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How universal does universal test and treat have to be?

HIV treatment as prevention, not only of HIV-related disease but also of transmission, was proposed in 2006 as a means to end the epidemic.[1] Several influential studies and models predicted that early treatment of most people who live with HIV (PLWH) could reduce HIV transmission rates to near zero, at the population level.[1–3] As a result, treatment as prevention evolved into the universal HIV test-and-treat (UTT) approach, which entails offering HIV counselling and testing to an entire population and ART to all PLWH. In 2014, UNAIDS announced ambitious new goals to "end AIDS by 2030" by reaching 90-90-90 targets by 2020: 90% of PLWH knowing their status, 90% ART coverage among those knowing their status, and 90% viral suppression among people on ART.

Great progress has been made, with an estimated 79% of people having been diagnosed, 62% of individuals aware of their status being on ART, and 53% of those on ART being virally suppressed globally, although heterogeneity exists between countries.[4] However, until UTT community-based trial results began to be reported 4 years ago, it remained unclear to what extent this remarkable increase in coverage translated into HIV prevention. In *The Lancet HIV*, Adam Akullian and colleagues[5] report that ART scale-up in eSwatini, which has the world's highest HIV prevalence, has largely been a success story, dramatically reducing adult HIV incidence and mortality. Using a mathematical model calibrated with demographic, HIV prevalence, and ART coverage data, they estimate that adult mortality decreased by more than 50% and HIV incidence by more than 40%, between 2010 and 2016. However, Akullian and colleagues also predict that with ART coverage maintained at current levels, HIV incidence will remain above 1 per 100 person-years—far above the target of 1 per 1000 person-years defined as representing epidemic control. Importantly, even 100% ART coverage within an average of 6 months since infection acquisition (implying annual universal HIV testing with 100% coverage), would reduce adult HIV incidence to 0·73 (95% CI 0·55–0·92) per 100 person-years by 2030 and 0·46 (0·33–0·59) per 100 person-years by 2050—still far off the epidemic control target.
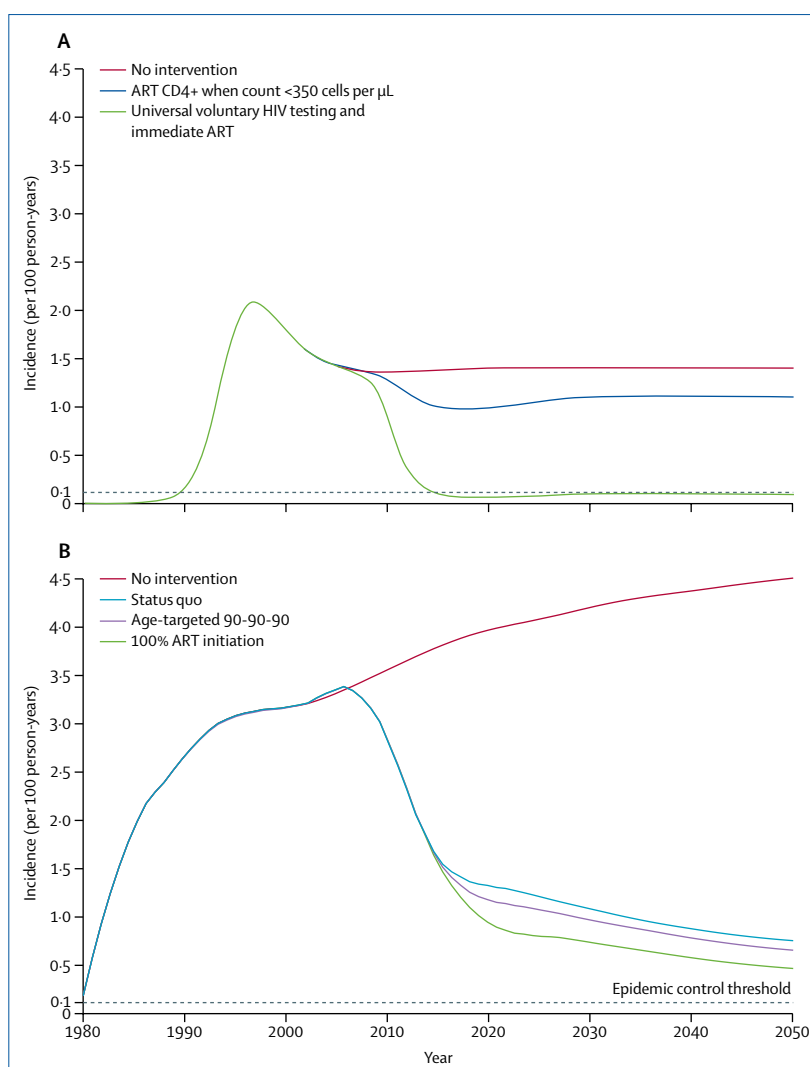
These findings concur with results of the UTT trials. Substantial reductions in HIV incidence were observed in study communities because ART access improved in both intervention and control groups (where standard of care was offered), but no significant differences in population-level HIV incidence reductions were found by study group, with HIV incidence reductions due to ART falling far short of epidemic control.[6] It seems logical that 90-90-90 levels would be insufficient to end the epidemic, as such coverage implies that 27% of PLWH would remain virally unsuppressed and capable of HIV transmission. But why have Akullian and colleagues predicted that UTT at even higher levels of ART coverage, at 95-95-95 and beyond, will not end the HIV epidemic, when previous models came to much more positive conclusions in similar settings (figure)?

Reasons the authors posit are HIV transmissions during the elevated infectiousness of early HIV infection and demographic gaps in testing, treatment, and viral suppression coverage. Treatment coverage is lower in younger age groups in eSwatini, particularly among young men. If these and other demographic groups that UTT misses are disproportionate transmitters of HIV infection, the population-level effectiveness is compromised. Early models of UTT were criticised for not adequately addressing behavioural heterogeneity or the natural history of HIV infection.[2] Since then, the modelling community has attempted to explore reasons for differences in model predictions between research groups. More real-world data from treatment-as-prevention studies have reduced variability in predictions, but differences remain. Hontelez and colleagues[7] developed nine structurally different models of the South African

epidemic, from the simplest (akin to early modelling), to models incorporating different HIV risk groups such as female sex workers, HIV natural history (including the high infectiousness accompanying early HIV infection), and cofactors such as sexually transmitted infections (STIs), male circumcision, and condom use. However, the more complex models still pointed in the same direction as the simple models, predicting HIV elimination with UTT at 90% coverage, albeit at later timepoints. We now know that, despite these attempts to reach consensus, the model failed to capture real-world epidemiology, one reason being that it assumed equal ART coverage across risk groups. Akullian and colleagues[5] found that closing age and sex gaps in ART coverage would reduce HIV incidence by a further 17% among young people (aged 15–24 years), but achieving this level of equity will be difficult.

Similarly, although the preintervention modelling of the PopART (HPTN071) trial predicted a substantial effect of the intervention in models that incorporated extensive behavioural heterogeneity,[8] subsequent analyses suggest that a likely driver of what turned out to be optimistic model predictions was the grouping of small risk groups who have large numbers of partners (such as female sex workers and clients) within a much larger group of high-risk individuals—diluting their impact on transmission.[6] In the same way, post-hoc modelling of STI treatment trials provided insights on why the effect of those interventions was not as predicted.[9,10] Models do not always get it right but they have been crucial in paving the way to empirical research that has given us a greater understanding of what is important for HIV prevention.

Although Akullian and colleagues' findings indicate that UTT in isolation cannot control HIV in eSwatini, expanded access to ART has decreased HIV transmission.[5] As always with HIV, the details of the epidemic and the overlap between individuals who access interventions and those who are transmitting most efficiently is crucial, as Akullian and colleagues highlight. Access to timely health care is a human right and so ART should be available to all those who would benefit. There must be scale-up of the three pillars of UTT across all risk groups and this should be in combination with the other prevention methods at our disposal, including pre-exposure prophylaxis,

Figure: Comparison of predictions of the impact of universal test and treat (UTT) on HIV incidence
(A) Granich and colleagues' 2009 model predicting epidemic control with UTT[2] and (B) Akullian and colleagues' model predicting substantial reductions in HIV incidence with ART scale-up but no epidemic control for decades to come.[5] The epidemic control threshold used by both studies is an incidence of less than 0·1 per 100 person-years. Figures[2,5] modified with permission from the authors and Elsevier Ltd.

behaviour change, syringe exchange, and condom use. Great strides have been achieved in UTT, but as Akullian and colleagues have shown, high-quality data combined with data analytics and modelling will be needed to help map the next steps toward elimination.

We declare no competing interests.

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Maintaining HIV care during the COVID-19 pandemic

Coronavirus disease 2019 (COVID-19) has spread rapidly around the world since the first reports from Wuhan in China in December, 2019, and the outbreak was characterised as a pandemic by WHO on March 12, 2020.[1] Approximately 37·9 million people living with HIV[2] are at risk of infection with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which causes COVID-19. Although some international institutions, in collaboration with governments and community partners, are working to sustain HIV service provision for people living with HIV, the COVID-19 pandemic presents several barriers and challenges to the HIV care continuum.[3]

First, implementation of quarantine, social distancing, and community containment measures have reduced access to routine HIV testing, which challenges completion of UNAIDS' first 90-90-90 target globally, that 90% of all people living with HIV will know their HIV status. HIV testing is the vital first step towards initiation into the HIV care continuum.[3] Even with availability of HIV self-testing kits in some areas,[4] testing remains a big challenge in settings with scarce access to these kits. Therefore, increased efforts are needed to augment access and to facilitate testing.

Second, timely linkage to HIV care could be hindered during the COVID-19 pandemic. People living with HIV who should have initiated antiretroviral therapy (ART) in hospital might be deterred or delayed because hospitals are busy treating patients with COVID-19. Furthermore, because many public health authorities globally are focused on COVID-19 control, allocation of resources for HIV care could be diminished, and circumstances surrounding the HIV care continuum could worsen.

Third, the COVID-19 pandemic might also hinder ART continuation. Hospital visits could be restricted because of implementation of city lockdowns or traffic controls. UNAIDS and the BaiHuaLin alliance of people living with HIV, with support of the Chinese National Center for AIDS/STD Control and Prevention, did a survey among people living with HIV in China in February, 2020.[5,6] Among this population, 32·6% were at risk of ART discontinuation and about 48·6% did not know where to get antiviral drugs in the near future.[5,6] People living with HIV who are faced with ART discontinuation not only could undergo physical health deterioration but also might suffer great psychological pressure.

In response to these challenges, WHO, UNAIDS, and the Global Network of People Living With HIV are working together to ensure continued provision of HIV prevention, testing, and treatment services.[6–8] The Chinese National Center for AIDS/STD Control and Prevention issued a notice guaranteeing free antiviral drugs for selected treatment management agencies in China, and released a list of ART clinics.[6] People living with HIV can refill antiviral drugs either at the nearest local Center for Disease Control and Prevention or by post, to maintain enrolment in treatment programmes and to continue ART.[6] Hospitals in Thailand are to dispense antiviral drugs in 3–6-month doses to meet the needs of people living with HIV and reduce facility visits.[9] The US Department of Health and Human Services released interim guidance for COVID-19 and people living with HIV on March 20, 2020,[10] which