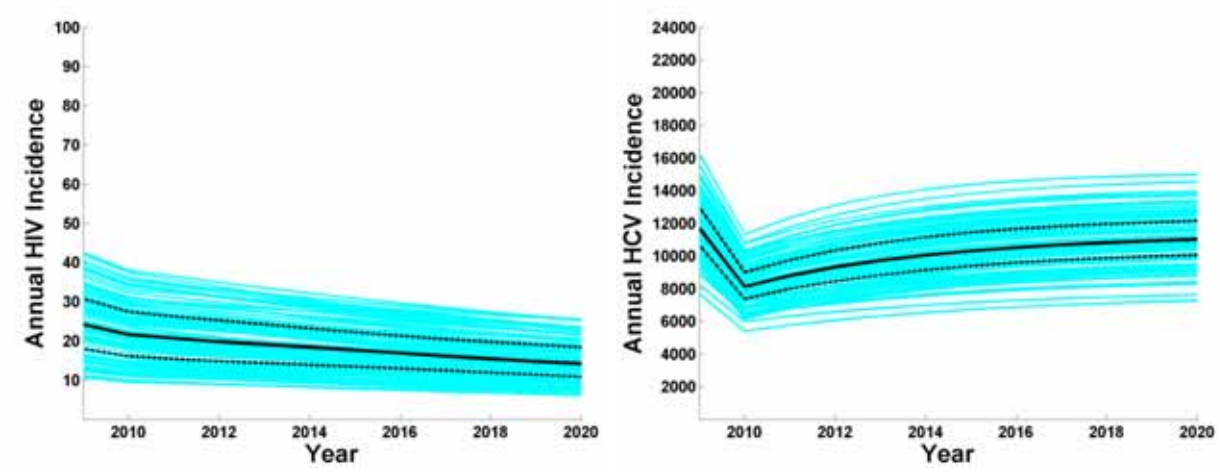


Figure 15: Projected HIV and HCV cases among Australian IDUs if the size of the IDU population increases by 10% (2010-2019)

HIV **HCV**

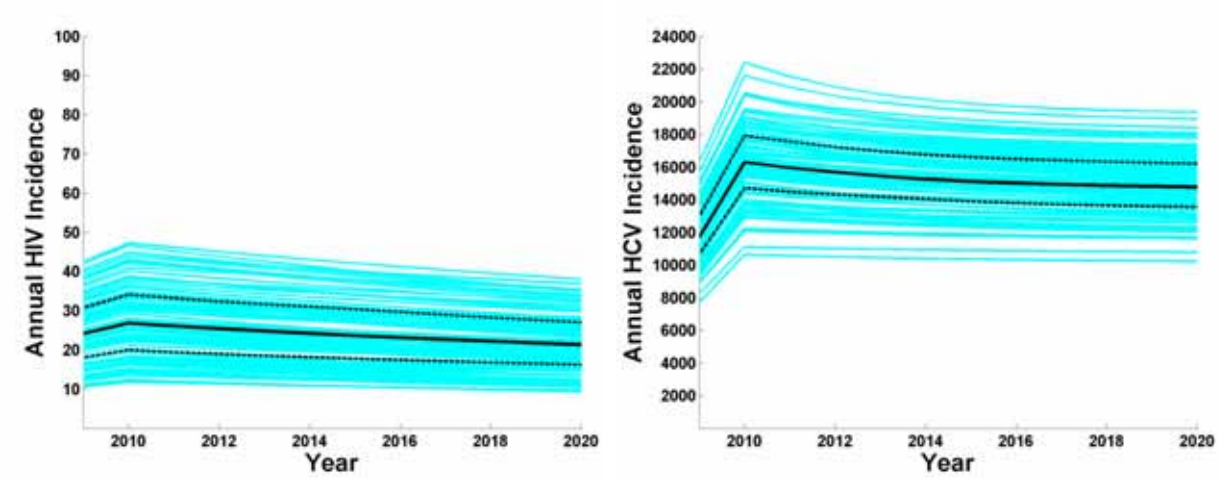
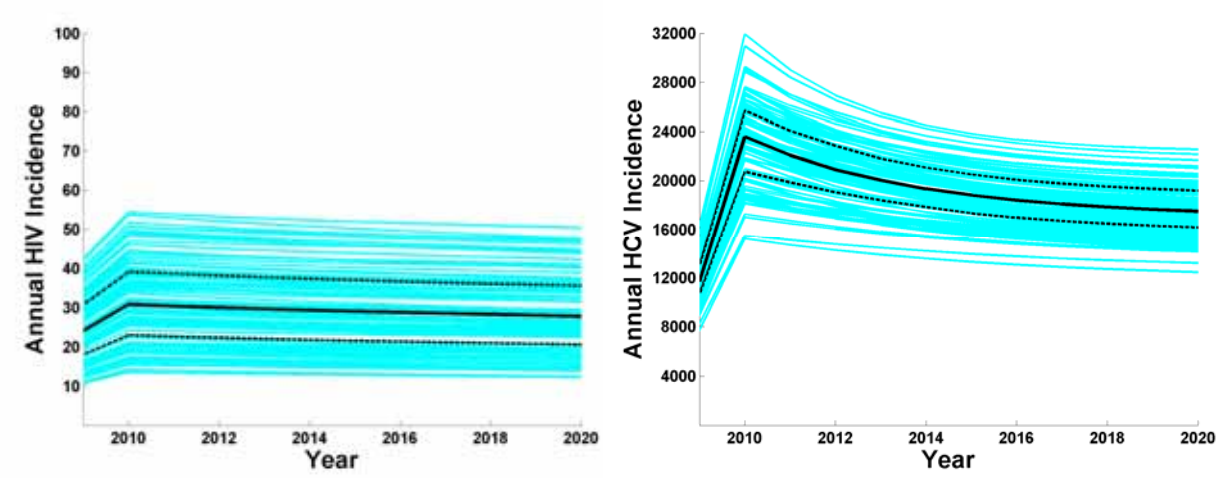


Figure 16: Projected HIV and HCV cases among Australian IDUs if the size of the IDU population increases by 25% (2010-2019)

HIV **HCV**



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)

HIV **HCV**

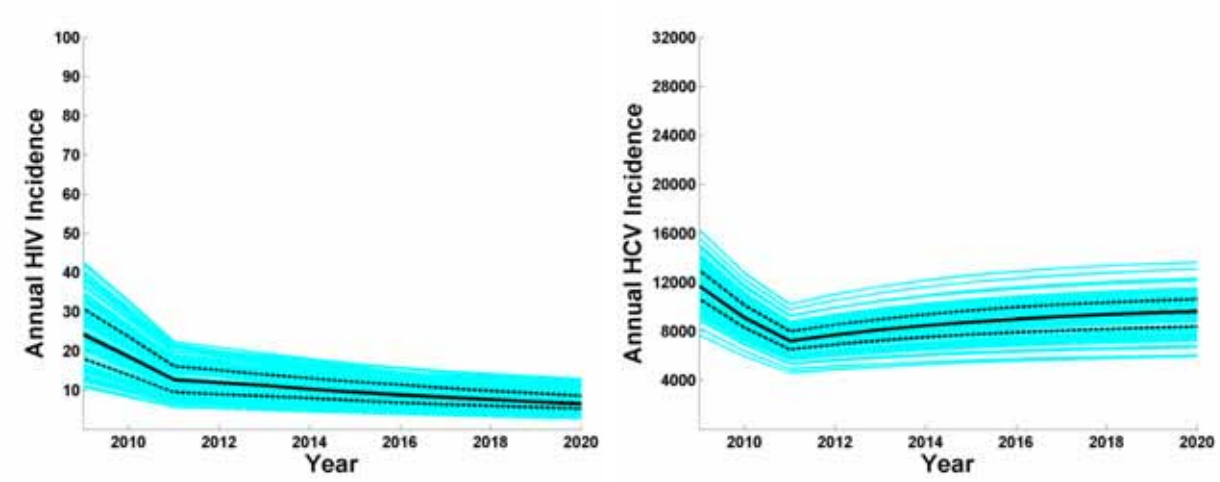


Figure 18: Projected HIV and HCV cases among Australian IDUs if the average frequency of injecting decreases by 10% (2010-2019)

HIV **HCV**

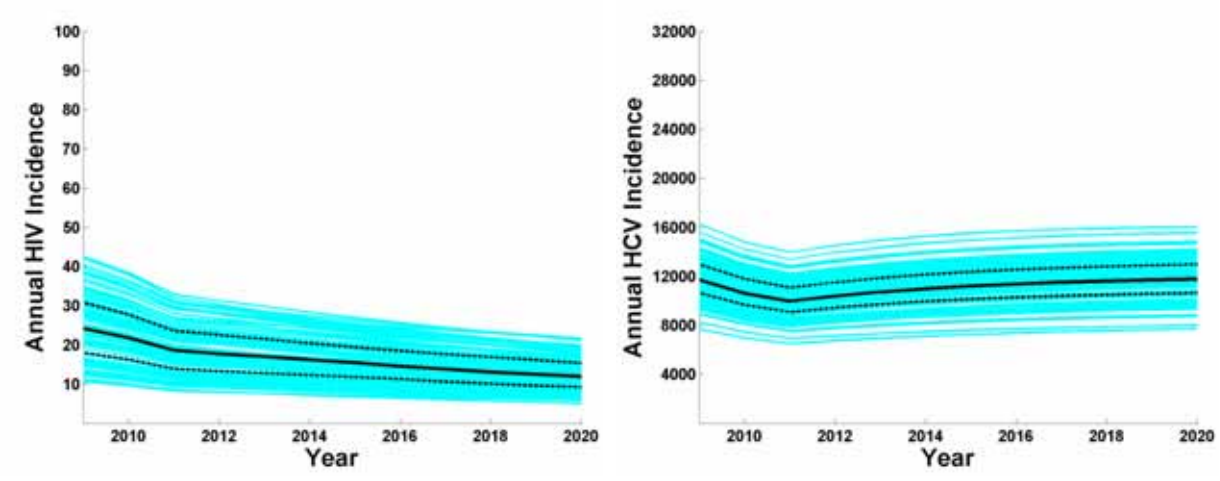


Figure 19: Projected HIV and HCV cases among Australian IDUs if the average frequency of injecting increases by 10% (2010-2019)

HIV **HCV**

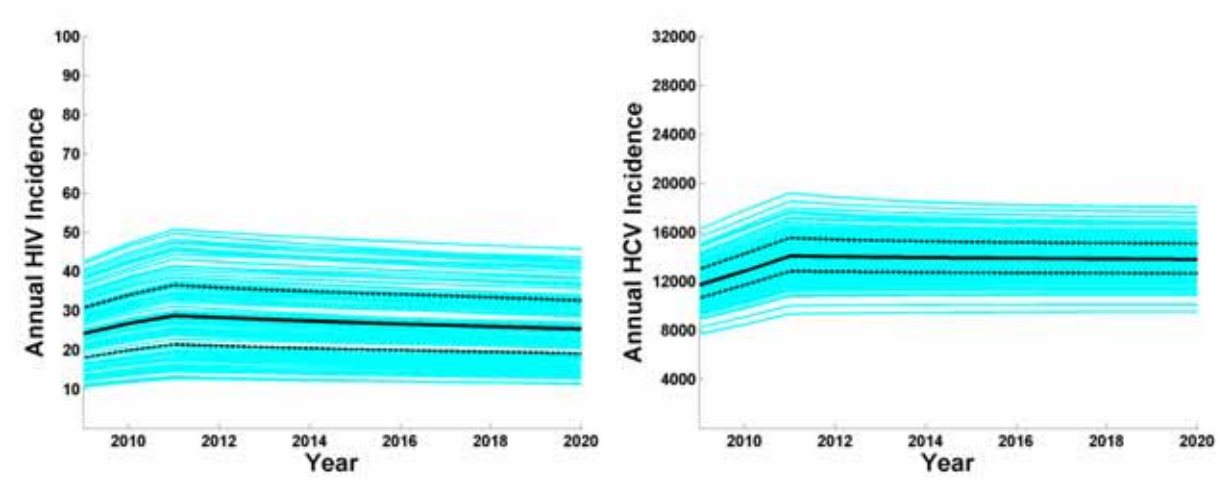
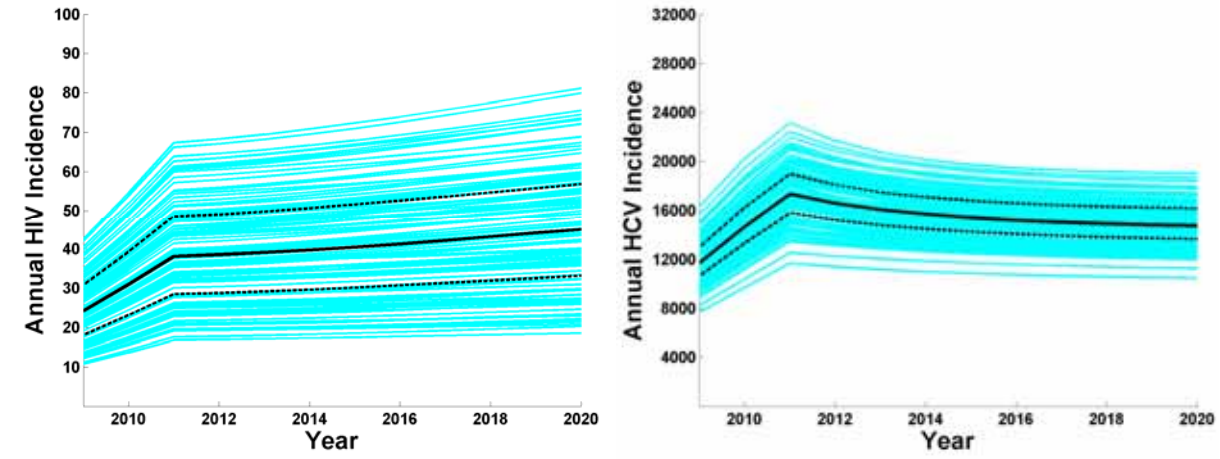


Figure 20: Projected HIV and HCV cases among Australian IDUs if the average frequency of injecting increases by 25% (2010-2019)

HIV **HCV**



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