Investigating the sustainability of antiretroviral treatment programs: the case of South Africa

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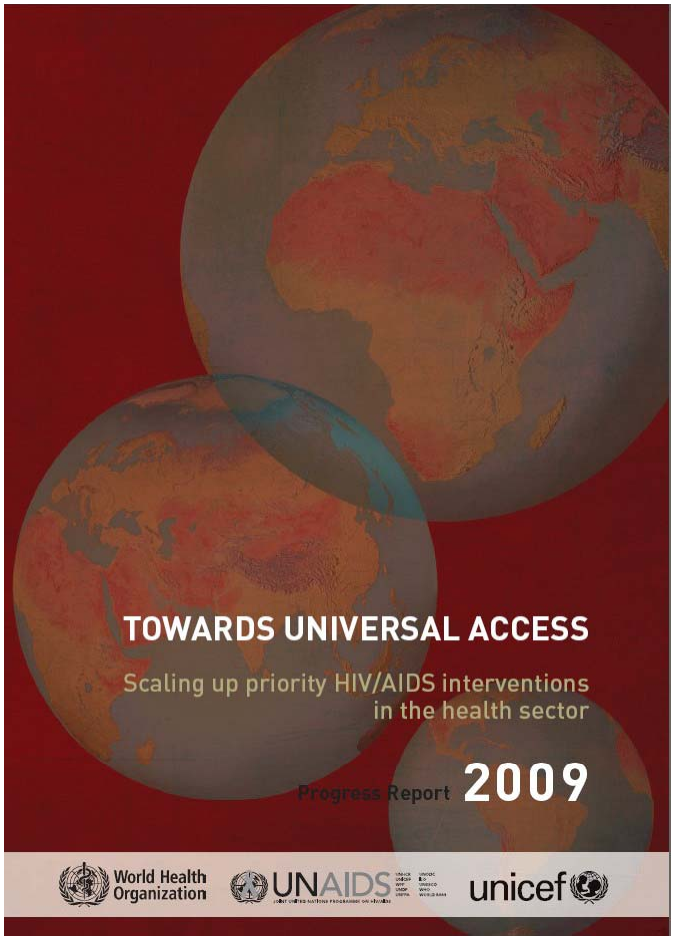
Outline

- **Background**
- Model
- Data sources
- Results
- Summary and discussion

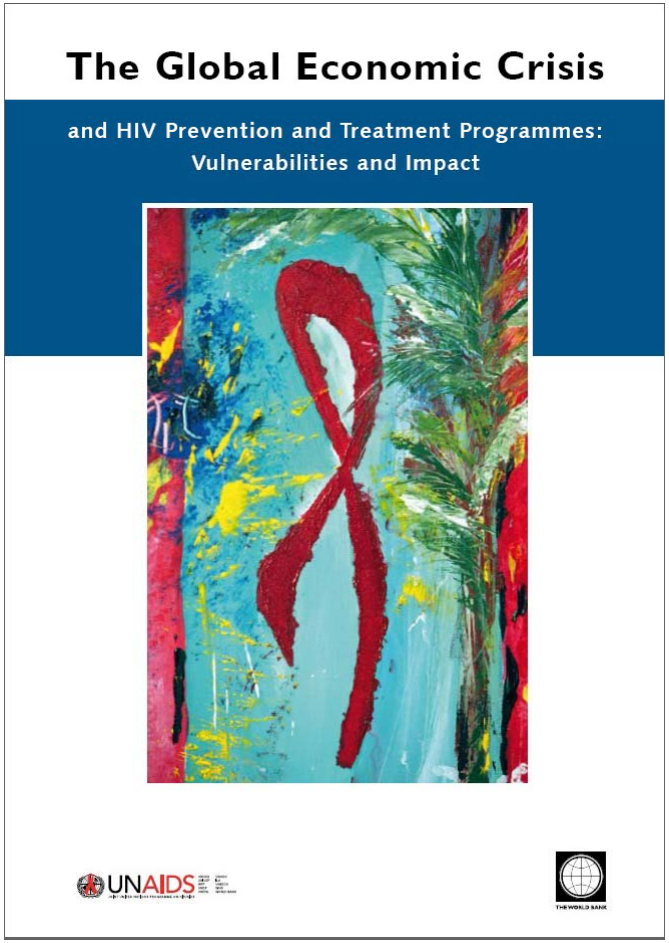
The global context (1)

- Rapid scale-up of worldwide antiretroviral treatment
  - From worldwide 3 to 4 million in 2008
  - 4 million estimated to represent two fifths of people needing treatment
  - Currently 33 million HIV-positive people, 2.7 million new infections in 2007
- Three fourths of patients on ART in sub-Saharan Africa
  - Countries rely to large extents on external funding
- “The hard-won gains of recent years are fragile and call for renewed commitment by all stakeholders” (WHO/UNAIDS/UNICEF 2009).
- Urgency of understanding long-term sustainability of funding brought to the fore by global financial crisis



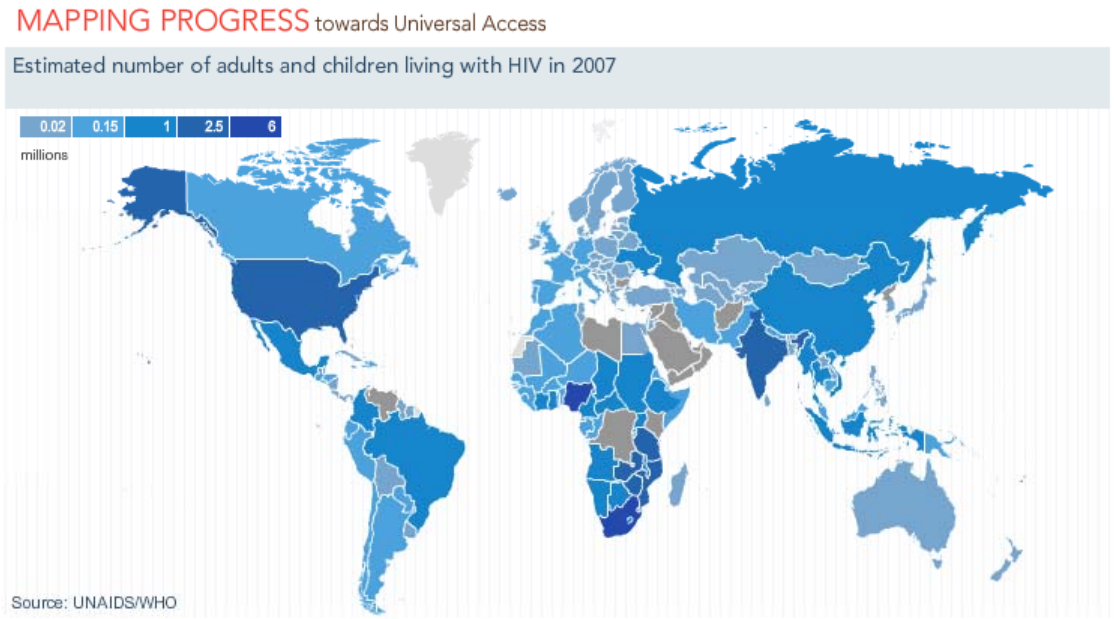
The global context (2)

- UN goal of universal coverage
- International funding commitments secure only through 2009 or 2010 in 40% of countries
- Survey of World Bank, WHO and UNAIDS staff in 71 countries in early 2009
  - By early 2009, the global economic crisis had affected 11% of countries
  - 31% of countries were expected to be affected in 2009
- "The global war on AIDS has racked up enormous successes over the past decade … Now the campaign is faltering … Now, instead of a sharp increase in donations, as once planned, the [US] administration proposes only a slight increase in bilateral financing and a modest reduction in its multilateral contribution."



Source: World Bank/UNAIDS 2009 http://siteresources.worldbank.org/INTHIVAIDS/Resources/375798-1103037153392/TheGlobalEconomicCrisisandHIVfinalJune30.pdf, NY Times, 13 May 2010

The local context

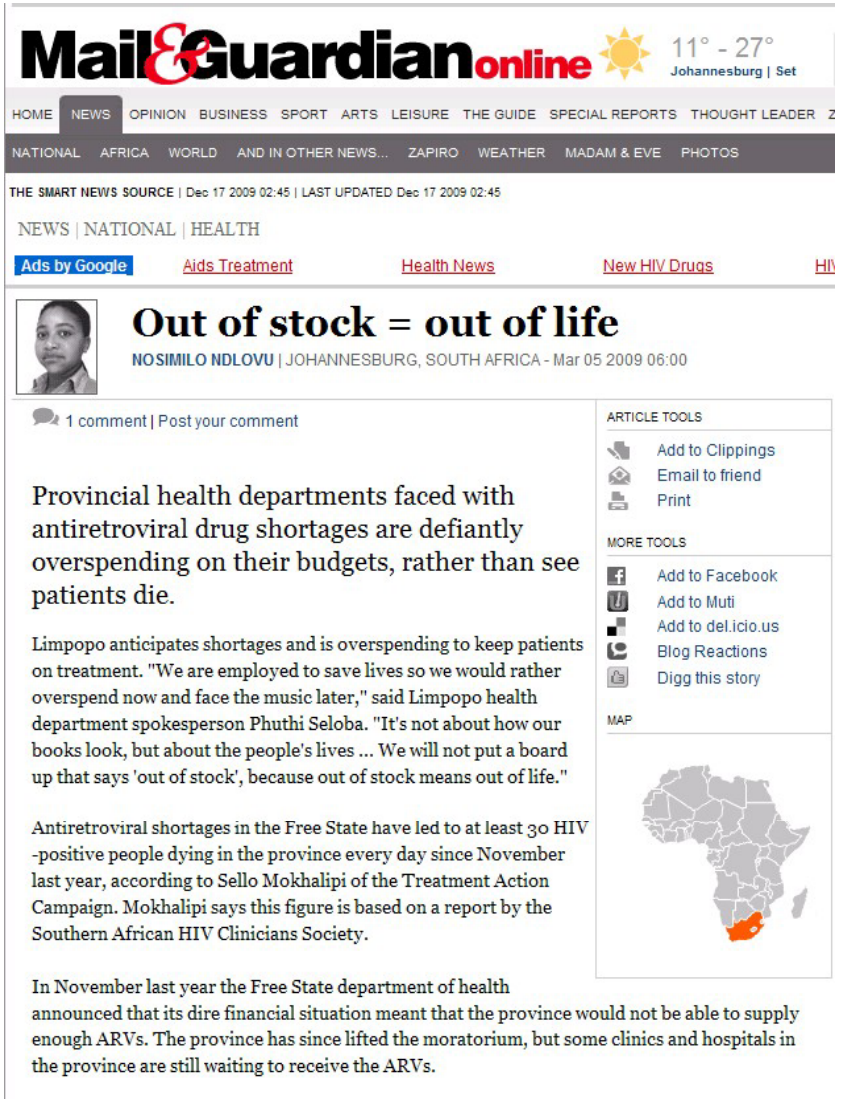


- South Africa (SA) is the country with largest HIV-infected population worldwide (>5 million)
- Public sector ART roll-out started in 2004
- Rapid scale-up since then, during period of strong economic growth and with external support (PEPFAR, Médecins San Frontières)
- SA is the country with the largest population receiving ART world wide (700,500 or 1.4% of the population)
- ART coverage estimated at 40% in the middle of 2008

Sources: WHO 2009, Adam and Johnson *South African Medical Journal* 2009

Impact on ART programmes?

- President Zuma announced in December 2009 that South Africa "will be treating significantly larger numbers of HIV positive patients"
- It is unclear how this further ART scale-up will be financed
  - PEPFAR pledged an additional US$ 120 million for 2010/11
  - Economic downturn in South Africa
  - In 2009, several SA provinces used up their ART budgets long before the year's end
  - Provincial governments (Free State, KZN) issued orders to stop starting new patients on ART



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Out of stock = out of life

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MAP

Provincial health departments faced with antiretroviral drug shortages are defiantly overspending on their budgets, rather than see patients die.

Limpopo anticipates shortages and is overspending to keep patients on treatment. "We are employed to save lives so we would rather overspend now and face the music later," said Limpopo health department spokesperson Phuthi Seloba. "It's not about how our books look, but about the people's lives ... We will not put a board up that says 'out of stock', because out of stock means out of life."

Antiretroviral shortages in the Free State have led to at least 30 HIV -positive people dying in the province every day since November last year, according to Sello Mokhalipi of the Treatment Action Campaign. Mokhalipi says this figure is based on a report by the Southern African HIV Clinicians Society.

In November last year the Free State department of health announced that its dire financial situation meant that the province would not be able to supply enough ARVs. The province has since lifted the moratorium, but some clinics and hospitals in the province are still waiting to receive the ARVs.

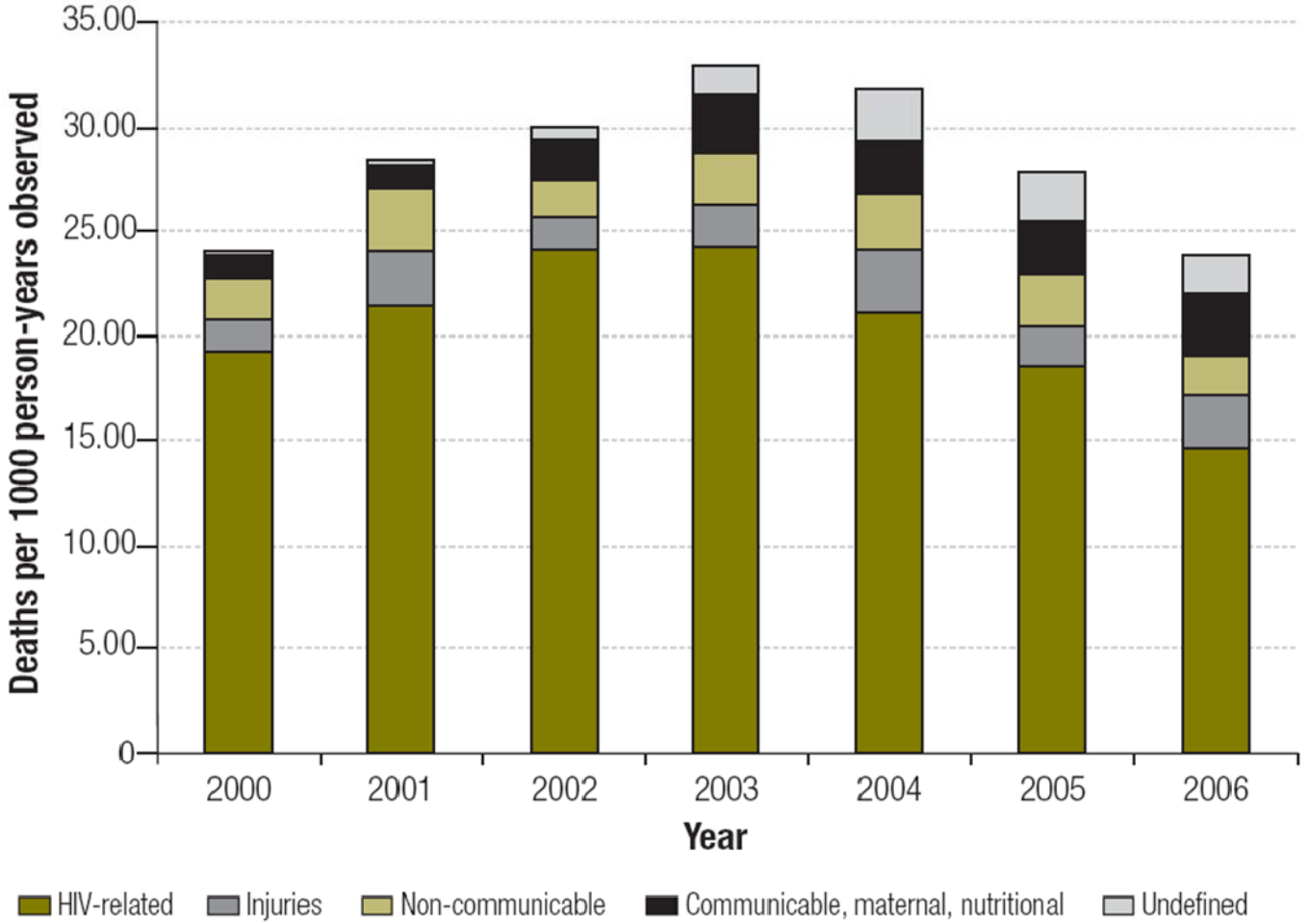
Sources: The Presidency 2009, Tutton 2009, AVERT 2009, Ndlovu 2009

Quantifying the health impact of changes in ART funding

- The first-instinct method is to simply scale up or down ART coverage and health outcomes based on available resources
- However, this static approach is of limited value, because of feedback effects
  - Feedback between current ART coverage and future ART need
  - Feedback between current ART coverage and HIV incidence

Sources: Bärnighausen, Bloom, Humair *Bulletin of WHO* 2010 (forthcoming)

Effectiveness of ART in rural SA



SMR, age-standardized mortality rate.

Source: Herbst, Cooke, Bärnighausen, KanyKany, Tanser and Newell *Bulletin of WHO* 2009

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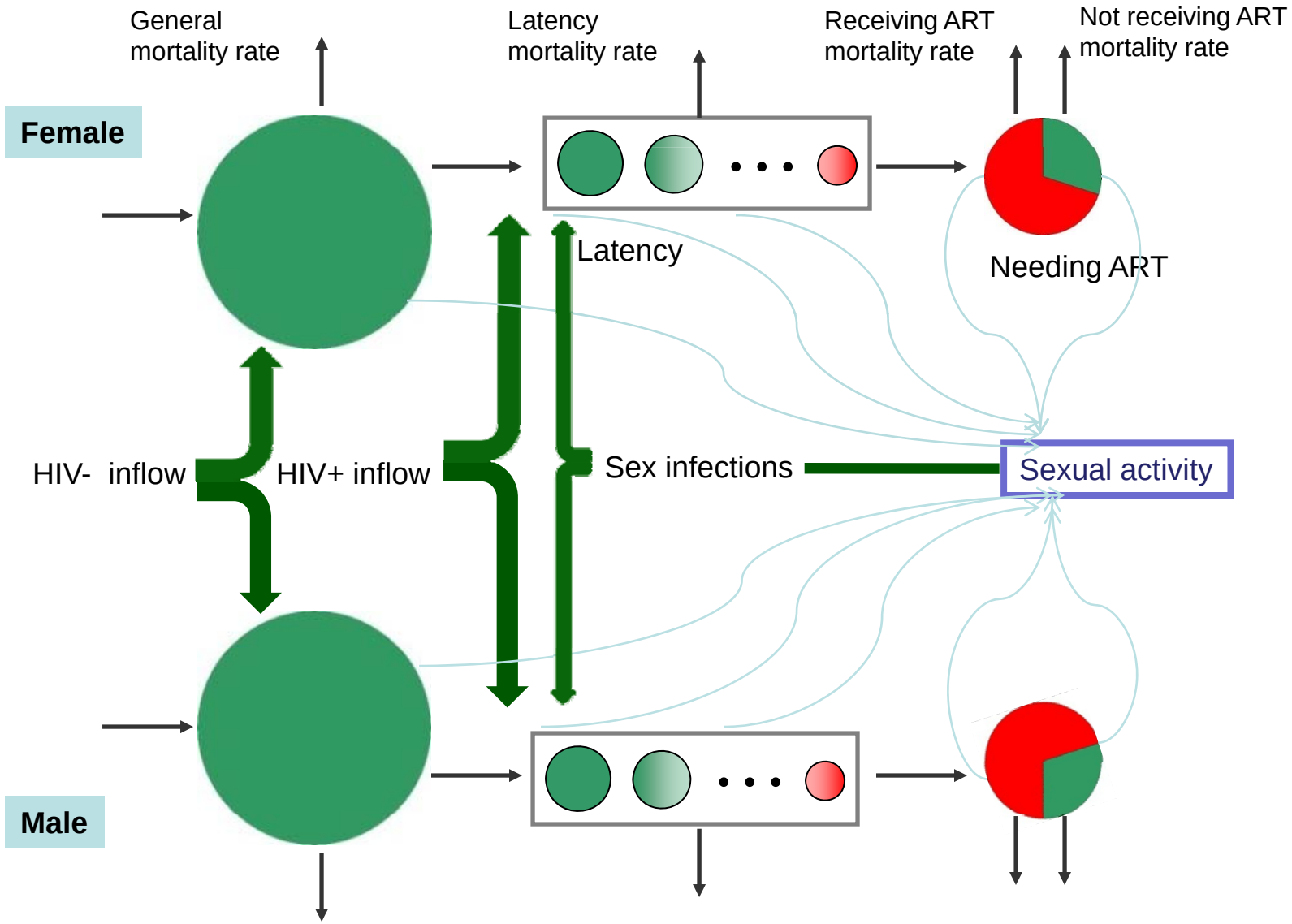
Model dynamics



Model states and parameters

- A discrete-time (annual increments) analytical model
- States
  - HIV-uninfected
  - HIV-infected, early stage
  - HIV-infected, latent stage, CD4≥350
  - HIV-infected, latent stage, CD4<350 & CD4≥200, not receiving ART
  - HIV-infected, late stage, CD4<200, not receiving ART
  - HIV-infected, receiving ART
- State-specific
  - Mortality
  - Transmission probability

Financing scenarios

Number	Name	Description
1	Flat line	Constant funding at 2008 level
2	Optimistic	Constant funding increases at 2007/8 rate
3	Crisis/pessimistic	Funding reduction by 1/3 by year 3, then constant
4	Crisis/optimistic	Funding reduction by 1/3 by year 3, then constant funding increase at 2007/8 rate
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Cases

- Base case
- ART eligibility at CD4<350
- Prevention cases
  - Reduction in frequency of unprotected sex acts
  - Reduction in HIV acquisition risk per unprotected sex act in men
  - Reduction in HIV acquisition risk per unprotected sex act in women

Relevant models in literature

- Spectrum-based models – used by AIDS2031 financing group, others
  - UNAIDS Spectrum and Modes of Transmission models[1]
  - Hecht et al. 2009, *Critical choices in financing the response to the global HIV/AIDS pandemic*, Health Affairs 28(6), pp. 1591-1605.
- Micro-simulation models
  - UNAIDS Geneva group – Erik Lamontagne etc.
  - Cutler et al. 2010, *The ABCDs of health: explaining the reduction of AIDS in Uganda*, Working Paper; other papers
- WHO *Towards Universal Access* 2009-cited models
  - Lima et al. 2008, *Expanded access to highly active antiretroviral therapy*, Journal of Infectious Diseases 198, pp. 59-67
  - Granich et al. 2009, *Universal voluntary HIV testing with immediate antiretroviral therapy as a strategy for elimination of HIV*, Lancet 373, pp. 48-57

[1]Available at: http://www.unaids.org/en/KnowledgeCentre/HIVData/Epidemiology/EPI_software2009.asp

Comparison with other models

- Our model has the following different features
  - Stage-specific mortalities
  - Stage-specific transmission probabilities
  - An endogenous behavioral model of incidence which results in non-linear effects of transmission probability changes on incidence
  - Feedback from ART coverage to both reduced mortality and to new infections
- Further, our model takes a high level view
  - Parsimonious (focusing on factors we expect are important in country-level HIV ART programs)
  - Intuitive (the model for infection, stages, coverage is easily understood)
  - Analytical (provides direct insight into the effect of changes in model parameters)
- Micro-simulation models can incorporate more complexity, but usually do not provide analytical insight

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Data sources

Parameter	Source
Baseline population	STATSSA 2009 Shisana et al. 2009 Adam & Johnson 2009
Baseline HIV incidence	Shisana et al. 2005 Rehle et al. 2006 Bärnighausen et al. 2007, 2009
Time from seroconversion to treatment need	Minga et al. 2009 Todd et al. 2008 WHO 2009
HIV-negative mortality	WHO life tables SA 1990
HIV-positive mortality	Badri et al. 2006 Braitenstein et al. 2006
Numbers of sex partners per year	Shisana et al. 2009
Transmission probability per unprotected sex act	Boily et al. 2009

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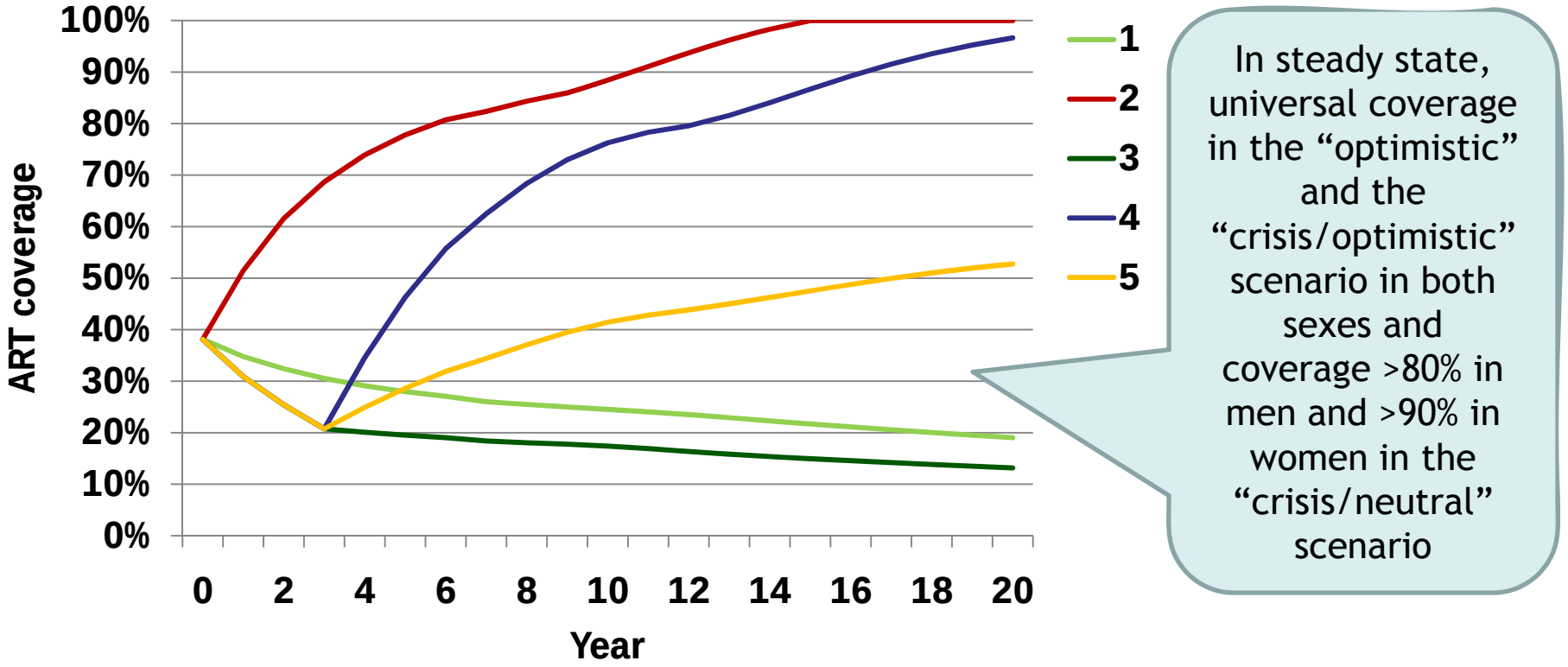
ART coverage, base case, men



In steady state, universal coverage in the "optimistic" and the "crisis/optimistic" scenario in both sexes and coverage >80% in men and >90% in women in the "crisis/neutral" scenario

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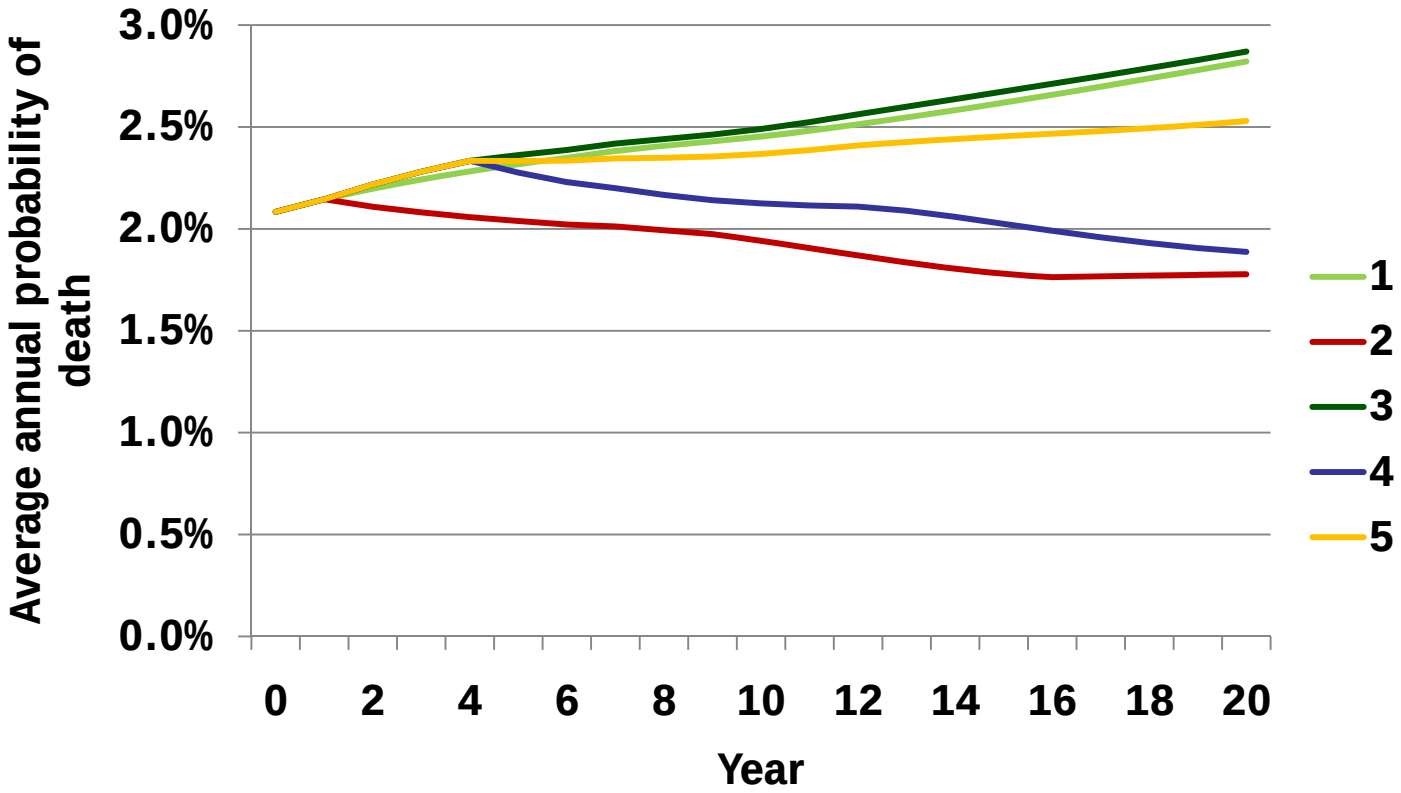
Mortality, base case, men



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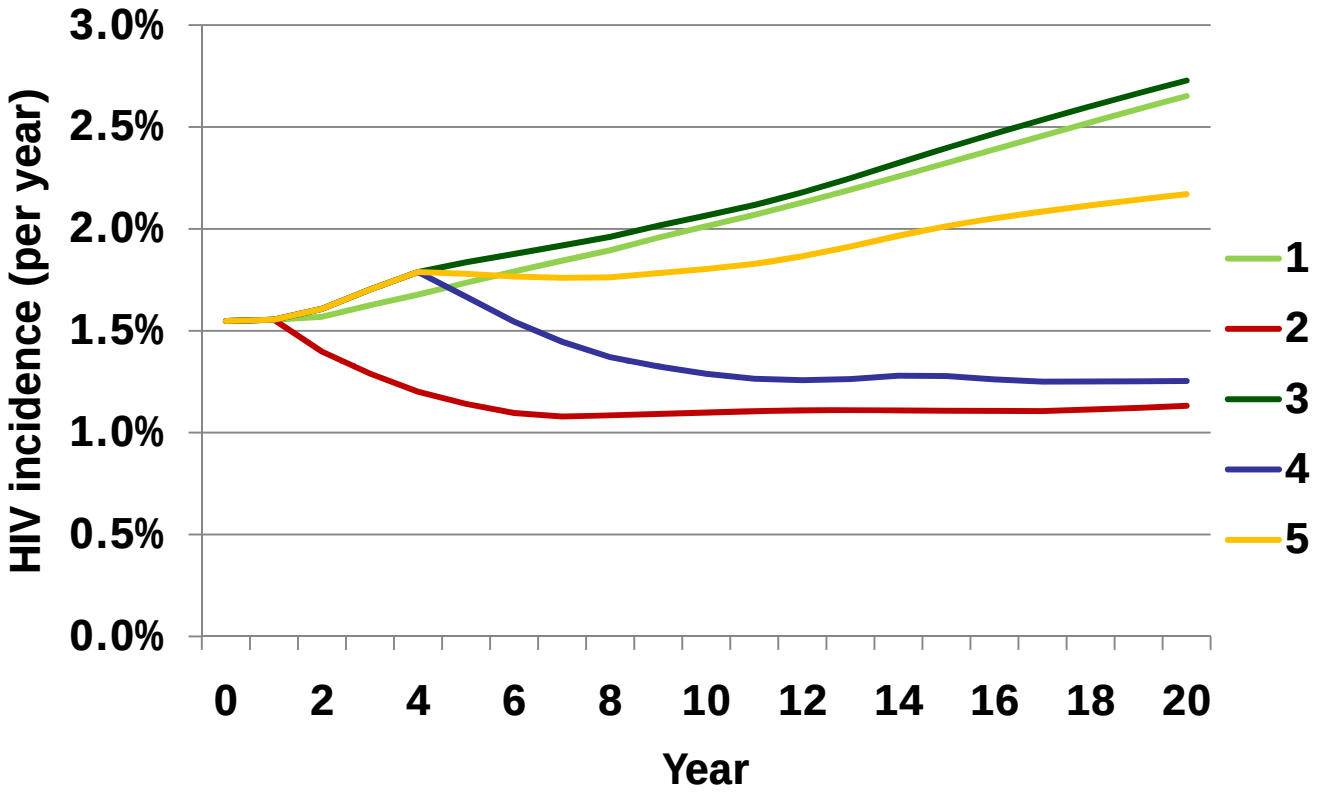
HIV incidence, base case, men



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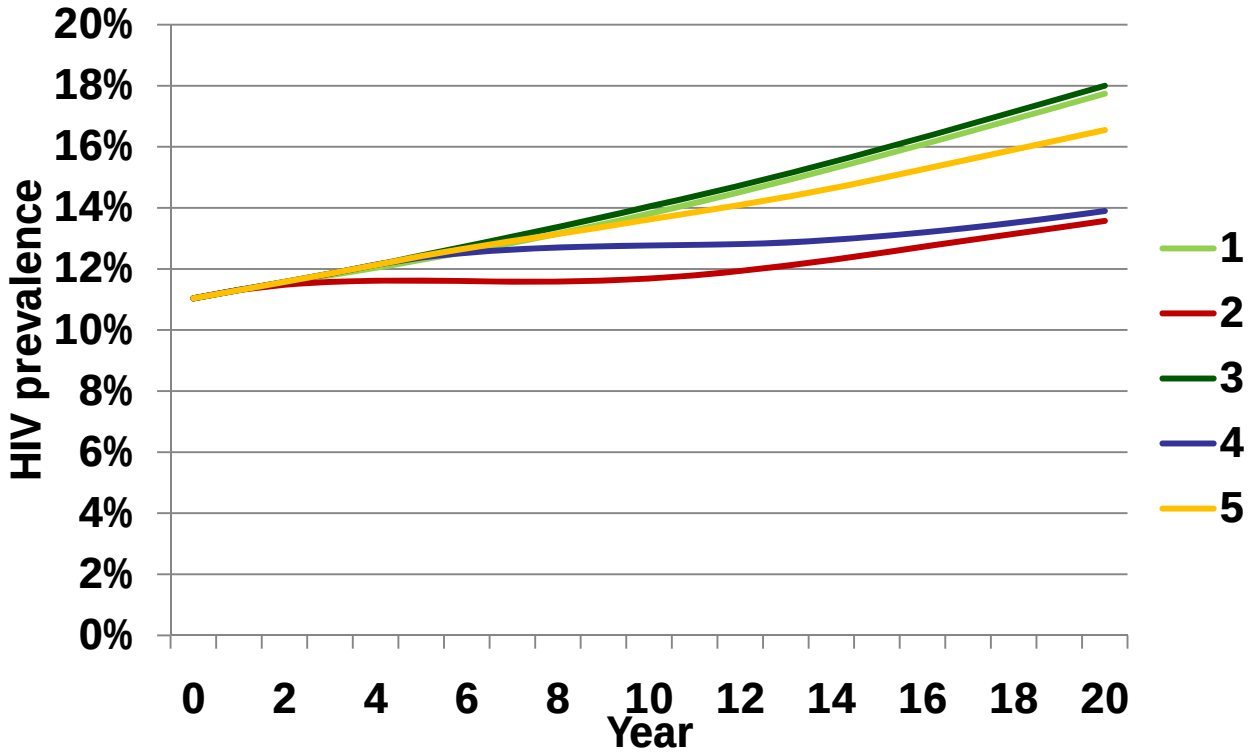
HIV prevalence, base case, men



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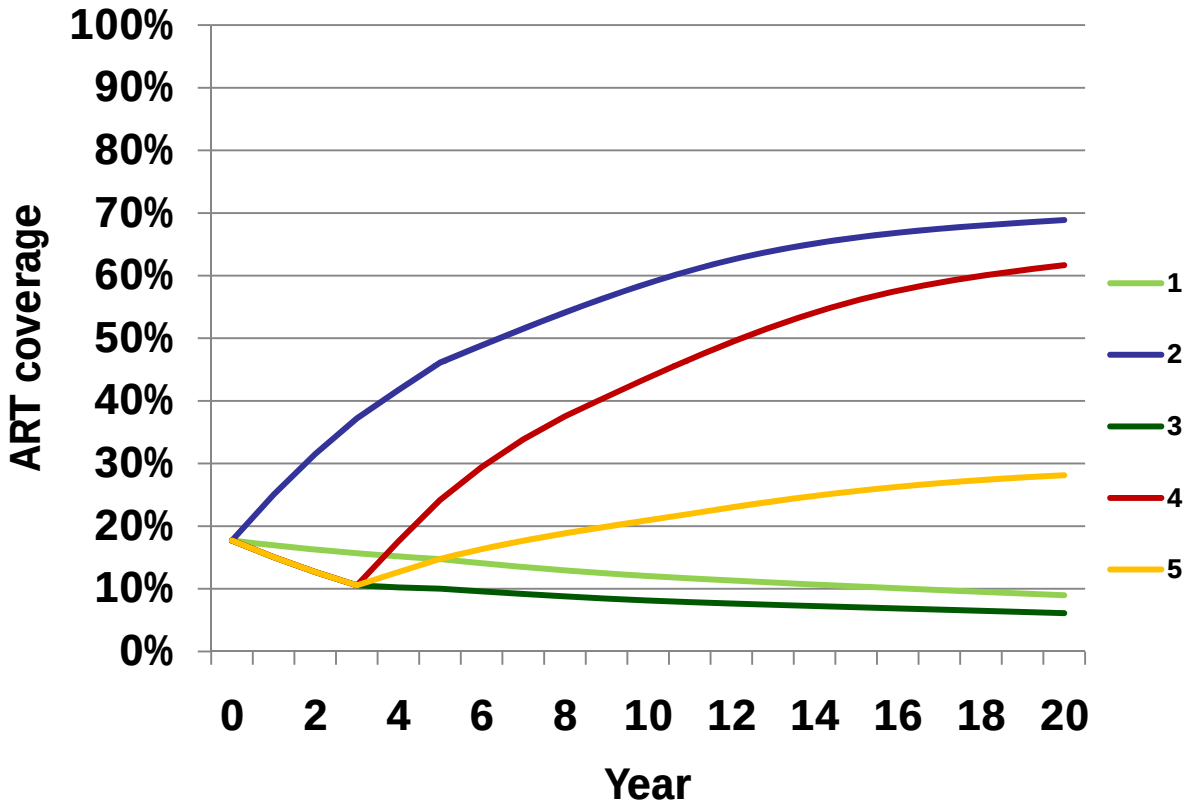
ART coverage, “eligibility at CD4<350”, men



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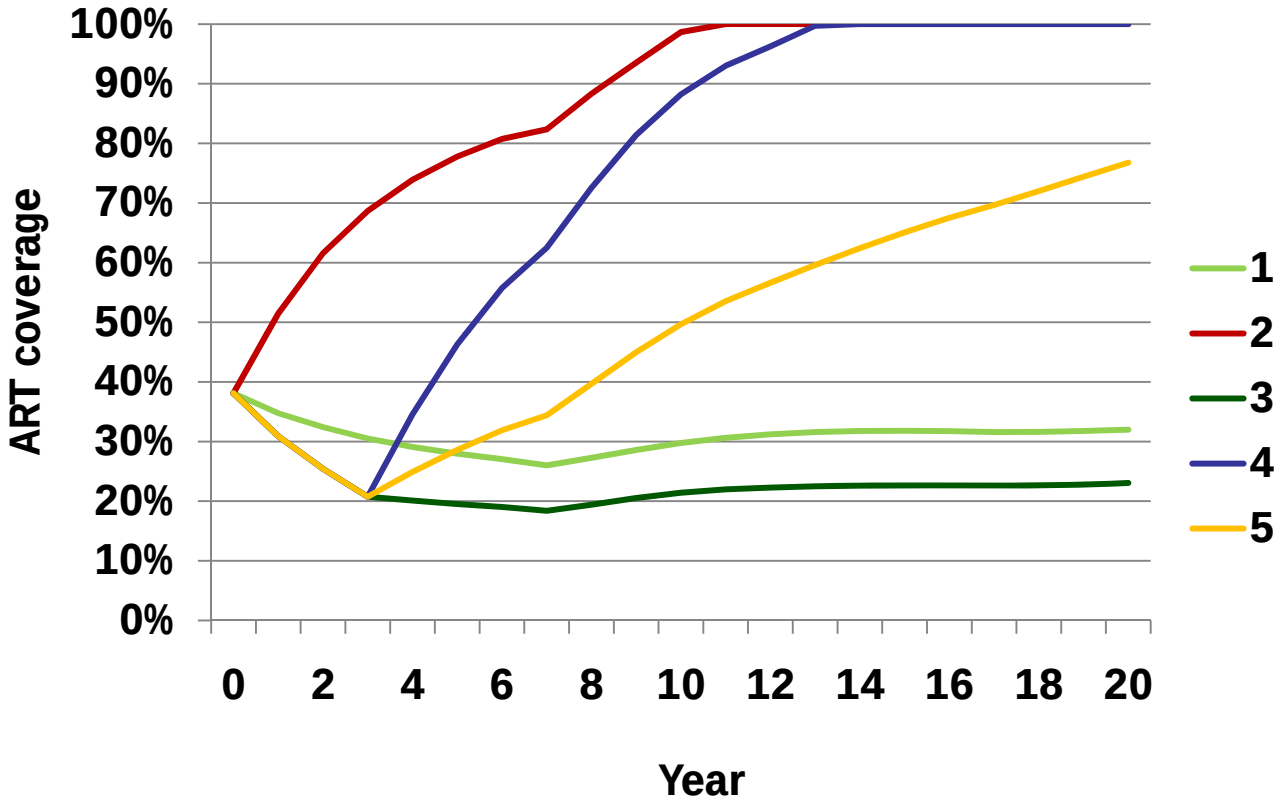
ART coverage, “successful behavioral prevention” (30%), men



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Comparing other prevention interventions, constant funding

	ART coverage		Incidence		Mortality		Prevalence	
Prevention	Men	Women	Men	Women	Men	Women	Men	Women
BP 1/3	63%	49%	-69%	-70%	-29%	-40%	-58%	-57%
BP 15%	22%	18%	-38%	-39%	-14%	-20%	-29%	-29%
MP ½	30%	12%	-43%	-34%	-17%	-15%	-34%	-24%
MP all	94%	31%	-76%	-65%	-34%	-33%	-66%	-50%
FP ½	12%	20%	-28%	-38%	-9%	-20%	-20%	-28%
FP all	35%	63%	-59%	-72%	-21%	-44%	-47%	-60%

Relative improvement in indicators for other prevention interventions over the base case values in 20 years, for constant funding

BP = behavioral prevention intervention, MP = intervention that reduces HIV acquisition probability in men (e.g., circumcision – 60% reduction in male HIV acquisition per unprotected sex act), FP (e.g., microbicides, assumed 60% reduction in female acuquisition probability)

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Summary (1)

- Only through sustained funding increases can universal coverage be achieved within the next 20 years
- “Flat line” funding will lead to a steady decline in coverage
- Even with sustained increases, initiating ART at CD4 count <350 cells per microliter will mean universal coverage cannot be achieved within the next 100 years
- Successful prevention can substantially reduce time to universal coverage

Summary (2)

- Two main prevention lessons from the "successful prevention" cases
  - In resource constrained settings, the importance of prevention is magnified in its effect on coverage and other indicators
  - Even if universal coverage is obtainable, a very significant level of human suffering can be avoided by prevention efforts, by reducing incidence, prevalence, and mortality

Conclusions for discussion

- Sustained increase in funding critical
- Flat-line funding insufficient to maintain current coverage levels
- Funding decreases, even if temporary, should be avoided
- Rate of funding increase can be decreasing in order to ensure that we remain on the path towards universal coverage
- Effective prevention can substantially decrease ART financing need

Model extensions

- Behavioural feedback effects
  - Improved health of people on ART: increased sexual activity in HIV-infected people?
  - Reduced effect of HIV infection on life expectancy: increased sexual risk taking in HIV-uninfected people?
- Relax assumption of homogeneity of sexual behaviour across infection stages
- Relax stable unit cost assumption
  - Efficiency in ART delivery
  - Different models of treatment delivery
  - Changes in input prices
- Other funding scenarios
- Prevention combination packages

Acknowledgements

We thank the World Bank for funding this study and members of the UNAIDS Economic Reference Group for helpful comments on earlier versions of our model.

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