

# Test and Treat: Forecasting the Clinical and Epidemiological Impact of Expanded HIV Screening and Immediate ART in Sub-Saharan Africa

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## BACKGROUND

- Expanded HIV screening and immediate ART upon diagnosis ("Test and Treat") is being considered as an HIV prevention strategy because of its potential to decrease individual HIV RNA.
- Our objective was to estimate the impact of a test and treat strategy on survival, individual HIV RNA, and lifetime 2° HIV cases attributable to a recently-infected individual in sub-Saharan Africa.

## METHODS

- We used a computer microsimulation model of HIV disease (CEPAC-International) and data from Côte d'Ivoire to project outcomes associated with alternative testing and treatment strategies in a cohort of recently-infected individuals.
- Strategies included combinations of:
  - Screening frequency (current practice [client-initiated screening or screening in patients with symptoms]; current practice + screening every 3 years; current practice + annual screening);
  - ART initiation criterion (never; CD4 ≤200/μL; CD4 ≤350/μL; upon diagnosis).

Outcomes included: 5-year survival; life expectancy; 2° HIV cases at 5 years; lifetime 2° HIV cases.

- We estimated 2° HIV cases attributable to an HIV-infected individual in a susceptible population as follows:

$$2^\circ \text{ HIV cases} = \beta_p d_p + \sum_{n=1}^6 \beta_n d_n, \text{ where}$$

$\beta_p$  = monthly transmission probability during primary HIV infection;

$d_p$  = months spent with primary HIV infection;

$\beta_n$  = monthly transmission probability in HIV RNA stratum  $n$  (≤500 c/mL, 501 – 3,000 c/mL, 3,001 – 10,000 c/mL, 10,001 – 30,000 c/mL, 30,001 – 100,000 c/mL, and >100,000 c/mL);

$d_n$  = months spent in stratum  $n$  following primary infection.

## INPUT DATA

**Table 1. Model input parameters**

Parameter	Base case value	Reference
<b>Cohort characteristics</b>		
Initial CD4, mean cells/μL (SD)	553 (230)	Minga, Bull WHO 2007
HIV RNA level, median log <sub>10</sub> copies/mL	4.7	Minga, Bull WHO 2007
<b>HIV screening program performance</b>		
Combined probability of test offer, acceptance, and linkage to care with each round of screening, %	30.8	Assumption; EIS-CI 2005; April, JAIDS 2009
<b>ART efficacy, 1st and 2nd line</b>		
HIV RNA suppression at 24 weeks, %	80.4	Touré, AIDS 2008
Treatment failure after 24 weeks, rate/100 PY	15.6	Touré, AIDS 2008
<b>Loss to follow-up</b>		
On ART ≤12 months, rate/100 PY	17.4	Touré, AIDS 2008
On ART >12 months, rate/100 PY	12.3	Touré, AIDS 2008
<b>2° HIV transmission</b>		
Primary infection, rate/100 PY	58.3	Wawer, AIDS 2009
Chronic infection, rate/100 PY by HIV RNA level	0.2 – 9.0	Attia, AIDS 2009

## RESULTS

- Compared to a standard of care with screening according to current practice and ART at CD4 ≤350/μL, a test and treat strategy with annual screening and ART upon diagnosis increased mean life expectancy from 162.7 months to 200.2 months, decreased 2° HIV cases at 5 years by 16.6%, but increased lifetime 2° HIV cases by 11.1% (**Table 2**).

**Table 2. Base case impact of testing and treatment strategies in sub-Saharan Africa**

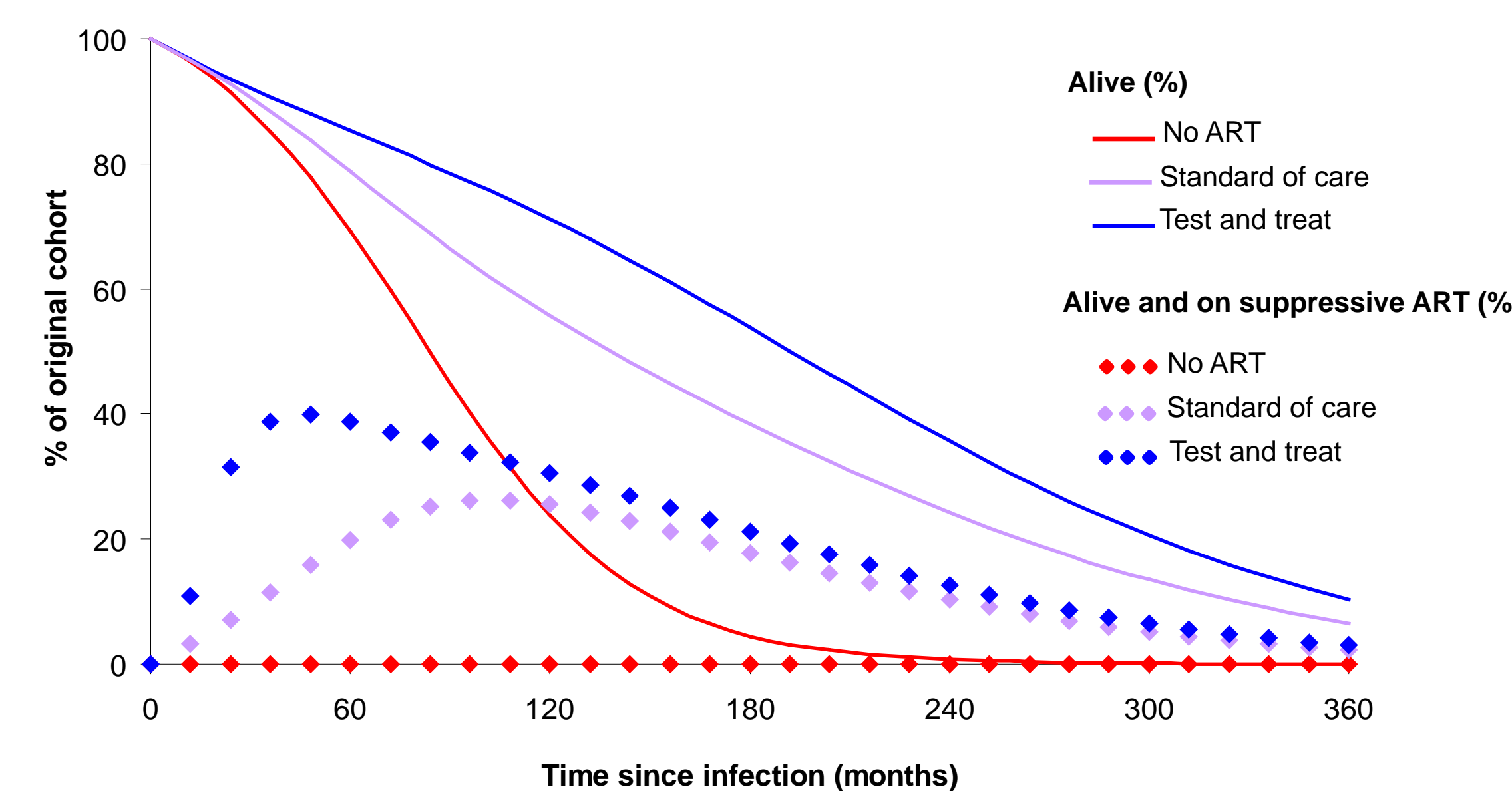
Strategy	Clinical outcomes		Epidemiological outcomes				
	5-year survival	Life expectancy	2° HIV cases at 5 years	% Δ vs. SOC	Lifetime 2° HIV cases	% Δ vs. SOC	
Test frequency, ART initiation	% alive	Months	Cases per person	% Δ vs. SOC	Cases per person	% Δ vs. SOC	
	Current practice alone						
	No ART	69.2	88.7	0.39	+5.7	0.58	-19.7
≤200/μL	77.6	152.6	0.38	+2.4	0.70	-3.0	
≤350/μL (Standard of care [SOC])	<b>78.8</b>	<b>162.7</b>	<b>0.37</b>	---	<b>0.72</b>	---	
Upon diagnosis	79.5	169.7	0.35	-6.0	0.74	+2.2	
Current practice + screening every 3 years	≤200/μL	78.8	161.3	0.38	+2.0	0.72	-0.3
	≤350/μL	80.2	173.8	0.37	-1.2	0.74	+3.3
	Upon diagnosis	81.1	182.4	0.34	-8.6	0.76	+5.8
Current practice + annual screening	≤200/μL	81.6	171.3	0.37	+0.9	0.74	+2.8
	≤350/μL	84.0	188.4	0.36	-4.1	0.78	+7.9
	<b>Upon diagnosis (Test and treat)</b>	<b>85.2</b>	<b>200.2</b>	<b>0.31</b>	<b>-16.6</b>	<b>0.80</b>	<b>+11.1</b>

## RESULTS (cont.)

- In **Figure 1**, the distance between the solid line and the diamonds of the same color represents the proportion of the cohort off ART or on non-suppressive ART.

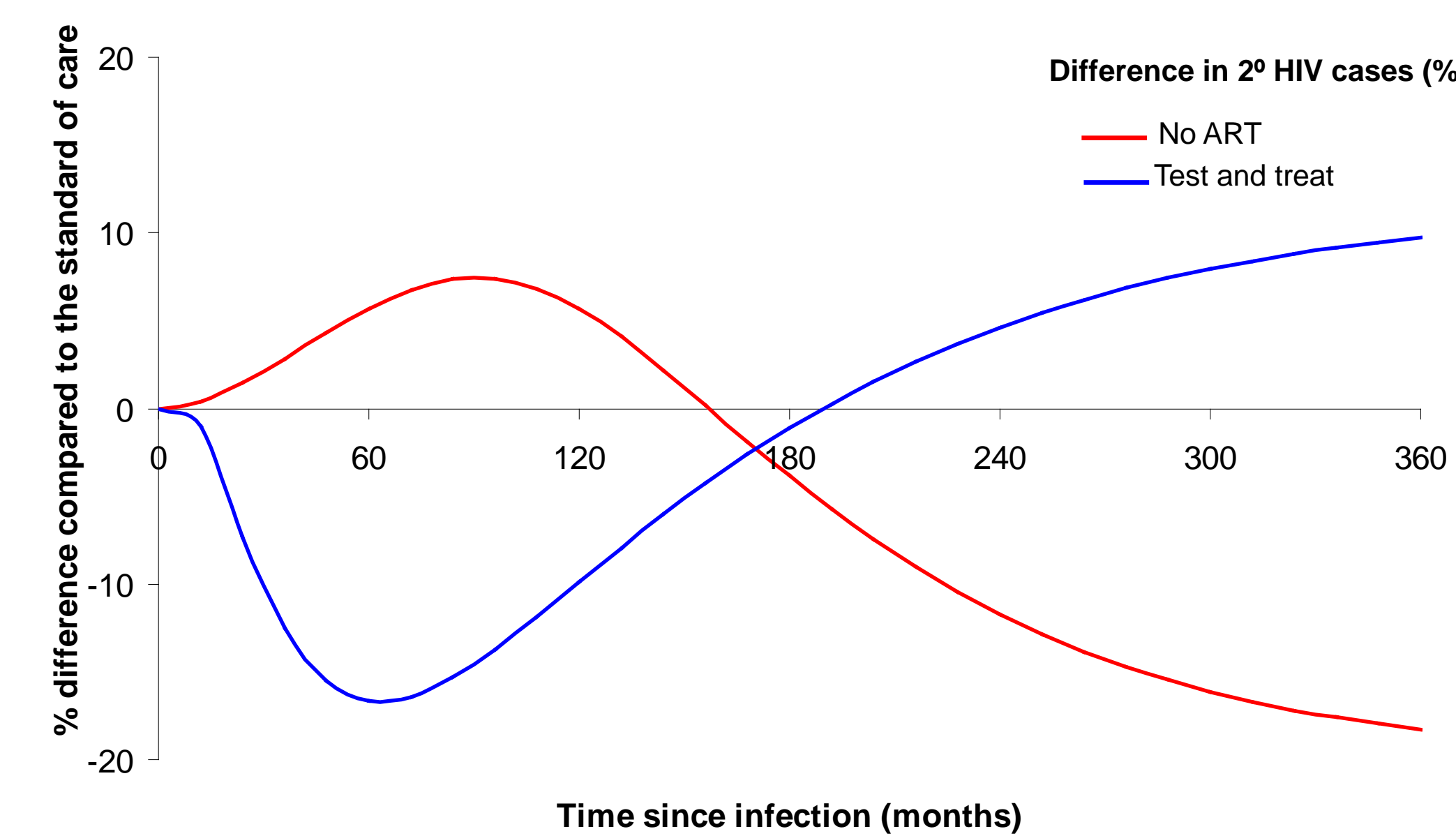
- The test and treat strategy increased lifetime 2° HIV cases by 11.1% relative to the standard of care because the mean 37.5 month survival gain associated with the test and treat strategy included 25.5 months on suppressive ART as well as 12.0 months off ART or on non-suppressive ART.

**Figure 1. Cohort survival and % of cohort on suppressive ART over time**



- The cumulative number of 2° HIV cases caused by an HIV-infected individual under the test and treat strategy exceeded the number caused under the standard of care after 190 months (**Figure 2**).

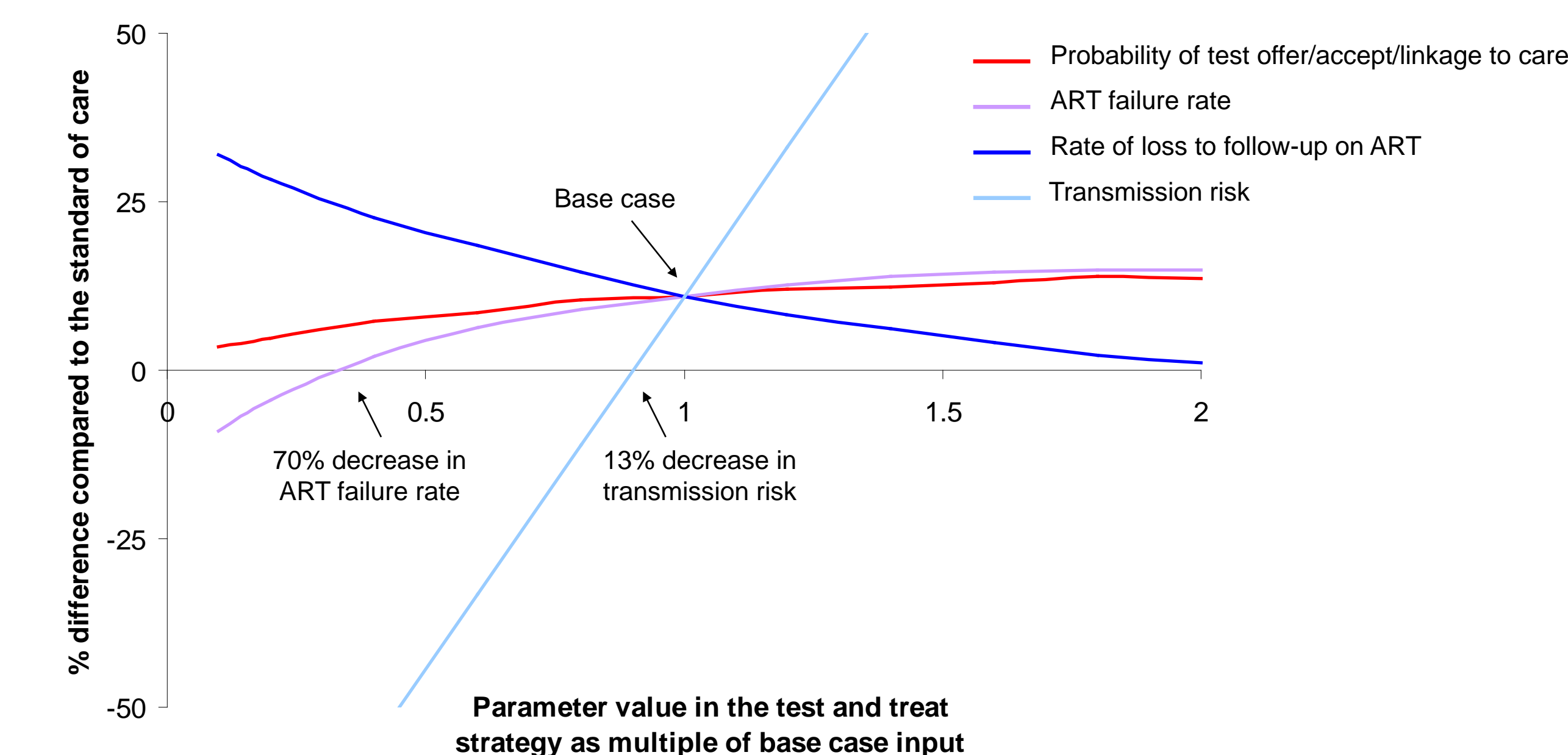
**Figure 2. Difference in 2° HIV cases in the no ART and test and treat strategies relative to the standard of care over time**



- Variation in 4 input parameters in the test and treat strategy had an impact on the difference in lifetime 2° HIV cases in the test and treat strategy relative to the standard of care (**Figure 3**): 1) the probability of test offer, acceptance, and linkage to care, 2) the ART failure rate (such as through changes in treatment adherence), 3) loss to follow-up on ART, and 4) transmission risk by HIV RNA (such as through use of other preventive interventions or behavioral disinhibition).

- Decreases in the ART failure rate (≥70%) and decreases in transmission risk (≥13%) led to decreases in lifetime 2° HIV cases with no decreases in life expectancy.

**Figure 3. One-way sensitivity analyses on the difference in lifetime 2° HIV cases in the test and treat strategy compared to the standard of care**



## LIMITATIONS

- 2° HIV cases are estimated using population averages; we assume sexual behavior is characterized by homogenous mixing and do not incorporate behavioral heterogeneity.
- Transmission estimates do not include "3rd generation" HIV cases resulting from 2° HIV cases.
- We do not model primary resistance or account for the impact of resistance on transmission.

## CONCLUSIONS

- A test and treat strategy will increase survival in newly HIV-infected individuals in sub-Saharan Africa.
- Survival gains will be accompanied by decreases in 2° HIV cases at 5 years but, with current rates of ART failure and transmission by HIV RNA, will be accompanied by increases in lifetime 2° HIV cases.
- Increases in treatment adherence and use of other preventive interventions, in conjunction with test and treat, will be necessary to decrease lifetime 2° HIV cases.