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Can the UK control viral hepatitis: modelling IDU and transmission of HCV

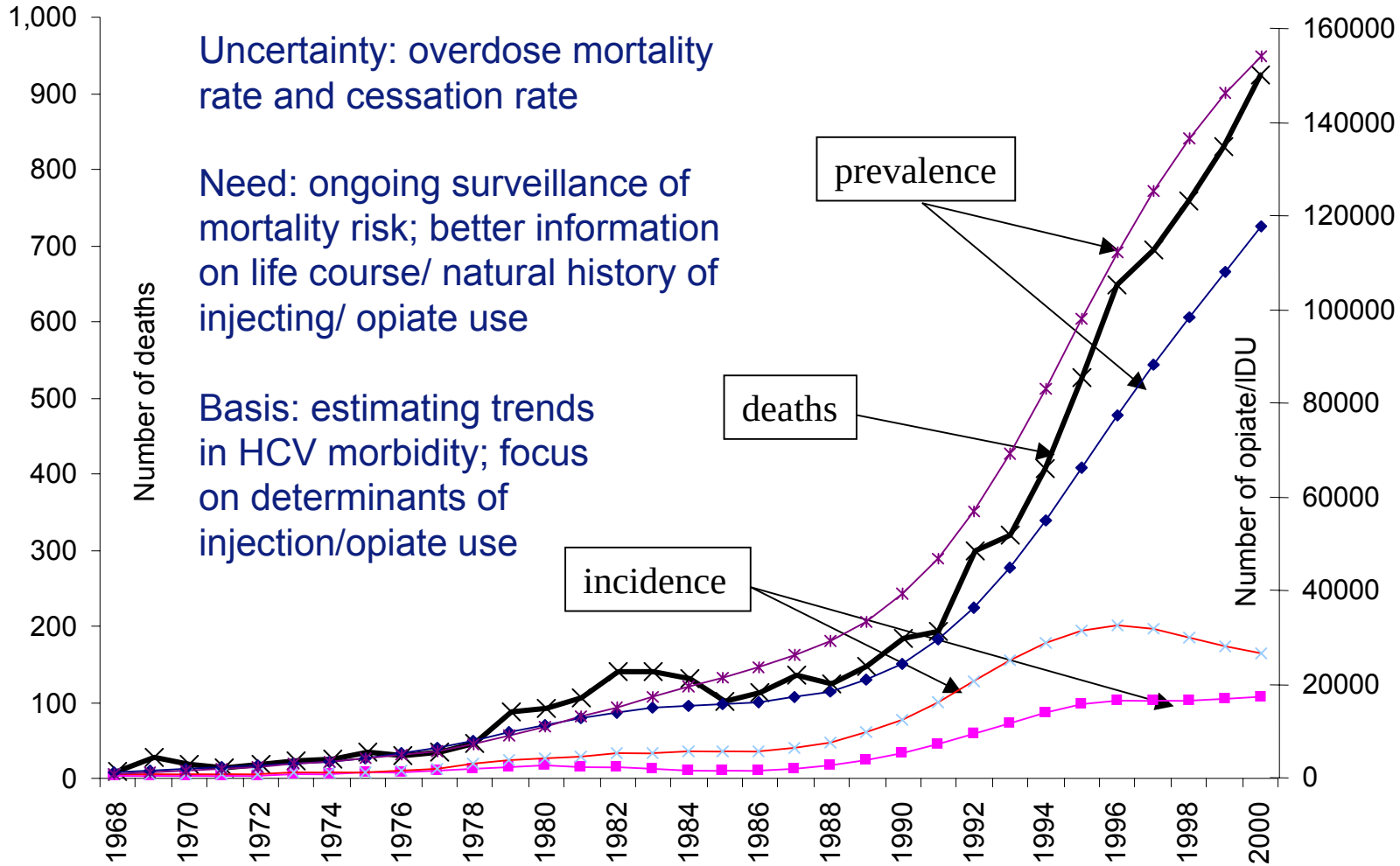
Matthew Hickman*+, Daniela De Angelis$, Vivian Hope$+, Andrew Sutton$, Peter Vickerman#

*Social Medicine, University of Bristol, +CRDHB, $ Health Protection Agency, #London School of Hygiene and Tropical Medicine

Can the UK control viral hepatitis?

- Trends in IDU
- Injecting Risk/ coverage of syringe distribution
- Coverage and endemic HIV
- Initial model of HCV
- Future developments

Increase in IDU prevalence: long term trends in opiate overdose and back-calculation estimates of incidence and prevalence deaths over time, England 1968-2000.



De Angelis, Hickman, Yang. Estimating long-term trends in the incidence and prevalence of opiate/injecting drug use and the number of ex-users: the use of back-calculation methods and opiate overdose deaths. Am. J. Epidemiol. 2004 160: 994-1004

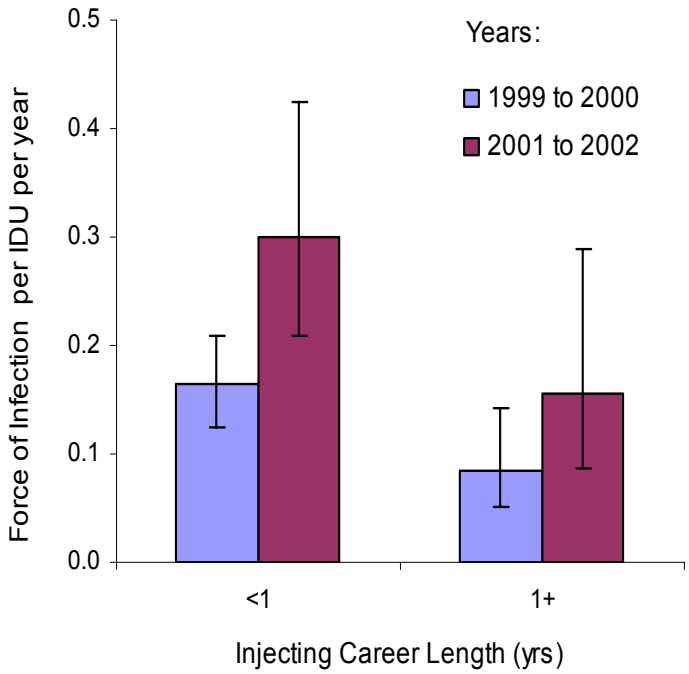
Background: evidence of increase in HCV incidence and prevalence

Prevalence (n=428)

anti- HIV 4%

anti-HBc 30%

anti-HCV 46%



Incidence (70% follow-up)

HCV (53 seroconverters)

rate = 42 per 100 py (32-55)

HIV (9 seroconverters)

rate = 3 per 100 py (2-7)

Crack injectors: 6.5 (3.4-12)

UAP HCV Prevalence (< 4 years injecting)

1999-2000: ~ 11%

2003-04: 20%

Judd, Hickman, Jones et al. Incidence of hepatitis C virus and HIV among new injecting drug users in London - prospective cohort study. *BMJ 2005 330: 24-25;* Sutton, Hickman, Gay, Hope. Modelling the force of infection in England and Wales (forthcoming); Shooting Up, HPA, 2004

Changes in IDU population & crack injection: reduction in syringe coverage

- 1997 survey of UK syringe exchange
  - 1,733 – 2000 sites distributing 1.7 – 2.3 million per month
  - 20-27 million per annum
  - 2003/04 ? Similar results
- Crack-use & injection
  - London estimate - 46,000 (> 1%, 15-44); ~60% opiate users
  - 70% crack & heroin IDU in selected cities (London, Manchester, Bristol...)
  - Average daily injecting frequency – crack vs. non-crack: 3+ vs. ~2
- Net reduction in coverage
  - At least 20% due to estimated increase in IDU prevalence
  - ~ 35% in sites with 70% crack+heroin IDU
  - Potentially > 50% in sites with increasing IDU and high crack IDU

Parsons, Hickman, Turnbull*, et al.* UK *Addiction* 2002,97:845-850; Hope, Hickman, Tilling. Capturing crack-cocaine… Addiction 2005; De Angelis, Hickman, AJE

Modelling Endemic HIV & Coverage of Syringe Distribution: Is there a critical threshold

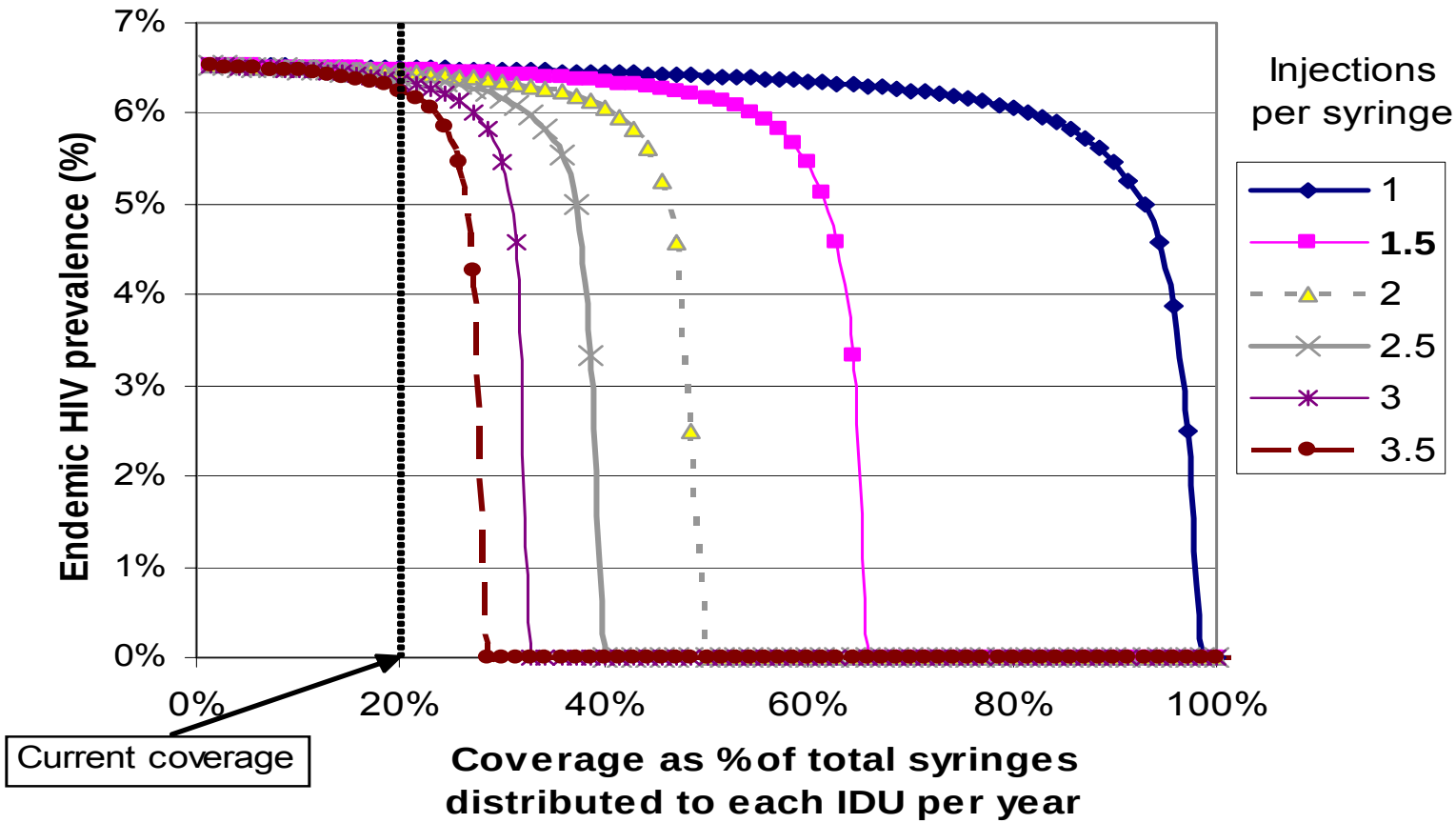
- Homogenous IDU population
  - Estimate endemic HIV prevalence
- Coverage –components:
  - Proportion of injections covered by syringes provided (ε) and personal re-use of syringe (δ)
  - Shortfall in syringe availability given reuse = sharing events
- Endemic HIV prevalence (p) – components:
  - Sharing (proportion IDU sharing (s), average number of IDU share with and sharing events (mn))
  - Transmission probability per sharing event (β)
  - Cleaning efficacy (frequency and success of cleaning (ec))
  - Injecting frequency (T) and duration (D)

$$R_0 = mD\left(1-\left(1-\beta\left(1-ec\right)\right)^n\right)$$

$$\frac{\varepsilon}{T} = \frac{1}{\delta}\left[1-\frac{S}{\beta(1-ec)DT(S-p)}\right]$$

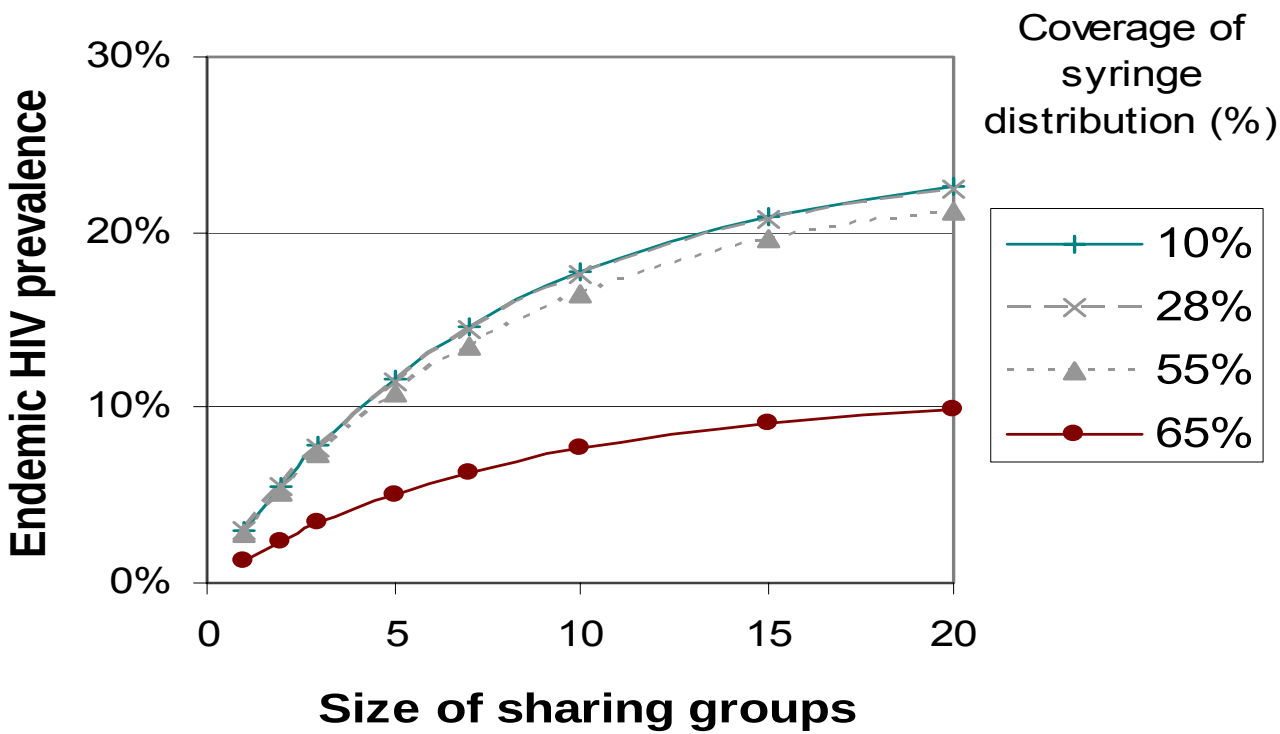
Vickerman, Hickman et al. What scale is needed? Model projections on the required coverage of syringe distribution to prevent HIV epidemics among injecting drug users. Under Review

Coverage and re-use of own syringe, London: step like function between endemic HIV prevalence and coverage "assuming other factors remain equal"



Vickerman, Hickman et al. What scale is needed? Model projections on the required coverage of syringe distribution to prevent HIV epidemics among injecting drug users. Under Review

Coverage – size of sharing group, London. Size of sharing group matters when HIV prevalence is low. To maintain low prevalence sharing groups need to be small or coverage very high.



Vickerman, Hickman et al. What scale is needed? Model projections on the required coverage of syringe distribution to prevent HIV epidemics among injecting drug users. Under Review

Preventing HIV coverage threshold – "rule of thumb"

- Product of transmission probability, cleaning effectiveness, injecting duration and frequency is relatively small (<0.1)

$$\frac{1}{\beta(1-ec)DT}$$

- Coverage threshold approximately the inverse of the number of times a syringe is safely used before disposal (1/δ)

- Other factors impact near coverage threshold
  - cessation rate, injecting frequency, efficacy and frequency of syringe cleaning

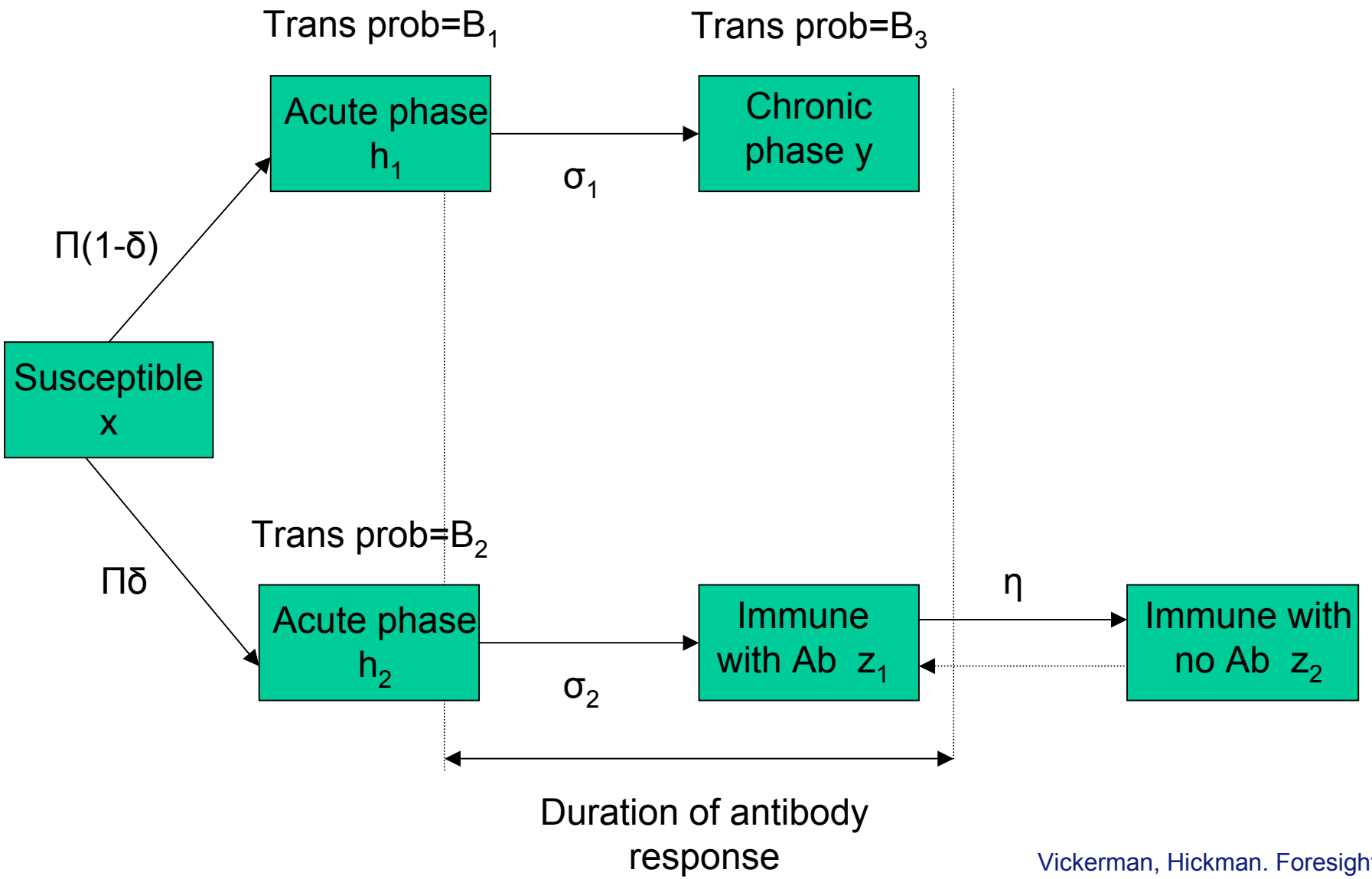
Vickerman, Hickman et al. What scale is needed? Model projections on the required coverage of syringe distribution to prevent HIV epidemics among injecting drug users. Under Review

Developing Transmission Model of HCV

- Construct a model for the dynamics of HCV amongst injecting drug users (IDUs) in London
- Fit the model to available data to explore impact of harm reduction interventions that may result in reductions in syringe sharing and other risk behaviours
- Summary IDU risk behaviour:
  - Frequency of injection 700 per year
  - Proportion of IDUs share in last 3-6 mths 30-66%
  - Rate of cessation of injecting 10% per year
  - Number of syringes exchanged per year ~140
  - How many times use each syringe 3.5
  - Syringe use data implies IDUs need to use somebody else's syringe ~16 times per month
  - IDU HCV prevalence ~ 50% 2003
  - IDU HCV incidence > 30% 2001-03

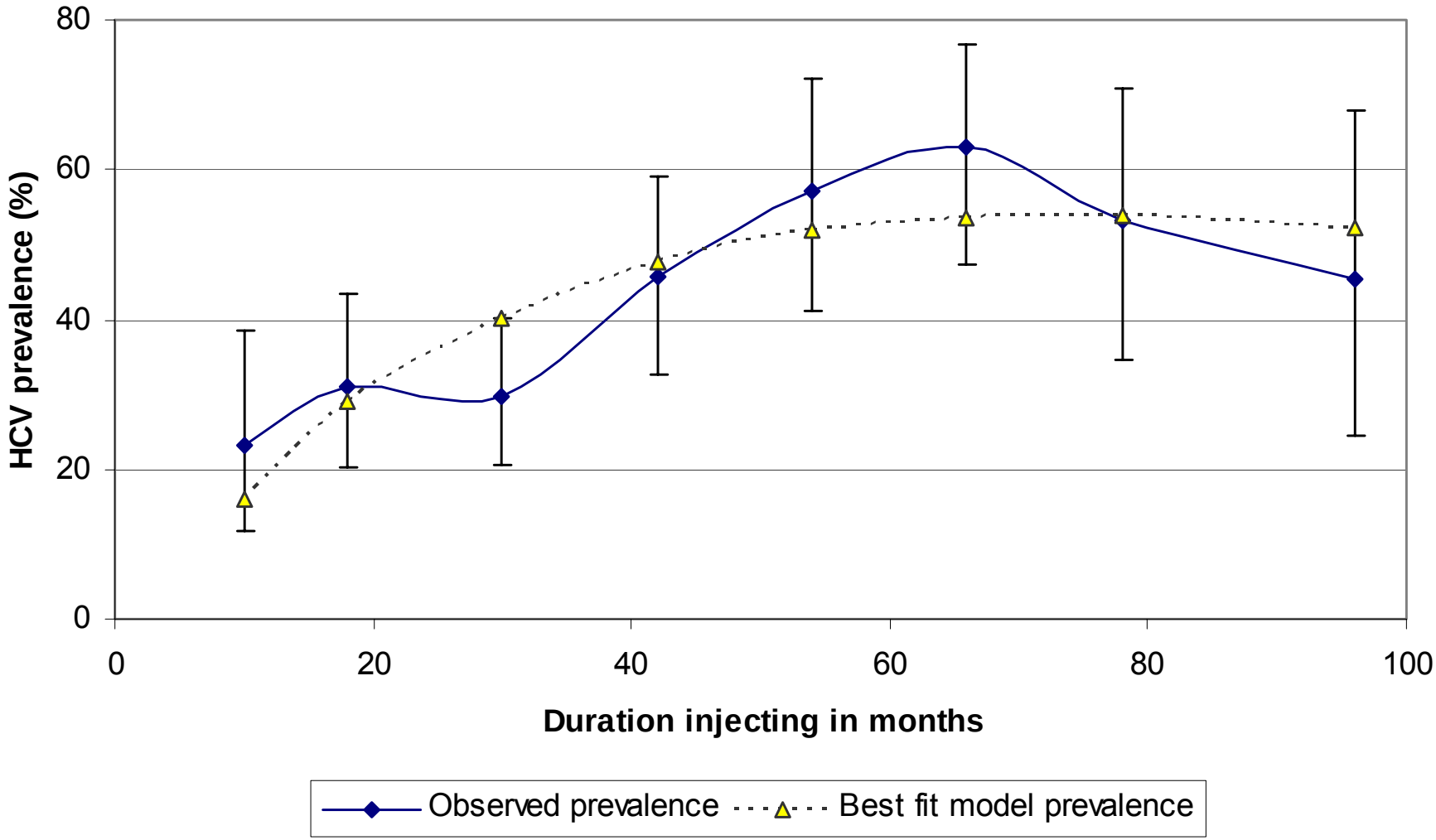
Vickerman, Hickman. Foresight Modeling Project, 2005.

HCV model flow diagram

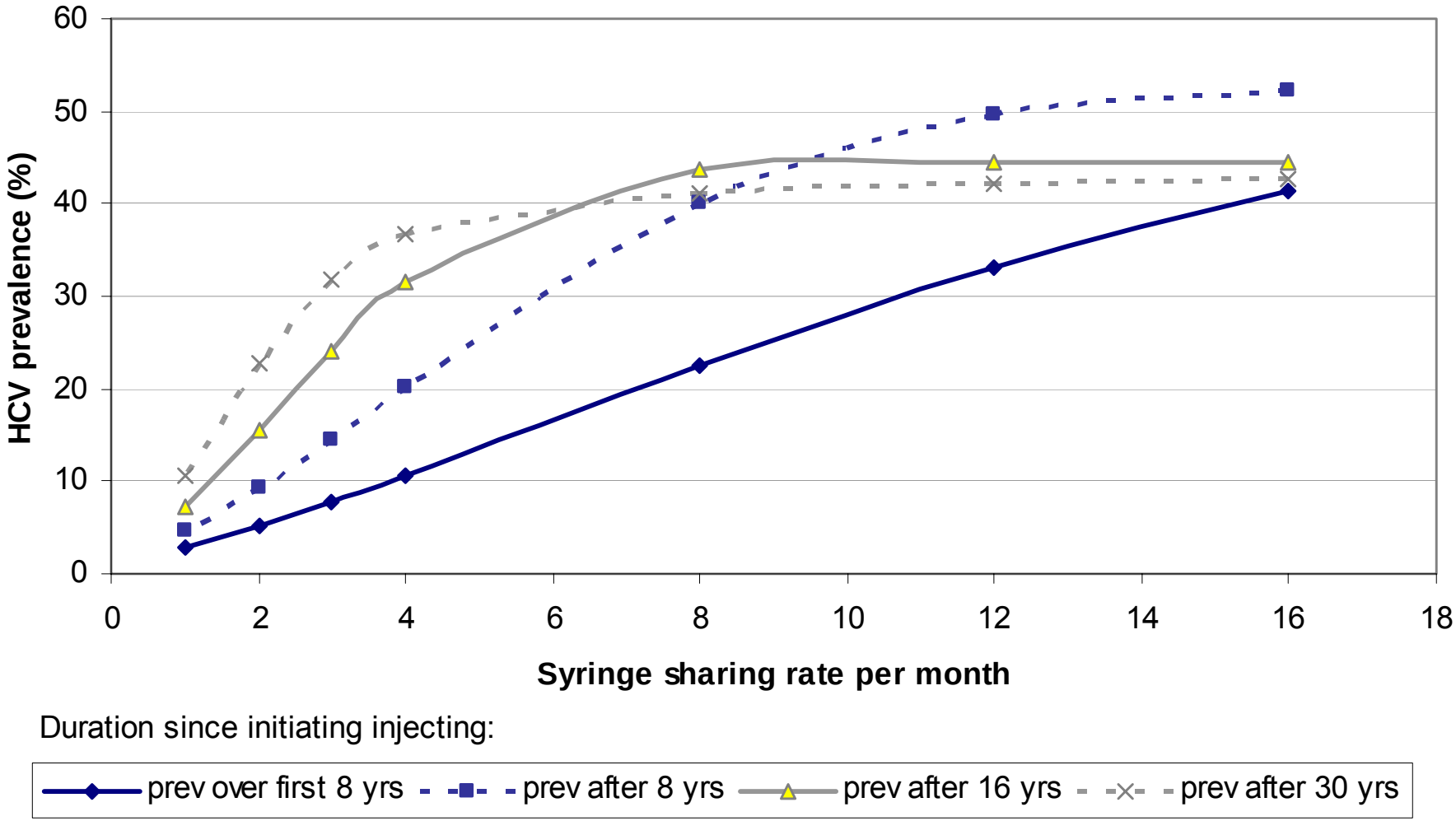


Vickerman, Hickman. Foresight Modeling Project, 2005.

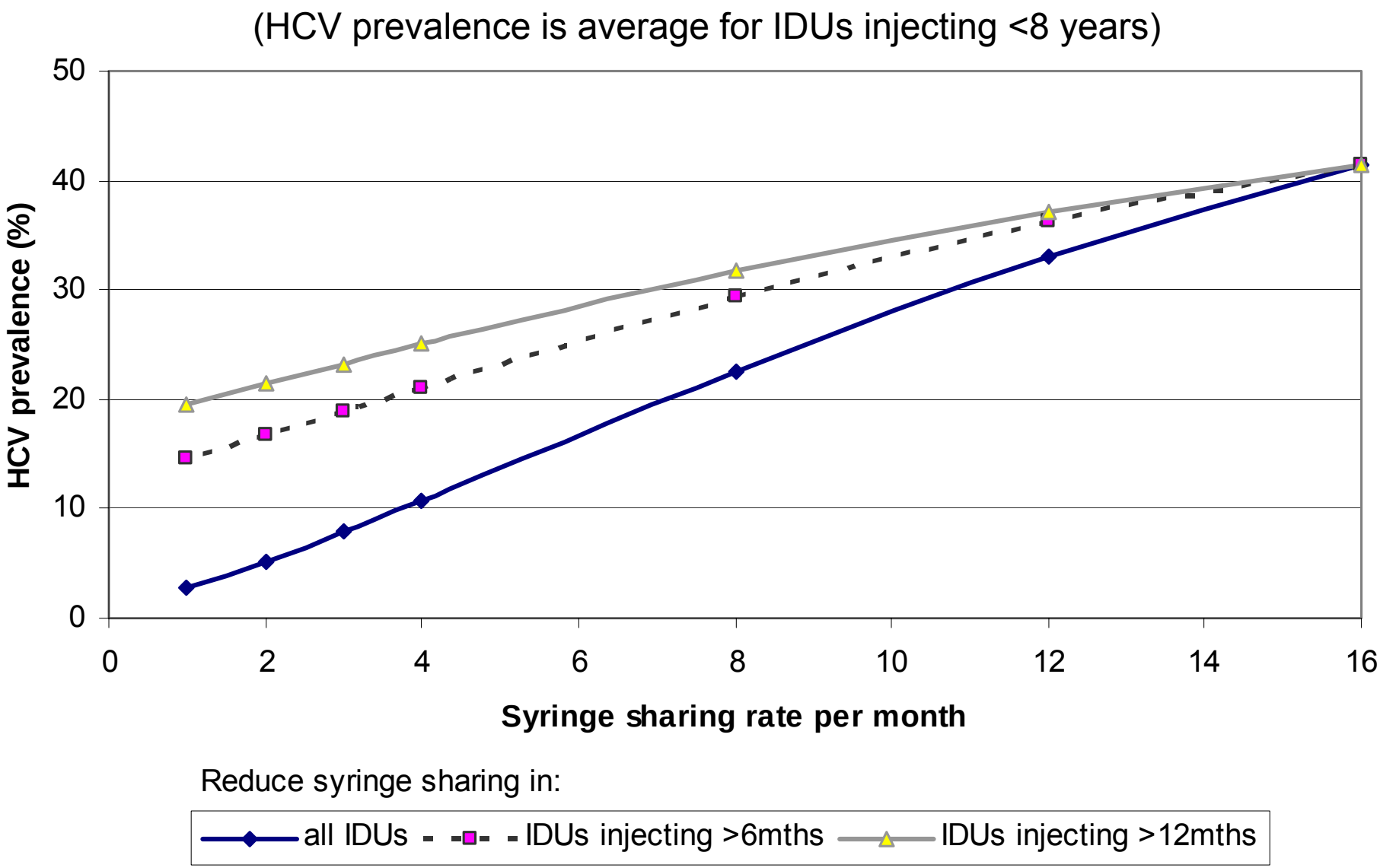
Comparison of model fit to HCV prevalence data from London for 2001/2002



Impact of reductions in syringe sharing on the HCV prevalence after different durations of injecting



Impact of reducing syringe sharing only amongst IDUs that have been injecting for >6 months or 1 year.



HCV Model: Summary

- Assuming current model structure is valid:
  - Small reductions in syringe sharing could reduce the HCV prevalence of new injectors, BUT
  - Large reductions in syringe sharing are required to reduce the HCV prevalence of long term IDUs
  - It maybe crucial for harm reduction activities to reach new IDUs because of rapid nature of HCV transmission
  - Changes in behaviour must be sustained over a long period to achieve reductions in HCV prevalence
  - Syringe sharing has to become very low (1-2 per mth) to reduce HCV prevalence to less than 10%
- Modelling limited by data uncertainty

HCV Modelling limited by data uncertainties

- Uncertainties in HCV biological parameters:
  - HCV transmission probability for syringe sharing
  - Effectiveness of syringe cleaning for HCV
  - % of acute infections that self cure
  - Status of protective immunity after self cure
- Uncertainty in IDU behavioural parameters:
  - Frequency and nature of syringe sharing
  - The impact of syringe distribution on syringe sharing
- Uncertainty resulted in:
  - Uncertainty over the most suitable model structure
  - Large numbers of different parameter combinations that fit the model to the data
  - Uncertainty over the model predictions

Future work

- Model with core group of higher frequency syringe sharers
  - Test for evidence within behavioural surveys
  - Consider implications for prevention
  - Fit model to other sites (and explore differences in HCV epidemics)
- Explicitly assess impact of increasing syringe distribution (and other potential 1ry interventions)
  - Consider optimal combination of range of interventions (injecting cessation/frequency, cleaning, re-use & coverage)
  - Consider impact of HCV treatment on prevention
- Model incidence/prevalence over time (and time to reduction in prevalence/ sustainability required)
  - Better understand relationship between syringe distribution/coverage, re-use and IDU syringe sharing

Can the UK control viral hepatitis?

- Epidemiology evidence
  - Increase in incidence and prevalence
  - Increase in injecting frequency & risk
  - Increase in IDU & crack IDU
  - Decrease in coverage of syringe distribution
- Model evidence
  - Reductions in HCV prevalence (and incidence) possible
  - Develop HCV model (behavioural and biological uncertainty)
  - Threshold coverage for HIV near 1/re-use
  - Sustained increase in syringe distribution (threshold level to be assessed)
  - Target recent injectors/ core group