Scale-up of Antiretroviral Therapy and Preexposure Prophylaxis in Swaziland

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Introduction

With an adult prevalence of 31%, Swaziland has a severe, generalized HIV epidemic. Despite behavior change and other prevention programs, including scale-up of antiretroviral therapy (ART), new incident infections continue to be a problem, especially in women (where incidence is 4.2% in women 20-24 years and 35-39 years, and prevalence is 49% in women 35-39 years). The importance of population-specific combination prevention approaches to HIV has made mathematical modeling an invaluable tool for planning efforts. As part of the evaluation of policy measures to end Swaziland's HIV epidemic by 2030, we modeled the efficacy and cost effectiveness of various treatment and prevention strategies.

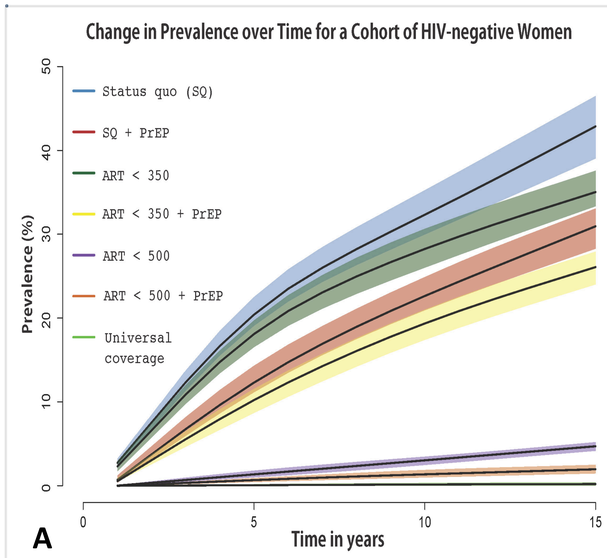
Materials and methods

Using demographic and epidemiological data from Swaziland, we constructed dynamic compartmental models as well as network models to assess the impact of ART scale-up as well as PrEP offered to 10% of the highest risk population over the next 15 years. See table below for parameters used.

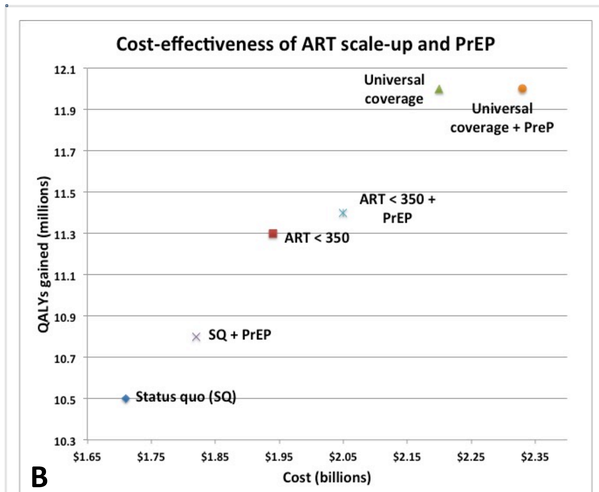
Parameter	Value	Source
Prevalence and Incidence		
HIV prevalence, adults 18-49 years	31%	1
HIV incidence, adults 18-49 years	2.4%	1
HIV incidence, women 20-24 years	4.2%	1
ART		
Median CD4 count at initiation	236	2
Sexual acquisition reduction	95%	3
PrEP		
PrEP quit rate (annual)	10%	goal
Sexual acquisition reduction	96%,	4
Sexual behavior		
Number of sexual partners per year (general)	1.09	5
Number of sexual partners per year (high risk)	4	est.
Condom usage rate (general)	20%	est.
Condom usage rate (high risk)	25%	est.
Condom effectiveness	90%	6
Coital frequency	5x per month	7
Probability of HIV transmission		
Male to female	.008 per act	8
Female to male	.004 per act	8
Annual costs (US$)		
Non-HIV medical costs	200	est.
HIV costs	348	9
ART costs	86	9
PrEP cost	80	
Demographics		
Death rate, crude	14 per 1,000	10

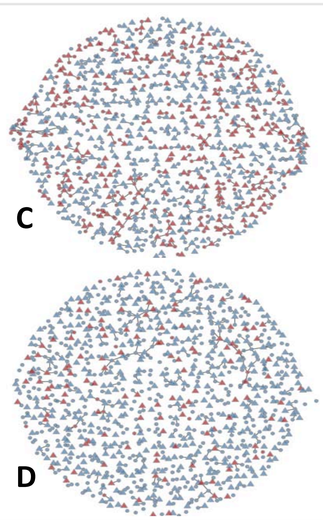
Results

Continuing the status quo—where ~$110 million is spent yearly on HIV programs and the median CD4 at initiation is 234—will yield 10.5 million quality-adjusted life years (QALYs) between 2015-30. For an added $110 million over 15 years, another 300,000 QALYs can be gained by offering PrEP to 10% of the highest risk population. This represents a cost of $366 per QALY gained. Compared to status quo, scale up of ART to CD4 < 350 yields an additional 800,000 QALYs at $288 per QALY gained, while universal ART coverage yields an additional 1.5 million QALYs at $327 per QALY gained. Figure A shows the potential benefit of PrEP delivered to one high-risk group in particular—young women—over the next 15 years.



a) Change in HIV prevalence over time for women (lines). Shaded areas represent 95% of the simulated data. Farthest point to the right marks prevalence at 15 years. Women start with 0% prevalence as the models simulate the 15-year effect of various strategies on a cohort of HIV-negative young women.
b) Cost-effectiveness (quality-adjusted life-years versus total costs over 15 years) of ART and focused PrEP (10% highest risk individuals, 90% adherence).
c) Network diagram for status quo. Blue = susceptible; red = infected; circle = female; triangle = male; lines = sexual relations.
d) Network diagram for ART < 500 and PrEP uptake by 60% of young women.





Conclusions

In the current setting of low median CD4 at ART initiation, immediate role-out of PrEP to 10% of the highest risk population is very cost-effective at $366 per QALY gained. As the country gets to 100% test and treat, however, PREP is no longer cost effective. Since scale up of ART to universal coverage will take many years, there is urgency to roll out PREP to populations where both risk and PREP adherence are deemed to be highest. Deliver of PrEP to high-risk subgroups (incidence > 3%) is supported in the most recent WHO guidelines. Given the preventive benefit of ART scale-up, an important caveat for PrEP programs is that they should be rolled out only if they do not detract from existing ART programs or future ART scale up. It must also be remembered that PrEP provides the most significant benefit for the group taking it. Thus, while prevalence in young women is significantly decreased in the approach modeled above, men still maintain a high prevalence.

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