Allocative and implementation efficiency in HIV prevention and treatment for people who inject drugs

UNODC Science Addressing Drugs and HIV: State of the Art Scientific Consensus for High Level Segment of the 59th session of the Commission on Narcotic Drugs

Authors:

David Wilson	World Bank, Washington, DC, USA
Clemens Benedikt	World Bank, Washington, DC, USA
David P. Wilson	Burnet Institute, Melbourne, Australia
Sherrie L. Kelly	Burnet Institute, Melbourne, Australia

Abstract:

Background: Estimated global new HIV infections among people who inject drugs (PWID) declined by approximately 10% from 110,000 in 2010 to 98,000 in 2013. To achieve the 2020 UNAIDS target of reducing adult HIV infections by 75% compared to 2010, accelerated action in scaling up HIV programs for PWID is required. In a context of diminishing external support to HIV programs in countries where most HIV-affected PWID live, it is essential that available resources are allocated and used as efficiently as possible.

Methods: Allocative and implementation efficiency analysis methods were applied. Optima, a dynamic, population-based HIV model with an integrated program and economic analysis framework was applied in eight countries in Eastern Europe and Central Asia (EECA). Mathematical analyses established optimized allocations of resources. An implementation efficiency analysis focused on examining technical efficiency, unit costs, and heterogeneity of service delivery models and practices.

Results: Findings from the latest reported data revealed that countries allocated between 4% (Bulgaria) and 40% (Georgia) of total HIV resources to programs targeting PWID – with a median of 13% for the eight countries. When distributed optimally, between 9% and 25% of all HIV resources are allocated to PWID programs with a median allocation of 16%. As a result of optimized allocations, new HIV infections are projected to decline by 3-28% and AIDS related deaths by 7-53% in the eight countries. Implementation efficiencies identified involve potential reduction in drug procurement costs, service delivery models, and practices and scale of service delivery influencing cost and outcome. A high level of implementation efficiency was associated with high volumes of PWID clients accessing a drug harm reduction facility.

Conclusion: Increasing efficiency of HIV programs for PWID is a key step towards avoiding implicit rationing and transparent allocation of resources where and how they would have the largest impact on the health of PWID, and thereby ensuring that funding spent on PWID becomes a global best buy in public health.

Introduction

Current HIV programs are faced with the necessity to scale-up prevention whilst also providing treatment to a larger number of people living with HIV (PLHIV) than ever before. In the 2011 United Nations Political Declaration on HIV and AIDS, countries agreed to reduce sexual and injection-related HIV transmission by 50% by 2015 (UNGASS, 2011). Estimated new HIV infections among PWID declined from 110,000 in 2010 to 98,000 in 2013 (UNODC, 2015a) – a reduction of only 10%, which suggests that there is need for accelerated action if 2020 targets of reducing new HIV infections and deaths by 75% compared to 2010 levels are to be achieved (UNAIDS 2014). At the same time, after a decade of rapid growth, international HIV financing stabilized around 2010 (UNAIDS, 2015) and is projected to decline in middle-income countries, in which a large proportion of HIV-affected PWID live. Programs for PWID have been supported by the Global Fund and other international partners and have been particularly dependent on external funding in many countries.

In this environment, there are two main options for how global HIV impact targets can be achieved: (1) increased domestic financing of HIV programs for PWID and (2) greater efficiency in program design and delivery to ensure that programs can do more with what is available. Previous research on cost and impact of HIV programs for PWID has focused on estimating cost-effectiveness of harm reduction (Wilson, 2015) overall or for specific interventions such as opioid substitution therapy (OST) and needle-syringe programs (NSP) (Cipriano, et al., 2012; Kim, et al., 2015). Less attention has been paid to the question of how to make HIV programs for PWID more efficient, as concepts of allocative and implementation efficiency have not been widely applied to PWID programs. Given the large gaps in coverage of HIV prevention and treatment programs for PWID at a time of limited resources, the question of efficiency will become essential not only for impact, but also sustainability of the response.

The concept of allocative efficiency refers to the maximization of health outcomes using the least costly mix of health interventions. HIV allocative efficiency analysis addresses the question “How can HIV funding be optimally allocated to the combination of HIV response interventions that will yield the highest impact?” Technically, allocative efficiency can be accomplished either within a fixed budget envelope to achieve maximal impact with given amount of money or within defined impact targets to achieve a given impact with minimal cost. In both cases, allocative efficiency is achieved by optimizing the *mix* of interventions to achieve specific impact-level goals. Implementation efficiency can be defined as a set of measures to ensure that programs are delivered in a way that achieves outputs with the lowest input of resources.

Methods

In this paper, we synthesize evidence in relation to HIV prevention and treatment programs for PWID from published and unpublished studies conducted by our group of allocative and implementation efficiency.

Allocative efficiency analysis

In the allocative efficiency analyses presented in this paper, impact goals have been defined as minimizing new HIV infections and AIDS-related deaths. We have conducted allocative efficiency

analyses in numerous country contexts in which drug injecting behaviors are common. For reasons of consistency and comparability of findings, we have focused on findings from eight countries in Eastern Europe and Central Asia generated using the Optima model.

Application of the Optima model

Optima is a dynamic, population-based HIV model with an integrated program and economic analysis framework. The total population is partitioned in two ways: by population group and by HIV health state. Individuals were assigned to a given population group based on their dominant risk, for example, drug-injecting practices. HIV infections occur through the interactions among different populations by regular, casual, or commercial sexual partnerships, through sharing of injecting equipment; or through mother-to-child transmission. In the present analysis, male and female PWID were tracked in relation to all three modes of transmission and across the different HIV related health states. The model uses a linked system of ordinary differential equations to track the movement of PLHIV among HIV health states. The full set of equations is provided in the supplementary material of a summary paper on the Optima model (Kerr et al, 2015).

To perform optimization analysis, Optima uses an adaptive stochastic descent algorithm to identify the optimal mix of programs within the very large number of possible combinations of programs (Kerr et al, 2016). The key assumptions of resource optimization are the relationships among (1) the cost of HIV programs for people who inject drugs and other populations, (2) the resulting coverage levels of populations targeted with these HIV programs, and (3) how these coverage levels of HIV programs for targeted populations influence behavioral and clinical outcomes. Cost assumptions were based on expenditure data collected by in-country experts in the context of global AIDS progress reporting using the National AIDS Spending Assessment (NASA) definitions of cost categories. Coverage of programs was established using data from national databases and implementation program records. Data from integrated bio-behavioral and other population-based surveys were used to establish behavioral and epidemic trends.

Allocative analysis efficiency beyond HIV

All HIV interventions have some direct or indirect non-HIV benefits. As these benefits extend into different areas including contraception for condom use and prevention of other infectious diseases for needle and syringe programs, secondary benefits of HIV programs on additional outcomes were not included within the optimization analysis. For opiate substitution therapy, a special approach was applied given the proven benefits on HIV and across different sectors (Mac Arthur,. 2012). Such additional benefits were reflected using a cross-sectoral financing model to effectively distribute the costs in accordance with the benefits. By adapting standard techniques from welfare economics to attribute the benefits of OST programs across the benefiting sectors, it was estimated that average HIV-related benefits represent only approximately 10% of the overall health and social benefits of OST. Therefore, only 10% of OST costs were included in this HIV-specific optimization analysis.

In addition to analyzing optimized allocation of HIV resources, a parameter scenario analysis was carried out to determine the effect of additional investment into programs for PWID by reallocating non-HIV resources into NSP, OST and ART programs.

Implementation efficiency analysis methods

Implementation efficiency analysis presented in this study included dimensions of (1) technical efficiency of service delivery, (2) efficiency of management including planning, quality assurance, monitoring, evaluation and information flows (3) efficiency in program financing and financial flows and (4) institutional efficiency and systems integration. A search for “efficiency“ in relation to HIV programs for PWID was conducted and only a very limited number of relevant articles could be identified that focused either on cost-effectiveness or very specific aspects of efficiency. We present results from a program efficiency study conducted in three Oblasts (districts) of Ukraine, which applied heterogeneity analysis of service delivery processes, service packages, staffing, and unit costs. In this approach variations in efficiency between different sites and regions is analyzed in order to understand factors influencing program performance and how good practice can be replicated in other facilities or regions.

Results

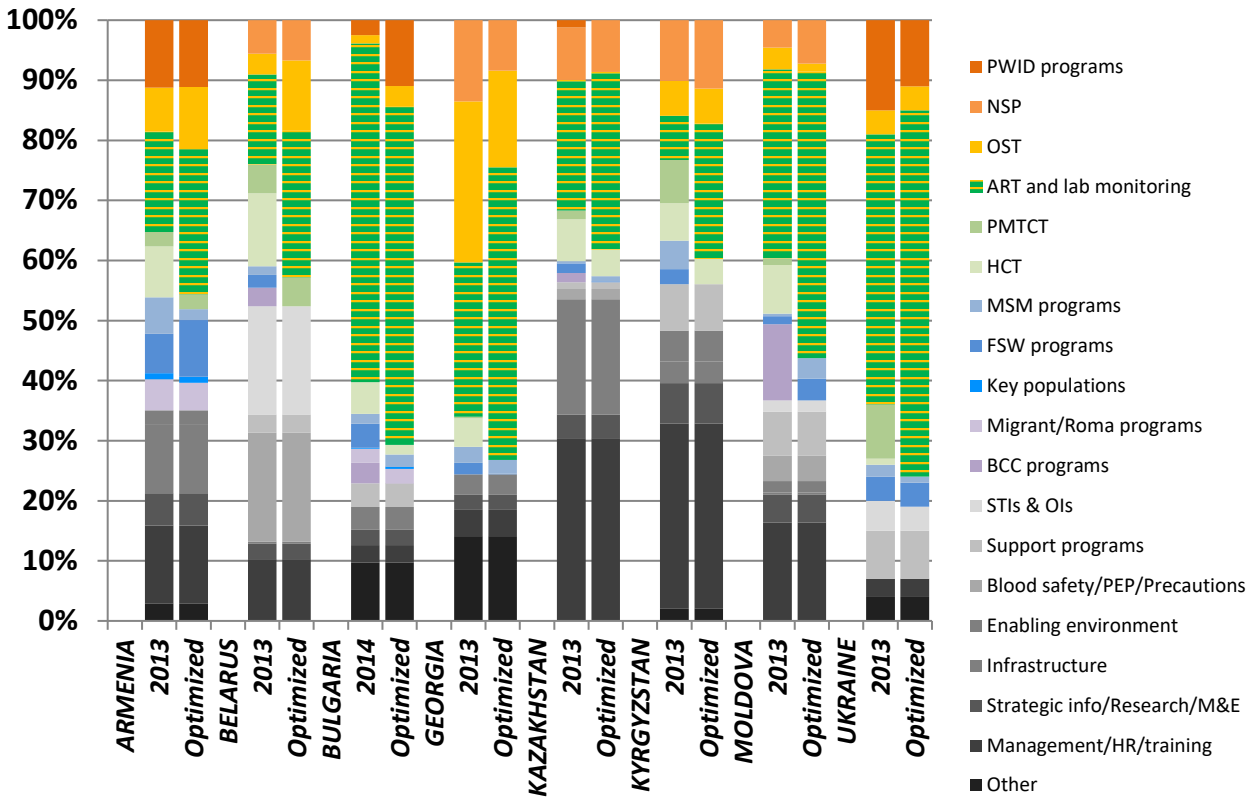
Allocative efficiency of HIV prevention and treatment programs for PWID

HIV allocative efficiency analysis was conducted in eight countries with significant HIV epidemics among PWID in Eastern Europe and Central Asia (Armenia, Belarus, Bulgaria, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Ukraine) using a similar analytical framework.

Figure 1 summarizes allocations of HIV resources to different programs. The left column for each country represents the total annual HIV spending from the latest year with reported data (either 2013 or 2014 for all countries).

The right column for each country represents optimized allocations for the same amount of funding to minimize cumulative HIV incidence and AIDS-related deaths by 2020 according to the Optima model. Programs for PWID and needle syringe programs represented in the charts include distribution of sterile needles, condoms, HIV testing and counselling, and related outreach in-line with country-specific program packages. Opioid substitution therapy includes medication, counselling, and related services. ART service provision for PWID is included within the overall ART program.

Figure 1. Optimized allocation of resources to minimize HIV incidence and deaths in eight countries with HIV epidemics among PWID



Source: Optima model results

In the last reported year, countries allocated between 3.9% (Bulgaria) and 40.3% (Georgia) of their total HIV resources to programs targeting PWID – with a median of 13.0% for the eight countries. In comparison, the optimized allocations between 8.6% of the total budget for Moldova and 24.5% for Georgia were allocated to PWID programs, with a median allocation of 16.1% for the eight countries. If HIV resources were allocated optimally according to the Optima model then new HIV infections would decline by 3-28% in the eight countries and AIDS-related deaths by 7-53% by 2020. Variation in allocations between countries is lower in optimized allocations than past allocations, but some variation remains due to differences in HIV epidemics, unit costs, and current resource allocation patterns.

Despite the large financial requirements for increasing ART coverage, optimized allocations imply that funding PWID prevention programs should be increased for five countries and decreased for only three countries. Whereas allocations to programs for PWID were reduced as a percentage of total HIV spending, this is not equivalent to reducing coverage. In Georgia and Ukraine, the two countries in which optimized allocations to PWID programs suggest reductions from 40.3% to 24.5% and 19.0% to 15.0%, respectively, based on discussions with country representatives it was assumed that the cost per PWID who is living with HIV reached could be reduced compared to baseline. Accordingly, the coverage of programs for PWID based on optimized allocations would remain stable. Investments in programs for PWID remain part of optimized allocations in Bulgaria and Georgia, where HIV epidemics among PWID have stabilized and sexual transmission among men who have sex

with men (MSM) has become the single most important mode of HIV transmission according to our model projections. In Georgia, the country with the largest current budget allocation to PWID programs, optimized allocations suggest reallocating funding from PWID programs to ART (including ART for PWID). In Bulgaria, the country with the lowest current budget allocation to PWID programs, optimized allocations suggest increasing total HIV investment toward PWID programs from 3.9% to 14.3%.

In Kazakhstan, OST allocations only represent 0.2% of the total HIV budget in 2013 and total allocations to PWID programs only 10.1%. In optimized allocations, funding for PWID programs did not increase, as 56.4% of the total budget were already being absorbed by fixed costs and another 29.3% by ART, leaving only 14.3% of the budget for re-allocation. Additional optimization analyses were conducted assuming a 67% reduction in prices of ARVs in-line with benchmarks of unit costs from other countries in EECA and a 20% reduction in management costs. When applying the reduced unit costs, allocations to programs for PWID would increase to 15.5% and new injection-related HIV infections would decline from an estimated 570 per year to only 210. (World Bank, 2016e; Shattock et al. 2016)

Three scenarios of investment in HIV prevention and treatment of PWID

An additional scenario analysis was conducted to estimate the effect of different levels of investment into programs for PWID. This analysis was not constrained in terms of reallocation of HIV resources, but based on estimated resource needs to achieve low, medium, and high coverage. **Table 1** summarizes key parameters used in this analysis. Cost and coverage estimates reported elsewhere were used in this analysis (Wilson, 2015).

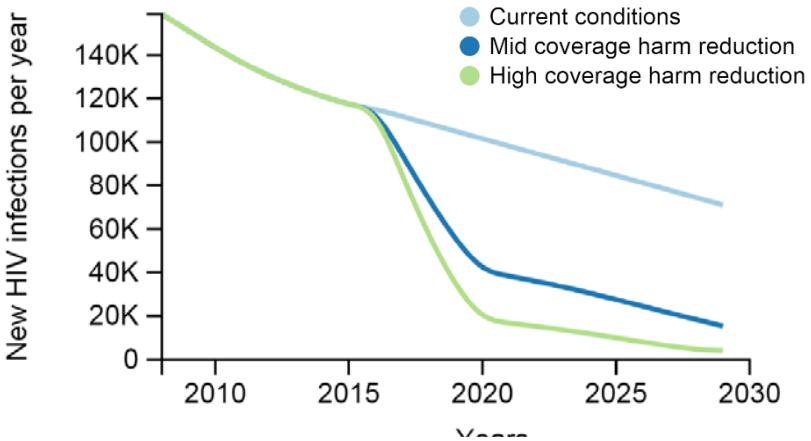
Table 1

Coverage scenario	Low	Medium	High
Investment (in US$ billion (bn))	0.16 bn	2.66	7.66
as % of total spending on drug control spending	0.0%	2.5%	7.5-10.0%
Needle syringe program coverage	10.0%	20.0%	60.0%
Opioid substitution therapy coverage	8.0%	20.0%	40.0%
Antiretroviral therapy coverage	14.0%	25.0%	75.0%

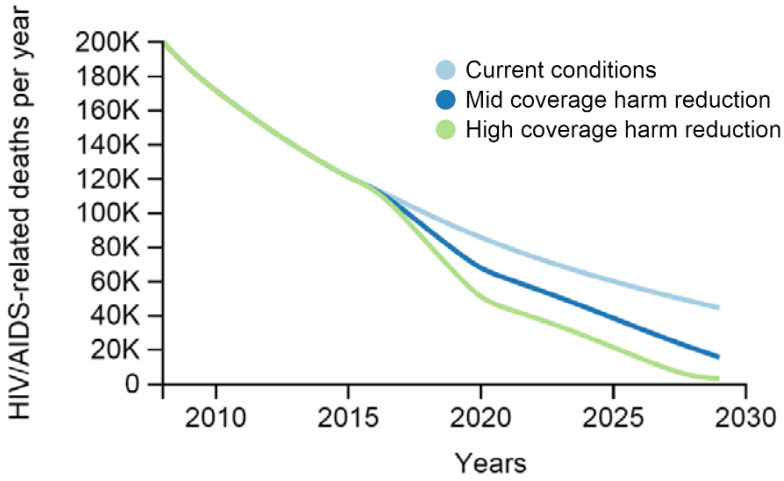
Figure 2 shows new HIV infections and AIDS-related deaths for the different coverage scenarios. By 2030, the medium coverage scenario is projected to reduce new HIV infections by 78% and AIDS-related deaths by 65%. For the same period, the high coverage scenario for PWID programs, which also includes high ART coverage for PWID, is estimated to reduce new HIV infections by 94% and deaths by 93%.

Figure 2. Health outcomes among PWID with different levels of HIV program coverage

A. New HIV infections



B. AIDS-related deaths



Source: Optima model results

The medium coverage HIV investment in PWID programs scenario cost of US$2.7 billion would represent approximately 12% of total global HIV spending of 21.7 billion US$ (UNAIDS, 2015, whereas the high-coverage scenario cost of US$7.7 billion would represent 35% of the total global HIV budget. When compared to estimated global spending on overall drug control and punitive

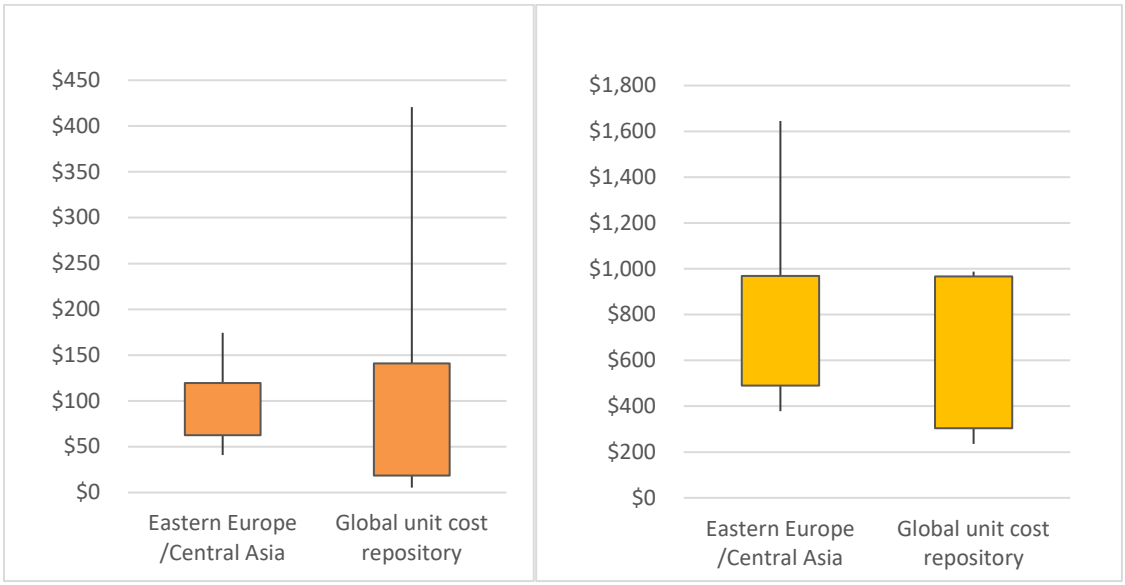
approaches of US$100 billion, the medium and high coverage scenarios would absorb 2.7% to 7.7%, respectively.

Implementation efficiency of programs for PWID

Data gathered for the eight countries in EECA suggest large inter-country variation in spending on, and coverage of, PWID programs, as well as cost per PWID living with HIV reached. **Figure 3** summarizes the cost ranges for NSP/PWID outreach programs and OST programs from Optima studies and compares them to costing data from a global unit cost repository (Avenir Health, 2016). Cost per person reached was defined as the total annual cost of the program divided by the number of people reached. This implies that cost does not only include programmatic unit cost, but also program support costs. In countries with the highest cost of OST and NSP/PWID programs, annual cost per person reached is more than four times the spending in the country with the lowest cost.

Figure 3: Program cost per person reached for HIV programs for PWID: Highest, lowest and interquartile ranges

A. NSP and PWID programs **B. Opioid substation therapy**

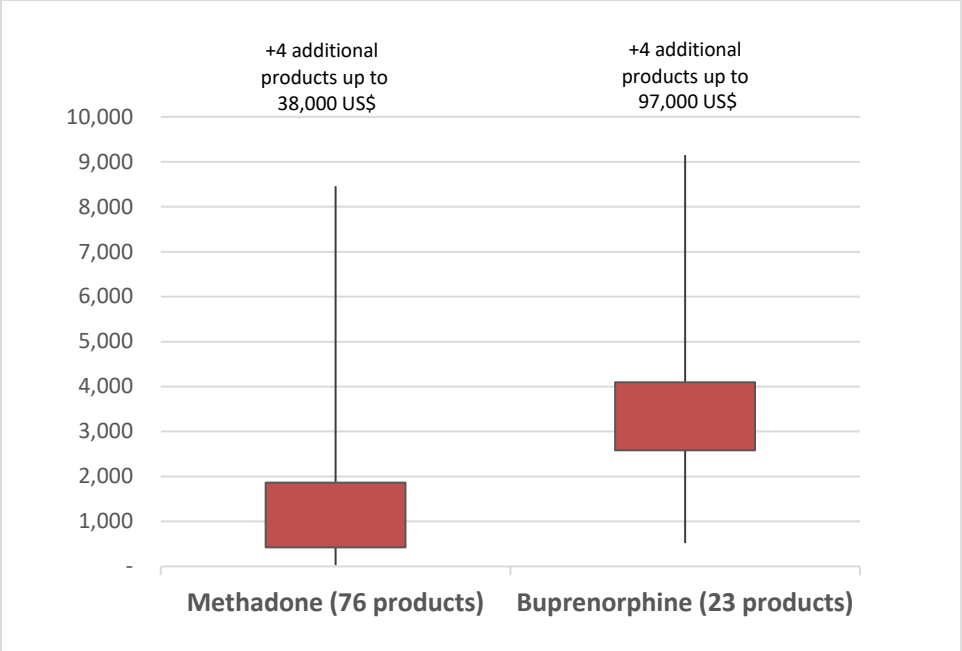


Source: Prepared by authors based on completed Optima spreadsheets for 8 countries and Avenir Health 2016

Figure 4 summarizes procurement costs for methadone and buprenorphine from the WHO Controlled Medicine Database, which includes the most comprehensive review of procurement prices available for this category of drugs (WHO, 2008). For purposes of standardization, a daily dose of 80 mg was used. Prices of an annual supply of methadone ranged from US$28 to US$38,000 with a median annual unit cost of US$785 (in 2008 USD). Prices of an annual supply of buprenorphine ranged from US$520 to US$97,000 with a median annual unit cost of US$ 3,341, more than four-fold higher than the median price of methadone. As the WHO database has not been updated since 2008, **Figure 5** presents more recent prices for methadone from different sources with annual cost ranging from US$96 with production in Viet Nam (USAID, 2014) to US$692 in the United Kingdom (World

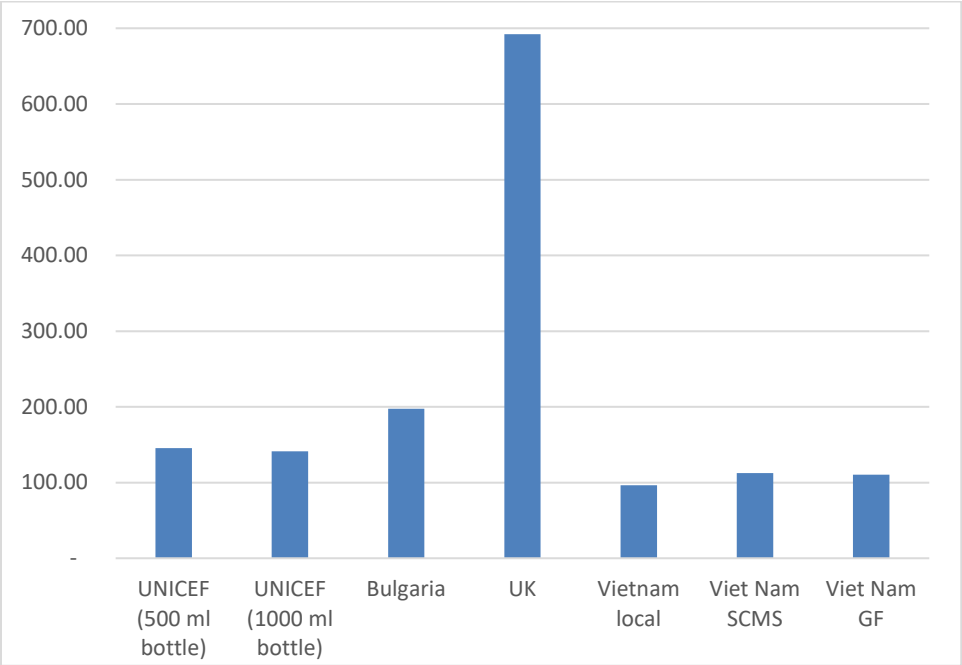
Bank, 2014), while an annual methadone supply can be purchased for US$141 globally (UNICEF, 2016).

Figure 4: Annual unit costs of methadone and buprenorphine



Source: Prepared by authors based on WHO, 2008

Figure 5:** Annual unit **costs of methadone

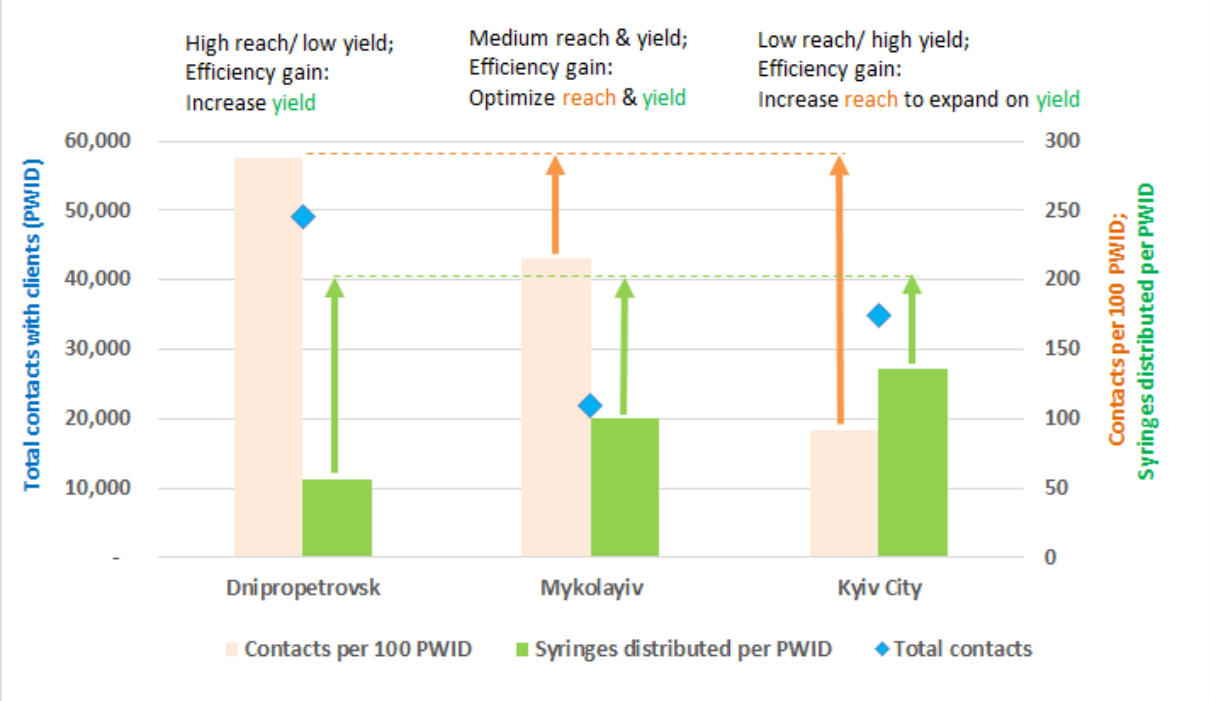


Source: Prepared by authors based on UNICEF, 2016, World Bank, 2014, USAID, 2014.

Five findings on implementation efficiency of NSP

Data from cost-effectiveness and allocative efficiency studies suggest that variation in cost extends beyond drug prices into other areas of program implementation. A study in Ukraine (World Bank, 2014) revealed five areas for enhancing implementation efficiency of NSP programs by comparing performance in specific sites and Oblasts. (1) Variation in service delivery focus on different components of service packages was high among different sites. The proportion of client visits, during which core NSP services were offered, ranged from 10% to 49%, with a mean of 28%. (2) Linkages, referrals, and integration with other services were not formalized leading to service disruption. (3) The same type of facility is operated with substantially different staff profiles, staff numbers, and opening hours contributing to wide variation in the number of clients who received service per hour from 0.3 of a client to 8.6 clients per hour per site. (4) There was high variation in operation of NSP sites and cost categories, and standardization could lead to 20% to 41% reductions in unit cost. (5) If the 48% to 59% of sites not operating at efficiency of scale could make improvements such that they operated at higher efficiency, 21% of costs could be saved overall. **Figure 6** illustrates variation in coverage and output (sterile needle and syringe distribution) between the 51 sites across the three Ukrainian Oblasts, where the study was conducted. Findings suggest that in Dnipropetrovsk high NSP program coverage was achieved, but levels of syringes distributed remained low, while in Kyiv higher levels of per capita distribution of syringes were achieved. These patterns point to a need for improved strategies to enhance implementation efficiency in these three Oblasts.

Figure 6: Implementation efficiency in Ukraine



Source: World Bank, 2014

Four findings on implementation efficiency of OST

Comparative analysis of OST implementation analysis in Ukraine revealed four key areas for efficiency gains (World Bank, 2014). (1) Access to OST was constrained by the legal environment, regulations, and law enforcement practices targeting OST providers and clients. (2) High variation in the level of site utilization was observed and the number of clients seen per hour per clinician varied from 3.7 to 17.5. (3) Staff costs account for the highest proportion of OST service costs and high variation in staffing levels was observed. (4) Costs at integrated OST sites, where other medical services are provided, were lower than stand-alone OST sites. Two sites efficiently provided integrated ART-OST services, while referrals were limited in other sites. (5) If sites could achieve unit costs levels from the most cost efficient site, who serve high volumes of clients at low cost, overall these cost-inefficient sites could save approximately 50% of their unit costs for stand-alone OST and 43% of the unit cost when all costs were included.

Discussion

Allocative and implementation efficiency analyses suggest that there are a range of options to enhance the efficiency of HIV prevention and treatment programs for PWID.

According to the studies we conducted in Eastern Europe and Central Asia**, a combination of investment to increase coverage of NSP, OST, and ART services are at the core of optimized allocations in HIV epidemics sustained by drug injecting practices**. Additional allocative efficiency analyses, which we carried out in other regions, confirms that for countries with high-level HIV epidemics among PWID, investment in these three core programs is effective in reducing HIV transmission.

In Bulgaria and Georgia, the HIV epidemic among PWID has stabilized and the Optima analyses showed continued effects of investment in NSP and OST programs as part of the optimization. The model suggests that defunding PWID programs could lead to higher HIV incidence rates, which even moderate increases in unsterile needle-sharing could cause. In a scenario analysis we conducted in Ukraine, defunding prevention programs for PWID and other key populations after 2018 would lead to 75% more new infections in 2030 even with high overall ART coverage (World Bank, 2015h). Recent increases in HIV transmission among PWID in Greece and Romania have demonstrated that rapid increases in HIV incidence in previously stable HIV epidemics need to be considered as plausible epidemic trajectories if programmatic attention is limited (EMCDDA & ECDC 2012).

In a number of countries in other regions where PWID account for smaller proportions of the HIV epidemic and HIV prevalence among PWID is lower than among MSM or other key populations, HIV specific allocative efficiency analyses suggest that the limited HIV resources should primarily be invested in ART and prevention programs for other key populations, e.g. female sex workers (FSWs) and MSM. This underlines the point that HIV resources alone will be insufficient to address the full global need to support health and harm reduction programs for PWID. Based on the assumption that high coverage levels of PWID programs could be achieved with an investment of US$ 7.7 billion, we estimated that this would absorb 35% of global HIV spending, but less than 10% of spending on overall drug control. A formal optimization tool for analyzing allocative efficiency of different drug control programs does not yet exist. However, the question of what allocations of drug control,

demand and harm reduction would maximize health impact warrants further exploration. This is particularly important, because HIV-related allocative efficiency analysis focuses primarily on HIV outcomes and thereby underestimates the wider health and social benefits of PWID programs in relation to responding to other infectious diseases such as Hepatitis infections, other blood-borne diseases, increasing economic productivity, and decreases in rates of crime.

The limited amount of reliable available data suggests that there is also large scope for improving implementation efficiency of HIV programs for PWID. The high variation in prices reported for methadone, buprenorphine and ARVs suggests that substantial efficiency gains can be made in drug procurements. Price comparisons using global ARV drug cost databases exist and are regularly updated, but the tracking mechanism is currently not being updated for methadone and buprenorphine. The price of methadone is listed in the global UNICEF supply catalogue as US$141, which offers a benchmark for the unit cost of an annual supply of methadone, although prices of less than US$100 for the same dose have also been reported (WHO, 2008, USAID, 2014). Practices enhancing implementation efficiency of drug procurements, which have been described elsewhere (Waning, 2009), include intensified price negotiations, pooled bulk procurement, and international procurement. For ARVs, additional options to reduce costs include reduced number of ART regimens through use of fix-dose combinations and procurement of generic prescription drugs or licensing under Trade-Related Aspects of Intellectual Property Rights (TRIPS) flexibilities.

Implementation efficiencies in service delivery identified in our study relate to models, practices, and scale of service delivery influencing cost and outcome. More evidence is required to determine the most effective strategies for PWID in different contexts. Our findings suggest that rapid heterogeneity analysis and comparison of site, district, and country performance can provide useful findings and be conducted within reasonable time frames. High performance was associated with high volume of client utilization and highly effective use of staff time per client interaction. Simplified types of service delivery models, standardized operating procedures, and effective staffing operations would help to optimize cost-effectiveness. In Georgia, utilization of OST sites was increased by removing a ceiling on the number of clients that can be registered and served at an OST site at a given time (World Bank, 2016c). Other analyses of cost-efficiency of PWID programs have emphasized the importance of retention, which requires attention to administered drug doses and adherence to screening criteria to avoid instances whereby clients who are not prepared for OST drop out of care and are then reinitiated for shorter periods (Sullivan, 2013). This also highlights the need to provide a core package of HIV services for PWID including NSP, OST, and ART within the wider package of health service delivery, which include diagnosis of HIV and other infectious diseases, but in particular Hepatitis, as well as condom promotion and distribution, HIV counselling, and psycho-social support.

Conclusions

Allocative efficiency analysis in countries with HIV epidemics sustained by PWID suggest that increased investment towards NSP, OST, and ART programs would lead to reductions in new HIV infections by 3-28% and deaths by 7-53% compared to business as usual, even without additional resources and with decreases in resources to other HIV programs. In order to end the HIV epidemic among PWID as a public health threat by 2030, high coverage levels of PWID programs will be

required; this could also be achieved through additional financing from non-HIV resources. Further analysis and a policy dialogue surrounding allocative efficiency of global spending on drug control are proposed as next steps. With efficient implementation models, the cost of PWID programs could be substantially reduced. Effective procurement, simplified service delivery models, improved utilization of staff, and service delivery facility capacities could contribute to achieving more with whatever resources are available. Increasing efficiency of HIV programs for PWID is not aiming for nor driven by austerity, but a key step to avoiding implicit rationing and transparently allocating resources where and how they will have the largest impact on the health of PWID.

Acknowledgements

The modelling studies in the eight countries were funded by the World Bank Group and supported by the Australian National Health and Medical Research Council. The authors wish to thank individuals involved in the modelling of individual case studies: Azfar Hussain, Andrew Shattock, Cliff Kerr, Hassan Haghparast-Bidgoli, Iyanoosh Reporter, Janne Estill, Jolene Skordis-Worrall, Kelsey Grantham, Laura Grobicki, Olivia Keiser, Richard Gray, Robyn Stuart, Sherrie Kelly, Zofia Baranczuk.

References

Avenir Health. (2016). Unit Cost Repository. Retrieved from http://www.avenirhealth.org/policytools/UC/ (last accessed on 5 March 2016)

Carasso, K.B., Chee, G., Cico, A., Quyen, D. H., Tu, P. C. & Sitruk, A. (2014). Options for Integrating Procurement and Supply Chain Systems for ARVs, Methadone, and anti-Tuberculosis Drugs in Vietnam. Bethesda, MD: Health Finance & Governance Project, Abt Associates Inc.

Cipriano, L. E., Zaric, G. S., Holodniy, M., Bendavid, E., Owens, D. K., & Brandeau, M. L. (2012). Cost Effectiveness of Screening Strategies for Early Identification of HIV and HCV Infection in Injection Drug Users. PLoS ONE, 7(9), e45176. http://doi.org/10.1371/journal.pone.0045176

European Monitoring Centre for Drugs and Drug Addiction (EMCDDA) and European Centre for Disease Prevention and Control (ECDC). (2012). Joint EMCDDA and ECDC rapid risk assessment. HIV in injecting drug users in the EU/EEA, following a reported increase of cases in Greece and Romania. Retrieved from: http://www.emcdda.europa.eu/system/files/publications/666/emcdda-ecdc-2012-riskassessment_321005.pdf

Kerr, C.C., T. Smolinski, S. Dura-Bernal, and D.P. Wilson. Under review. (2016). “Optimization by Adaptive Stochastic Descent.” “Nature Scientific Reports.” http://scholar.google.com/citations?view_op=view_citation&hl=en&user=TFy7ncUAAAAJ&citation_for_view=TFy7ncUAAAAJ:Ug5p-4gJ2f0C.

Kerr, C.C., et al. (2015). Optima: A Model for HIV Epidemic Analysis, Program Prioritization, and Resource Optimization.” JAIDS (Journal of Acquired Immune Deficiency Syndromes) (March). http://mobile.journals.lww.com/jaids/_layouts/oaks.journals.mobile/articleviewer.aspx?year=2015&issue=07010&article=00017

Kim, S. W., Pulkki-Brannstrom, A.-M., & Skordis-Worrall, J. (2014). Comparing the cost effectiveness of harm reduction strategies: a case study of the Ukraine. *Cost Effectiveness and Resource Allocation : C/E*, *12*, 25. http://doi.org/10.1186/1478-7547-12-25

Shattock, A., et al. (2016). Efficency gains could lead to Kazakhstan achieving excellent epidemiological outcomes. (Submitted to JAIDS).

Sullivan, S. (2013). Opioid substitution: improving cost–efficiency. Bulletin of the World Health Organization, 91(2), 83. http://doi.org/10.2471/BLT.13.117374

Tajikistan, Republic of. (2014). "Modeling an Optimized Investment Approach for Tajikistan: Sustainable Financing of National HIV Responses." By C. Hamelmann, P. Duric, C. Kerr, and D.P. Wilson, Ministry of Health. Dushanbe. http://www.eurasia.undp.org/content/dam/rbec/docs/UNDP20Modelling20Tajikistan_English.pdf.

UNAIDS. (2014). Fast-Track: Ending the AIDS Epidemic by 2030. Geneva: UNAIDS.

UNAIDS. (2015). How AIDS changed everything. MDGs, 15 years, 15 lessons of hope from the AIDS response. Geneva. Retrieved from http://www.unaids.org/sites/default/files/media_asset/MDG6Report_en.pdf

UNGASS (United Nations General Assembly). (2011). Resolution adopted by the General Assembly 65/277. Political Declaration on HIV and AIDS: Intensifying Our Efforts to Eliminate HIV and AIDS. New York.

UNICEF. (2016). Supply Catalogue. Copenhagen. Retrieved from https://supply.unicef.org/ (accessed on 4 March 2016)

UNODC. (2015). World Drug Report 2015. Vienna: UNODC.

USAID. (2014). Options for Integrating Procurement and Supply Chain Systems for ARVs, Methadone, and anti-Tuberculosis Drugs in Vietnam

Waning, B., Kaplan, W., King, A. C., Lawrence, D. A., Leufkens, H. G., & Fox, M. P. (2009). Global strategies to reduce the price of antiretroviral medicines: evidence from transactional databases. Bulletin of the World Health Organization, 87(7), 520–528. http://doi.org/10.2471/BLT.08.058925

Wilson, D.P., B. Donald, A.J. Shattock, D. Wilson, N. Fraser-Hurt.(2015). "The Cost-Effectiveness of Harm Reduction." *International Journal of Drug Policy* 26 (Suppl 1): S5–S11.

World Bank. (2014). Ukraine HIV Program Efficiency Study: Can Ukraine improve value for money in HIV service delivery? Washington DC: World Bank.

World Bank. (2015a). Optimizing Investments in Armenia. Washington DC: World Bank.

World Bank. (2015b). Optimizing investments in Belarus for the National HIV Response. Washington DC: World Bank.

World Bank. (2015c). Optimizing Investments in Georgia's HIV Response. Washington DC: World Bank.

World Bank. (2015d). Optimizing Investments in Kazakhstan's HIV Response. Washington DC: World Bank.

World Bank. (2015e). Optimizing Investments in Kyrgyz Republic's HIV Response. Washington DC: World Bank.

World Bank. (2015f). Optimizing Investments in Moldova's HIV Response. Washington DC: World Bank.

World Bank. (2015g). Value for Money in Ukraine's HIV Response. Strategic Investment and Improved Efficiency Washington DC: World Bank.

World Bank. (2015h). Final Report with Recommendations for Reforming Bulgaria's Pharmaceutical Sector. Washington DC: World Bank.

World Health Organization. (2008). Controlled medicine database. Retrieved from: http://www.who.int/hiv/amds/controlmedicine/en/ (accessed on 5 March 2016)