



The cost-effectiveness of HIV preventive
measures among injecting drug users in
Svetlogorsk, Belarus

DRAFT

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Foreword

This cost-effectiveness analysis is the result of a study carried out in 1999 in Svetlogosk, Belarus. The analysis included the collection of costs using the approach described in "Cost analysis: HIV prevention with injecting drug-using populations. Report of the field study in Belarus", UNAIDS, May, 2000. To estimate effectiveness a dynamic mathematical model was created. This model is available in: " The impact of HIV prevention activities focussing on injecting drug users", UNAIDS, May 2000. The analysis estimates that the average cost per HIV infections averted was \$68 excluding the media campaign and approx. \$340 including the media campaign . The Svetlogosk approach to HIV prevention for injecting drug-user populations is thus a very cost-effective strategy in a country in transition. Hopefully, many more projects and cost-effectiveness analysis will be carried out in these countries and will confirm these promising results for similar interventions elsewhere in the region. The tools to do so are now available from UNAIDS.

Throughout the course of the research, guidance was provided by a joint UNAIDS/WHO advisory group. The advisory group included:
Lev Khodakevich, Team Leader, Europe desk, UNAIDS;
Yuri Kobyshcha, Intercountry Technical Adviser (Eastern and Central Europe), UNAIDS;
Werasit Sittitrai, Associate Director, Policy Strategy and Research, PSR, UNAIDS;
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UNAIDS, May 2000

Abstract

Aims:

The aim of the research was:

- To document the costs of a harm-reduction project in Svetlogorsk, Belarus;
- To compile epidemiological, behavioural and intervention related data collected by the project;
- To use *IDU 2.0*, a model to estimate the cost-effectiveness of HIV preventive measures among injecting drug users, to estimate the trends in HIV infection and the numbers of HIV infections averted by the project;
- To estimate the cost per HIV infection averted by the project.

Methods: Costs figures were obtained following standardised guidelines. A retrospective review of project documents, behavioural surveys and epidemiological information was conducted. A dynamic mathematical model, '*IDU 2.0*', was developed. The model incorporates mobility in and out of the IDU population; HIV transmission between IDUs with different patterns of sharing behaviour; and the sexual transmission of HIV and STDs among IDUs and between IDUs and non-IDU sexual partners. The model was used to project the trends in HIV infection in different sub-groups both in the presence and absence of the intervention. These were used to estimate the number of HIV infections averted among IDUs and non-IDU sexual partners as an outcome of the intervention.

Results: The model projections fit the observed temporal trends in HIV prevalence documented among IDUs in Svetlogorsk. Even though the HIV prevalence among IDUs was initially high in Svetlogorsk (74%), and has not declined substantially since the start of the intervention, the model projections suggest that nevertheless, the intervention is averting HIV infection among IDUs and their non-IDU sexual partners. The total costs of the intervention (over two years) was 1998 US \$32 768, but rose to \$144 617 if the newspaper space, radio and television airtime used by the mass media campaign were valued at commercial rates. The model was used to obtain impact and cost-effectiveness estimates. It was estimated that the average cost per HIV infection averted was about \$68, and ranged between \$54.43 and \$100.21 reflecting the uncertainty associated with some of the data inputs used to calculate the number of HIV infections averted. If the imputed airtime were included in economic costs, the cost per HIV infection averted would range from \$240 - \$442.

Conclusion: The findings highlight the importance of IDU HIV prevention activities in settings such as Belarus and other countries within Eastern Europe.

1. INTRODUCTION

Injecting drug users (IDUs) are often at high risk of HIV infection due to the risk of HIV transmission associated with sharing injecting equipment with others. The rapid spread of HIV among IDUs has now been documented in an increasing number of countries including Eastern Europe, Latin America and Asia. Groups vulnerable to IDU use include the urban poor, street children, prisoners, sex workers, itinerant and guest workers; and communities in drug-producing areas (Ball et al, 1998). The major factor associated with the transmission of HIV among IDUs is multi-person reuse or sharing of syringes. In addition, indirect sharing of equipment such as water, cotton, cookers and other drug preparation equipment has also been attributed to assisting the transmission of HIV (McCoy et al, 1998). Thus one key aim of IDU interventions is to prevent multi-person reuse of syringes and allow IDUs access to sterile syringes (Koester, 1998). IDUs are also at high risk for transmission of other blood-borne infections such as hepatitis B and C, and from premature death from drug overdose or sepsis infection. Experience suggests that if HIV epidemics associated with IDUs can be prevented or slowed, then the overall HIV epidemic can also be slowed down (Ball et al, 1998).

The general objectives of HIV prevention activities focused on IDUs are to avert both drug related and sexual transmission of HIV infection. This includes addressing the risk of HIV infection both through drug use and sexual behaviours simultaneously. The most effective way to prevent HIV transmission among IDUs is the elimination of drug using. However, in reality programmes work towards minimising or reducing harm. Thus there are a hierarchy of activities and educational messages which are used: (1) stop using and injecting drugs; (2) if not continuing to use drugs use, do not share equipment, but use own supplies; (3) if sharing, then disinfect to reduce transmission (Needle et al, 1998).

A comprehensive strategy for HIV prevention among IDUs may include primary prevention of drug abuse, provision of information, education, counselling to reduce needle/syringe sharing, use of bleach to clean/disinfect syringes/needles and drug preparation equipment, changing laws to permit legal purchase of needle/syringe, outreach programs for IDUs, syringe/needle exchange activities, referral for treatment of medical problems such as STDs, peer education programmes, and access to substance abuse treatment (Jones and Vlahov 1998, McCoy et al, 1998). IDU programmes are relatively labour intensive, engaging a variety of staff and volunteers.

Whilst our understanding of some of the essential features of different prevention strategies is becoming increasingly refined, little information had been compiled on the relative cost and likely impact of each intervention in different settings, either individually or in combination. There is limited information on the costs and impact of HIV prevention measures among IDUs. Based on the limited evidence, projects promoting access to sterile syringes appear to be relatively cost-effective, especially when compared to the life-time cost of HIV treatment in the US context (Holtgrave *et al.*, 1998; Lurie *et al.*, 1998). However, at present, there is very little information available of the costs of the different models of HIV prevention for IDUs in a developing or transitional country context, or their likely cost-effectiveness.

A major challenge associated with undertaking a cost-effectiveness analysis (CEA) of an IDU intervention is that interventions are primarily able to collect process and not much outcome data. In some settings information on the temporal trends of HIV among IDUs are available. However, it is particularly difficult to estimate how averting HIV infection among IDUs may affect the subsequent chain of HIV infection to the non-sexual partners of IDUs.

In addition, the results of cost-effectiveness analyses are also context-specific, so the extent to which any conclusions are generalisable to other settings may be limited. For this reason, a model-based evaluation has developed as means of estimating HIV infections averted. These models attempt to capture the dynamic nature of this transmission, as well as epidemiological and behavioural patterns

2. AIMS OF THE RESEARCH

The aims of this research note are to:

- Document the costs of the HIV preventive activities among IDUs in Svetlogorsk, Belarus
- Review epidemiological, behavioural and intervention-related data collected by the project;
- Develop and use an epidemiological model to estimate the trends in HIV infection and the numbers of HIV infections averted by the project;
- Estimate the cost per HIV infection averted by the project.

3. HIVTOOLS: A COST-EFFECTIVENESS TOOLKIT FOR HIV PREVENTION

Since 1994, the London School of Hygiene and Tropical Medicine (LSHTM) has worked in collaboration with UNAIDS to explore the use of economic evaluation in resource allocation for AIDS control strategies in developing countries. This collaboration has resulted in a number of outputs including the development of a *HIVTools*.

HIVTools is a set of models and costing guidelines that can be used to estimate the impact, cost and cost-effectiveness of HIV prevention strategies. The toolkit aims to be a flexible and easy-to-use product, for use by policy makers, programme managers and AIDS service organisations. The *Costing Guidelines For HIV/AIDS Prevention Strategies Among Injecting Drug User Populations* (Kumaranayake and Walker, 1999) provide the basis for standardising the collection of cost data for HIV prevention strategies, giving guidance on methods to address commonly seen issues and problems in cost analyses.

A mathematical simulation model to estimate the impact of needle exchange programmes (*IDU 2.0*) has been developed. The focus of the simple, user-friendly model is to incorporate some of the essential aspects of the transmission dynamics of HIV infection, and how the intervention alters these patterns of transmission. The models use epidemiological, behavioural and intervention-specific inputs to simulate

patterns of HIV and STD transmission in the presence and absence of an intervention. From this, estimates of the number of HIV infections averted over different time spans are made.

4. HIV IN EASTERN EUROPE AND BELARUS

Until the mid-1990s, most of the countries of Eastern Europe¹ appeared to have been spared the worst of the HIV/AIDS epidemic. In 1994, the whole of Eastern Europe had about 30,000 infections, 15 times fewer cases than Western Europe, and 400 times fewer than in sub-Saharan Africa. However, in the last few years this region has seen more than a ten-fold increase in the number of infections, and as much as seventy-fold in the worst affected areas; by the end of 1999, it was estimated that 360,000 people were infected. The predominant mode of HIV transmission in the region is through the injection of drugs. The proportion of the population living with HIV doubled between 1997 and 1999 in the newly independent states of the former Soviet Union (UNAIDS, 1999). At present Ukraine is the worst affected country in the region, though the Russian Federation, Belarus, Moldova have all registered large increases in recent years.

A characteristic of HIV transmission among IDUs, relative to other vulnerable groups, is its potential for rapid spread. For example, between 1995 and 1996 in the Ukrainian cities of Odessa and Nykolayev, HIV prevalence among IDUs increased from 2% to 32% and from 2% to 57% respectively (Strathdee *et al.*, 1998).

The first HIV-positive case was diagnosed in Belarus in 1987. Until 1996, the HIV prevalence remained very low, but thereafter there has been a rapid increase in the number of people infected with HIV. As of 1 September 1998, 2173 HIV-infected individuals were registered - an estimated 83% were infected through unsafe injecting drug use, 15% infected through sexual transmission, and the remainder through other modes of transmission. Current statistics provided by the National AIDS Prevention Centre (NAPC) indicate that each administrative region in Belarus has now reported HIV infections. However, the epicentre of the Belorussian epidemic is Gomel region, which accounts for 81% of all HIV infections. This is due to high levels of injecting drug use among young people, particularly in the city of Svetlogorsk.

While the actual numbers of people infected with HIV appear to be small at the moment, the prevailing economic and social conditions suggest that unless immediate effective steps are taken, the country is likely to face a rapid spread of the infection among the young population. As well as IDU use, there have been reports that prostitution is on the rise within Belarus and, in addition, a number of women travel across to Poland and other neighbouring countries to work as sex workers. There has also been a substantial rise in sexually transmitted diseases (STDs) among the youth in Belarus, also increasing the risk of HIV transmission. The prevalence of syphilis rose from less than 10 per 100,000 between 1976-1990 to 147 per 100,000 by 1995 (UNAIDS, 1998). Clearly, interventions to reduce transmission among IDUs, and

¹ This region is defined here as comprising Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Krygyzstan, Latvia, Lithuania, Poland, Republic of Moldova, Romania, Russian Federation, Slovakia, Tajikistan, Turkmenistan, Ukraine and Uzbekistan.

between IDUs and their non-IDU sexual partners is an important component of a co-ordinated response.

5. DESCRIPTION OF THE PROJECT

Given the increasing risk of HIV, a pilot project was implemented by UNAIDS and the NGO 'Parents for the future of Children'. Seen as a pilot for both Belarus and neighbouring countries, 'Prevention of HIV-infection among the people using drugs by injections in the city of Svetlogorsk' began in January 1997 with behavioural studies in order to access the specific needs of the target population and the best ways in which to deliver services.² Following these studies, two syringe exchange points were established respectively in the areas with the highest concentration of IDUs. The main types of activities performed in this needle exchange programme are:

1. Informing and educating town population and target group of safe use of syringes;
2. Reduction of risk of HIV infection through dirty needles (e.g. distribution of disinfectants and clean syringes, and the collection and incineration of used syringes);
3. Promotion of safer sexual practices (e.g. distribution of condoms);
4. Advice and counselling IDUs on safe behaviour, medical care issues, psychological and legal support;
5. Outreach services by volunteers.

In addition, via the syringe exchange points, IDUs are referred to consultations with a STD specialist.

6. METHODOLOGY FOR COST ANALYSIS

The cost analysis was performed using standard costing guidelines, and has taken a health service provider perspective. The project has been costed by the ingredients approach, in which the total quantities of goods and services actually employed in delivering the activities were estimated, and multiplied by their respective unit prices (Kumaranayake and Walker, 1999). Much of the information and data was initially compiled using a questionnaire that was completed by our Belorussian counterparts before a field trip in June 1999. Relevant information was obtained from various sources, including administrative records, interviews and direct observation. Cost and outcome indicators (such as the number of syringes or condoms distributed) were collected for 1997-1998. All figures are presented in 1998 US dollars. For items not purchased in US dollars, items were converted at the prevailing official exchange rate at the time of purchase³.

² It should be noted that the carriage and distribution of syringes is legal in Belarus. However, legislation is likely to vary in the region.

³ The average official exchange rate over this period was \$1 US = 46,597 Belorussian roubles.

Resources, and hence costs, have been categorised according to whether they are capital (one-time start-up activities⁴, buildings and equipment) or recurrent items. There are six categories of recurrent costs: personnel⁵; mass media; supplies⁶; vehicle operating and maintenance; building operating and maintenance; and other.

In addition, a distinction has been made between financial and economic costs. Financial costs represent actual expenditure on goods and services purchased. Costs are thus described in terms of how much money has been paid for the resources used in the project or service. For the financial costs of capital items, the annual costs were imputed by straight-line depreciation, i.e. cost divided by lifetimes appropriate to each item, which were ascertained through interviews with relevant personnel and standard estimates.

Economic costs include the estimated value of goods or services for which there are no financial transactions or when the price of the good does not reflect the cost of using it productively elsewhere. The key differences between financial and economic costs were that the latter included:

- rent for buildings used⁷;
- IDU volunteers⁸;
- various supplies and equipment not reflected in the financial costs;
- disposal of syringes - containers and incineration;
- mass media: donated radio and television time, and the provision of newspaper pages free of charge⁹.

Because there is a substantial difference in the costs depending on whether the value of free mass media is included, we estimated economic costs both with and without the valuation of mass media. Mass media quite widely inform about the problems of HIV/AIDS in the city of Svetlogorsk: in February 1998, the local TV station “Ranak”, started to broadcast eight short spots on drug-use and AIDS. Half of them are speeches by drug-users themselves, one by a narcologist, an other by a specialist in infections, one by a teacher and one by a representative of the police. The spots are broadcast in the evenings, three cycles a month. Only the cost of producing the video clip series “Road to Nowhere” was paid for by UNAIDS - all the airtime was

⁴ This includes the situation analysis/needs assessment surveys carried out prior to the project in order to ascertain the appropriate types of activities, the printing of various IEC materials and the training of trainers.

⁵ Project staff, needle exchange point staff, lawyer, doctor, psychologist, STI specialist, social worker, accountant, interpreter, driver and IDU volunteers.

⁶ Drugs, condoms, syringes, bleach, plastic containers for the disposal of syringes, IEC materials and mass media.

⁷ 10% of the annual rent price was imputed to cover the costs of furnishings.

⁸ Although 29 volunteers were recruited and trained during the project, there was a high dropout rate. Therefore, we have assumed that six volunteers were involved in the work at the syringe exchange points each year. Although no salary was paid to the volunteers during 1997 and 1998, the project has recently begun to pay one of their volunteers \$10 a month - we have used this amount as the shadow wage rate for the period of costing.

⁹ The radio station has not been working since April 1998. However, in order to estimate the economic cost of the provision of newspaper pages, radio and TV airtime, a 1998 price list was used. It was assumed that during 1997 and 1998, 7500cm²/year of newspaper space was donated and 20 minutes/month of radio airtime was used. During 1998, 228 minutes/month of peak TV airtime was donated.

provided free of charge. The radio broadcasting company did a series of radio broadcasts with participation of the city administration, representatives of the law enforcement agencies and the health care services. The articles in support of the Project are regularly published in local newspapers “Ranak”, “Svetlogorsk News”, youth supplement “Telescope”, “Evening Newspaper”. The radio airtime and newspaper pages were provided free of charge.

For economic costs, capital items were calculated as an annualised cost that takes into account the possible earnings that the money could have made if it had not been tied up in the purchase of the capital item. A discount rate of 3% was used to obtain the annualised cost (consistent with health economic appraisals in developing countries), and appropriate lifetimes to each item.

7. RESULTS OF COST ANALYSIS

Total financial costs for the project were approximately \$31,919 until the end of 1998 and are presented in Table 1. Of this amount, slightly more was spent in 1998. Without including the cost of the free mass media services, a valuation of the economic costs increases total costs by about 15% to \$32,768. However, when free mass media services are also included, economic costs are more than five times this figure (\$144,617) and dominate the entire costs of the project – almost 86% of total costs (Walker et al, 2000).

Table 1: Results from Cost Analysis 1996-1998 US\$ (1998)

	Financial	Economic	Economic (MM)
Capital	1.7 %	4.4%	1.0%
Recurrent	98.3%	95.6%	99.0%
Total	\$28,524	\$32,768	\$144,617

1. Economic (MM) includes a valuation of mass media costs.

2. Using Official exchange rates

Table 2 presents a summary of the unit costs for the project. These are calculated by dividing total costs for a given period by the total output. Four measures of output have been used: number of IEC material distributed, number of syringes distributed, number of condoms distributed and number of visits to the NEPs. Due to funding problems, one of the NEPs was closed between August 1998 and March 1999. Thus the output indicators underestimate the potential reach of the project during this period.

Table 2: Unit Costs US\$(1998)

Unit Cost	Financial	Economic	Economic (MM)
Cost per IEC material distributed	\$0.24	\$0.28	\$1.27
Cost per disposable syringe distributed	\$0.32	\$0.37	\$1.68
Cost per condom distributed	\$1.03	\$1.19	\$5.38
Cost per person contacted	\$0.98	\$1.13	\$5.10

1. Using Official 1998 exchange rate 1 US\$ = 46,597 Belorussian roubles

8. FACTORS INFLUENCING COSTS

There were a number of factors influencing the costs of the intervention. Scale effects have not been observed in IDU programmes, given that most interventions operate at a relatively small scale and have a high proportion of recurrent costs. Key intervention-related factors influencing costs included:

- **Materials development.** The amount of time and type of work invested in development of the IEC materials will influence costs. For example, external consultancy resources may be drawn upon during this phase. These costs may be smaller if materials are used which have already been produced elsewhere.
- **The amount of time invested in staff and peer educator training.**
- **The geographical and social accessibility of target groups.** It appears that in Svetlogorsk the IDU population was relatively easy to access by the intervention.
- **The total number of IDUs targeted.** Large numbers may mean greater expenditure on some of the IEC materials and on supplies but may contribute to lower average costs.
- **The intensity of contact between peer educators and IDUs.** For example whether educational sessions are conducted with individuals or in groups.
- **Whether peer educators are salaried or voluntary staff.**
- **Type, intensity and quality of media used.** There are clearly different costs associated with broadcast media and, for example, print media relative to radio and television. The length of a programme or publication, the frequency with

which it is transmitted, and the duration of the campaign will also influence costs, as will the use of peak or off-peak air-time for broadcasting.

- **Rate of charging for airtime or press space.** Media coverage may be paid for at commercial rates, or sponsored by the private sector, or subsidised by the government
- **Personnel costs.** The strategy is labour intensive and the relative costs of staff should be borne in mind in making any international comparisons or extrapolating cost data to other countries.
- **Provision of project condoms.** These may be bought on the international market or donated to the project at inflated or subsidised prices.
- **Whether drugs are provided by the project.** Alternatively, they may be prescribed only, the costs falling on patients.
- **The existence of complementary activities.** Such as legal and welfare counselling.

9. DEVELOPMENT OF THE IDU 2.0 MODEL

The *IDU 2.0* model was developed to simulate patterns of HIV transmission among IDUs, and between IDUs and their non-IDU sexual partners (Vickerman and Watts, 2000). From conception, the aim was that *IDU 2.0* would be a simple tool that could be used to provide applied, intervention specific insights that would be of use to program managers and policy makers concerned about IDU related HIV transmission at the national and local level. For this reason, the model's structure was intentionally kept as simple as possible, and geared towards obtaining impact estimates using the routine forms of monitoring and evaluation data currently being collected by the Svetlogorsk intervention.

The steps in the development of the model were:

- Review of literature on current transmission models and IDU interventions.
- Consultation with UNAIDS and WHO steering committee.
- Draft version of model developed.
- Visit to Belarus and field-testing of model.
 - Discussion with project staff
 - Review of project documents
 - Compilation of existing IDU behavioural, epidemiological, and intervention-specific data
- Revision of model to reflect forms of data collected from Belarus project.

The resulting model can be used, within a particular setting, to estimate the impact on HIV transmission of prevention activities focusing on the injecting drug users. It can also be used to explore the likely impact of different policy options. The extent to which an intervention may avert HIV infection is estimated using a range of context

specific inputs. This includes epidemiological information describing the prevalence of HIV infection among the IDU's and their non-IDU sexual partners at the start of the intervention, and the probabilities of HIV and STD infection. Behavioural inputs are used to describe the patterns of needle sharing, sexual behaviour and condom use among the IDU's reached and not reached by the intervention. Demographic and intervention specific inputs are used to estimate the size of the total IDU population, the proportion of males and females in the IDU population, and the proportion of each reached by the intervention.

10. MODEL OUTLINE

Estimates of the impact of an IDU intervention were obtained using demographic, behavioural and intervention processes and outcome evaluation data from Svetlogorsk to estimate:

- 1) The total size of the drug user population in Svetlogorsk
- 2) The numbers of drug users recently reached by the intervention
- 3) The impact of the intervention on
 - The overall distribution of needle sharing by drug users.
 - Levels of sexual activity among IDUs
 - Levels of bleach use when sharing syringes
 - Patterns of sexual mixing among IDU's and with non-IDU's
 - The consistency of condom use amongst IDU sexual partnerships
 - The movement of individuals into and out of the IDU population

Thus, for example, the overall distribution of needle sharing among the IDU population in the presence of the intervention is calculated using inputs describing:

- the size of the overall IDU population;
- the proportion of IDUs targeted by the intervention;
- the proportion of those targeted who have been recently reached by the intervention;
- information on the distribution of needle sharing among IDUs who have not been recently reached by the intervention;
- information on the distribution of needle use among IDUs who have been recently reached by the intervention.

The model then assesses the extent to which an IDU intervention may alter patterns of HIV transmission among IDUs and their sexual partners by:

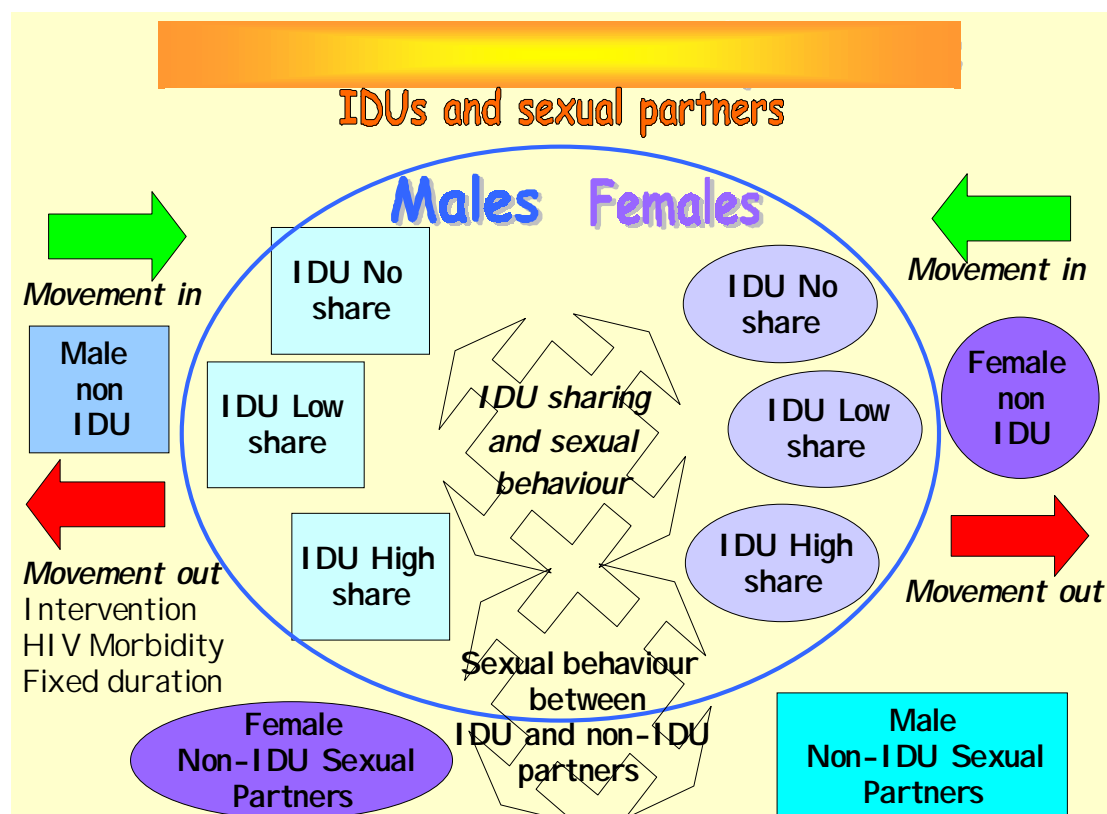
- Reducing the rates of movement into the IDU population each year.
- Decreasing the number of needle sharing incidents among IDU's
- Reducing the average number of people sharing needles
- Increasing the level and/or consistency of cleaning used needles
- Decreasing the number of sexual partners of IDU's
- Increasing the consistency of condom use in IDU sexual partnerships

- Increasing the coverage of the intervention

The program then simulates the transmission of HIV between injecting drug users and the transmission of HIV and STDs between IDU's and their sexual partners, both in the presence and absence of the intervention.

Figure 1 outlines the structure of the HIV and STI transmission dynamics included in the model. The mathematics underlying the model are given in Vickerman and Watts, (2000). The model is a deterministic and compartmentalised dynamic model.

Figure 1: IDU transmission dynamics



Specifically, the model simulates the patterns of HIV and STD transmission resulting from needle sharing and sexual contact between six groups of male IDUs, six groups of female IDUs, and their non-IDU sexual partners. Male and female IDUs are divided into three categories - those that do not share needles, those that have a low degree of needle sharing and those that have a high level of needle sharing. These in turn are divided into those with no sexual partners, those with low numbers of sexual partners, and those with high numbers of sexual partners. Inputs describing patterns of condom use are used to estimate the proportion of males and females with a high number of sexual partners who use condoms 'all of the time', 'half of the time' or who are 'not using' condoms. In each case the proportions in each sub-group are

influenced by the baseline distribution of reported behaviour, the extent to which the intervention reaches the overall population, and the degree to which contact with the intervention results in changes in different risk behaviours. The size of each of these sub-groups is estimated using context specific behavioural and intervention specific inputs. Each sub-group is then assumed to be homogeneous, and to randomly select needle sharing and sexual partners according to specified rules of mixing defined using the model's input parameters.

The model includes the possibility of HIV and/or STD transmission between IDUs and their non-IDU sexual partners. This is done using inputs describing the initial prevalence of HIV and STI among non-IDU males and females, estimates of the numbers of male and female non-IDU sexual partners of IDUs, and estimates of the average number of sex acts per partnership.

Because the transmission of HIV infection is facilitated by the presence of a STD, the model simulates how, over time, both a 'generic' STD and HIV infection may spread among IDUs and their sexual partners both in the presence and absence of the intervention. As there is also an increased probability of HIV transmission during the initial high viraemia phase of HIV infection, at each point in time, HIV infected individuals are divided into those with early infections (in a high viraemia phase) and those with more long-term infections (in a low viraemia phase).

For simplicity, it is assumed that the baseline IDU population remains fixed in size over the timeframe considered. In this case, IDUs may stop injecting either after a fixed duration of time, or due to HIV or IDU related morbidity, (such as overdose or sepsis) and be replaced by new, HIV susceptible, IDUs. In contrast the IDU population that has been reached by the intervention may vary in size due to the intervention affecting the movement of individuals into the IDU population, or by reducing IDU related mortality.

11. SVETLOGORSK IDU POPULATION

The initial size of the registered IDUs in the population was 411 males and 137 females. The majority of IDUs are aged between 19 and 29 years of age. The average duration that IDUs have been injecting drugs was 6.5 years in 1999. The estimated HIV prevalence among the IDU population was about 74% in 1997 before the start of the intervention, and approximately 75% in 1999.

Two main behavioural surveys among IDUs were conducted. The first was conducted in 1997 among IDUs attending needle-exchange centres. A follow-up survey was conducted in 1999 (not among the same sub-population). Despite a number of methodological limitations, the data collected do suggest that there was a significant change in key reported behaviours following the implementation of the intervention (as shown in Table 3). The findings from these surveys were reviewed, and data from these were used to obtain baseline and intervention related data for use in the model. Although it is difficult to validate such reported information, there was also a decrease in the proportion of HIV-susceptible IDUs being infected each year – suggesting that some degree of behaviour change among IDUs may have occurred.

A key input in the model is the proportion of the IDU population having recent contact with the intervention. This was difficult to assess, although it did appear that the intervention had widespread coverage among IDUs. For many of the model runs we used a conservative estimate that 50% of the IDU population had had recent contact with the intervention.

Table 3: Changes in reported behaviour from 1997 to 1999 among IDUs of Svetlogorsk

IDU REPORTED BEHAVIOUR	1997 (N=200)	1999 (N=110)
Percentage sharing syringes	92%	35% **
Percentage not cleaning syringes before re-use	84%	45% **
Percentage injecting for less than one year	13%	5% *
Percentage of sex partners that are non-IDUs	37%	56% **
Percentage that report not using condoms	71%	37% **
Percentage that have casual sex partners (>2 per week)	29%	18% *

** p<0.01, * p<0.05

12. ESTIMATES OF HIV INFECTIONS AVERTED

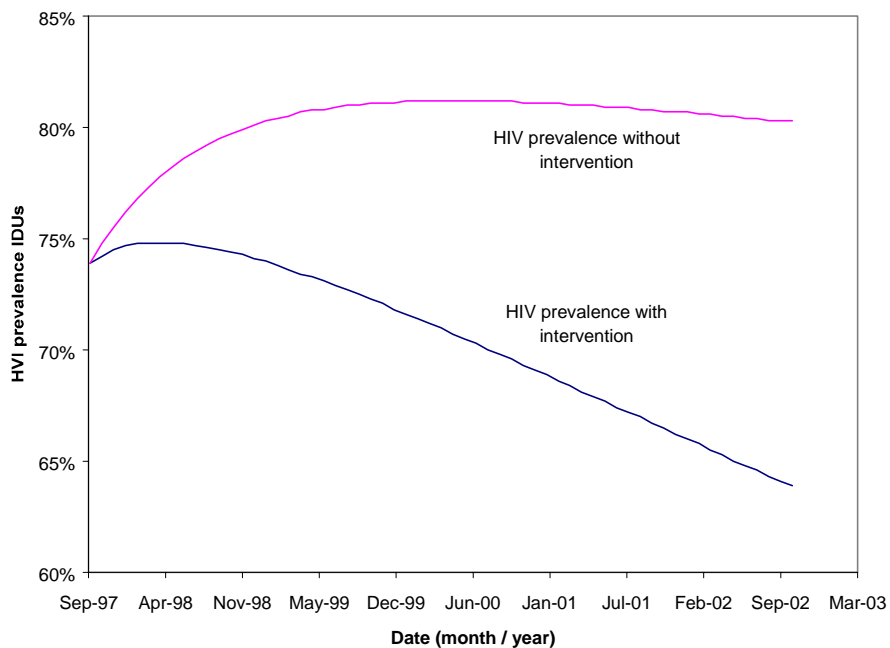
The *IDU 2.0* model and the Svetlogorsk data inputs were used to calculate the number of HIV infections averted due to the implementation of the intervention. The inputs used are given in Appendix 1.

The model was used to predict the HIV prevalence among the IDU population without the intervention (the baseline case) and with the intervention (reached) for a five-year period. The initial HIV prevalence in September 1997 was 74% among IDUs. The model predictions for the Svetlogorsk project are presented in Figure 2. The model prediction suggests that without the intervention, and with continued patterns of baseline behaviour, HIV prevalence among the IDU population increase to over 80%, and then decline very slowly. In contrast, with the intervention, it is estimated that, with sustained activity, HIV prevalence among the IDU population will decline to about 64% by September 2002, assuming that the intervention had a coverage of 50% of the IDU population.

It is important to note that the model predictions are highly dependent on the validity of the data inputs used. In fact, there is uncertainty over many of the parameter values used (see sensitivity analysis in next section for a further discussion of this). In particular, there is uncertainty over the probability of HIV transmission per sharing act. The default value used in the calculation comes from New Haven USA, and is

likely to represent a low-end estimate. This parameter has a significant effect on the HIV prevalence in the IDU population, but only a small effect on the number of HIV cases averted in the IDU and non-IDU population, as the HIV transmission probability per sharing act may be higher in Svetlogorsk due to the contamination of drugs with blood products. However, an increased probability of transmission will not substantially effect the estimated number of infections averted¹⁰

Figure 2: Projected trends in HIV prevalence among IDUs with and without the intervention, September 1997-September 2002



¹⁰ This is because an increase probability of transmission affects the projected HIV prevalence in IDUs in both with and without intervention scenarios. But for the estimates of infections averted we are essentially looking at the difference between these.

The model was used to estimate the number of HIV infections averted in the first and second year of the intervention. Estimates of HIV infections averted were calculated both for IDUs and for non-IDUs. Estimates of the cumulative number of HIV infections averted by year are presented in Table 4. The results suggest that despite the high HIV prevalence in the IDU population, a substantial number of HIV infections were averted. The majority of the HIV infections averted were among non-IDUs

Table 4; Cumulative HIV infections averted after 2 years of intervention activity

HIV infections averted among IDUs	HIV infections averted among non-IDUs	Total HIV infections averted
111	370	481

The majority of HIV infections averted are among the non-IDU sexual partners of IDUs. This is a result of the high initial prevalence of HIV infection among IDUs, and the relatively slow rate of movement of IDUs out of injecting drug use. This highlights the importance of condom promotion and STD treatment as a part of the IDU intervention.

13. SENSITIVITY ANALYSIS OF MODEL PARAMETERS

As the model findings are dependent upon the validity of the data inputs used. In general, where there was a large degree of uncertainty concerning a particular input, a value that would tend to under-estimate the likely impact was used. For this reason, for example, an assumption that 50% of the IDU population have had recent contact with the intervention was used, even though it is likely that the intervention's true coverage was higher.

In some cases in particular, there was a large degree of uncertainty associated with the input parameters used. In particular, the overall impact estimate is highly dependent upon the estimate of HIV infections averted among the non-IDU sexual partners of IDUs. However, this is where there has been least research conducted, and where the behavioural and epidemiological data is weakest. For this reason, sensitivity analysis was used to explore how the uncertainty associated with these input parameters would combine to affect the overall intervention impact estimates obtained. For this, a potentially very 'low' input (that would tend to reduce the estimated number of HIV infections averted), and a potentially 'high input' (that would tend to increase the estimated number of HIV infections averted) were identified. The input parameters for the different scenarios are given in Table 5.

Table 5: Low, standard and high input values

Inputs	'Low' input	Standard Input	'High' input
Estimated size of female non-IDUs population that male IDUs mix with sexually	2000	4000	8000
Estimated size of male non-IDUs population that female IDUs mix with sexually	1500	3000	6000
Initial HIV prevalence female sexual partners of male IDUs	5%	2.5%	1%
Initial HIV prevalence male sexual partners of female IDUs	5%	2.5%	1%
Initial STD prevalence female sexual partners of male IDUs	2%	6%	10%
Initial STD prevalence male sexual partners of female IDUs	2%	6%	10%
Needle cleaning efficacy per sharing act	0	15%	30%
Degree of 'like with like' mixing between IDUs for needle-sharing (0 being no like with like, 1 being all like with like)	0.6	0.7	0.8
Average number of sex acts per month for IDU partnerships (low number sexual partners)	10	12	14
Degree of like with like mixing between males and females by sexual activity (range 0 – 1, 0 no like with like mixing, 1 all like with like mixing)	0.6	0.7	0.8
Adjustment factor for differences in male / female reporting of proportion of sexual partners that are IDUs (range 0 to 1, 0 most confident in male reports, 1 most confident in female reports)	0.3	0.2	0.1

These inputs were used to obtain 'low' and 'high' estimates of HIV infections averted which are presented in table 6. All other inputs were held unchanged as they appear in Appendix 1.

Table 6: Low, standard and high estimates of cumulative HIV infections averted for a two year period

	'Low'	Standard	'High'
IDUs	92	111	115
Non-IDUs	235	370	487
Total (2 years)	327	481	602

As can be seen, the range in the estimated number of HIV infections averted varies widely. In particular, the estimated number of HIV infections averted among non-IDUs may range from 104 to 555, depending upon the assumptions made about the patterns of mixing with non-IDUs, and the size of this sub-population. The high scenario represents an estimate of the size of the male population aged 25 to 29, and the female population aged 15 – 29. This reflects a situation in which female and male IDUs randomly select non-IDU sexual partners from these age ranges. Clearly, the true scenario is likely to fall between these two extremes. However, without more detailed behavioural and epidemiological information, more accurate estimates are not possible.

14. COST-EFFECTIVENESS OF THE PROJECT

Table 7 presents the estimated cost-effectiveness of the project over the two-year period 1996-1998. It was estimated that the average cost per HIV infection averted was about \$68, and ranged between \$54.43 and \$100.21 reflecting the uncertainty associated with some of the data inputs used to calculate the number of HIV infections averted from the sensitivity analysis. If the imputed airtime were included in economic costs, the cost per HIV infection averted would range from \$240 -\$442. While, mass media may have been one of the key factors of the intervention reducing movement into the IDU population, it is unclear whether a project would use these channels to this extent if they were to actually pay commercial rates. Thus, it is not clear whether the project would have actually borne the entire mass media cost if they did actually have to pay for it.

Table 7: Estimated Cost-Effectiveness of the Project, US\$(1998)

Method of Cost Analysis	Cost per HIV infection averted	Cost per HIV infection averted	Cost per HIV infection averted
	Low scenario	Standard scenario	High Scenario
Economic	\$100.21	\$ 68.12	\$ 54.43
Economic (MM)	(\$442.25)	(\$300.66)	(\$240.23)

Using Official exchange rate.

Economic (MM) includes the valuation of radio and television airtime and newspaper space used by the mass media campaign.

The different scenarios presented in the sensitivity analysis above reflect a possible range of input values. Critical to the results were the data inputs reflecting the size of the non-IDU sexual partner population that IDUs draw from, as well as the patterns of sexual behaviour. Standard sensitivity analysis was also conducted on the cost analysis (Walker et al, 2000). These results show that the costs are highly sensitive to the rate of exchange between the US dollar and the Belorussian rouble. If a black market (rather than official rate) was used, the total costs of the project would be 44%, 45% and 35% lower for financial, economic (without mass media) and economic (with mass media) cost results. The sensitivity of these cost-effectiveness results to these epidemiological and exchange rate changes are presented in Table 8. We have continued to use official exchange rates in the CEA, as the black market rate itself is highly variable.

Table 8: Variation of Cost-effectiveness results by exchange rate US\$ (1998)

	Method of cost analysis	Cost per HIV infection averted - Low case	Cost per HIV infection averted - Standard case	Cost per HIV infection averted - High case
Official exchange rate (average over the period is 1 US\$ = 46,597 Belorussian roubles)	Economic	\$100.21	\$ 68.12	\$ 54.43
	Economic (MM)	(\$442.25)	(\$300.66)	(\$240.23)
Black market exchange rate (average over the periods was 1US\$ = 112,762 Belorussian roubles)	Economic	\$55.11	\$ 37.47	\$ 29.94
	Economic (MM)	(\$287.46)	(\$195.43)	(\$156.15)

Economic (MM) includes the valuation of radio and television airtime and newspaper space used by the mass media campaign

15. DISCUSSION

A number of factors influenced the costs borne by the project and its impact. The project had high levels of political support and commitment by its staff members. Svetlogorsk is a small city with a relatively concentrated IDU population that could be accessed by the intervention. In addition, there had been changes in the law to making the carrying of syringes legal – thus reducing barriers to IDUs using the needle exchange points. The mass media campaign had high impact because, although it was on local media, there were no competing channels and so achieved a high coverage. If a similar intervention had been implemented in a city such as Minsk, with a much larger and more diffuse IDU population, the costs of reaching IDUs would likely be much larger. In addition, it may be more difficult for a mass media campaign using any one channel to achieve the same coverage in a larger city with multiple channels. Finally, differences in patterns of injecting behaviour and sexual behaviour between cities may influence the patterns of sharing and sex and the extent to which behaviour can be achieved. For example, in Svetlogorsk IDUs predominantly inject opium, whilst in Minsk heroin is the main drug in use. Similarly, in Svetlogorsk there was little evidence of commercial sex linked to IDU use. In larger cities, it is likely that IDU and sex work transmission may be more interrelated.

It is also important to note that despite the substantial number of HIV infections averted, the model also projects that over the two year timeframe of the intervention, 86 HIV infections will have occurred among IDUs, and 893 HIV infections among the sexual partners of IDUs. Consequently, it is important that this success is not only

sustained, but also that HIV prevention activities among IDUs and their sexual partners are intensified.

Appendix 1: Input parameters used with IDU 2.0, to obtain impact estimates for Svetlogorsk

Data input type	Data inputs	Standard case values	
		Male	Female
Epidemiological inputs	Initial HIV prevalence among IDUs	0.74	
	Average STI duration among IDUs ¹¹	1.0	1.5
	Average duration of high viraemia phase (months)	1.5	
	Average duration between HIV infection and severe HIV morbidity (months)	120	
	Estimated size of population of non-IDU sexual partners	3,000	4,000
	Non-IDU Initial HIV prevalence	2.5%	2.5%
	Non-IDU STI prevalence for males and females	6%	6%
	Initial proportion of non-IDU sexual partners with high viraemia	10%	10%
Transmission probabilities	Probability of HIV transmission per sex act (male to female) ¹²	0.002	
	Probability of HIV transmission per sex act (female to male)	0.001	
	Probability of HIV transmission per needle sharing act ¹³	0.0068	
	Probability of STI transmission per sex act both sexes ¹⁴	0.35	
	Average STI cofactor per sex act ¹⁵	30	
	Sexual transmission multiplicative factor during high viraemia phase ¹⁶	10	
	Injecting transmission multiplicative factor during high viraemia phase ¹⁷	10	
	Condom efficacy per sex act	0.9	
	Cleaning efficacy per sharing act	0.15	
Size of IDU population and intervention coverage	Proportion of male and female IDU's that have been injecting for less than one year before the intervention	0.13	0.13
	Proportion of male and female IDU's that have been injecting for less than one year after the intervention	0.053	0.053
	Annual mortality rate from IDU (eg. sepsis or drug overdose) for males and females	0.04	0.04
	Initial size of IDU population for males and females	411	137
	Proportion of IDU's recently reached by the intervention for males and females	0.7	0.7
Fixed needle sharing behaviour inputs	Definition of 'low' and 'high' number of needle sharing partners for IDU's reached by the intervention	Low	4
		High	10
	Definition of 'low' and 'high' number of needle sharing partners for IDU's not reached by the intervention (or	Low	4

¹¹ STI duration is dependent on availability and quality of local STI treatment services

¹² HIV transmission rate for male to female, European study group 1992

¹³ Probability of HIV transmission per needle sharing act, Kaplan & Heimer 1992

¹⁴ STI transmission rate, Hook & Marra 1992, Hethcote & York 1984, Over & Piot 1996

¹⁵ STI cofactor for HIV transmission, Laga *et al.* 1993, Hayes *et al.* 1995, Cameron *et al.* 1989, Plummer *et al.* 1991

¹⁶ High viraemia cofactor for sexual HIV transmission, Cohen *et al.* 1997, Pinkerton & Abramson 1996, Jacquez *et al.* 1994

¹⁷ Syringe transmission cofactor, there have been no published studies documenting this and so the same value is used as for the sexual high viraemia cofactor

Data input type	Data inputs		Standard case values		
			Male	Female	
	baseline)	High	10		
	Definition of 'low' and 'high' frequency of needle shares per needle sharing partner for reached IDU's	Low	3		
		High	5		
	Definition of 'low' and 'high' frequency of needle shares per needle sharing partner for not reached IDU's	Low	3		
		High	5		
	Degree of 'like with like' mixing between IDU's, by level of needle sharing activity			0.7	
Fixed sexual behaviour inputs	Definition of 'low' and 'high' number of sexual partners per month for males and females	Low	1.7	1.7	
		High	6.0	8.0	
	Definition of 'NONE', 'SOME' and 'ALL' consistency of condom use for IDUs with high numbers of sexual partners	NONE	0.0		
		SOME	0.3		
		ALL	0.7		
	Average number of sex acts per month for IDU partnerships with a low number of sexual partnerships			12	
	Average number of sex acts per month for IDU partnerships with a high number of sexual partners			2	
Degree of 'like with like' mixing between male and female IDU's with different levels of sexual activity (0 for no like with like, 1 with all like with like)			0.7		
Sexual activity of IDU's	Distribution of reached IDUs with respect to their level of sexual activity (with none, low or high numbers of partners)	None	0.2	0.2	
		Low	0.51	0.51	
		High	0.29	0.29	
	Distribution of not reached IDU's with respect to their level of sexual activity for (with none, low or high numbers of sexual partners)	None	0.2	0.2	
		Low	0.51	0.51	
		High	0.29	0.29	
Proportion of the IDU's sexual partners that are IDU's	Proportion of reached IDU's sexual partners that are IDU's for low and high sexual activity	Low	0.44	0.44	
		High	0.44	0.44	
	Proportion of not reached IDU's sexual partners that are IDU's for low and high sexual activity	Low	0.37	0.37	
		High	0.37	0.37	
	Adjustment factor to account for possible differences in males / females reporting of the proportion of sexual partners that are IDUs (range 0 to 1 – 0 when most confident with male numbers, 1 when most confident with female numbers)			0.2	

Proportion of IDU's with different levels of needle sharing	Average consistency of cleaning syringes for reached and not reached IDU's	Reached	0.55		
		Not reached	0.16		
	Population distribution of reached IDU's level of needle sharing (needle sharing activity is either none, low or high)	None	0.65	0.08	
		Low	0.2	0.59	
		High	0.15	0.33	
	Population distribution of not reached IDU's levels of needle sharing (needle sharing activity is either none, low or high)	None	0.08	0.08	
		Low	0.59	0.59	
		High	0.33	0.33	
	Condom use in the IDU population	Average consistency of condom use amongst 'low' sexually active IDU's	Reached	0.45	
Not reached			0.2		
Distribution of condom use amongst 'high' sexually active IDU's reached by the intervention		NONE	0.37	0.37	
		HALF	0.12	0.12	
		ALL	0.51	0.51	
Distribution of condom use amongst 'high' sexually active IDU's (male and female), by the intervention, reached and not reached		NONE	0.71	0.71	
		HALF	0.15	0.15	
		ALL	0.14	0.14	

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