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Using Microsimulation Modeling to Inform County EHE Efforts in California

Background

New HIV prevention strategies, such as pre-exposure prophylaxis (PrEP), post-exposure prophylaxis (PEP) and Treatment as Prevention (TasP) have enabled the United States to make considerable progress in reducing the annual number of new HIV infections. Although the number of new diagnoses dropped from 45,700 in 2008 to 37,500 in 2014, the number has remained stubbornly constant at about 38,500 in 2017.

California similarly emphasizes PrEP and TasP to curb forward HIV transmission. Among the measurable goals it lays out in its *Integrated HIV Surveillance, Prevention, and Care Plan*, several directly relate to boosting PrEP uptake among high-risk HIV-negative persons and achieving viral suppression among persons living with HIV (PLWH). Specifically, the goals of the Plan are to:

- Reduce the number of new HIV diagnoses in California by at least 50 percent, to fewer than 2,500 per year
- Increase the number of Californians at high risk for HIV infection who are on PrEP to 60,000
- Increase the percentage of newly diagnosed persons in California linked to HIV medical care within one month of their HIV diagnosis to at least 85 percent
- Increase the percentage of Californians newly diagnosed with HIV who are virally suppressed within six months of diagnosis to at least 75 percent
- Increase the percentage of Californians with diagnosed HIV infection who are virally suppressed to at least 80 percent
- Increase the percentage of Californians with diagnosed HIV infection who are in HIV medical care (at least one visit per year) to at least 90 percent.

When the plan was conceived, the intention was to meet those goals by December 2021. The latest California data available, however, suggest there is a considerable way to go. New HIV cases per year since 2017 have averaged 4,600, compared to the target of 2,500. Among those newly diagnosed in 2018, the proportion linked to HIV care within a month of diagnosis was 79% and those linked to care within three months was 85%, compared to the target of linking 85% to care within a month of diagnosis. Only 64% of newly diagnosed persons in 2018 were virally suppressed within six months, 11% lower than the target of 75%. Even at the end of 12 months, only 70% of those newly diagnosed achieved viral suppression. As for all PLWH statewide, the proportion linked to care who had at least one CD4, viral load, or HIV-1 genotype test in a year, averaged 64% between 2017 to 2018, far below the target of 90%. For the same group, the goal is for 80% to attain viral suppression; in both 2017

and 2018, the actual proportion that met this target was 56%. Finally, the total number of PrEP users, irrespective of risk level, averaged roughly 24,000 in California, compared to the target of 60,000 high-risk persons using PrEP.

To accelerate the use of effective strategies like PrEP and TasP in the areas and communities most affected by HIV, the federal government launched a new ten-year initiative called Ending the HIV Epidemic: A Plan for America (EHE). The goal of this plan is to reduce the number of new HIV infections by 75% by 2025 and 90% by 2030. EHE is initially focusing efforts in 48 counties, Washington, DC, San Juan (PR), and seven states with substantial rural HIV burden.

As part of the EHE, the Centers for Disease Control and Prevention (CDC) and the Health Resources and Services Administration (HRSA) are providing additional resources to state and local health departments in the 57 jurisdictions to develop and implement their local plans. To launch the program, the CDC awarded $109 million to state and local health departments while HRSA awarded $117 million to service delivery sites and Ryan White HIV/AIDS Program recipients. The collective programming funded by CDC and HRSA falls under four key pillars:

1. **Diagnose** all people with HIV as early as possible.
2. **Treat** people with HIV rapidly and effectively to help them reach sustained viral suppression.
3. **Prevent** new HIV transmissions by using proven prevention interventions, including Pre-Exposure Prophylaxis (PrEP) and syringe services programs (SSPs)
4. **Respond** rapidly to potential HIV outbreaks to get needed prevention and treatment services to people who need them.

Eight California Counties have been prioritized in the EHE: Alameda, Orange, Los Angeles, Riverside, Sacramento, San Bernardino, San Diego, and San Francisco. Additional federal funding in the hardest hit areas is intended to address barriers and disparities that have limited the successful uptake of proven-effective interventions like PrEP and TaSP. Policymakers need tools to make better and more informed decisions about funding allocation. Being able to predict likely outcomes of potential interventions is a critical component of California's statewide planning efforts. This can be achieved through computer-based simulation models, such as microsimulation models.

What is Microsimulation Modeling?

Modeling is a term used to describe different mathematical models to simulate processes and phenomena such as disease transmission. Microsimulation models are a particular type of such models, designed to capture complex disease dynamics with a series of transition probabilities that quantify the likelihood, for example, of transitioning from not living HIV to living with HIV. Using the most accurate, available, individual- and/or population-level data, these models can help make predictions about epidemic and economic outcomes. For example, a model could be used to predict to what degree a jurisdiction can help avert new HIV diagnoses based on different levels of PrEP uptake in a certain community.

Microsimulation models are especially powerful because they can simultaneously control for many factors, such as: disease prevalence among likely sex partners, differences across racial and ethnic groups, historical data on linkage to HIV care and treatment adherence, PrEP uptake, and disease prevalence. Microsimulation models can incorporate data that are specific to a geographical location (e.g., a county or local jurisdiction), rather than relying on national estimates that might not accurately reflect the local situation. Most importantly, a microsimulation model can be used to project the

impact of implementing different hypothetical policies (e.g., supporting PrEP implementation) on ultimate outcomes of interest, such as viral suppression, new infections, or mortality. Because microsimulation models can support ethnic and gender-specific predictions, they have the potential to provide a useful forecast of the disparate impact of different policies on the ethnic/racial groups included in the model.

Information incorporated in the current microsimulation models includes: (1) historical surveillance data to understand patterns of transmission; (2) documented effectiveness of interventions such as PrEP from randomized trials; and (3) historical data on prevalence of HIV in particular sexual networks. Current models work toward understanding what strategies or combinations of strategies may be most effective in averting new HIV diagnoses among MSM.

Strategic Partnerships

The California HIV/AIDS Policy Research Centers, in partnership with the UCLA Center for HIV Identification, Prevention and Treatment Services' (CHIPTS) Policy Impact Core and colleagues from the University of Southern California (USC) and Johns Hopkins University, is developing microsimulation models of HIV transmission. Given the existing disparities in HIV outcomes among men who have sex with men (MSM), these initial models in Los Angeles, San Diego and San Francisco counties focus on this population. Our team is actively collaborating with the California State Office of AIDS, the Division of HIV and STDs in Los Angeles, the San Francisco Department of Public Health, and the San Diego County Department of Public Health, to both populate the model with existing surveillance data and to learn which interventions would be most productive to model.

Health Equity

In California, MSM accounted for 73% of all PLWH in 2018. Of roughly 4,700 new HIV cases that year, 66% were associated with MSM, including MSM with injection drug use. Rates of new diagnoses per 100,000 for MSM of all race/ethnicities decreased from 2010 to 2018, except for Asians, whose rates were constant over the period. Those rates for Black and Latino MSM were, respectively, four times and twice that of White MSM. MSM newly diagnosed with HIV in 2018 had higher rates of linkage to care and viral suppression than statewide rates overall, except for Black MSM. Among persons newly diagnosed with HIV, 79% were linked to care in 30 days and 64% achieved viral suppression in 6 months, but the corresponding figures for newly diagnosed Black MSM were 74% and 58%, respectively (California Department of Public Health, 2020).

Though PrEP is a key strategy for reducing HIV transmission, among women and Black and Latino persons in particular, the gap between persons with PrEP indications and those given prescriptions is considerable (Huang et al., 2018). National HIV Behavioral Surveillance data in 2017 from 23 urban areas indicated that only one-third of MSM with PrEP indications reported taking PrEP in the past year, and the gap between being indicated for PrEP and PrEP use was larger for Hispanic and Black MSM than White MSM (Kanny et al., 2019). In California, increases in PrEP uptake among Medi-Cal enrollees were initially lower for Hispanic and Black enrollees than their White counterparts. This pattern reversed from 2016 to 2017, though White enrollees still accounted for the largest proportion of PrEP users covered by Medi-Cal (California HIV/AIDS Policy Research Centers, 2019).

The current models developed for Los Angeles and San Diego counties incorporate information about existing patterns of sexual partnership and adherence to PrEP and antiretrovirals by race/ethnicity. It can predict the effects of PrEP and antiretroviral treatment on new HIV infections among MSM. The models can estimate effects of various strategies on particular groups of MSM, such as racial/ethnic minority MSM. This disaggregation of effects allows us to examine the effect of policies on outcomes for the entire MSM population as well as on disparities in outcomes across sub-groups (e.g., across

MSM of different racial/ethnic groups) and will be useful in prioritizing policy interventions and funding to target the most impacted communities.

However, the model does have limitations that affect its utility for state and local health departments. First, the model is limited to racial/ethnic MSM. Additional models will be needed to understand the impact of PrEP and antiretroviral treatment on other communities disproportionately impacted by HIV in California, including cisgender women and transgender, gender non-conforming, and intersex individuals. Second, the model currently only examines the effects of PrEP and TasP. Future models should examine the effects of other highly effective HIV prevention strategies, including harm reduction services and SSPs. Third, the model is currently limited to Los Angeles, San Diego, and San Francisco. Additional models will be needed to understand the impact of these various interventions on other highly impacted jurisdictions and the state of California overall. Finally, future models should also explore the impact of various social and economic conditions on HIV-related health outcomes, including housing status and homelessness, citizenship status, education, income, and carceral history.

Future Directions

The models have produced preliminary estimates on the impact of different allocation strategies for increased PrEP use on different population groups. Over the coming year, we will work to enhance the models to incorporate the most recent surveillance data and incorporate measures to address cost effectiveness. Equity demands that modeling studies explicitly consider the needs of key populations who remain at greater risk for poor HIV-related outcomes due to a range of social, economic, and demographic factors. Guiding principles, designed by researchers, public health officials and community stakeholders, can ensure equity considerations hold weight in shaping the model itself, identifying potential gaps in data, generating relevant simulations, and ensuring broad input throughout the various decision-making processes that occur in developing such models. Placing equity considerations at the fore has the additional benefit of garnering early support for policy strategies informed by models.

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