Poster Number 1109
22nd CROI
Seattle, WA
February 23-26, 2015

Epidemiologic Benefits and Cost-Effectiveness of Improving HIV care in Rwanda

Eran Bendavid(1), Edward Mills(2), Steve Kanters(2), Eric Remera(3), Sabin Nsanzimana(3)

(1) Stanford University, Stanford, CA; (2) Global Evaluative Sciences; (3) Rwanda Biomedical Center

Eran Bendavid, MD MS
251 Campus Drive x332
Stanford CA 94305
ebd@stanford.edu
650-723-2363

ABSTRACT

Background
Despite the rising number of people initiating antiretroviral therapy (ART), HIV remains the leading cause of death among adults in sub-Saharan Africa. We provide an analysis of HIV mortality trends in Rwanda.

Methods
We calibrated an age-structured HIV disease and transmission simulation model to the epidemic in Rwanda. We modeled HIV-infected individuals transitioning among the following states in the HIV health care system: untested, unlinked to an ART clinic following HIV testing (unlinked), leaked from care after linkage but prior to initiating ART (leaked), lost to follow-up following initiation of ART care (LTFU), and retained in active ART care. Our base case simulated Rwanda's HIV care in 2014. We project the patterns of mortality in the base case and with improvements to HIV care processes alone and in combination.

Results
In 2014, an equal portion of deaths occurred among the unlinked (32.7%) and those on ART (32.6%). Deaths among those LTFU made up 14.4%, and among the untested 12.6%. In the base case, the portion of deaths among those LTFU is expected to increase to 19.1%, while the portion of those unlinked will decrease. Immediate initiation of ART and a combined effort to improve all aspects of HIV care lead to the greatest reductions in overall mortality among those with HIV, 29.1% and 40.1%, respectively. At the same time, immediate initiation of ART and a combined strategy lead to the greatest reduction in incidence, resulting in net decline in HIV prevalence to 2.6% and 2.5%, respectively.

Conclusions
Mortality among those unlinked makes up the greatest portion of deaths among HIV-infected individuals in Rwanda not on ART, but the portion of those LTFU is expected to increase the most over the next decade. Immediate initiation of ART and a combined strategy to improve all aspects of HIV care lead to the greatest reductions in overall mortality as well as the greatest reduction in incidence, resulting in a net modest reduction in HIV prevalence over the next decade.

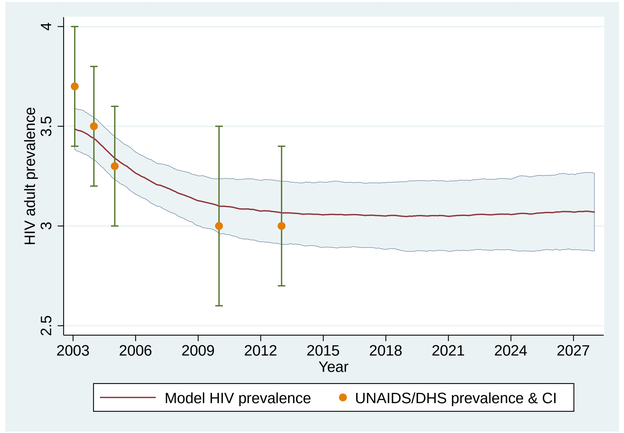
BACKGROUND

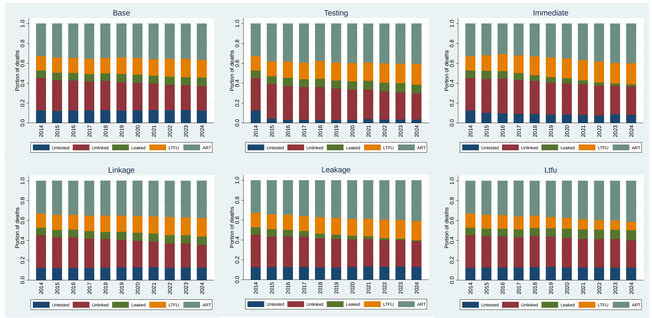
1. Though scale-up of ART has led to measurable declines in HIV-related and all-cause adult mortality, HIV remains the leading cause of death in highly endemic countries.
2. Who is dying with HIV? The distribution of deaths in different parts of the health care system is incompletely understood, and future trends may depend on existing epidemiologic and demographic trends.
3. Rwanda's public HIV care system includes over 465 ART sites, and patient status for those in care is well-characterized, enabling detailed parameterization of this predictive modeling study.

METHODS

1. Overview: using a simulation model parameterized to Rwanda's HIV care continuum and calibrated to HIV epidemiologic outcomes and a detailed embedded HIV disease model, we estimate the distribution of deaths along the HIV health care system between 2014 and 2024.
2. We modeled HIV-infected individuals transitioning among the following states in the HIV health care system: untested, unlinked to an ART clinic following HIV testing (unlinked), leaked from care after linkage but prior to initiating ART (leaked), lost to follow-up following initiation of ART care (LTFU), and retained in active ART care.
3. Our base case simulated Rwanda's HIV care in 2014, with 40% tested for HIV annually, 80% of those who are tested are linked, ART initiation at 350 cells/mm^3, 0.5% monthly probability of leakage among those who are linked, and 0.09% monthly probability of LTFU (with 50% return to care among those with advanced disease)
4. We tested the effects of increasing testing rates to 95% of the population, improving linkage to 90%, initiating ART immediately among those tested HIV+, reducing leakage to 0.1% (without changing ART initiation threshold), and halving LTFU.

Model Calibration and Base Case HIV Prevalence Projection. Orange dots and uncertainty bars represent UNAIDS (2003-2005) and DHS (2010, 2013) estimates of Rwanda adult population prevalence; red line and shaded area represent model prevalence 95% CI in model 1st order parameter uncertainty.





Distribution of Deaths in the HIV Health Care System. In the base case, an equal portion of deaths occur among the unlinked (32.7%) and those on ART (32.6%); over time, as increasing numbers initiate ART and the HIV-infected population ages, we project that on-ART will experience the most deaths, but those LTFU will increase in importance. The prominence of on-ART deaths increases the most with a combined intervention to improve HIV care, as mortality in all other stages of HIV care will decrease.

MAIN FINDINGS

1. The model was calibrated to maintain a 3.0% (2.8-3.3%) prevalence among adults at the current level of HIV care.
2. Stable adult HIV prevalence with 2.8% annual population growth suggests that the size of the HIV-positive population will increase by approximately 30% over the next decade.
3. In 2014, an equal portion of deaths occur among the unlinked (32.7%, 31.2-34.1%) and those on ART (32.6%, 31.1-34.1%). Deaths among those LTFU made up 14.4% (13.8-15.1%), and among the untested 12.6% (11.6-13.5%).
4. Over the next decade, as increasing numbers initiate ART and the HIV-infected population ages, we project that in the base case, those on ART will make the largest mortality group (36.3%), while those unlinked will decrease to 23.4% (22.2-24.5%). We project that the portion of deaths among those LTFU will increase to 19.1% (18.1-20.0%).
5. With the exception of immediate ART initiation, improving any aspect of HIV care such as testing or leakage *in isolation* leads to a downstream transition of mortality, with the greatest increases felt among those LTFU. For example, improving leakage reduces the contribution of that group to 1.0% over the next decade, but leads to an increase in the portion of deaths among those LTFU from 14.4% to 21.9%.
6. Immediate initiation of ART and a combined effort to improve all aspects of HIV care lead to the greatest reductions in overall mortality among those with HIV, 29.1% and 40.1%, respectively.
7. At the same time, immediate initiation of ART and a combined strategy lead to the greatest reduction in incidence, resulting in net decline in HIV prevalence to 2.6% (2.5-2.7%) and 2.5% (2.4-2.6%), respectively.

CONCLUSIONS

1. Mortality among unlinked individuals makes up the greatest portion of deaths among HIV-infected individuals not on ART in Rwanda.
2. At the present state of HIV care in Rwanda, the portion of deaths among those lost to follow-up is expected to increase over the next decade.
3. Improving any single aspect of HIV care (except for immediate ART initiation) shifts the distribution of mortality downstream along the HIV care system while resulting in modest total mortality benefits.
4. Immediate initiation of ART and a combined strategy to improve all aspects of HIV care lead to the greatest reductions in overall mortality as well as the greatest reduction in incidence, resulting in a net modest reduction in HIV prevalence over the next decade.
5. Limitation: all future projections result from parameters about the past and present HIV epidemic and assumptions about HIV transmission, disease, and treatment.

ACKNOWLEDGMENTS

This research is supported by NIAID and the Doris Duke Charitable Foundation

RWANDA BIOMEDICAL CENTER
A Healthy People. A Wealthy Nation
GLOBAL EVALUATIVE SCIENCES