

# HIV/AIDS: Epidemiologic Perspective

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## Session Overview

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- Key concepts in epidemiology
- What is epidemiology?
- Study design
- Measures of association
- Epidemiology of HIV

## Epidemiology: A Brief Introduction

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## What is Epidemiology?

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*The study of anything that happens to people*

## History of Epidemiology

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## History of Epidemiology



## History of Epidemiology



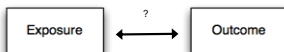
## What is Epidemiology?

- The study of the *distribution* and determinants of disease *frequency* in human populations and the application of this study to control health problems

• Disease frequency - count cases, need system, records

• Disease distribution - who, when, where

• Determinant - a characteristic that influences whether or not disease occurs

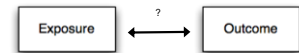


Aschengrau and Seage

## Study Design: Overview

### • Observational

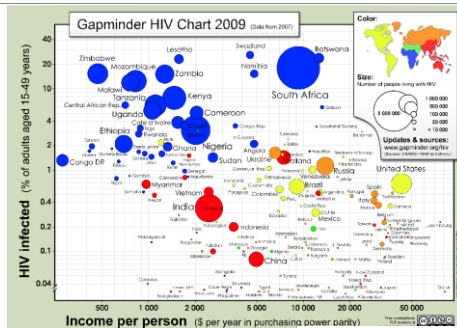
- Ecologic
- Cross-sectional
- Case-Control
- Cohort



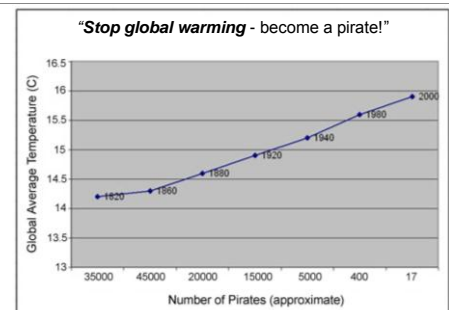
### • Experimental

- Randomized trials / Intervention studies

## Ecological Study: HIV and Income

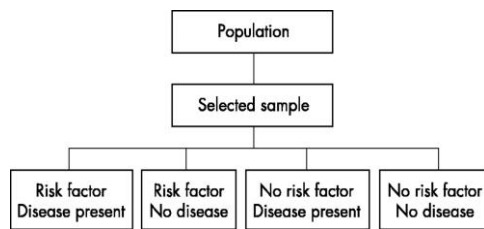


## Ecological Study

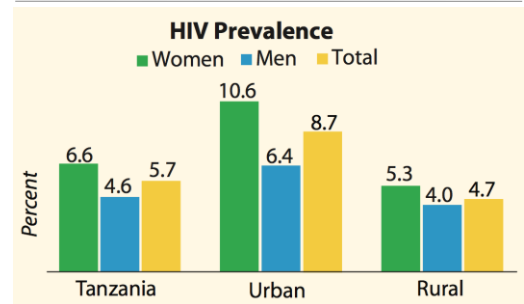


Venganzos.org

## Cross-sectional Study

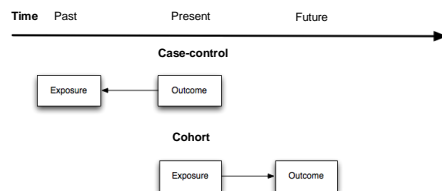


## Cross-sectional Study

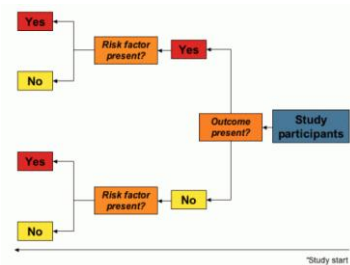


2007-08 Tanzania HIV and Malaria Indicator

## Analytic Epidemiology

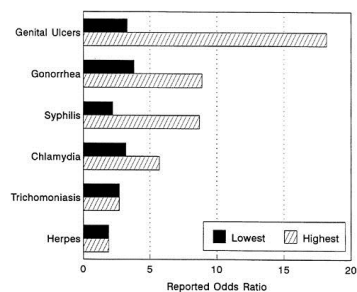


## Case-control Study



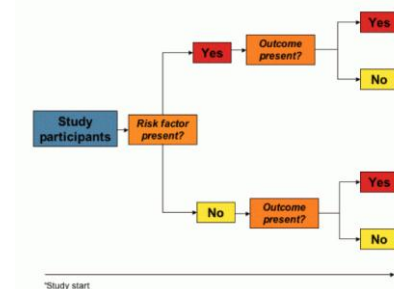
UIC 2012

## Case-control Study



Cohen, 1996

## Cohort Study



UIC 2012

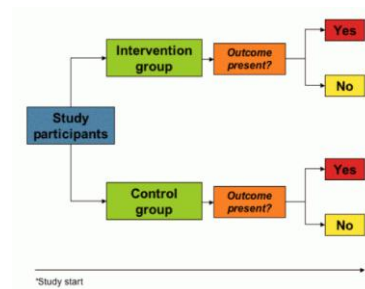
## Cohort Study



- The longest U.S. study of people with HIV/AIDS
- Over 1,000 publications
- Numerous seminal discoveries:
  - How best to diagnose HIV infection
  - The direct relationship between viral load and HIV disease progression
  - The importance of CD4 T-cells - and link between low numbers of these cells and progression to clinical AIDS
  - The central role of immune activation in HIV disease
  - How to best manage HIV/AIDS care and treatment
  - The epidemiology of major diseases that occur in conjunction with HIV/AIDS, including Kaposi's

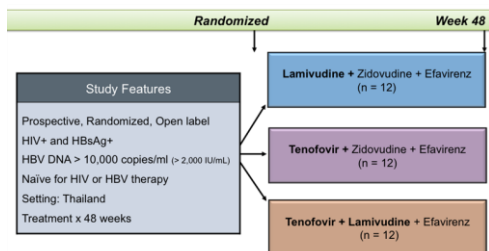
2009: NIH Multicenter AIDS Cohort Study (MACS) commemorates 25 Years of Discovery

## Randomized Trial



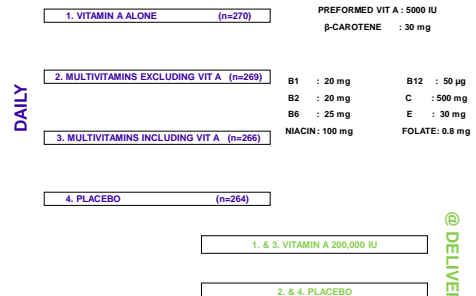
UIC 2012

## Randomized Trial



Mathews, 2008

## Randomized Trial



TOV Study Profile

Fawzi WW, et al. Lancet 1998;351:1477-1482

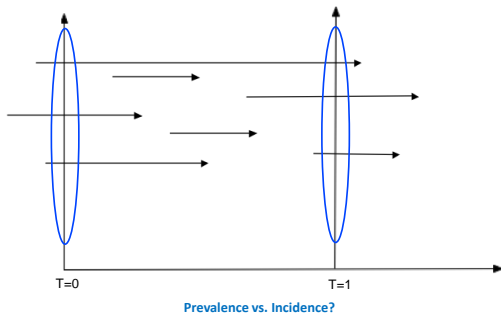
## Measures of Disease Frequency

- Prevalence
  - Number of cases of a disease in a specified population at a designated point in time
- Incidence
  - Measures occurrence of *new* cases of disease that develop in a population over a specified time period
  - *At risk, follow-up time*

## Prevalence and Incidence: Public Health

- Prevalence
  - To estimate the needs of medical facilities and to allocate resources for treating diseased individual
  - Heterogenous: Prevalence = Incidence X duration
- Incidence
  - To evaluate effectiveness of programs that try to prevent disease and for etiologic studies

## Measures of Disease Occurrence



## Summary

- Research questions should inform epidemiologic methods
- Critical role of epidemiologic methods in public health research
- Strengths and limitations of methods utilized
- Training in epidemiology



HIV/AIDS

“The time has come to close the book on  
infectious diseases.

We have basically wiped out infection...”

- William Stewart, US Surgeon General 1967

## Case Report: First Report of AIDS (1981)



### Epidemiologic Notes and Reports

#### Pneumocystis Pneumonia --- Los Angeles

In the period October 1980-May 1981, 5 young men, all active homosexuals, were treated for biopsy-confirmed *Pneumocystis carinii* pneumonia at 3 different hospitals in Los Angeles, California. Two of the patients died. All 5 patients had laboratory-confirmed previous or current cytomegalovirus (CMV) infection and candidal mucosal infection. Case reports of these patients follow.

**Patient 1:** A previously healthy 23-year-old man developed *P. carinii* pneumonia and oral mucosal candidiasis in March 1981 after a 2-month history of fever associated with elevated liver enzymes, leukopenia, and CMV viremia. The acute complement-fixation CMV titer in October 1980 was 256; in May 1981 it was 12. The patient's condition deteriorated despite courses of treatment with streptomycin sulfadiazine (TMP-SMX), penicillamine, and acyclovir. He died May 3, and postmortem examination showed residual *P. carinii* and CMV pneumonia, but no evidence of toxoplasmosis.

**Patient 2:** A previously healthy 30-year-old man developed *P. carinii* pneumonia in April 1981 after a 5-month history of fever each day and of elevated liver-function tests, CMV viremia, and documented seroconversion to CMV, i.e., an acute phase titer of 16 and a convalescent phase titer of 256 in anticomplement immunofluorescence tests. Other features of his illness included leukopenia and mucosal candidiasis. His pneumonia responded to a course of intravenous TMP-SMX. Six, as of the latest report, he continues to have a fever each day.

**Patient 3:** A 30-year-old man was well until February 1981 when he developed cough and oral candidiasis that responded to Amphotericin B treatment. He was hospitalized in February 1981 for *P. carinii* pneumonia that responded to TMP-SMX. His coughing continued after the pneumonia was diagnosed, and he was again given Amphotericin B. The CMV complement fixation titer in March 1981 was 8. Material from an endotracheal biopsy was positive for CMV.

**Patient 4:** A 29-year-old man developed *P. carinii* pneumonia in February 1981. He had had Hodgkin disease 3 years earlier, but had been successfully treated with radiation therapy alone. His last test results after being given streptomycin, sulfadiazine, and cotrimoxazole and died in March. Postmortem examination showed no evidence of Hodgkin disease, but *P. carinii* and CMV were found in lung tissue.

**Patient 5:** A previously healthy 36-year-old man with clinically diagnosed CMV infection in September 1980 was seen in April 1981 because of a 4-month history of fever, dyspnea, and cough. On admission he was found to have *P. carinii* pneumonia, oral candidiasis, and CMV viremia. A complement fixation CMV titer in April 1981 was 128. The patient has been treated with 3 short courses of TMP-SMX, but has been limited because of a mild neutrophilic neutropenia. He is being treated for candidiasis with topical nystatin.



Françoise Barré-Sinoussi



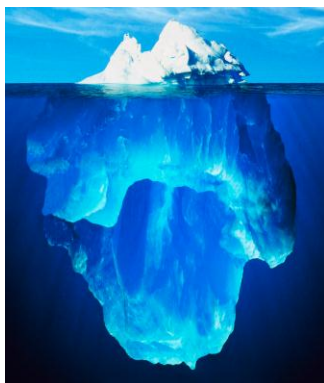
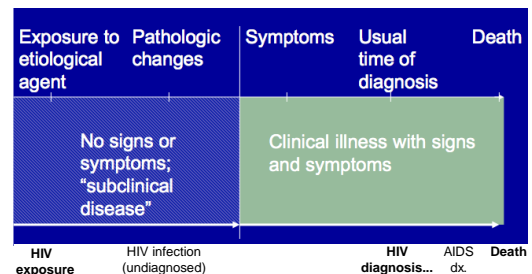
Luc Montagnier

Nobel Prize 2008

## Key Terms

- Incidence = # of *new* cases that develop during a given time period
- Prevalence = # of cases at a specific time point
- Endemic = habitual presence of a disease under normal circumstances
- Epidemic = occurrence of larger number of cases than expected ordinarily and derived from a common/propagated source
- Pandemic = a worldwide epidemic

## Natural History of Disease



Clinical disease

Subclinical disease  
(no symptoms  
but can transmit  
to others)

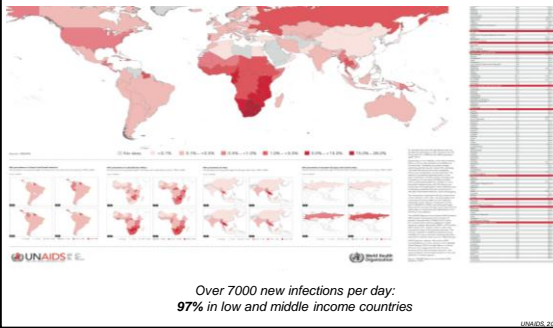
## HIV in the United States

- More than one million people are living with HIV in the U.S.
- Every 9 1/2 minutes, someone in the U.S. is infected with HIV
- One in five people living with HIV doesn't know they are infected
- Only 45% of HIV-infected patients in the U.S. are currently receiving regular medical care

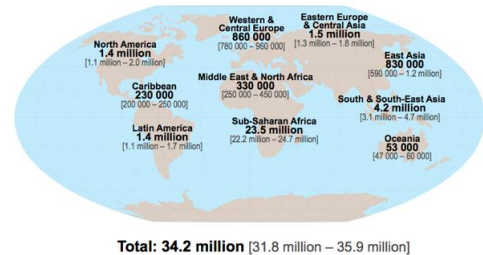




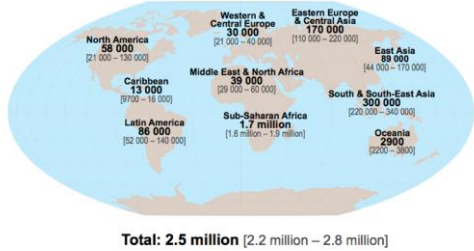
## Global Burden of HIV/AIDS



## Adults and children estimated to be living with HIV | 2011



## Estimated number of adults and children newly infected with HIV | 2011

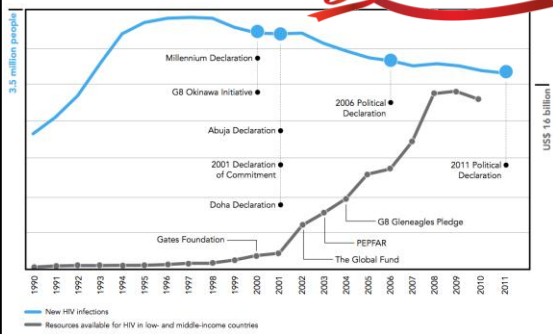


## Children (&lt;15 years) estimated to be living with HIV | 2011

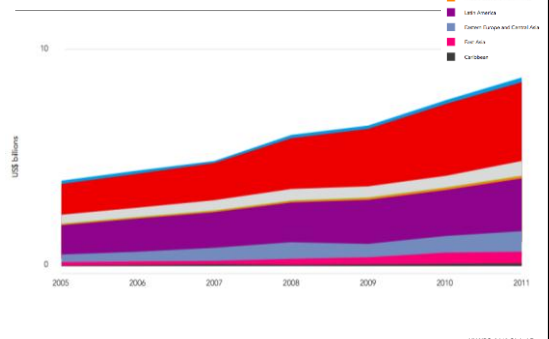


## Global Response to HIV/AIDS

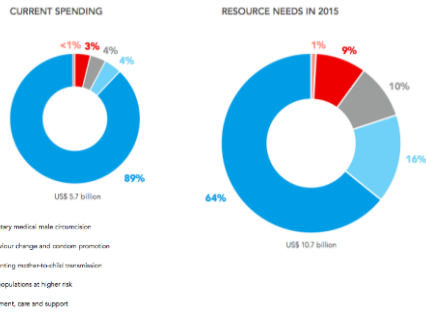
30 Years of HIV/AIDS



## HIV Investment in Low and Middle-Income Countries in Billions of USD (2005-2011)

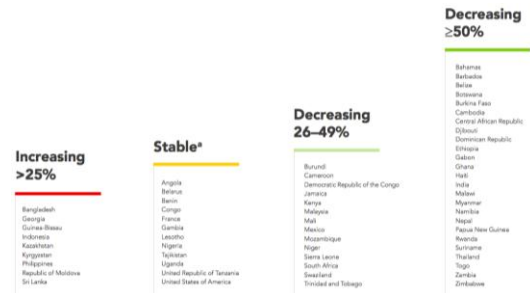


## HIV Investment vs. Resource Needs



UNAIDS, 2012 Global Report

## Change in HIV Incidence Over Time 2001-2011



UNAIDS, 2012 Global Report

## % Change in AIDS-related Deaths (2005-2011)

### No change or decrease <25%

Afghanistan  
Algeria  
Angola  
Armenia  
Australia  
Azerbaijan  
Bangladesh  
Belarus  
Belgium  
Bolivia  
Brazil  
Bulgaria  
Burkina Faso  
Burundi  
Canada  
Cape Verde  
Catalonia  
Cuba  
Czechia  
Cote d'Ivoire  
Croatia  
Cyprus  
Denmark  
Dominican Republic  
Ecuador  
Egypt  
Equatorial Guinea  
France  
Germany  
Ghana  
Greece  
Guatemala  
Guinea-Bissau  
Honduras  
Hungary  
Indonesia  
Iran (Islamic Republic of)  
Italy  
Japan  
Jordan  
Kazakhstan  
Kenya  
Korea, Republic of  
Kuwait  
Kyrgyzstan  
Laos  
Latvia  
Lebanon  
Lesotho  
Lithuania  
Luxembourg  
Madagascar  
Malawi  
Malaysia  
Mali  
Mauritania  
Mauritius  
Mexico  
Moldova  
Mongolia  
Morocco  
Mozambique  
Myanmar  
Nepal  
Netherlands  
Niger  
Nigeria  
Pakistan  
Panama  
Paraguay  
Peru  
Poland  
Portugal  
Romania  
Russian Federation  
Senegal  
Serbia  
Sierra Leone  
Singapore  
Slovakia  
Slovenia  
South Africa  
Spain  
Sri Lanka  
Sweden  
Switzerland  
Tajikistan  
Tanzania  
Thailand  
Timor-Leste  
Togo  
Tunisia  
Turkey  
Ukraine  
United Kingdom  
United States of America  
Uruguay  
Uzbekistan  
Vanuatu  
Vietnam  
Yemen  
Zambia  
Zimbabwe

### Decrease 25-49%

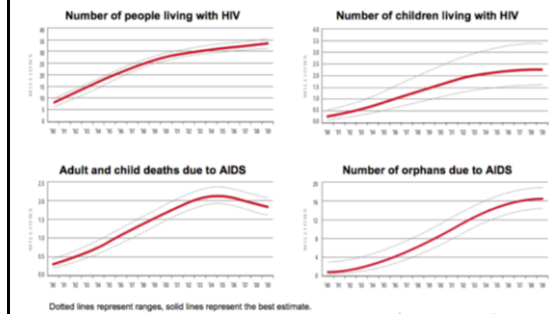
Barbados  
Belize  
Bhutan  
Bolivia (Plurinational State of)  
Bosnia and Herzegovina  
Botswana  
Brazil  
Bulgaria  
Burkina Faso  
Burundi  
Cambodia  
Cameroon  
Canada  
Cape Verde  
Catalonia  
Cuba  
Czechia  
Cote d'Ivoire  
Croatia  
Cyprus  
Denmark  
Dominican Republic  
Ecuador  
Egypt  
Equatorial Guinea  
France  
Germany  
Ghana  
Greece  
Guatemala  
Guinea-Bissau  
Honduras  
Hungary  
Indonesia  
Iran (Islamic Republic of)  
Italy  
Japan  
Jordan  
Kazakhstan  
Kenya  
Korea, Republic of  
Kuwait  
Kyrgyzstan  
Laos  
Latvia  
Lebanon  
Lesotho  
Lithuania  
Luxembourg  
Madagascar  
Malawi  
Malaysia  
Mali  
Mauritania  
Mauritius  
Mexico  
Moldova  
Mongolia  
Morocco  
Mozambique  
Myanmar  
Nepal  
Netherlands  
Niger  
Nigeria  
Pakistan  
Panama  
Paraguay  
Peru  
Poland  
Portugal  
Romania  
Russian Federation  
Senegal  
Serbia  
Sierra Leone  
Singapore  
Slovakia  
Slovenia  
South Africa  
Spain  
Sri Lanka  
Sweden  
Switzerland  
Tajikistan  
Tanzania  
Thailand  
Timor-Leste  
Togo  
Tunisia  
Turkey  
Ukraine  
United Kingdom  
United States of America  
Uruguay  
Uzbekistan  
Vanuatu  
Vietnam  
Yemen  
Zambia  
Zimbabwe

### Decrease ≥50%

Barbados  
Belize  
Bhutan  
Bolivia (Plurinational State of)  
Bosnia and Herzegovina  
Botswana  
Brazil  
Bulgaria  
Burkina Faso  
Burundi  
Cambodia  
Cameroon  
Canada  
Cape Verde  
Catalonia  
Cuba  
Czechia  
Cote d'Ivoire  
Croatia  
Cyprus  
Denmark  
Dominican Republic  
Ecuador  
Egypt  
Equatorial Guinea  
France  
Germany  
Ghana  
Greece  
Guatemala  
Guinea-Bissau  
Honduras  
Hungary  
Indonesia  
Iran (Islamic Republic of)  
Italy  
Japan  
Jordan  
Kazakhstan  
Kenya  
Korea, Republic of  
Kuwait  
Kyrgyzstan  
Laos  
Latvia  
Lebanon  
Lesotho  
Lithuania  
Luxembourg  
Madagascar  
Malawi  
Malaysia  
Mali  
Mauritania  
Mauritius  
Mexico  
Moldova  
Mongolia  
Morocco  
Mozambique  
Myanmar  
Nepal  
Netherlands  
Niger  
Nigeria  
Pakistan  
Panama  
Paraguay  
Peru  
Poland  
Portugal  
Romania  
Russian Federation  
Senegal  
Serbia  
Sierra Leone  
Singapore  
Slovakia  
Slovenia  
South Africa  
Spain  
Sri Lanka  
Sweden  
Switzerland  
Tajikistan  
Tanzania  
Thailand  
Timor-Leste  
Togo  
Tunisia  
Turkey  
Ukraine  
United Kingdom  
United States of America  
Uruguay  
Uzbekistan  
Vanuatu  
Vietnam  
Yemen  
Zambia  
Zimbabwe

UNAIDS, 2012 Global Report

## HIV/AIDS Burden in the Past Two Decades

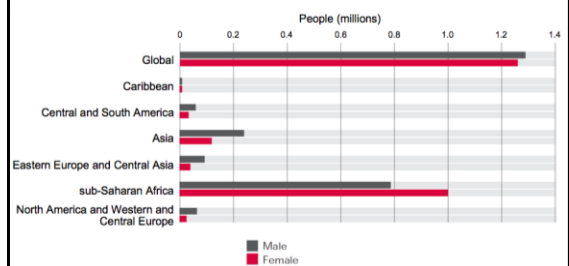


UNAIDS, 2012



Photo: UNICEF

## People Newly Infected with HIV Annually



UNAIDS, 2012



## HIV Prevalence in Young Adults

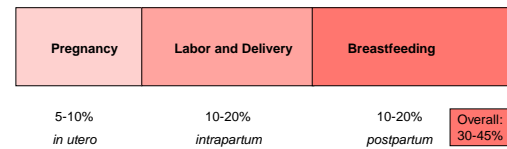


## Are women more vulnerable to the impact of HIV?



Steve McCurry, National Geographic

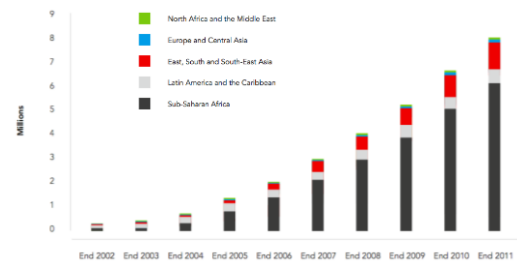
## Risk of Mother to Child HIV Transmission Without Interventions



Breastfeeding and HIV-free survival

Adapted from Lehman, 2007 and CDC

## Number of People Receiving Antiretroviral Therapy in Low and Middle Income Countries (2002-2011)

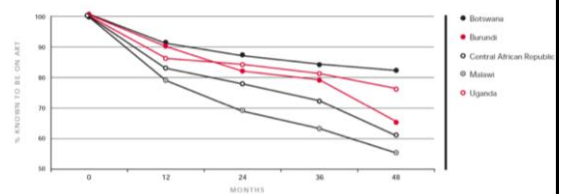


UNAIDS, 2012 Global Report

## Proportion of Eligible People Receiving ART

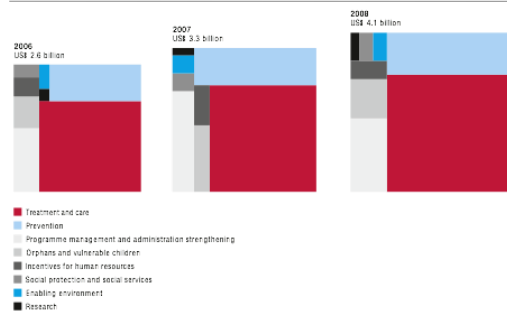


## Adult Retention in ARV Therapy in First 48 Months



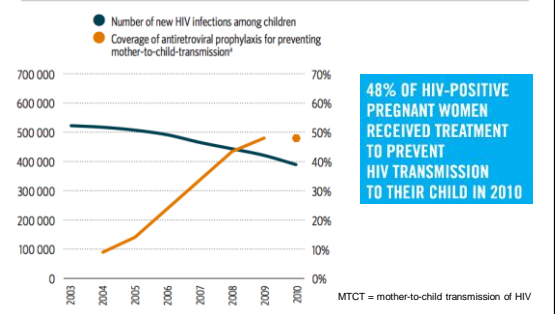
UNAIDS, 2012

## HIV Investment in Resource-Limited Countries



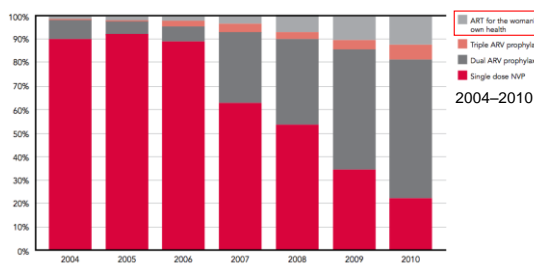
UNAIDS, 2010

## Antiretroviral Therapy to Prevent MTCT of HIV



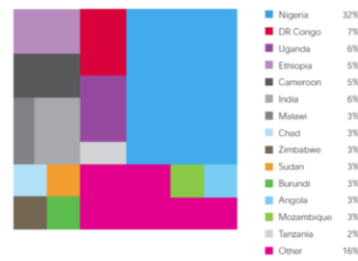
UNAIDS, 2012

## Gaps in Antiretroviral Therapy to Prevent Mother to Child HIV Transmission



UNAIDS, 2011

## Gap in ART Coverage for PMTCT of HIV Globally



PMTCT = prevention of mother-to-child transmission of HIV

UNAIDS, 2010

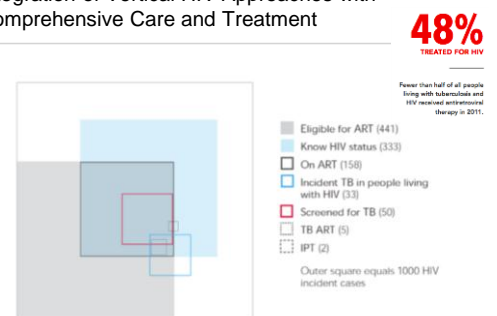
## New UNAIDS Targets for 2015

Recognizing the genuine opportunity to plan for the end of AIDS, countries pledged in the 2011 United Nations Political Declaration on HIV and AIDS: Intensifying Our Efforts to Eliminate HIV and AIDS (1) to take specific steps to achieve ambitious goals by 2015. Drawing from the 2011 Political Declaration, UNAIDS has articulated 10 specific targets for 2015 to guide collective action.

1. Reduce sexual transmission by 50%.
2. Reduce HIV transmission among people who inject drugs by 50%.
3. Eliminate new infections among children and substantially reduce the number of mothers dying from AIDS-related causes.
4. Provide antiretroviral therapy to 15 million people.
5. Reduce the number of people living with HIV who die from tuberculosis by 50%.
6. Close the global AIDS resource gap and reach annual global investment of US\$ 22 billion to US\$ 24 billion in low- and middle-income countries.
7. Eliminate gender inequalities and gender-based abuse and violence and increase the capacity of women and girls to protect themselves from HIV.
8. Eliminate stigma and discrimination against people living with and affected by HIV by promoting laws and policies that ensure the full realization of all human rights and fundamental freedoms.
9. Eliminate restrictions for people living with HIV on entry, stay and residence.
10. Eliminate parallel systems for HIV-related services to strengthen the integration of the AIDS response in global health and development efforts.

UNAIDS, 2012 Global Report

## Integration of Vertical HIV Approaches with Comprehensive Care and Treatment

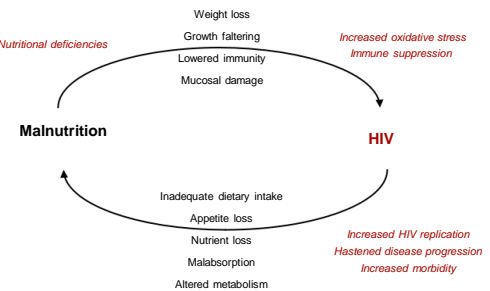


UNAIDS, 2012

## HIV and Nutrition



Partners in Health: Courtesy of Paul Farmer



## Malnutrition and HIV

Modified from Scrimshaw and Santha, & Tang. British Journal of Nutrition, 1999; 81(2):181-193

## Integration of HIV Prevention into Antenatal Care

Pregnancy	Labor and Delivery	Postnatal
<ul style="list-style-type: none"> <li>Prevention</li> <li>Treatment of sexually transmitted infections</li> <li>Adequate nutrition</li> <li>Treatment of malaria and other infections</li> <li>Counseling on safe sex, infant feeding, family planning, self-care, planning for the future</li> <li>Voluntary counseling and testing (VCT)</li> <li>Access to antiretroviral therapy (HAART)</li> </ul>	<ul style="list-style-type: none"> <li>ARVs</li> <li>Safe delivery planning</li> <li>Non-invasive procedures</li> <li>Elective Caesarian section</li> <li>Minimal infant exposure to maternal fluids</li> </ul>	<ul style="list-style-type: none"> <li>ARVs</li> <li>Counseling and support for infant feeding</li> <li>Prevention and treatment of breastfeeding problems</li> <li>Promotion of breast health (screening/tx of infections)</li> <li>Care of infant thrush and oral lesions</li> <li>Counseling on complementary feeding and weaning</li> <li>Nutritional support</li> <li>Infection prevention</li> </ul>

## Women's Health



Partners in Health

## Summary

- Despite progress, HIV/AIDS continues to pose a severe threat to human health
- Disproportionate burden in lower income countries, particularly women
- In addition to rapid scale-up of essential antiretroviral therapy, further efforts in prevention are urgently needed
- Emphasis on prevention is needed to prevent new infections
- HIV/AIDS care and treatment needs to be further integrated with health services, including antenatal care, nutrition, infectious disease, and infant and child young feeding

Asanten! sana!



Finkelstein