Estimating HIV treatment coverage in South African ART clinics based on the time trend of the CD4 count distribution at ART initiation and a dynamic epidemiological model.

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SACEMA Research Day

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Human Immunodeficiency Virus (HIV)

- HIV is the virus that causes AIDS (Acquired Immune Deficiency Disease Syndrome).
- It is a life-threatening disease.
- Attacks the body’s immune system and destroys the CD4 cells.
- ARVs are currently the primary method for treating HIV.
Motivation

- CD4 count is the main factor that decides whether or not to initiate ART.
- All HIV-infected with CD4 count below 350 are eligible for ART initiation.
- Dynamics of CD4 count $\rightarrow$ delays between ART eligibility and ART initiation.
Motivation

Why South Africa (SA)?

* SA is the country with largest HIV-infected population worldwide.

* About 5.6 million individuals are HIV positive in South Africa, 2011.
* Less than 2 million on treatment, 2011. [1]
* SA is the country with the largest population receiving ART worldwide. [2]
HIV Treatment Coverage

Definition

HIV treatment coverage is defined to be the number of individuals receiving ART at a certain time divided by the sum of the number of individuals receiving ART at that time and the number of individuals who are eligible to receive treatment at that time.
Determine the success of ART programmes and infer their impact.

Substantial increase in ART coverage can have high effect on HIV transmission.

- 22% treatment coverage in 2008 (<350 cells/µL).
- 54% treatment coverage in 2008 (<200 cells/µL).
- HIV coverage reached 79%, 2012 (<200 cells/µL). [1,3]
Aim and Objectives

**AIM:** To contribute and improve methods for estimation of HIV treatment coverage.  

**Objectives:**
- To determine whether the CD4 count distribution at the time of ART initiation is consistent with previous ART coverage estimates.
- To investigate the time to start treatment in patients eligible for ART.
- To estimate treatment coverage, taking into account the time trend of the CD4 count distribution at ART initiation.
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Methodology

- Assumed CD4 Count decline by 60 cells/µL per year.
- Calibrate the model to reproduce the reported number of individuals currently alive and on ART.
- Estimate the treatment coverage in South African clinics.
Adults CD4 count distribution at ART initiation

- Sample size = 51,641 patients.
- Median age = 36 (IQR 31-146) years.
- Gender: Female = 59%, Male = 41%.
- Median CD4 Count = 121 cells/µL.

Figure: CD4 count distribution for all sites participated in the cohort study.
Adults CD4 count distribution

- Average CD4 count 125 cells/µL at ART initiation, 2006.
- Average CD4 count 149 cells/µL at ART initiation, 2009.

**Figure:** CD4 count distribution for year 2004-2009
Adults CD4 count distribution

- Approximately 28% males initiated ART with <50 cells/µL.
- Only 23% females initiated ART with <50 cells/muL.
- Average CD4 count at ART initiation higher on females.

**Figure:** CD4 count distribution for women and men.
Adults CD4 count distribution

- Highest median CD4 count, 162 cells/µL.
- Lowest median CD4 count, 88 cells/µL.

Figure: CD4 count distribution by cohort participated in the study.
Treatment Delay Analysis

- Median treatment delayed time = 3.3 (IQR 2-5) years.
- Advance time = 19 years.
- Maximum treatment delayed time = 5 years.

Figure: *Estimated number of years delayed before ART initiation.*
Treatment Delay Analysis

**Figure:** Average years of delay by gender over time

![Average delay over time, by gender](chart.png)

**Figure:** Average years of delay by gender over time
Treatment Delay Analysis

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Figure: *Estimated number of years delayed before ART initiation.*
Hazard of time since eligibility

- Shape parameter = 14.1
- Scale parameter = 23.7

Figure: *Instantaneous hazard with a fitted Weibull function.*
**HIV Model**

Figure: *The epidemiological model structured by time since infection, $\tau$.***

- $h(t, \tau)$ is the ART access rate
- $g(\tau)$ is the eligibility rate
Preliminary model output

Figure: The estimated hazard of starting HIV treatment in South Africa.
Preliminary model output

Figure: *The estimated number of individuals starting HIV treatment.*
Figure: The estimated number of individuals on antiretroviral treatment.
Preliminary model output

Figure: *The estimated HIV treatment coverage for South African ART clinics.*
Conclusions

- Approximately 82% individuals initiated treatment with low CD4 count.
- More than 50% individuals were delayed treatment for 4 years.
- Only 25% will survival beyond 5 years after ART has been delayed.
- Delays in treatment after eligibility must be reduced much further since it increases mortality and morbidity.
Conclusions

- Approximately 313,000 individuals started treatment in 2011.
- Our results can be explain by many individuals starting treatment late.
- Treatment coverage reach 33% in 2011, using the new ART threshold.
- About 1.3 million of 3.5 million individuals eligible for ART are receiving it.
1. Leigh Johnson et al; *Estimation of adult antiretroviral treatment coverage in South Africa;* SAMJ, 2009
4. IeDEA-SA; *The International Epidemiologic Databases to Evaluate AIDS Southern Africa.*
THANK YOU