ORIGINAL RESEARCH ARTICLE

Cost-effectiveness of voluntary HIV screening in Russia

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Summary: Russia has one of the world's fastest growing HIV epidemics, and HIV screening has been widespread. Whether such screening is an effective use of resources is unclear. We used epidemiologic and economic data from Russia to develop a Markov model to estimate costs, quality of life and survival associated with a voluntary HIV screening programme compared with no screening in Russia. We measured discounted lifetime health-care costs and quality-adjusted life years (QALYs) gained. We varied our inputs in sensitivity analysis. Early identification of HIV through screening provided a substantial benefit to persons with HIV, increasing life expectancy by 2.1 years and 1.7 QALYs. At a base-case prevalence of 1.2%, once-per-lifetime screening cost $13,396 per QALY gained, exclusive of benefit from reduced transmission. Cost-effectiveness of screening remained favourable until prevalence dropped below 0.04%. When HIV-transmission-related costs and benefits were included, once-per-lifetime screening cost $6910 per QALY gained and screening every two years cost $27,696 per QALY gained. An important determinant of the cost-effectiveness of screening was effectiveness of counselling about risk reduction. Early identification of HIV infection through screening in Russia is effective and cost-effective in all but the lowest prevalence groups.

Keywords: Russia, HIV, AIDS, screening, prevention, cost-effectiveness

INTRODUCTION

Russia has one of the world's fastest growing HIV epidemics. Driven by an increase in injection drug use and commercial sex after the dissolution of the Soviet Union, HIV prevalence doubled annually between 1995 and 2001.[1–3] Recent data suggest that the epidemic is becoming generalized, with many cases now associated with heterosexual contact or vertical transmission.[4,5] While there are more than 380,000 officially registered HIV/AIDS cases in Russia,[1] experts estimate that more than one million people are infected, which corresponds to a prevalence of 1.2% in the 15–49-year-old age group.[2,5–8] Since 80% of cases are comprised of individuals under 30 years of age, in stark contrast to Western epidemics,[5,8] HIV could be especially detrimental to Russia's economy, compounding effects of its already declining population size.

Early detection of HIV through voluntary screening is important for treatment and for reducing HIV transmission. Early identification can provide the opportunity for timely treatment of infected individuals, thus reducing morbidity and mortality.[9] Additionally, the decrease in risky behaviour resulting from HIV counselling and the reduction in infectivity due to use of antiretroviral therapy (ART)[9–14] can translate into a significant benefit from reduced HIV transmission.[9]

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Since the late 1980s, screening for HIV in Russia has been widespread.[4,8] Whether such screening is an effective and efficient use of resources is unclear, particularly since many individuals are screened multiple times each year and high-risk individuals may not undergo screening at all.[2,15,16] Consequently, many infections are likely undiagnosed, leading experts to report that the prevalence of HIV is at least three times the officially registered number.[5,8] Furthermore, cases are often detected late in the course of illness: most people with HIV/AIDS in Russia survive only three to five years after initial diagnosis.[8,17] While pre- and post-test counselling are mandated by the Russian Federal AIDS Act of 1995, the extent and nature of counselling is unclear,[18] potentially reducing the effectiveness of the programme in decreasing the spread of HIV.

In the United States, a number of recent studies have demonstrated the cost-effectiveness of expanded screening for HIV.[9,19–21] However, the generalizability of this finding to other countries is unclear, and there have been extremely limited evaluations of costs and benefits of screening in middle- and low-income countries.[22] Because of the importance of the epidemic in Russia, we sought to evaluate the cost-effectiveness of a voluntary HIV screening and counselling programme in Russia.

METHODS

Model overview

We developed a Markov model using Decision Maker software to estimate the health-related costs and benefits of a voluntary HIV screening programme in Russia. We followed a cohort of

15–49-year-old individuals over their lifetimes. Our model included HIV natural history, voluntary testing and counselling, HIV transmission and treatment with ART. Our model included natural history data to estimate disease progression without ART and estimated relative hazard of death based on changing viral loads and CD4 counts.[9] We measured health-related costs and life expectancy in quality-adjusted life years (QALYs), both discounted at 3% annually. A detailed description of the model structure, assumptions and parameters has been published previously.[9]

We evaluated three voluntary screening strategies: no HIV screening, once-per-lifetime HIV screening and repeat HIV screening. Each month, patients could undergo HIV testing through symptom-based case finding and/or a screening programme. We evaluated screening intervals of every one to five years in the repeat HIV screening strategies; such screening intervals are commonly reported in the literature.[9,21]

For each screening programme, we calculated lifetime per person costs and QALYs, as well as incremental cost-effectiveness ratios. Cost-effectiveness ratios were interpreted using criteria developed by the World Health Organization.[23] WHO guidelines propose that interventions that cost less than three times the per capita gross domestic product (GDP) are cost-effective, and interventions costing less than the per capita GDP are very cost-effective. Russia's per capita GDP in 2006 was approximately $12,000.

Treatment regimens

Patients identified with HIV initiated ART once their CD4 counts dropped below 350 cells per mm^3. In our base-case analyses, we estimated health outcomes and costs for the case in which 50% of patients had access to treatment with ART; we examined lower and higher rates in sensitivity analyses. We modelled treatment with three suppressive ART regimens, followed by a lifelong non-suppressive therapy. Such comprehensive treatment is not always available currently, but reflects the recent emphasis on expanding ART in Russia.[6,24]

HIV epidemic data

Our analysis focused on individuals aged 15–49 in health-care settings whose HIV status was unknown (Table 1). The cohort had an average age of 32.5 years, which is the average age of 15–49-year-olds in Russia.[25] Based on data from the Joint United Nations Programme on HIV/AIDS (UNAIDS) and the World Health Organization (WHO), we calculated an HIV prevalence of 1.2% among 15–49-year-olds, with two-thirds of cases undiagnosed.[5,6,8]

Considerable uncertainty exists regarding HIV incidence in Russia. Russia's Federal AIDS Center has recorded all newly diagnosed cases since 1987.[1] However, given likely underdetection and late detection, these recorded cases underestimate true incidence. One small population-based study that evaluated incidence in a cohort of injection drug users demonstrated seroconversion at a rate as high as 4.5% per year.[26] Based on Federal AIDS Center data,[1] annual HIV incidence is approximately 0.05% in the 15–49-year-old age group. Because of likely under-detection, we estimated a higher incidence of 0.075% for our base-case analyses. Since the age distribution of HIV in Russia is markedly skewed toward young people,[8] we estimated a 90% reduction in incidence per decade of life after age 50. We varied these assumptions widely in sensitivity analysis.

HIV transmission

We considered sexual and needle-sharing transmission of HIV. The probability of sexual transmission of HIV depended on the patient's gender, partner's gender, number of partners, knowledge of HIV status and viral load. The effectiveness of counselling in reducing risk behaviour is an important determinant of the reduction in transmission that can occur through screening.[9] Based on evaluations of the effectiveness of counselling and testing in the United States, we estimated that counselling reduced risk behaviours by 20%, which is likely conservative for counselling as practiced in the United States.[9,12–14,27–30] However, because little direct evidence is available about the effectiveness of counselling in Russia, we evaluated scenarios in which counselling has minimal effectiveness. Because needle exchange programmes and substitution therapy for substance abuse are rarely available in Russia,[2,31,32] we assumed that counselling did not alter the risk of transmission via injection drug use.

Costs

We obtained Russia-specific costs through a number of different sources, including Russian Bulletins of Laboratory Services, Russian Regional AIDS Center directors and non-governmental organizations (Table 1). As costs of medical visits and laboratory tests were often not standardized across clinics, we obtained prices from several regions in Russia and varied cost parameters in sensitivity analysis. Our analysis included costs of testing and counselling, follow-up, treatment and support services while on treatment.

The cost of ART in Russia is evolving. The price of three-drug ART regimen recently dropped from approximately $8000 to $1700 per year in 2006, and is expected to decrease three-fold over the next several years.[6,33,34] Our base case assumed an annual cost of $1700 for ART. We explored lower costs of treatment in sensitivity analysis.

Quality of life with HIV

We based our estimates of quality of life with HIV on published assessments.[9,35–42] Because utility-based estimates of quality of life are not available from Russia, we evaluated whether changes in quality of life influenced our results in sensitivity analyses.

RESULTS

Benefit to infected individuals

We calculated the benefit of early identification and treatment of HIV compared with symptom-based case finding. HIV-infected individuals identified early through screening who initiated ART did so at a CD4 count of 350 cells per mm^3, compared with an average CD4 count of 175 cells per mm^3 for those identified through symptom-based case finding. In our base-case analysis, screening and early treatment resulted in an additional 2.1 years of life expectancy for HIV-infected individuals and an additional 1.7 years of quality-adjusted life expectancy. This benefit varied by age, but persisted into the eighth decade of life (Figure 1).

Base-case health and economic outcomes

When we included costs and benefits for index cases only, once-per-lifetime screening cost $56 more per person screened than symptom-based case finding alone, and increased life expectancy by 1.5 quality-adjusted days per person screened, yielding an

Table 1 **Model parameters and sources***

Parameter	Base-case value	Range	Source
Demographic variables			
Age of screened population (years)	32.5	20–40	25
Prevalence of HIV (%)	1.2	0.01–30	1,5,6,25,44
Prevalence of unidentified HIV (%)	0.83	0.01–40	1,5,6,25,44
Annual HIV incidence, 15–49-year-olds (%)	0.075	0.0375–0.3	1
Proportion of uninfected female population (%)	50.4	40–60	5,6,44,45
Proportion of infected male population (%)	65	50–75	5,6,45
Proportion of infected males who are MSM (%)	19	0.2–20	46
Age of index case's sexual partners (years)	32.5	20–40	25
HIV testing and treatment variables			
Probability that patients return for test results (%)	80	50–100	9,47–53
Probability that eligible patients receive ART (%)	50	5–100	Estimated
Effectiveness of testing and counselling in reducing sexual transmission (%)	20	0–25	9,12–14,27–30
Sensitivity of screening test (%)			
First 3 months after infection	60	11–83	9,54–56
Established disease	99.5	98.0–99.9	9,54,55,57
Specificity of entire sequence of screening tests (%)	99.9994	99–100	9,54,55,58
Cost variables			
Cost of negative HIV test ($)	1	1–10	Bulletins of Laboratory Services, interviews with HIV experts in Russia
Cost of positive HIV test ($)	70	50–100	Bulletins of Laboratory Services, interviews with HIV experts in Russia
Cost of HIV counselling ($)	3	1–10	Interviews with HIV experts in Russia
Cost of CD4 count test ($)	7	1–10	Interviews with HIV experts in Russia
Cost of viral load test ($)	80	50–120	Interviews with HIV experts in Russia
Annual health-care costs (non-HIV related) ($)	115	80–250	59
Annual cost of HIV infection ($)	570	400–1000	60
Annual cost of three-drug therapy ($)	1700	500–2000	33,34
Annual cost of fourth drug ($)	600	100–1000	Interviews with HIV experts in Russia
Annual cost of salvage therapy ($)	2300	2000–3000	Interviews with HIV experts in Russia
Annual cost of additional support services while on therapy ($)	600	100–1000	Interviews with HIV experts in Russia
Cost of ART side effect per episode ($)	5	1–20	Interviews with HIV experts in Russia
Quality-of-life variables			
Unknown asymptomatic HIV infection	0.91	0.85–1.00	9,37
Diagnosed asymptomatic HIV infection	0.84	0.68–1.00	9,37
Symptomatic (untreated) HIV infection	0.79	0.45–1.00	9,37,39–42
HIV infection during HAART	0.83	0.45–1.00	9,37,39–42
AIDS	0.73	0.30–0.80	9,37,39–42
Decrease in quality of life due to side effects of HAART (multiplier)	0.53	0.44–0.62	35,36,38

MSM=men who have sex with men; (HA) ART=(highly active) antiretroviral therapy
*Parameter values and ranges were estimated based on sources listed

incremental cost-effectiveness ratio of $13,396 per QALY gained (Table 2). Repeat screening every five years cost $25,388 per QALY gained compared to once-per-lifetime screening.

When we included costs and benefits for index cases and their sexual partners, the cost-effectiveness of once-per-lifetime screening improved to $6910 per QALY gained and screening every five years cost $7402 per QALY.

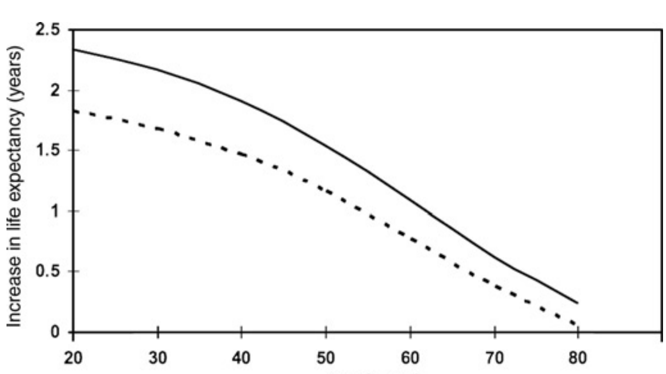

Figure 1 **Effect of early identification and treatment of HIV infection on life expectancy. Solid line depicts the increase in life expectancy associated with identification of asymptomatic HIV, compared with symptom-based case finding. Dotted line shows increase in quality-adjusted life expectancy**

Prevalence

We evaluated the effect of HIV prevalence on the cost-effectiveness of screening. The cost-effectiveness of screening for HIV remained favourable until prevalence dropped substantially below one-tenth of our base-case estimate of 1.2% (Figure 2). When including benefits and costs for index cases only, once-per-lifetime screening cost less than $36,000 per QALY gained (three times the per capita GDP) if prevalence was at least 0.04% (Figure 2). With inclusion of costs and benefits to sexual partners, screening cost less than $36,000 per QALY gained if HIV prevalence was at least 0.02% and cost less than $12,000 per QALY gained (the per capita GDP) if prevalence was at least 0.08%.

Repeat HIV screening

The cost-effectiveness of repeat HIV screening was determined primarily by the incidence of HIV in the screened population. In our base-case analysis, including costs and benefits to both index cases and their sexual partners, screening every five years cost $7402 per QALY gained compared with

Table 2 **Health and economic outcomes***

Strategy	Cost per person screened ($)	Incremental cost ($)	Quality-adjusted life expectancy (years)	Incremental quality-adjusted life expectancy (days)	Incremental cost-effectiveness ($/QALY)
Index cases only					
No screening	3121		23,813		
Once-per-lifetime screening	3177	56	23,817	1.5	13,396
Screening every 5 years	3282	105	23,822	1.5	25,388
Index cases and sexual partners					
No screening	3289		23,697		
Once-per-lifetime screening	3345	56	23,705	3.0	6910
Screening every 5 years	3450	105	23,719	5.2	7402

QALY=quality-adjusted life year
*Analysis was based on HIV prevalence of 1.2% in 15–49-year-olds, undiagnosed HIV prevalence of 0.83% and 50% of identified individuals receiving antiretroviral therapy

once-per-lifetime screening (Figure 3). At half of the base-case incidence, screening every five years cost $8421 per QALY gained compared with once-per-lifetime screening. At double the base-case incidence, screening every five years cost $6847 per QALY gained.

The impact of incidence on cost-effectiveness was more apparent at more frequent screening intervals. The cost-effectiveness of screening every two years compared with screening every three years was $27,696 per QALY gained in the base case, $32,841 per QALY gained when incidence was half that of the base case and $19,301 per QALY gained at double the base-case incidence.

Annual screening was expensive, costing $85,972 per QALY gained in the base case, $123,626 per QALY gained when incidence was half that of the base case and $55,812 per QALY gained at double the base-case incidence. Incidence would need to be approximately four times that of our base case or 0.3% per year in the 15–49 age group, for annual screening to cost less than $36,000 per QALY gained.

Impact of counselling

The degree to which screening and counselling reduced risky behaviour was an influential determinant of the cost-effectiveness of screening. Our base-case analysis of the cost-effectiveness of screening ($6910 per QALY gained) included a 20% reduction in risky sexual behaviour. If counselling was half as effective, decreasing risky behaviour by only 10%, screening cost $9100 per QALY gained.

The influence of counselling on the cost-effectiveness of periodic screening was substantial. Screening every five years cost $7402 per QALY gained in our base case and $10,711 per QALY gained if counselling was half as effective. Screening every two years cost $27,696 per QALY gained in our base case and $77,008 per QALY gained if counselling was half as effective.

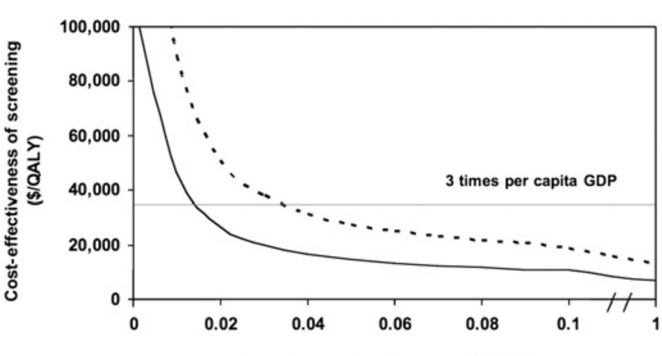

Figure 2 **Effect of prevalence of unidentified HIV on the incremental cost-effectiveness of once-per-lifetime HIV screening. Solid line depicts incremental cost-effectiveness ratio when costs and benefits to sexual partners are included. Dotted line includes costs and benefits to index cases only**

Additional sensitivity analysis

The cost-effectiveness of screening was moderately influenced by quality of life associated with diagnosed or symptomatic HIV infection. When the quality-of-life decrement associated with diagnosed or symptomatic infection was twice that of the base case, cost-effectiveness worsened from $6910 to $11,942 per QALY gained for once-per-lifetime screening and from $7401 to $12,530 per QALY gained for screening every five years.

Reduction in the cost of ART has been a worldwide public health priority. When the annual price of a three-drug ART regimen was reduced from $1700 in our base case to $500, once-per-lifetime screening cost $4913 per QALY gained after including costs and benefits to sexual partners. Screening every five years cost $5495 per QALY gained, but annual screening remained expensive at $85,309 per QALY gained.

If effective counselling was included with screening, our results were minimally influenced by changes in the proportion of individuals who received ART; however, if counselling was

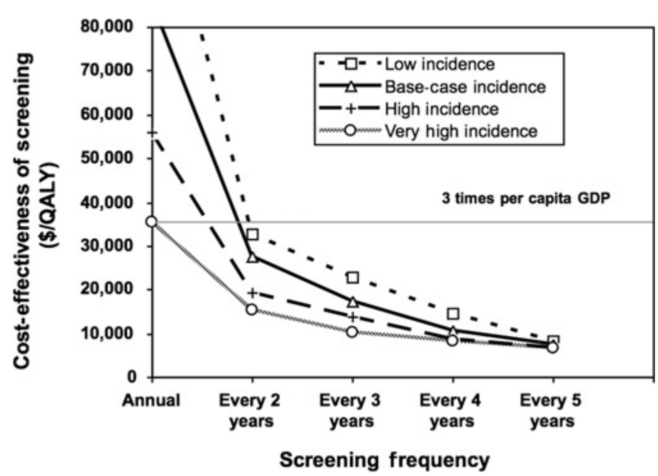

Figure 3 **Incremental cost-effectiveness of recurrent HIV screening in very high, high, middle and low incidence settings. Base-case incidence corresponds to annual incidence of 0.075% in 15–49-year-olds, with 90% decrease per subsequent decade of life. Low, high and very high incidence corresponds to half, double and four times the base-case incidence**

ineffective, the cost-effectiveness of screening became less favourable if access to ART was reduced.

DISCUSSION

We evaluated the health outcomes, costs and cost-effectiveness of voluntary HIV screening and counselling among 15–49-year-olds in Russia. The costs and benefits of HIV screening have not been evaluated rigorously in middle-income countries and, therefore, the value of screening has been uncertain. The effectiveness and efficiency of HIV screening in Russia is particularly important because it is prototypic of the epidemics in Eastern Europe.

Our analysis has three main findings. First, early diagnosis through screening resulted in a substantial gain in life expectancy and quality-adjusted life expectancy for HIV-infected individuals. The life expectancy increase of approximately two years is a large increment and is similar to the gain we estimated for individuals identified through screening in the United States.[9] Second, one-time screening is cost-effective, even when prevalence is extremely low, if it is accompanied by modestly effective counselling to reduce risk behaviour and at least partial access to ART. Because HIV testing is inexpensive in Russia, counselling of modest efficacy and less-than-universal access to ART are sufficient to justify the costs of screening. Third, as expected, periodic screening is most cost-effective in high-incidence risk groups.

Based on our estimate of 1.2% HIV prevalence, once-per-lifetime screening cost $6910 per QALY gained, which is just over half of Russia's per capita GDP. WHO guidelines consider interventions that cost less than the per capita GDP very cost-effective and interventions that cost less than three times the per capita GDP cost-effective.[23] Screening is very cost-effective because the cost of a negative HIV test and counselling in Russia are low; counselling and treatment reduce HIV transmission; and the survival benefit due to ART is substantial.

Using WHO guidelines, screening was cost-effective even with very low prevalence of undiagnosed HIV cases. Disregarding transmission, screening was cost-effective if prevalence was at least 0.04%. When transmission-related costs and benefits were included, once-per-lifetime HIV screening was cost-effective if prevalence was at least 0.02%. The considerable survival benefit associated with early identification and treatment resulted in favourable cost-effectiveness ratios for HIV screening at low prevalence, even when transmission-related benefits were not taken into account.

The ideal repeat screening interval varied depending on HIV incidence, but our findings were robust across a wide range of incidence. When annual incidence ranged from 0.0375% to 0.15% per year among 15–49-year-old individuals, screening as frequently as every two years remained cost-effective. Incidence would need to be at least 0.3% per year for annual screening to be cost-effective, suggesting that annual screening could be appropriate for high-risk groups, but would not be an efficient use of resources for the general population.

Our analysis highlights the critical importance of including risk-reduction counselling in HIV screening programmes in Russia. In our base-case analysis, we assumed counselling reduced risky sexual behaviour by 20% and had no effect on injection drug-use behaviour. The degree to which counselling reduces risky behaviour has a large impact on the cost-effectiveness of once-per-lifetime and repeat screening because effective counselling can lead to substantial reductions in HIV transmission.

It is important to note that we analysed voluntary screening. If serious adverse outcomes relating to HIV diagnosis, such as discrimination or stigmatization, were to occur, our results would not be applicable. In addition to ethical considerations, such consequences could substantially reduce quality of life, which would make screening less cost-effective, as shown in our sensitivity analysis.

Our analysis has several limitations. We included only the benefit from reduced sexual transmission of HIV. Given the limited availability of needle exchange and the lack of substitution therapy in Russia,[2,31,32] we assumed no change in transmission via injection drug use, as a conservative approach. Should such programmes expand in Russia, HIV screening would likely become even more cost-effective than we estimated due to additional reduction in transmission.[43]

In addition, in our analysis, HIV-infected individuals who did have access to ART could receive up to three ART regimens aimed at suppressing viral load, followed by lifelong nonsuppressive therapy. Given limited access to ART in Russia, it is possible that some individuals on treatment will have access to fewer drug regimens, which could lead to lower lifetime costs as well as fewer benefits. Nonetheless, our findings were robust to the proportion of patients receiving ART because screening in Russia is relatively inexpensive and counselling alone can offer substantial transmission benefit. Therefore, even in the setting of limited ART access, screening can be an efficient use of resources.

In conclusion, early detection and treatment of HIV in Russia result in substantial improvements in life expectancy among infected individuals. Voluntary HIV screening of 15–49-year-olds every two years is cost-effective by WHO guidelines. Such screening identifies HIV-infected individuals earlier, providing health benefits to infected individuals and to the rest of the population due to reduced transmission. Effective counselling is a key component of both the effectiveness and cost-effectiveness of these programmes. The health benefit that we projected for screening will be fully realized only if HIV-infected individuals do not suffer adverse outcomes from stigmatization and discrimination.

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REFERENCES

1 AIDS Foundation East-West (AFEW). *Officially Registered Cases in the Russian Federation, 1 January 1987–30 September 2007*. Moscow: AFEW, 2007
2 Csete J. Lessons not learned: human rights abuses and HIV/AIDS in the Russian Federation. *Human Rights Watch* 2004;**16**:1–64
3 United Nations Development Programme (UNDP). *HIV/AIDS in Eastern Europe and the Commonwealth of Independent States: Reversing the Epidemic, Facts and Policy Options*. Bratislava: UNDP, 2004
4 EuroHIV. *HIV/AIDS Surveillance in Europe: End-year Report 2005*. Report No. 72. Saint-Maurice: Institut de Veille Sanitaire, 2006
5 Joint United Nations Programme on HIV/AIDS (UNAIDS). *2006 AIDS Epidemic Update: Eastern Europe and Central Asia*. Geneva: UNAIDS, 2006
6 World Health Organization (WHO). *Summary of Country Profile for HIV/AIDS Treatment Scale-up: Russian Federation, December 2005*. Geneva: WHO, 2006
7 National Intelligence Council. *The Next Wave of HIV/AIDS: Nigeria, Ethiopia, Russia, India, and China*. Washington, DC: National Intelligence Council, 2002

8 Feshbach M, Galvin CM. *HIV/AIDS in Russia – An Analysis of Statistics*. Washington, DC: Woodrow Wilson International Center for Scholars, 2005
9 Sanders GD, Bayoumi AM, Sundaram V, *et al.* Cost-effectiveness of screening for HIV in the era of highly active antiretroviral therapy. *N Engl J Med* 2005;**352**:570–85
10 Chou R, Huffman LH, Fu R, Smits AK, Korthuis PT. Screening for HIV: a review of the evidence for the U.S. Preventive Services Task Force. *Ann Intern Med* 2005;**143**:55–73
11 Quinn TC, Wawer MJ, Sewankambo N, *et al.* Viral load and heterosexual transmission of human immunodeficiency virus type 1. Rakai Project Study Group. *N Engl J Med* 2000;**342**:921–9
12 The National Institute of Mental Health (NIMH) Multisite HIV Prevention Trial Group. The NIMH Multisite HIV Prevention Trial: reducing HIV sexual risk behavior. *Science* 1998;**280**:1889–94
13 DiClemente RJ, Wingood GM. A randomized controlled trial of an HIV sexual risk-reduction intervention for young African-American women. *J Am Med Assoc* 1995;**274**:1271–6
14 Kamb ML, Fishbein M, Douglas JM Jr, *et al.* Efficacy of risk-reduction counseling to prevent human immunodeficiency virus and sexually transmitted diseases: a randomized controlled trial. Project RESPECT Study Group. *J Am Med Assoc* 1998;**280**:1161–7
15 Cartwright K. *Problems with Russia's Compulsory Screening for HIV/AIDS*. Washington, DC: Urban Institute and World Bank, 2001
16 Twigg JL, Skolnik R. *Evaluation of the World Bank's Assistance in Responding to the AIDS Epidemic: Russia Case Study*. Washington, DC: World Bank, 2005
17 *Moskovsky Komsomolets,* Volume 35, Sect. 4, 1999
18 Irwin K, Heimer R, Smoyer A. *Drug Policy and HIV Prevention in Russia: The Case of HIV/AIDS Prevention*. New Haven: Center for Interdisciplinary Research on AIDS, Yale University, 2004
19 Owens DK, Sundaram V, Lazzeroni LC, *et al.* Prevalence of HIV infection among inpatients and outpatients in Department of Veterans Affairs Health Care Systems: implications for screening programs for HIV. *Am J Public Health* 2007;**97**:2173–8
20 Paltiel AD, Walensky RP, Schackman BR, *et al.* Expanded HIV screening in the United States: effect on clinical outcomes, HIV transmission, and costs. *Ann Intern Med* 2006;**145**:797–806
21 Paltiel AD, Weinstein MC, Kimmel AD, *et al.* Expanded screening for HIV in the United States – an analysis of cost-effectiveness. *N Engl J Med* 2005;**352**:586–95
22 Walker D. Cost and cost-effectiveness of HIV/AIDS prevention strategies in developing countries: is there an evidence base? *Health Policy Plan* 2003;**18**:4–17
23 World Health Organization (WHO). *The World Health Report 2002 – Reducing Risks, Promoting Healthy Life*. Geneva: WHO, 2002
24 World Health Organization (WHO). *Progress on Global Access to HIV Antiretroviral Therapy: A Report on "3 by 5" and Beyond*. Geneva: WHO, 2006
25 Federal State Statistics Service. *Population by Age Groups. Moscow: Goskomstat*, 2004
26 Kozlov AP, Shaboltas AV, Toussova OV, *et al.* HIV incidence and factors associated with HIV acquisition among injection drug users in St Petersburg, Russia. *AIDS* 2006;**20**:901–6
27 Hogan D, Salomon J. Prevention and treatment of human immunodeficiency virus/acquired immunodeficiency syndrome in resource-limited settings. *Bull World Health Organ* 2005;**83**:135–43
28 Kalichman SC, Cain D, Weinhardt L, *et al.* Experimental components analysis of brief theory-based HIV/AIDS risk-reduction counseling for sexually transmitted infection patients. *Health Psychol* 2005;**24**:198–208
29 Valdiserri RO, Ogden LL, McCray E. Accomplishments in HIV prevention science: implications for stemming the epidemic. *Nat Med* 2003;**9**:881–6
30 Wiktor SZ, Abouya L, Angoran H, *et al.* Effect of an HIV counseling and testing program on AIDS-related knowledge and practices in tuberculosis clinics in Abidjan, Cote d'Ivoire. *Int J Tuberc Lung Dis* 2004;**8**:445–50
31 Finnerty E. Opiate substitution treatment in the former Soviet Union. *Lancet* 2006;**368**:1066
32 Zandonella C. *International AIDS Vaccine Initiative (IAVI) Report*. New York: IAVI, 2006
33 Bobrik A. *Expected Price of the Cheapest ARV Regimens*. Moscow: Open Health Institute, 2005
34 Boykewich S. Supply of anti-HIV drugs falls short. *Moscow Times*, 16 August 2005
35 Bayoumi AM, Redelmeier DA. Preventing *Mycobacterium avium* complex in patients who are using protease inhibitors: a cost-effectiveness analysis. *AIDS* 1998;**12**:1503–12
36 Gable CB, Tierce JC, Simison D, Ward D, Motte K. Costs of HIV+/AIDS at CD4+ counts disease stages based on treatment protocols. *J Acquir Immune Defic Syndr Hum Retrovirol* 1996;**12**:413–20
37 Honiden S, Sundaram V, Nease RF, *et al.* The effect of diagnosis with HIV infection on health-related quality of Life. *Qual Life Res* 2006;**15**:69–82
38 Keiser P, Kvanli MB, Turner D, *et al.* Protease inhibitor-based therapy is associated with decreased HIV-related health care costs in men treated at a Veterans Administration Hospital. *J Acquir Immune Defic Syndr Hum Retrovirol* 1999;**20**:28–33
39 Revicki DA, Wu AW, Murray MI. Change in clinical status, health status, and health utility outcomes in HIV-infected patients. *Med Care* 1995;**33**:AS173–82
40 Tengs TO, Lin TH. A meta-analysis of utility estimates for HIV/AIDS. *Med Decis Making* 2002;**22**:475–81
41 Tsevat J, Sherman SN, McElwee JA, *et al.* The will to live among HIV-infected patients. *Ann Intern Med* 1999;**131**:194–8
42 Tsevat J, Solzan JG, Kuntz KM, *et al.* Health values of patients infected with human immunodeficiency virus: relationship to mental health and physical functioning. *Med Care* 1996;**34**:44–57
43 Zaric GS, Barnett PG, Brandeau ML. HIV transmission and the cost-effectiveness of methadone maintenance. *Am J Public Health* 2000;**90**:1100–11
44 World Health Organization (WHO). *Life Tables for WHO Member States: Russian Federation – 2004*. Geneva: WHO, 2004
45 Rakhmanova A. VICH Infektsiya v Rossii [HIV Infection in Russia]. Epidemic situation and priorities in halting the spread of HIV infection in the Russian Federation. *AIDS J: AIDS Sex and Health*, Available from [http://www.aidsjournal.ru/journal/54_17.html] (Accessed 24 August 2005)
46 Amirkhanian YA, Kelly JA, McAuliffe T. Psychosocial needs, mental health, and HIV transmission risk behavior among people living with HIV/AIDS in St. Petersburg, Russia. *AIDS* 2003;**17**:2367–74
47 Erickson B, Wasserheit JN, Rompalo AM, Brathwaite W, Glasser D, Hook WE. Routine voluntary HIV screening in STD clinic clients: characterization of infected clients. *Sex Transm Dis* 1990;**17**:194–9
48 Hightow L, Miller W, Leone P, Wohl D, Smurzynski M, Kaplan A. Failure to return for HIV posttest counseling in an STD clinic population. *AIDS Educ Prev* 2003;**15**:282–90
49 Holman S, Sorin M, Crossette J, LaChance-McCullough M. A state program for postpartum HIV counseling and testing. *Public Health Rep* 1994;**109**:521–9
50 Irwin K, Olivo N, Schable C, Weber J, Janssen R, Ernst J. Performance characteristics of a rapid HIV antibody assay in a hospital with a high prevalence of HIV infection. CDC-Bronx-Lebanon HIV Serosurvey Team. *Ann Intern Med* 1996;**125**:471–5
51 Kassler W, Dillon B, Haley C, Jones W, Goldman A. On-site, rapid HIV testing with same-day results and counseling. *AIDS* 1997;**11**:1045–51
52 Kelen G, Hexter D, Hansen K, *et al.* Feasibility of an emergency department-based, risk-targeted voluntary HIV screening program. *Ann Emerg Med* 1996;**27**:687–92
53 Sullivan P, Lansky A, Drake A. Failure to return for HIV test results among persons at high risk for HIV infection: results from a multistate interview project. *J Acquir Immune Defic Syndr* 2004;**35**:511–8
54 Mylonakis E, Paliou M, Lally M, Flanigan TP, Rich JD. Laboratory testing for infection with the human immunodeficiency virus: established and novel approaches. *Am J Med* 2000;**109**:568–76
55 Owens DK, Nease RF Jr, Harris RA. Cost-effectiveness of HIV screening in acute care settings. *Arch Intern Med* 1996;**156**:394–404
56 Schwartz JS, Kinosian BP, Pierskalla WP, Lee H. Strategies for screening blood for human immunodeficiency virus antibody: use of a decision support system. *J Am Med Assoc* 1990;**264**:1704–10
57 Centers for Disease Control. Update: serologic testing for antibody to human immunodeficiency virus. *MMWR Morb Mortal Wkly Rep* 1988;**36**:833–40, 45
58 MacDonald KL, Jackson JB, Bowman RJ, *et al.* Performance characteristics of serologic tests for human immunodeficiency virus type 1 (HIV-1) antibody among Minnesota blood donors: public health and clinical implications. *Ann Intern Med* 1989;**110**:617–21
59 World Health Organization (WHO). *Per Capita Total Expenditure on Health at Average Exchange Rate (US$)*. Geneva: WHO, 2001
60 Adeyi O, Baris E, Chakraborty S, Novotny T, Pavis R. *Averting AIDS Crises in Eastern Europe and Central Asia*. Washington, DC: World Bank, 2003

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