# Epidemiology and economics: modelling the scenarios for the end of AIDS

Controlling the HIV Epidemic with Antiretrovirals: from consensus to implementations

London, England

September 22, 2013

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Senior Advisor, Care and Treatment
UNAIDS



### Outline

#### TREATMENT 2015

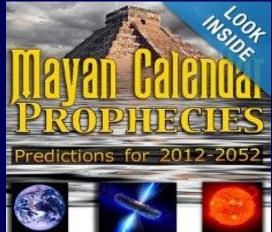
- HIV modelling and policy (twins separated at birth?)
- HIV modelling and financing the response
- Strategy
   OODA loop and the dreaded
   retrospectoscope
- Conclusion





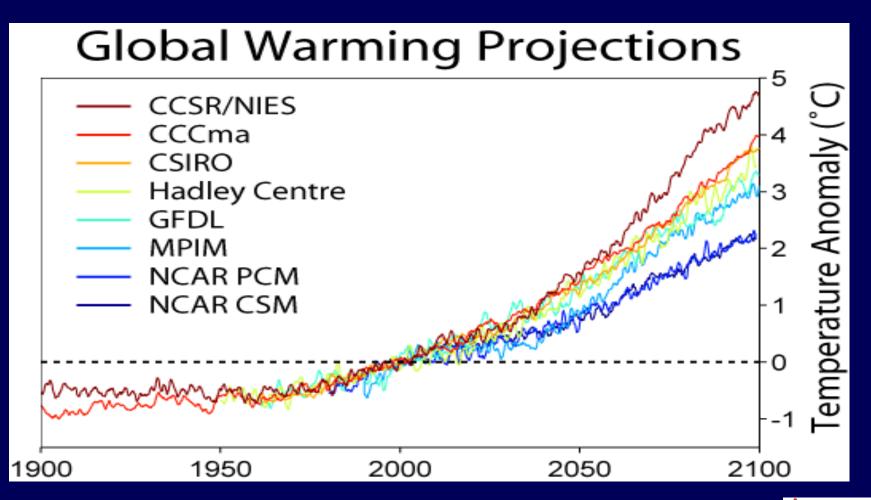
### Predicting the future is easier than we think





Discussing modelling, economics and the end of AIDS in 15 minutes is more of a challenge

# Climate change modelling has provided us with options





### Anderson and May 1988

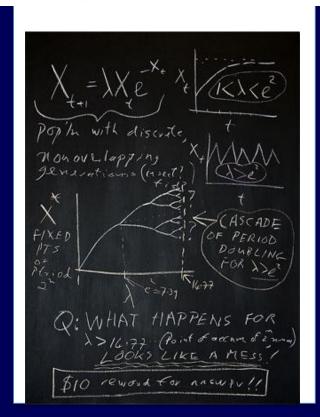


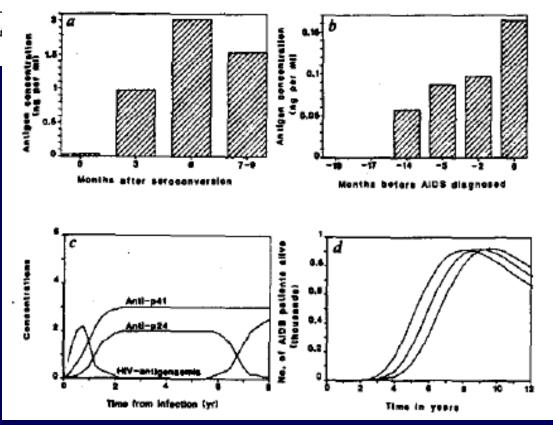
# **Epidemiological parameters of HIV transmission**

Roy M. Anderson\* & Robert M. May\*

\* Parasite Epidemiology Research Group, Department of Pure and Applied Biology, Imperial College, London University, London SW7 2BB, UK † Biology Department, Princeton University, Princeton, New Jersey 08540, \*ISA

Epidemiological data on the main determinants of the transmi accumulating, but many uncertainties remain.







#### A Tale of Two Futures: HIV and **Antiretroviral Therapy in San Francisco**

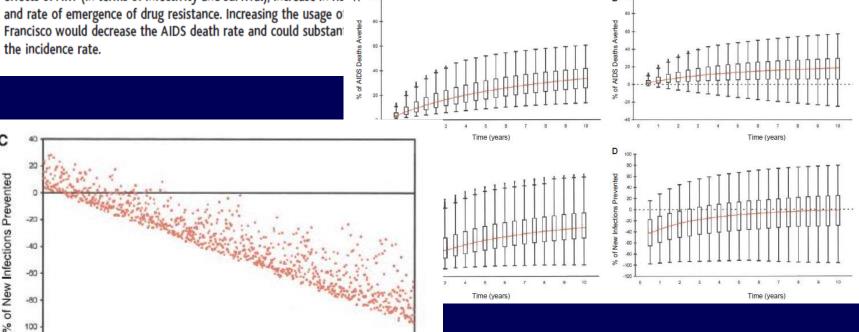
S. M. Blower, 1\* H. B. Gershengorn, 1 R. M. Grant 2

The effect of antiretroviral therapy (ART) in preventing human immunodeficiency virus (HIV) infections and averting acquired immunodeficiency syndrome (AIDS) deaths in the San Francisco gay community over the next 10 years was predicted. A transmission model was coupled with a statistical approach that enabled inclusion of a high degree of uncertainty in the potential treatment effects of ART (in terms of infectivity and survival), increase in ris A \*\*\* T and rate of emergence of drug resistance. Increasing the usage of Francisco would decrease the AIDS death rate and could substant the incidence rate.

% Increase in Risk Behavior

100

#### Blower, Science 2000





#### Can Highly Active Antiretroviral Therapy Reduce the Spread of HIV?

A Study in a Township of South Africa

Bertran Auvert, MD, PhD, \*†‡\$ Sylvia Males, † Adrian Puren, MD, PhD, <sup>||</sup> Dirk Taljaard, ¶ Michel Caraël, PhD, <sup>||</sup> and Brian Williams, PhD\*\*

#### **Auvert Williams JAIDS 2003**

TABLE 2. Estimates of the Potential Impact of HAART on the Annual Risk of HIV-1 Transmission

						Total (6)
Plasma HIV-1 RNA load (copies/mL)	<399	400–3499	3500-9999	10,000-49,999	>49,999	NA
Annual risk of HIV-1 transmission (person/y)	0	0.04	0.12	0.14	0.23	NA
Percentage of HIV-1-positive population (%)	3.1 (1.1-6.5)	8.2 (4.7–12.9)	12.2 (8.0–17.7)	25.5 (19.6–32.2)	51.1 (43.8–58.2)	100
Weighted annual risk of HIV-1 transmission without HAART (person/y)	0	0.00327 (0.00188-0.00516)	0.0147 (0.00960-0.0212)	0.0357 (0.0274-0.0451)	0.118 (0.101–0.134)	0.171 (0.1591–0.183)
Percentage of HIV-1-positive population with CD4 <sup>+</sup> counts >200 cells/mm <sup>3</sup>	3.1 (1.1–6.5)	8.2 (4.7–12.9)	12.2 (8.0–17.7)	23.5 (17.5–30.0)	43.4 (36.3–50.6)	90.3 (85.3–94.1)
Weighted annual risk of HIV-1 transmission with HAART (person/year)	0	0.00327 (0.00188-0.00516)	0.0147 (0.00960-0.0212)	0.0329 (0.0245-0.0420)	0.0997 (0.0835-0.116)	0.151 (0.136–0.165)

The table gives estimates of the annual risk of HIV-1 transmission as a function of plasma HIV-1 RNA load, <sup>27</sup> the proportion of the present population falling into each plasma HIV-1 RNA load band, the weighted annual risk of HIV-1 transmission, the proportion of the population that will not receive HAART under present guidelines, and the weighted annual risk of HIV-1 transmission with the provision of HAART. The decrease in the annual risk of HIV-1 transmission from 0.171/person/y without HAART to 0.151/person/y with HAART corresponds to a reduction of 11.9% (7.1%–17.0%).

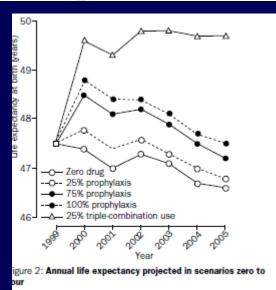
NA, not applicable.



#### Articles

### Extent to which low-level use of antiretroviral treatment could curb the AIDS epidemic in sub-Saharan Africa

Evan Wood, Paula Braitstein, Julio S G Montaner, Martin T Schechter, Mark W Tyndall, Michael V O'Shaughnessy, Robert S Hogg



#### Wood Lancet 2000

#### **Montaner Lancet 2006**

The case for expanding access to highly active antiretroviral therapy to curb the growth of the HIV epidemic

Julio S G Mont aner, Robert Hogg, Evan Wood, Thomas Kerr, Mark Tyndall, Adrian R Levy, P Richard Harrigan

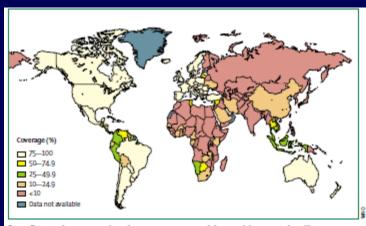
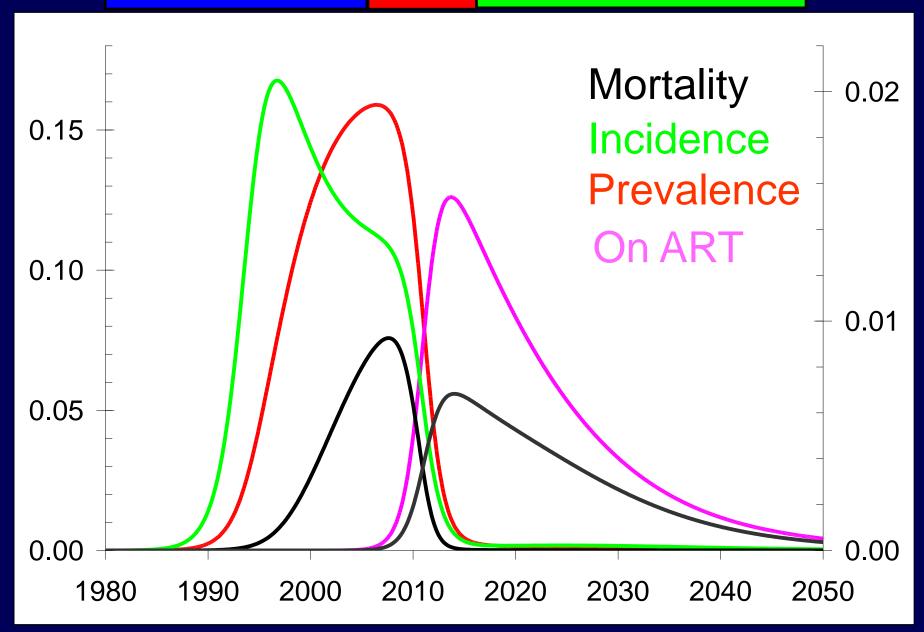


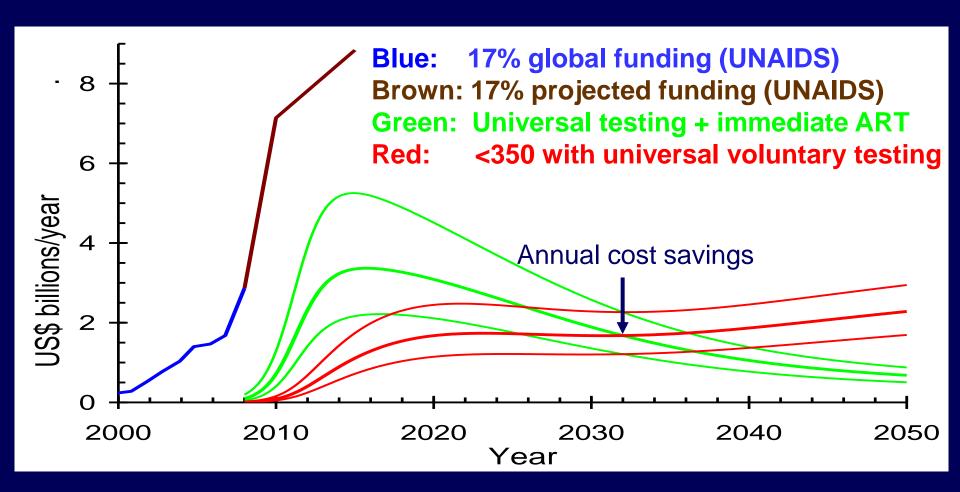
Figure: Estimated percentage of people receiving antiretroviral therapy of those in need as of June 2005. Reproduced from reference 54.

Montaner Lancet 2006





# Estimated and projected funding and costs: We appear to be in the right ball park....





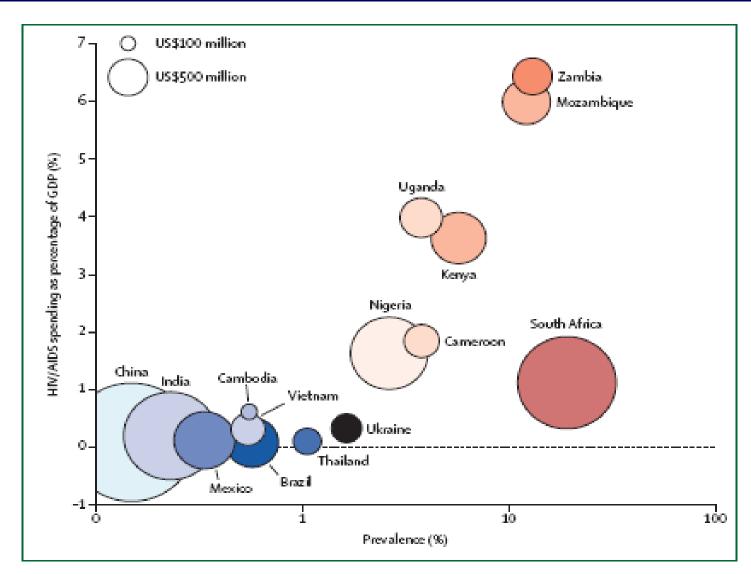
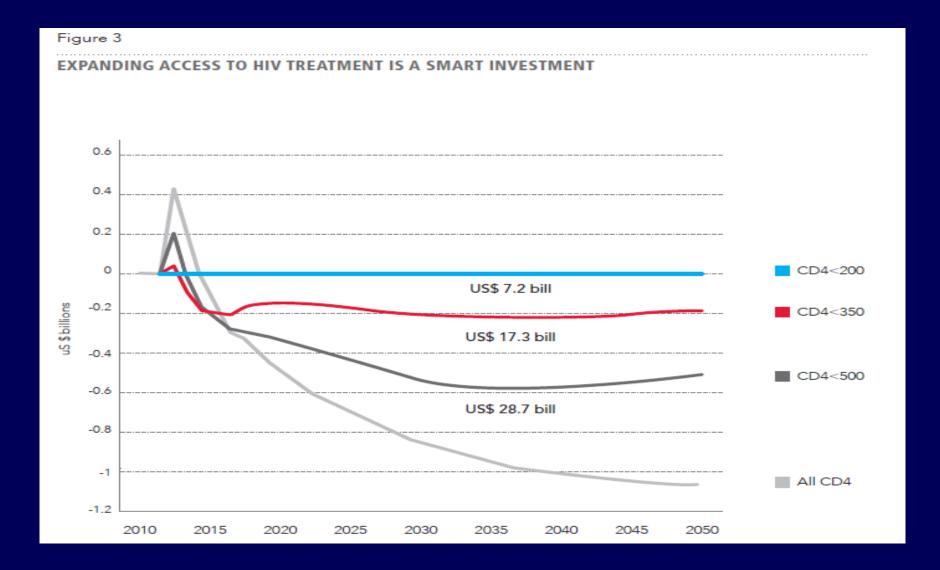


Figure: AIDS spending requirements in 2015 for selected low-income and middle-income countries\*\* Circle size is proportional to a country's total projected AIDS spending needs in 2015, calculated on the basis of the rapid scale-up scenario.



# Potential economic impact of ART expansion in South Africa



### When to start policy by date



**Lao PDR** 

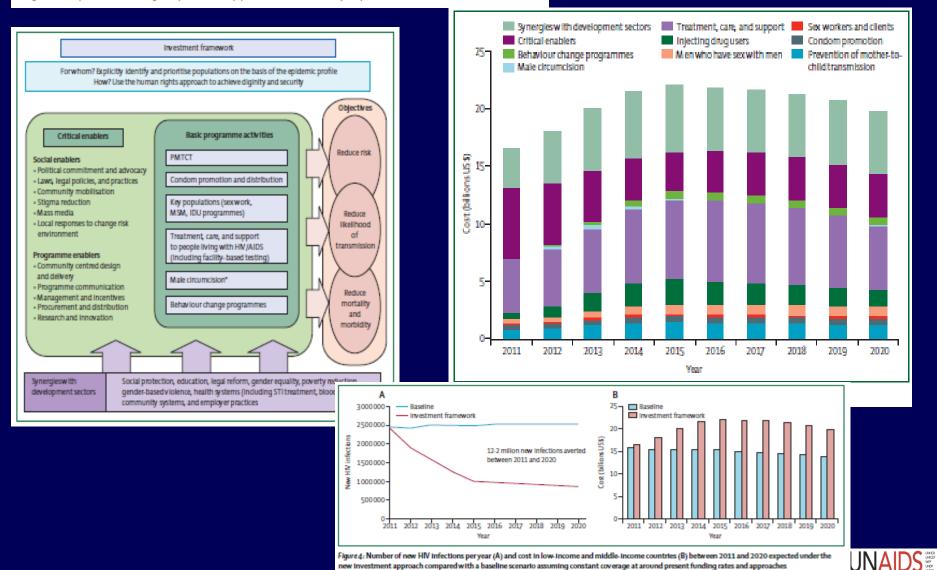
Zimbabwe

## Towards an improved investment approach for an effective response to HIV/AIDS



Bernhard Schwart länder, John Stover, Timothy Hallett, Rifat Atun, Carlos Avila, Eleanor Gouws, Michael Bartos, Peter D Ghys, Marjorie Opuni,
David Barr, Ramzi Alsallaq, Lori Ballinger, Marcelo de Freitas, Geoffrey Garnett, Charles Holmes, Ken Legins, Yogan Pillay, Anderson Eduardo Stanciole,
Craig McClure, Gottfried Hirnschall, Marie Laga, Nancy Padian, on behalf of the Investment Framework Study Group\*

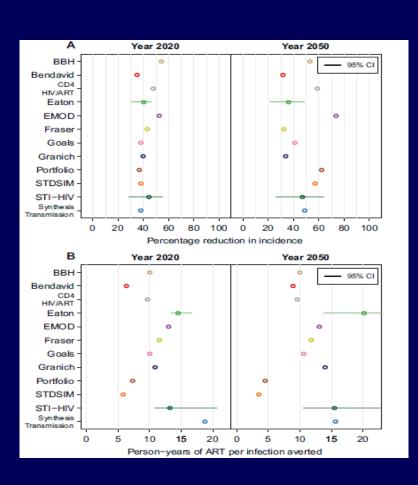
#### Schwartlander Lancet 2011 2<sup>nd</sup> generation economics

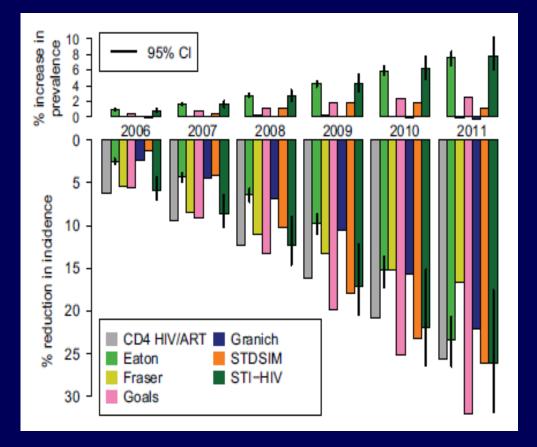


#### HIV Treatment as Prevention: Systematic Comparison of Mathematical Models of the Potential Impact of Antiretroviral Therapy on HIV Incidence in South Africa

Jeffrey W. Eaton<sup>1</sup>\*, Leigh F. Johnson<sup>2</sup>, Joshua A. Salomon<sup>3</sup>, Till Bärnighausen<sup>3,4</sup>, Eran Bendavid<sup>5</sup>, Anna Bershteyn<sup>6</sup>, David E. Bloom<sup>3</sup>, Valentina Cambiano<sup>7</sup>, Christophe Fraser<sup>8</sup>, Jan A. C. Hontelez<sup>4,9,10</sup>, Salal Humair<sup>3,11</sup>, Daniel J. Klein<sup>6</sup>, Elisa F. Long<sup>12</sup>, Andrew N. Phillips<sup>7</sup>, Carel Pretorius<sup>13</sup>, John Stover<sup>13</sup>, Edward A. Wenger<sup>6</sup>, Brian G. Williams<sup>14</sup>, Timothy B. Hallett<sup>1</sup>

#### Eaton PlosMed 2013







# Third generation economics: significantly higher employment at CD4≥500 among adults

- Compared to CD4<200,</li>
   CD4≥500 associated with
  - 5.8 more days/month
  - 2.2 more hours/day (40% more than ref. mean of 5.5)

Regression m	odel coefficients	
	(1)	(2)
	Days worked in the	Hours worked on
Outcome:	past month	usual day in past
CD4<200	Reference	Reference
CD4 200-349	2.7	1.8
CD4 350-499	4.8	0.9
CD4 ≥500	5.8**	2.2*
Observations	107	107

- Linear regression model with age, age-squared, and sex included as controls
- \*\* p<0.05, \* p<0.10
- Reference group has CD4<200</li>

Those with CD4≥500 worked nearly 1 week/month more than those with CD4<200, and as much as HIV-uninfected adults

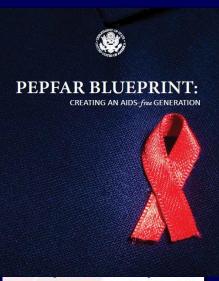


## How do we spend the money?















November 29, 201

ha a nation, we are firmly committed to turning the tide on the 30-year-old fight against AIDS. That' why I proudly announced last year that creating an AIDS-free generation is a new policy imperative fi he United States.

o be clear, we still face enormous challenges. Far too many people are dying from this disease. We nees reach more people with both prevention and treatment services. But today, thanks to remarkable isentific discoveries and the work of countless individuals, organizations and governments, an AIDS-fr neration is not just a rallying cry—it is a goal that is within our reach.

At the International AIDS Conference this past July, I asked our Global AIDS Coordinator, Ambassa Eric Goodby, so prepare this blueprint outlining our path to helping create an AIDS-free generation. I want the next Congress, the next Secretary of State, and all of our partners here at home and around the world to understand everything we've learned and to have a road map for how the United State w

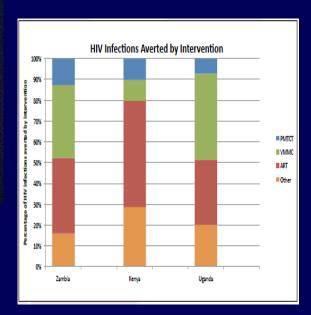
this blueprint should make one thing clear: the United States is and will continue doing our part. But reating an AIDS-free generation is too big a task for one government or one country. It requires the world to share in the responsibility. We call on partner countries, other donor nation, civil sockety, faith used organizations, the private sector, foundations, multilateral institutions and people living with HIV

Together, we can deliver a better future to millions across the globe. A future where children are not bow with HIV... where teenagers and adults are at far lower risk of contracting the virus... where those who do have the virus get lifesaving treatment. A future where every child has the chance to live up to his or

That's a future worth fighting for, together

Hillary Rodlan Clinton

#### PEPFAR Blue Print

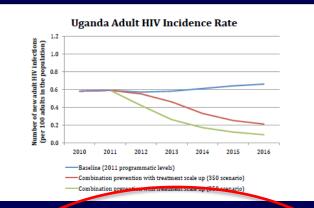


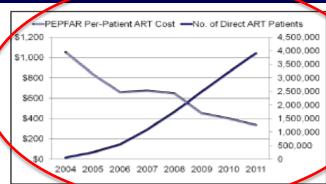
Contaily	2011 New HIV Infections	2011 Increase in New Patients on Treatment	Ratio of New HIV Infections to Inchese in New Patients on Treatment		
Botswana	8,500	17,811	0.5		
Cote d'Ivoire	13,000	6,844	1.9		
DRC	46,000*	9,375	4.9		
Ethiopia	11,000	40,507	0.3		
Kenya	91,000	93,912	1.0		
Lesotho	22,000	5,845	3.8		
Mozambique	100,000	48,912	2.0		
Namibia	80,000	14,539	0.6		
Nigeria	270,000	56,789	4.8		
Rwanda	8,400	4,083	2.1		
South Africa	350,000	276,017	1.3		
Swaziland	12,000	11,751	1.0		
Tanzania	120,000	31,700**	3.8		
Uganda	120,000	60,014	2.0		
Zambia	42,000	66,479	0.6		
Zimbabwe	60,000	142,155	0.4		
Official data not available for one WV infections data reported through					

 Official data not available for new HIV infections; data generated through internal PEPFAR modeling.

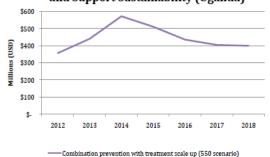
\*\*Due to concerns about data validity, the ratio shown for Tanzania was calculated using the increase in new patients on ART directly supported by

Source: UNAIDS 2012 World AIDS Day Report





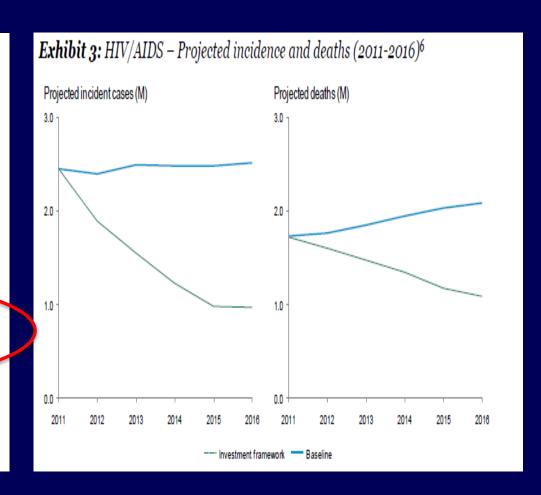
#### Rapid Scale Up of Combination Prevention Can Reduce Resource Needs and Support Sustainability (Uganda)



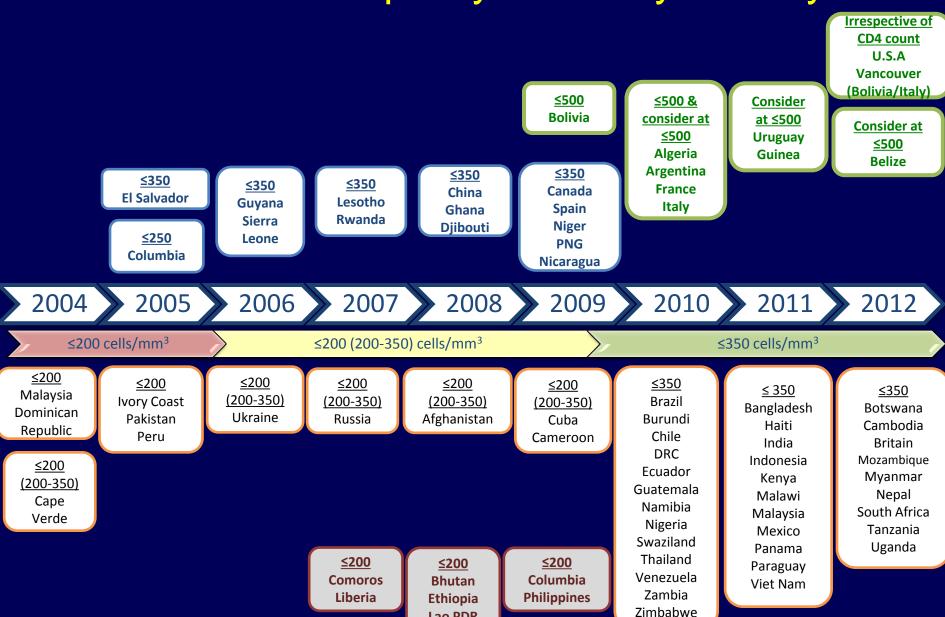


#### REVIEW OF HIV/AIDS, TUBERCULOSIS AND MALARIA LANDSCAPE FOR THE GLOBAL FUND STRATEGY 2012-2016

Exhibit 5: HIV/AIDS – Likelihood and impact of new interventions <sup>12</sup>						
Туре	Existing	Anticipated	Timing	Likelihood	Impact	
Vaccine	N/A	RV144, HVTN 505	2020+	0		
Prevention	Condoms, Male Circumcision	Treatment as Prevention (discordant couples)	2011		•	
		Oral PReP (for MSMs)	2011	•		
		Male circumcision devices	2012	-		
	ADV	m				
Treatments	ARV	Treatment. 2.0	2011	•		
Diagnostics	CD4, viral load	Point of care	2011			
		Couples testing	2011		•	



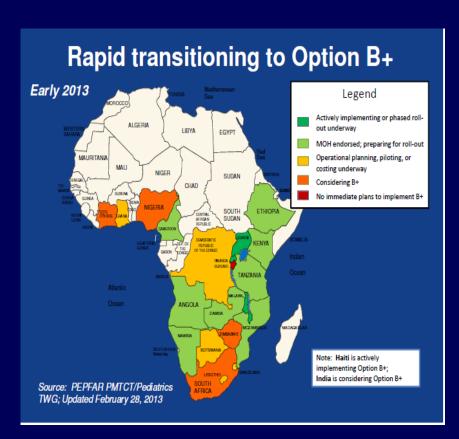
### When to start policy varies by country

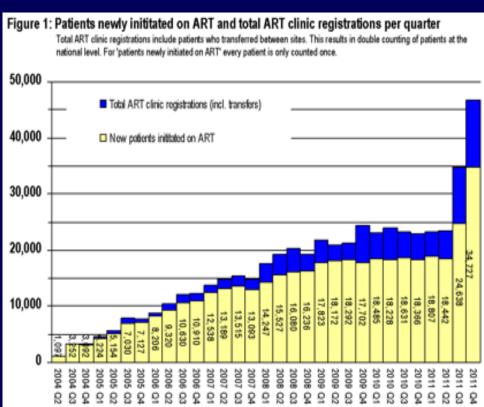


**Lao PDR** 



#### One size does not fit all....

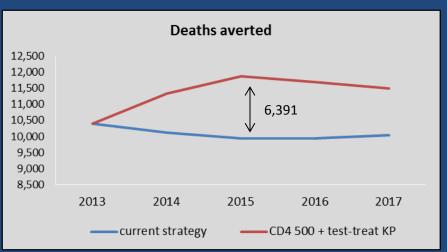


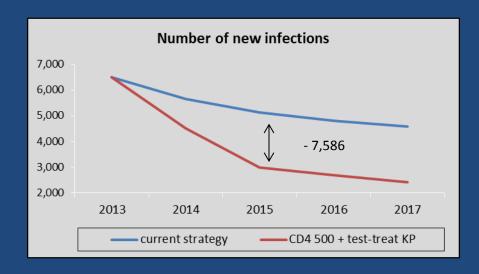


Option B+: early 2013

# Comparison between the current situation and proposed strategy of ART initiation at < 500 CD4 and test-to-treat for MSM and CSW

Over a 5 year period, a 5.2% increase in costs\* would results in 12.7% additional deaths averted and a 28.4% decrease in new infections\*\*







Investing an additional 12.7M \$ would results in 6,391 deaths averted and 7,586 fewer new infections

<sup>\*</sup> Additional costs may be underestimated as current resources were assumed to be able to absorb the new ART and pre-ART patients. \*\* EPI impact calculated with Spectrum, with conservative assumptions

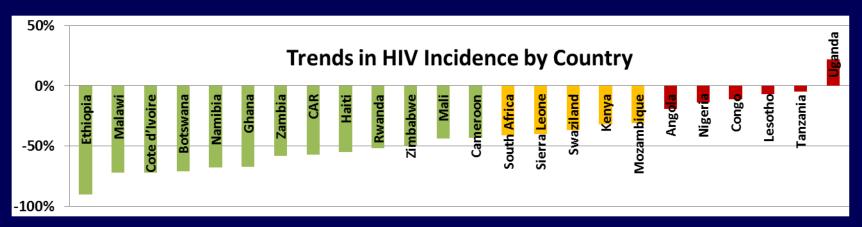
# However beautiful the strategy, you should occasionally look at the results

--Winston Churchill



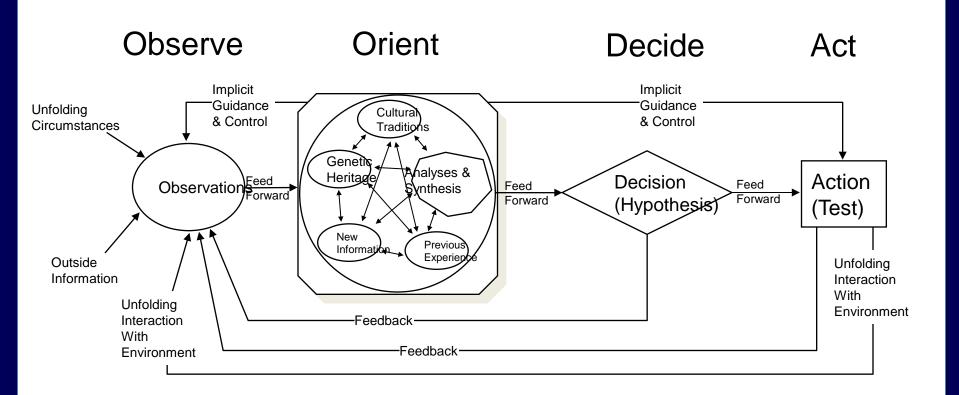
# High level political support for TasP (Vancouver 2013)

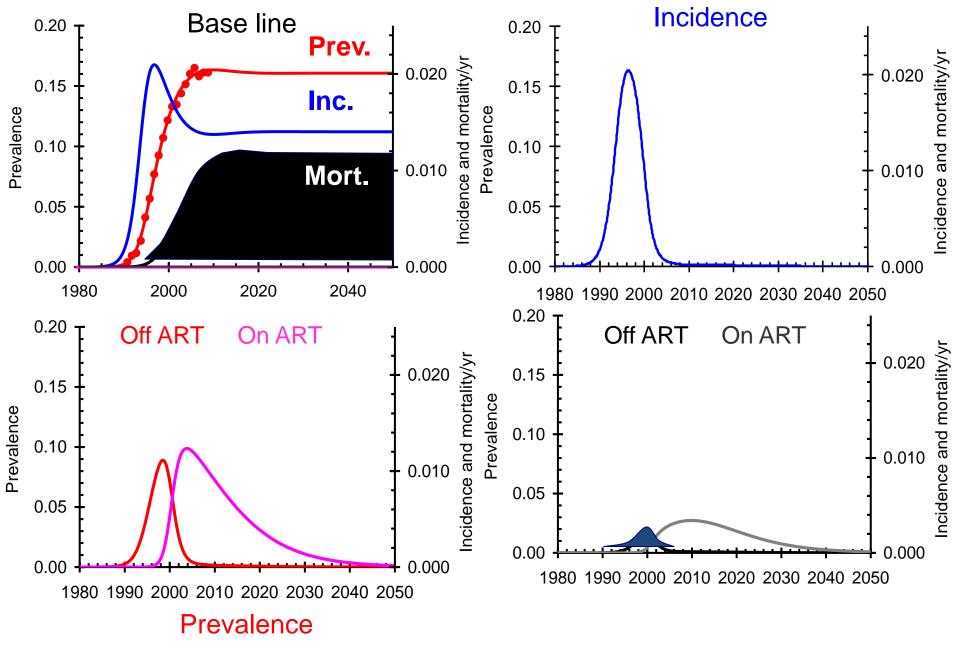




Transition from "does it work" to "how do we expand"

# The OODA Loop: speed matters...and we are very slow





HIV in South Africa: test and treat starting in 1995

Williams 2010

### Conclusion

- Models are very useful but are not sufficient to change policy—science, politics, and finance and leadership are essential
- Better data, better clarity when framing questions
- Better feedback loops—OODA loop is weak and slow
- Improve and accelerate policy making AND implementation to end AIDS



Public health is purchasable. Within a few natural and important limitations any community can determine its own health.

#### -Hermann M. Biggs

(29 Sep 1859 - 28 Jun 1923) New York City's Public Health Officer and public health pioneer



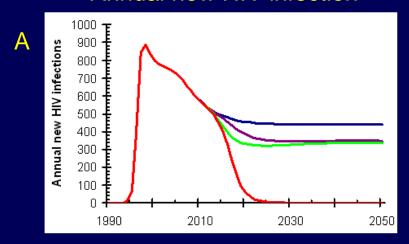
### Thank You

- Brian Williams
- Julio Montaner
- Badara Samb
- Brad Hersh
- Debbi Birx
- Somya Gupta
- Amitabh Suthar
- Swarup Sarkar
- Mona Sfeir

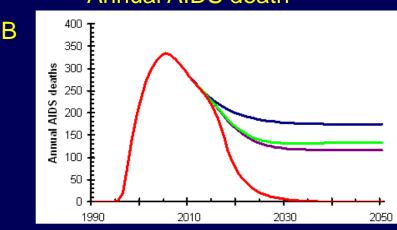
Views expressed in this presentation are those of the author and do not necessarily represent the views of the Joint United Nations Programme on HIV/AIDS (UNAIDS).

# Periodic testing & immediate ART significantly reduces new HIV infections and AIDS deaths in the context of Vietnam's HIV epidemic

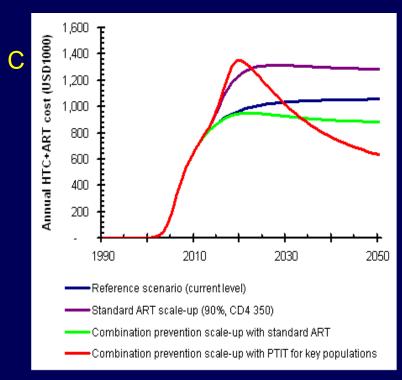
#### Annual new HIV infection



#### Annual AIDS death



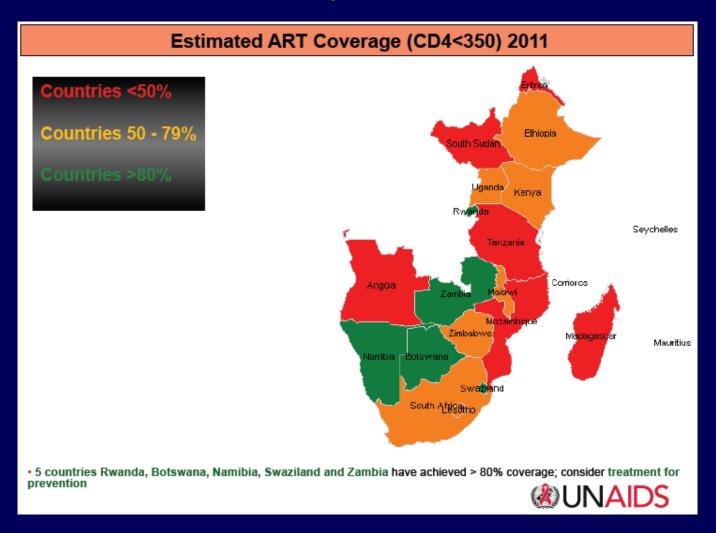
#### ART and HTC cost



Periodic testing and immediate treatment (PTIT)



## Policy matters



ART coverage at <350 varies and is related to policy



# Considering earlier treatment? Rwanda is not alone

- Zanzibar earlier testing and treatment for PWID and SWs?
- Cote d'Ivoire treating all SWs in selected clinics?
- Kenya MSM test and treat research study? Earlier treatment for other key populations? Test and treat in parts of Nyanza?
- South Africa considering move to <500?</li>
- Thailand testing and treatment for MSM?
- Cambodia targeting elimination (3/100,000 incidence) with emphasis on treatment for sex workers
- Viet Nam considering offering immediate treatment for drug users and sex workers in selected provinces
- Brazil considering national or sub-national level test and treat

