# The role of HIV research in building health system capacity in developing countries

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**Purpose of review**

There is growing recognition that greater investment in research is needed to expand our knowledge and understanding of how to scale up HIV programmes effectively and equitably in the context of weak health systems. Current debates acknowledge that there remains a gap in evidence on how HIV resources can best be managed to contribute to building health system capacity; how to integrate HIV interventions into primary healthcare systems; and how HIV scale-up is affecting other disease programmes.

**Recent findings**

Findings suggest that global health initiatives, including HIV/AIDS programmes, should allocate a set portion of funding for research and knowledge generation in improving health system performance. Forms of HIV research with potential for building health system capacity in developing countries include clinical research, implementation and operations research, quality improvement research, economic evaluation and cost–effectiveness, HIV surveillance and population-based surveys, and monitoring and evaluation.

**Summary**

In this review, we present an overview of the imperative for HIV research in building health system capacity, provide examples of current trends and the forms of research with potential for enhancing health system performance, and highlight priorities for enhancing the role of HIV research in building health system capacity.

**Keywords**

capacity building, health system, HIV research, scale-up

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## Introduction

The HIV pandemic remains the most serious infectious disease challenge to public health, especially in sub-Saharan Africa where AIDS is still the leading cause of death. While increased resources for the global AIDS response has enabled the quality of information and our understanding of the pandemic to blaze the trail for other global disease estimates, it has also created urgent demands for strengthening systems for HIV scale-up and generation of strategic information to guide programming and resource management [1]. There remains, however, a gap in evidence on how increased resources available for the HIV response can best be managed to contribute to strengthening of health systems in developing countries; how current HIV-driven innovations in responding to health workforce constraints enhance health system performance; how to integrate HIV scale-up into primary healthcare systems and how HIV scale-up is impacting other disease programmes. In this review, we present an overview of the imperative for HIV research in building health system capacity; provide examples of current trends and the forms of research with potential for enhancing health system performance, and highlight priorities for enhancing the role of HIV research in building health system capacity.

## Imperative for HIV research in building health system capacity

In 2001, the Commission on Macroeconomics and Health recognized that as treatment efforts are scaled up in low- and middle-income countries, funding would be needed to develop research capacity and conduct operational research necessary to optimize treatment regimens to local conditions and identify how best to integrate these into existing services. In order to ensure that an adequate proportion of country-specific project assistance was devoted to operational research, the report proposed that a minimum of 5% of HIV funding from bilateral agencies, such as the World Bank and the Global Fund to Fight AIDS, Tuberculosis and Malaria (Global Fund), be spent on operational research [2].

In 2004, Richard Feacham, the then Executive Director of the Global Fund, argued that there was an imperative for investing in operational research or 'learning by doing', to study and share lessons from the massive scale-up of HIV prevention activity and access to treatment. Yet none of the financing mechanisms at the time, including the President's Emergency Plan for AIDS Relief (PEPFAR), the World Bank's Multi-Country AIDS Program and the Global Fund, had any arrangements in place to ensure that the necessary operational research was done [3].

The 2005 58th World Health Assembly [4] endorsed the Mexico Statement on Health Research from the Ministerial Summit of 2004, urging member states to consider implementing the 1990 recommendation made by the Commission on Health Research for Development, that 'developing countries should invest at least 2% of national health expenditures in research and research capacity strengthening, and at least 5% of project and programme aid for the health sector from development aid agencies should be earmarked for research capacity strengthening' [5].

The International AIDS Society, through the 2007 Sydney Declaration, called for up to 10% of all resources dedicated to HIV programming to be used for research towards optimizing interventions; ensuring that health systems are strengthened as a result of scaling-up, and that desired health outcomes are achieved [6]. Current guidance to teams in PEPFAR focus countries suggests 1–4% of spending to support Public Health Evaluations [7]. The global health community, however, is not keeping pace with these recommendations. A report from the Alliance for Health Policy and Systems Research estimated that only about 0.017% of health projects' expenditures in low- and middle-income countries was devoted to implementation research [8]. The global AIDS response is still largely focused on strengthening coordination and building capacity of national monitoring frameworks for measuring progress against international commitments and targets. These efforts may have inadvertently overshadowed the lack of adequate attention to longer-term strategic research questions on health system performance and health outcomes [9].

## Forms of HIV research with potential for strengthening health systems

The suggested list of forms of HIV research for building health system capacity is adapted from Hirschhorn *et al.* [10••].

### Clinical research

Clinical research seeks to advance scientific knowledge and understanding of HIV prevention, care and treatment. Clinical studies are the engine for innovation, pilot testing, development and application of new technologies and strategies, rigorously checked against health outcomes through strengthened clinical and laboratory systems [10••]. The opportunity now exists also to explore how these controlled HIV research processes can inform system-wide application, system strengthening and population health. Relevant studies include investigation of routine use of HIV interventions of known clinical benefits including co-trimoxazole prophylaxis; trends in fatality among HIV-positive patients with tuberculosis treated with with antiretroviral therapy (ART) in the routine health system; and analysis of risk factors and health system barriers for high early mortality in patients on ART [11••,12•,13].

### Implementation and operations research

Implementation research calls for closing the 'programme-implementation gap' between the actual delivery of care, and best practices or guidelines in HIV care with proven efficacy in a clinical research setting. It also focuses on promoting the understanding of factors associated with gaps between expected results and observed outcomes [10••,14].

Operations research has been used to study barriers to access and barriers to implementation, as well as to guide design of national and local HIV treatment interventions. The field of operational research takes on the challenge of linking research to policy in the emergency context of the HIV epidemic, and of providing rapid evidence to scale-up and improve programmes. Opportunities range from simple systematic collection of data right through to ambitious randomized controlled trials, and research on adherence to treatment regimens, toxicity, development of resistance, modes and costs of delivery [2,3,11••,15,16].

### Quality improvement research

Systems to measure and improve quality are growing in importance as HIV-treatment programmes mature and numbers of patients on ART continue to expand. Quality assurance of HIV services provided is critical to improving long-term treatment success, decrease risk of drug resistance and promote optimal use of existing resources including health workforce and commodities. While building and monitoring quality of care has been an essential element of strengthening health systems in resource-limited settings for many years, it is yet to leverage HIV scale-up for system-wide benefits [10••,17••,18].

### Economic evaluation and cost–effectiveness

With current annual global HIV spending of US$10 billion, more comprehensive economic evaluation research is needed at national and regional levels, with critical consideration of how efficiencies and benefits for the health sector as a whole could be improved and how economic

information generated can complement existing resource tracking mechanisms such as National Health Accounts [19,20••].

Cost–effectiveness research in HIV scale-up uses analytical tools to establish the relative costs and impacts of different prevention, care and treatment interventions. The purpose is to provide information to guide policy development and use of resources, eliminate disparities, maximize value and improve health outcomes. Economic questions for HIV research cover a broad range of issues, such as incentives, including how to promote compliance with treatment and prevention guidelines; the cost of antiretroviral (ARV) programmes; the effect of expanded treatment on household economics; the differential access of some individuals and groups to diagnostics, medicines, care and follow-up; use and cost of HIV therapeutic, laboratory and preventive services; the relative flow of resources to HIV, integration and impacts on other health issues at primary, sub-national and national levels; and the cost–effectiveness of different clinical guidelines, care strategies, and interventions [10••,21•,22,23••,24].

#### Monitoring and evaluation

The 'Three Ones' framework has created joint efforts at national and international levels to build timely and credible monitoring and evaluation systems for collecting simplified, standardized and prioritized data to monitor and manage programmes. The use of common indicators and methods of measurement allows consistent assessments over time and cross country comparability and reporting on progress against international frameworks, including the UNGASS Declaration of Commitment and Millennium Development Goals (MDGs). Most monitoring and evaluation activities, however, necessarily focus on measuring the services provided, and strengthening coordination, partnerships and accountability [25].

#### HIV surveillance and population-based surveys

HIV sentinel surveillance and population-based surveys are established HIV research strategies, available to national programmes and the global AIDS response, to provide quality information on national HIV epidemiology and increase global understanding of the pandemic. This research is fundamental to realizing the HIV prevention principle of 'know your epidemic', and allows improved targeting of prevention efforts. In addition, the systems and capacities built can form the foundation for improved surveillance of other diseases and overall health information systems [1,7,26,27,28].

## Current trends in HIV research and building health system capacity

In 2007 WHO defined six building blocks to characterize the capacities that a health system should have in order to deliver the goals of improving health outcomes and health equity in ways that are responsive, ensure social health protection and make the most efficient use of available resources. The six blocks are service delivery, health workforce, information, medical products and technologies, financing, and leadership and governance [29].

Health system goals will not be attained without research addressing system constraints to delivering effective interventions. While HIV/AIDS responses can have a dramatic positive impact on overall health systems, research is needed to enhance outcomes including reducing overall burden of HIV on the health workforce, and freeing up hospital beds to treat people with other disease conditions [30,31•,32••].

#### Service delivery: community-based models

By the end of 2007, it was estimated that globally there were close to 2 700 000 people receiving antiretroviral therapy, projected to rise to 3 380 000 by the end of 2008 [33]. Reports documenting the impact of ARV treatment scale-up from Uganda and elsewhere show outcomes of 50–60% reduction of HIV-related hospital admissions; rehabilitation of laboratory infrastructure and other vital health system components; increased availability of drugs and diagnostics; and strengthened procurement systems [34••].

There is growing evidence from HIV research into the effectiveness of scaling up community-based, public sector and home-based ART programmes in Uganda, Lesotho, Rwanda, and South Africa supporting comparable results in clinical and virological outcomes, high rates of adherence and retention, and reduction in mortality and hospital admissions [34••,35••,36,37]. In addition, transportation requirements are reduced, and community-based providers allow more strategic use of healthcare professionals while reducing unemployment rates. Standardized simplified treatment approaches to monitoring and referral of patients enhance quality of care and the collection of much needed data [38].

#### Health workforce: task-shifting models

Studies of AIDS and human capacity in the health sector suggest that the twin burden of the health workforce crisis and the HIV/AIDS crisis is largely an African phenomenon; compounded by the increased attrition from AIDS related illness and deaths, significant additional work load and demands of expansion of antiretroviral therapy [39]. Barnighausen *et al.* [40•] predict that HIV treatment scale-up will generate greater need for health workers, because of increased survival of patients. This will be compounded by increasing numbers needing ART from new HIV infections. The study suggested that even with optimistic assumptions about emigration, incidence and death, HIV

treatment scale-up will continue to demand substantial numbers of health workers over the coming decades. HIV research into the health workforce will, therefore, need to guide policymakers to ensure that the flow of workers into ART programmes does not jeopardize the provision of other important health services [41].

HIV scale-up in Malawi provided the impetus for health workforce research, planning for human resources for health, treatment of health workers, expansion of training programmes and task shifting between healthcare workers and training members of the community [42]. Task shifting, models of nurse-led care, and development of the roles of other nonphysician and community health professionals will not only enable human resource-constrained countries to increase the number of patients on ART, especially in rural areas, but will also expand the resource pool and maximize the availability of skilled workers for other health conditions and services [43,44•].

The demand for increased health workforce capacity, performance and new cadres has opened up yet another area of HIV research: to review approaches, challenges and costs in health workforce training. Research into how proven interventions can be implemented to accelerate high-quality public health approaches to HIV treatment scale-up, begs the question: what is the optimal approach to training the health workforce for an expanding HIV treatment programme in resource-limited settings [45]?

#### Information: building surveillance systems

HIV surveillance is a core function of national AIDS programmes worldwide. Since the beginning of the epidemic, most countries have initiated sero-surveillance systems and built capacity to study the distribution of infection among different populations and monitor trends in levels of infection over time. A global analysis of trends in the quality of HIV sero-surveillance found that sero-surveillance systems were of higher quality in countries with high HIV burdens: the 31 countries with a generalized epidemic that had a fully implemented system in 2002 represented 74% of the global HIV burden [26,27].

PEPFAR surveys in 30 countries, including Botswana, Côte d'Ivoire, Ethiopia, and Vietnam, have helped to improve prevalence estimates and incidence data, including mapping locations of treatment and care sites. Maps depicting ARV treatment delivery sites provide developing countries with the foundation tools and technology for system-wide mapping of access to services, which can be applied in identifying inequities in health service provision [7].

#### Leadership and governance: collaborating with community leadership

Events leading up to the termination of tenofovir-based HIV prevention trials in Cambodia, Cameroon and Nigeria in 2005 led to the development of new guidelines for the engagement of community organizations in clinical trials and HIV research. A review conducted by Bhan *et al.* [46•] defines six roles played by community service organizations in facilitating community engagement in research: community interface including ethical assessments and establishing community advisory boards; development of formal partnerships with communities; involvement in research and peer review processes; priority setting and watch-dog functions to ensure that the research being planned is in the best interest of local populations; advocacy to policy makers for postresearch adoption of innovative findings and ensuring that they are locally available; and dissemination of findings and delivery of effective interventions arising out of the research. The review also, however, called for greater transparency and declaration of conflicts of interests of civil society organizations; for research and evaluation of best practice models on collaboration and engagement of community organizations; and for assessments of the resulting impacts of these engagements on local health needs [46•].

In some cases, community organizations may provide leadership in HIV research that provides critical information in enhancing the role of HIV scale-up in building health systems. The December 2007 series report of the International Treatment Preparedness Coalition (ITPC), *Missing the Target*, expanded the focus of research beyond monitoring ARV roll out to include attention to critical challenges to health systems in delivering HIV and tuberculosis services. It highlighted health workforce constraints, barriers to antiretroviral drug access, including inefficiencies in drug registration, procurement, supply management, stock-outs, as well as high costs of second-line and other medicines, patent restrictions on some essential drugs, and corrupt drug management systems [47].

## What are the next steps in enhancing the role of HIV research in building health system capacity?

The potential return on investment in HIV research geared to improving health system performance is currently unknown. A study surveying deaths among children less than 5 years of age in 42 low-income countries, estimated the return on investment in new technology versus research that could improve the delivery and utilization of health services. It concluded that while improved technology had the potential to avert 21.5% of potential deaths, improved service utilization could avert 62.5% of child deaths [48••].

### Integrate HIV research into national health research systems

A 2006 study of the status of national health research systems in 10 countries of the WHO African Region provides insight into the challenges and alarming gaps in some national health research systems including lack of strategic plans and legislation relating to health research; deficiencies in ethical and scientific review committees; and inadequate capacity at national and institutional levels for training, implementation and governance of health research. Only four out of the 10 countries that responded reported that they had a budget line for health research in the Ministry of Health [49]. Given the levels of HIV research needed to support scale-up, the development of high-performing national health research systems is urgently needed. HIV research investments must be integrated into national health research systems and harnessed in improving the health research policy environment (policies, strategic plans, legislation, ethical and scientific review structures), in order to advance scientific knowledge across disease programmes, and promote its utilization in improving health outcomes and health equity.

### Build capacity, and research the impact of HIV research on health system capacity

There is growing interest in health research systems and how they are organized, with developments and innovations in conceptualization, evaluation and analysis across several countries. As HIV scale-up programmes mature, and if treatment and prevention access continues to expand and funding levels increase, there is an opportunity for HIV research to build on emerging issues in strengthening health research systems including the following:

(1) provide accountability for funds spent and justification for future funding; the challenge is to measure benefits in ways accepted as being valid and that also meet increasing demands to demonstrate funding for research provides value for money, especially when money could otherwise have been used directly to provide healthcare, including ARV treatment [50];
(2) assess the impact of research on health policy and progress towards achieving a health gain from health research; either through exploring the impact of specific research programmes or examining policy areas for evidence of policy impact [51];
(3) investigate how health research systems could best be organized to enhance the payback from research; generate a substantial body of evidence from evaluation studies showing how using research in policy, programmes, and practices has led to improved health outcomes;
(4) evaluate the roles, performance and impact of ethics committees; in order to respond to an increased emphasis on research ethics, and develop new ways to commission research to allow greater involvement of affected communities [52];
(5) investigate specific research programmes' capacities and barriers to address equity-oriented research in access to services and health status across the socio-economic factors of sex, urban–rural differences and income [53];
(6) evaluate health research capacity; capacity to conduct research and how to attract and retain staff in the public health research sector; and investigate the amount of health research financing; number of researchers, research infrastructure or research institutions [54];
(7) investigate the alignment of research with national health priorities and needs; research on impact of research on population health and health equity.

### Define a comprehensive HIV research agenda

There are a number of challenges in enhancing the role of HIV research in building capacity of health systems including the lack of clear descriptions of how complex HIV programmes and research interventions fit within a comprehensive national health systems research agenda [30]. This agenda has limited the number of initiatives mapping relevant research that has already taken place, high-quality systematic reviews that are a prerequisite to new research and avoidance of duplication, and synthesis of relevant existing knowledge to provide a body of knowledge and a strong evidence base on how HIV research contributes to building health system capacity. A recent systematic review of patient retention in ART programmes in sub-Saharan Africa, for example, highlighted the need for patient tracing systems and regular research on retention rates [55••].

Defining, therefore, an agenda linked to the six health system building blocks will not only help to identify key topics for HIV research essential to scale-up and programme success, it will also enhance positive impacts on health system capacity. In addition, a common agenda will enable development of public health approaches for system wide benefits that can be reviewed, evaluated and revised in light of lessons learnt in different settings. A common agenda will also expand the work of developing generic tools, foster collaborative networks, and enable multicountry and case study comparisons [16,30,56].

## Conclusion

HIV research has a strong role to play in building health system capacity in developing countries. A number of

lessons learned can already be applied, but huge gaps remain in identifying best practice that can improve HIV treatment, care and prevention services whilst strengthening overall health systems. There is currently a dearth of research in all areas identified in this regard. The HIV community at national, regional and international levels must act quickly to integrate HIV research into national health research systems to bridge the 'know–do' gap. Research is required to clarify the impact desired of HIV research on health systems strengthening, and a comprehensive and collectively agreed HIV research agenda should be defined to guide expanded research to strengthen health systems in developing countries [57].

Current debates that pit the expansion of HIV-specific programming against the goal of health systems strengthening are missing the point [58]. The scandal is not that HIV services in poor countries are now seen to be vastly superior to services for other diseases and primary healthcare. The real scandal is that these other services are so pitifully substandard. Responding effectively to HIV/AIDS can have dramatic positive effects on overall health systems in many ways. In many countries integrated HIV programmes have helped to strengthen health services for other areas including antenatal services, pediatric care, nutrition, malaria, and tuberculosis [32••,35••,36,59]. A return to a 'horizontal' approach to building health systems may inadvertently undermine HIV scale-up efforts and be a step backwards in the fight for health for all.

## References and recommended reading

Papers of particular interest, published within the annual period of review, have been highlighted as:

- • of special interest
- •• of outstanding interest

Additional references related to this topic can also be found in the Current World Literature section in this issue (p. 528).


**1** UNAIDS and WHO. 2007 AIDS Epidemic Update. December 2007. http://data.unaids.org/pub/EPISlides/2007/2007_epiupdate_en.pdf. [Accessed 17 April 2008]

**2** Report of the Commission on Macroeconomics and Health. Macroeconomics and Health: Investing in Health for Economic Development. World Health Organization. Presented by Jeffrey D. Sachs to Gro Harlem Bruntland. 20 December 2001. Geneva: WHO; 2001.

**3** Feacham RGA. The research imperative: fighting AIDS, TB and malaria. Trop Med Int Health 2004; 9:1139–1141.

**4** Resolution WHA 58.34 passed at the 58th meeting of the World Health Assembly. 2005. http://www.who.int/rpc/meetings/58th_WHA_resolution.pdf. [Accessed 17 April 2008]

**5** Report from the Ministerial Summit on Health Research. Identify challenges, inform actions, correct inequities. Co-organized and co-sponsored by World Health Organization and Government of Mexico. Mexico City. 16–20 November 2004. http://www.who.int/rpc/summit/documents/summit_report_final2.pdf. [Accessed 17 April 2008]

**6** The Sydney Declaration. In: 4th IAS Conference on Pathogenesis, Treatment and Prevention. 22–25 July 2007, Sydney. Geneva: IAS; 2004.

**7** PEPFAR. The Power of Partnerships: Fourth Annual Report to Congress on PEPFAR. 2008. http://www.pepfar.gov/documents/organization/100029.pdf. [Accessed 17 April 2008]

**8** Alliance for Health Policy and Systems Research. Strengthening health systems in developing countries: the promise of research on policy and systems. Geneva: Alliance for Health Policy and Systems Research; 2004. http://www.who.int/alliance-hpsr/resources/Strengthening_complet.pdf. [Accessed 17 April 2008]

**9** Bennett S, Boerna T, Brugha R. Scaling up HIV/AIDS evaluation. Lancet 2006; 367:79–82.

**10** •• Hirschhorn LR, Ojikutu B, Rodriguez W. Research for change: using implementation research to strengthen hiv care and treatment scale-up in resource-limited settings. J Infect Dis 2007; 196 (Suppl 3):516–522.
This article presents strong arguments for research to strengthen scale-up of HIV care and treatment in resource-limited settings. It is an excellent review of current understanding of the field of implementation research and discusses its association with other areas of health services research, clinical research, and quality management work. It also highlights opportunities and next steps for conducting implementation research.

**11** •• Zachariah R, Harries AD, Luo C, Bachman G, *et al.* Scaling-up co-trimoxazole prophylaxis in HIV-exposed and HIV-infected children in high HIV-prevalence countries. Lancet Infect Dis 2007; 7:686–693.
This review is an excellent example of research needed to generate knowledge and inform policy development for system-wide scaling up of benefits of clinical research. This article discusses some of the major barriers, including health system constraints, preventing the scale up of co-trimoxazole prophylaxis for children in countries with high prevalence of HIV and proposes specific actions required to tackle these challenges.

**12** • Zachariah D, Fitzgerald M, Massaquoi M, Acabu A, *et al.* Does antiretroviral treatment reduce case fatality among HIV-positive patients with tuberculosis in Malawi. Int J Tuberc Lung Dis 2007; 11:848–853.
This article sets forth a comparative analysis of treatment outcomes for tuberculosis patients registered in 2004 in the Thyolo district, Malawi. It shows that ART provided in the continuation phase of tuberculosis treatment does not have a significant impact on reducing case fatality.

**13** Zachariah D, Fitzgerald M, Massaquoi M, Pasulani O, *et al.* Risk factors for high early mortality in patients on antiretroviral treatment in a rural district of Malawi. AIDS 2006; 20:2355–2360.

**14** Sanders D, Haines A. Implementation research is needed to achieve international health goals. PLOS Med 2006; 3:e186.

**15** World Health Organization. Expanding capacity for operations research in reproductive health: summary report of a consultative meeting. Geneva: WHO. 10–12 December 2001. http://www.who.int/reproductive-health/docs/expanding_capacity.pdf. [Accessed 17 April 2008]

**16** World Health Organization. Summary of activities. Evidence to improve HIV treatment and prevention programs: operational research to support HIV treatment and prevention in resource-limited settings. July 2004–January 2006. Geneva: WHO; 2006.

**17** •• Hirschhorn LR. Ensuring quality of care in the scale-up of HIV care and treatment in resource-limited settings: a challenge for all. Future Medicine 2007; 4:737–744.
This article presents current thinking on the need to expand and strengthen quality assurance and quality research in the scale-up of HIV care and treatment in resource-limited settings. The discussion brings the field of measuring and improving quality to the different disciplines engaged in HIV scale-up efforts, and outlines key areas that need to be addressed to improve programme efficacy, decrease risk of drug resistance and promote optimal use of existing resources including personnel and drugs.

**18** Mashauri FM, Siza JE, Temu MM, *et al.* Assessment of quality assurance in HIV testing in health facilities in Lake Victoria zone, Tanzania. Tanzan Health Res Bull 2007; 9:110–114.

**19** UNAIDS. Financial resources required to achieve universal access to HIV prevention, treatment, care and support. 26 September 2007. http://data.unaids.org/pub/Report/2007/20070925_advocacy_grne2_en.pdf. [Accessed 17 April 2008]

**20** •• Chisholm D, Evans DB. Economic evaluation in health: saving money or improving care? Journal of Medical Economics 2007; 10:325–337.
This policy review studies the appropriate role and use of cost–effectiveness analysis within the context of health system financing. The authors conclude that, beyond the purpose of addressing the health-financing objective of efficiency, economic evaluation can be usefully extended to other health system goals, between which financial protection and equity in financing, by adopting a sectoral or population-based approach.

**21** • Pitter C, Kahn JG, Marseille E, Lule JR, *et al.* Cost-effectiveness of cotrimoxazole prophylaxis among persons with HIV in Uganda. J Acquir Immune Defic Syndr 2007; 44:336–343.
This study analysed the cost–effectiveness of daily co-trimoxazole prophylaxis, based on modeling clinical results and operational data from a prospective cohort study of home-based care delivery to adults and children with HIV living in rural Uganda. The study adds to the body of evidence on the beneficial effects on health outcomes and health system demands associated with co-trimoxazole prophylaxis. It critically underscores a highly cost-effective algorithm that maximizes investments and reduces costs compared with other approaches.

**22** Goldie SJ, Yazdanpanah Y, Losina E, *et al.* Cost imeffectiveness of HIV treatment in resource-poor settings: the case of côte d'Ivoire. N Engl J Med 2006; 355:1141–1153.

**23** •• Koenig S, Riviere C, Leger P, Severe P, *et al.* The cost of antiretroviral therapy in Haiti. Cost Eff Resour Alloc 2008; 6:3.
This research determines direct medical costs, overhead costs, societal costs, and personnel requirements for the provision of antiretroviral therapy to patients with AIDS in Haiti. The importance of this research is that it provides empirical evidence required not only for planning and budgeting national treatment programmes, but also for developing national and international funding projections; developing health system policies to ensure equitable access between urban and rural regions; and evidence for advocacy for increased price reductions for second-line drugs.

**24** Kahn JG, Marseille E, Auvert B. Cost–effectiveness of male circumcision for HIV Prevention in a South African Setting. PLOS Med 2006; 3:e517.

**25** UNAIDS. ''Three Ones'' key principles: ''Coordination of National Responses to HIV/AIDS'' Guiding principles for national authorities and their partners. 25 April 2004. http://data.unaids.org/UNA-docs/Three-Ones_KeyPrinciples_en.pdf. [Accessed 17 April 2008]

**26** Garcia-Calleja JM, Zaniewski E, Ghys PD, *et al.* A global analysis of trends in the quality of HIV sero-surveillance. Sex Transm Inf 2004; 80:30.

**27** Walensky RP, Weinstein MC, Yazdanpanah Y, Losina E, *et al.* HIV Drug resistance surveillance for prioritizing treatment in resource-limited settings. AIDS 2007; 21:973–982.

**28** Otwombe KN, Wanyungu J, Nduku K, Taegtmeyer M. Improving national data collection systems from voluntary counseling and testing centres in Kenya. Bull World Health Organ 2007; 85:315–318.

**29** World Health Organization. Everybody's business: Strengthening health systems to improve health outcomes, WHO's framework for action. Geneva: WHO; 2007.

**30** Task Force on Health Systems Research. Report of the Task Force on Health Systems Research, The Millennium Development Goals will not be attained without new research addressing health system constraints to delivering effective interventions. March 2005. Geneva: WHO; 2005.

**31** • El-Sadr WM, Abrams EJ. Scale-up of HIV care and treatment: can it transform healthcare services in resource-limited settings? AIDS 2007; 21 (suppl 5): S65–S70.
This article presents arguments supporting use of resources available for the scale-up of HIV care and treatment, in the design and implementation of HIV programmes with the additional goal of benefiting the broader health services. The paper highlights ways in which HIV programmes may catalyze the transformation into more effective and responsive health systems capable of addressing other community health needs, and proposes relevant research and evaluation to guide this process.

**32** •• Katabira ET, Oelrichs RB. Scaling-up antiretroviral treatment in resource-limited settings: successes and challenges. AIDS 2007; 21 (suppl 4):S5–S10.
This article presents the current achievements and challenges of scaling up antiretroviral treatment in resource limited settings (Uganda) The study describes successes including increased number of patients on treatment with benefits of easing of HIV burdens on the health system, development of training programmes, rehabilitation of infrastructure, strengthening procurement systems, and reduction of drug prices and other related costs. It also highlights numerous challenges that must still be addressed including retaining capable health-workers, maintaining patient adherence to minimize drug resistance, sustaining drug procurement/supplies, and building health systems.

**33** Mexican National Institute of Public Health (INSP), Clinton Foundation HIV/AIDS Initiative (CHAI). ARV demand forecast: 2007–2008. Geneva, 11 December 2007. http://www.who.int/hiv/amds/ARVDemandForecastINSP_CHAI.pdf. [Accessed 17 April 2008]

**34** •• Mermin J, Were W, Ekwaru JP, *et al.* Mortality in HIV-infected Ugandan adults receiving antiretroviral treatment and survival of their HIV-uninfected children: a prospective cohort study. Lancet 2008; 371:752–759.
This article presents the results of a prospective cohort study that investigated the effect of a home-based ART programme in Uganda on mortality, hospital admissions and orphanhood in people with HIV-1 and their household members. It concludes that the expansion of access to ART and co-trimoxazole prophylaxis could substantially reduce mortality and orphanhood among adults with HIV and their families living in resource-poor settings.

**35** •• Keshavjee S, Seung K, Satti H, *et al.* Building capacity for multidrug resistant tuberculosis treatment: health systems strengthening in Lesotho. Innovations: Technology, Governance, Globalization 2007; 2:87–106.
The article presents the experience of a multidrug resistance tuberculosis treatment programme in Lesotho. After a general overview of the drug-resistant tuberculosis issue, this case exemplifies a programme whose aims are to address the epidemic, to build capacity in the health sector through close integration with national government, to reduce limitations in infrastructures and structural barriers to care and to set the foundation for nationwide treatment expansion.

**36** Partners in Health Bulletin. Autumn 2007. http://www.pih.org/inforesources/newsletters/PIH-Newsletter-2007Autumn.pdf. [Accessed 17 April 2008]

**37** Bekker LG, Myer L, Orrell C, *et al.* Rapid scale-up of a community-based HIV treatment service: Programme performance over 3 consecutive years in Guguletu, South Africa. S Afr Med J 2006; 96:315–320.

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