What will it take to ‘End the HIV epidemic in the US’: An economic modeling study in 6 US cities including Miami-Dade County

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On behalf of the Health Economic Research Unit at the Centre for Health Evaluation and Outcome Sciences and the Localized Economic Modeling Group. R01 DA041747. PI: Nosyk B; Co-I: Schackman BR, Gebo K, Metsch L, Feaster D, Kirk G, Golden M, Mehta S, Shoptaw S, Strathdee S, Dombrowski J, Montaner JSG, Small W, Poon AFY, Del Rio C. Localized economic modeling to optimize public health strategies for HIV treatment and prevention. National Institutes on Drug Abuse; RFA-DA-16-001.

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SFU

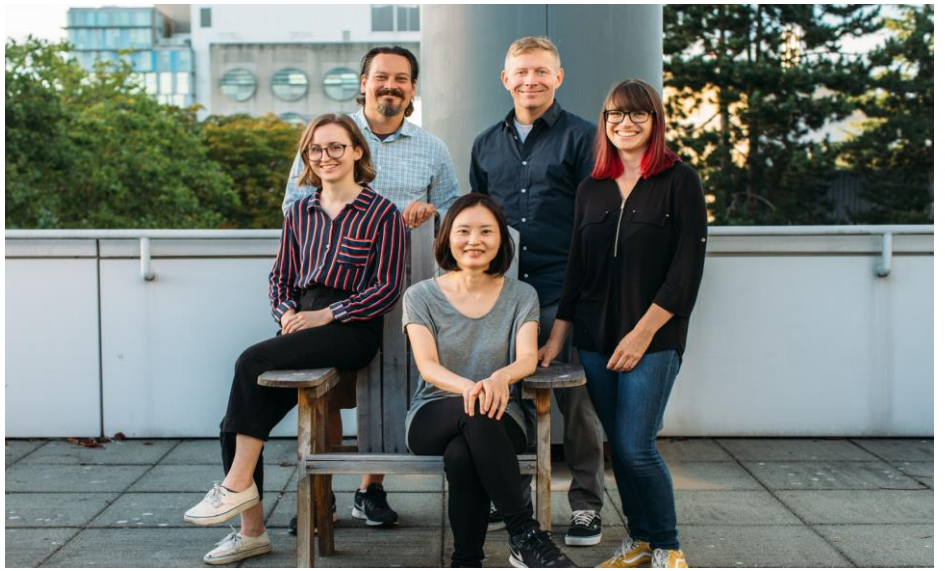
CHÉOS Centre for Health Evaluation & Outcome Sciences

Outline

- Introduction
- Study background
- Results
- Next steps
- Discussion/Q&A

The Health Economic Research Unit at CHEOS

- Bohdan Nosyk, PhD, Research Scientist
- Jeong Eun Min, MSc, Senior Statistician (2013 -)
- Emanuel Krebs, PhD (c), Senior Health Economist (2013 -)
- Xiao Zang, PhD, Postdoctoral Fellow (2015 -)
- Benjamin Enns, MA, Health Economist (2016 -)
- Fahmida Homayra, MSc, Statistician (2018 -)
- Micah Piske, MScPH, Epidemiologist (2018 -)
- Megan Kurz, MSc, Statistician (2020 -)
- Laura Dale, MPH, Project Coordinator (2020 -)
- Lia Humphrey, MSc, Math Modeler (2021 -)
- Bianca Yeung, BSc, Project Coordinator (2021 -)



Left to right: Laura Dale, Bohdan Nosyk, Jeong Min, Emanuel Krebs, Megan Kurz

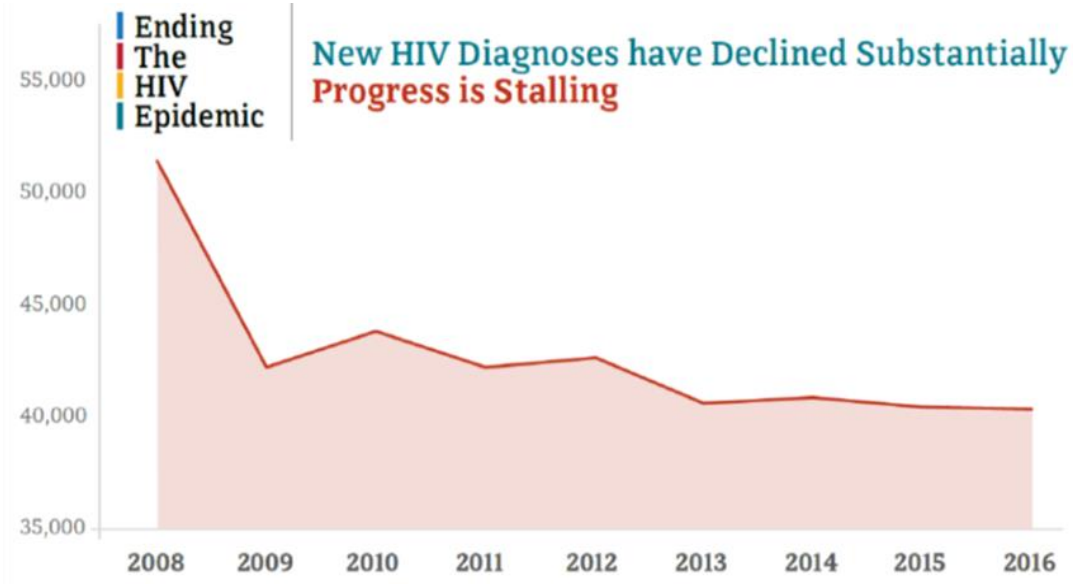


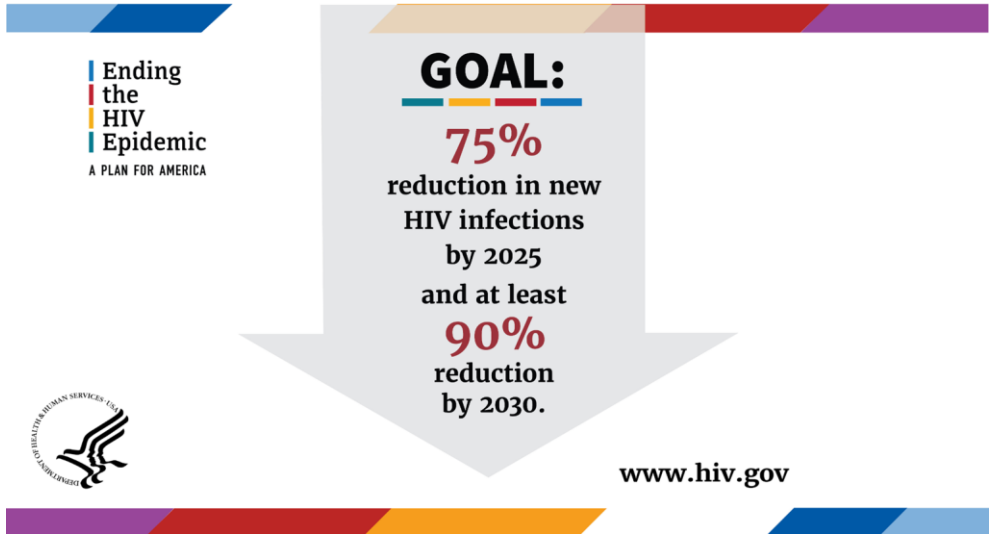



Top left to bottom right: Xiao Zang, Ben Enns, Fahmida Homayra, Micah Piske, Lia Humphrey, Bianca Yeung.

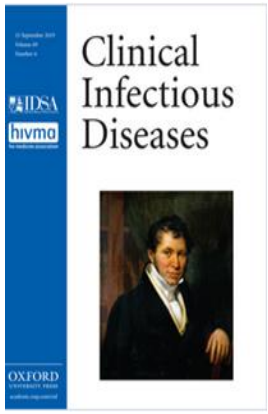
Study Background

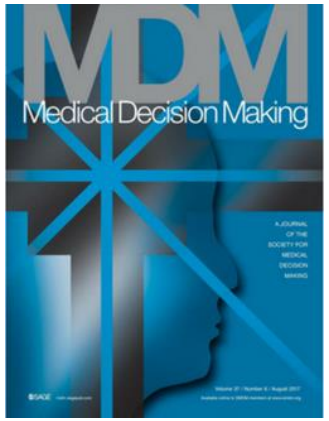
- In 2016 we began a study to identify combination strategies to reduce the public health burden of HIV/AIDS in six US cities including Miami
- Included 12 of 48 Ending the HIV Epidemic (EHE) counties making up ~25% of people living with HIV in the US
- Research question: What combinations of evidence-based interventions to ***Diagnose, Treat*** and ***Prevent*** HIV/AIDS will achieve the greatest health benefits for each setting?





Background Research





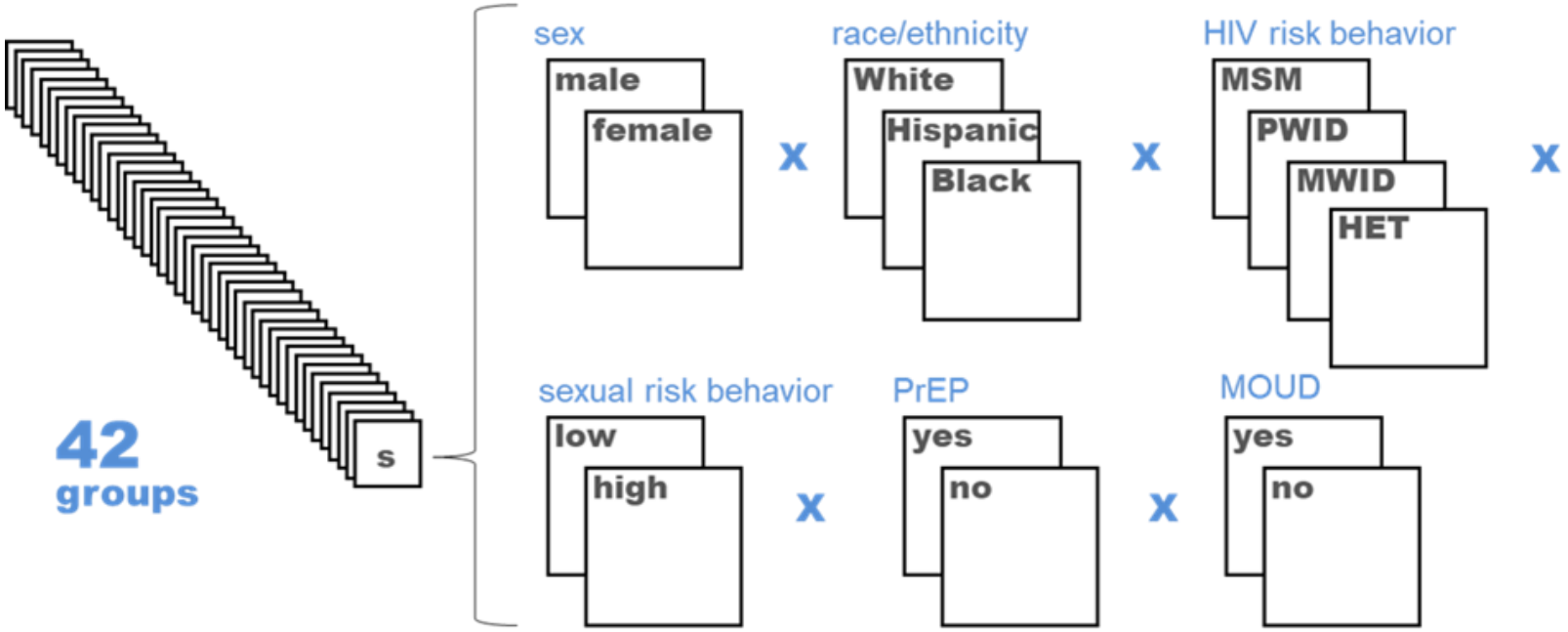
1. **Scientific Case** (Panagiotoglou et al, AIDS Behav. 2018;22(9):3071-3082)
2. **Evidence Synthesis** (Krebs et al, PLoS One. 2019;14(5):e0217559)
3. **Medical Care Costs** (Enns et al, AIDS. 2019;33(9):1491-1500)
4. **Disease progression, ART persistence** (Wang et al, Lancet HIV. 2019;6(8):e531-e539)
5. **Model Calibration and Validation** (Zang et al, Med Decis Making. 2020;40(1):3-16)
6. **Defining the 'status quo' comparator** (Nosyk et al, Clin Infect Dis. 2019;69(12):2195-2198)
7. **Defining the evidence-based interventions** (Krebs et al, AIDS 2020;34(3):447-458)
8. **What will it take to 'End the HIV Epidemic' in the US?** (Nosyk et al., *Lancet HIV,* 2020;7(7):e491-e503.)
9. **Reducing racial disparities to 'End the HIV Epidemic' in the US** (Quan et al, Lancet HIV. 2021;8(9):e581-590)

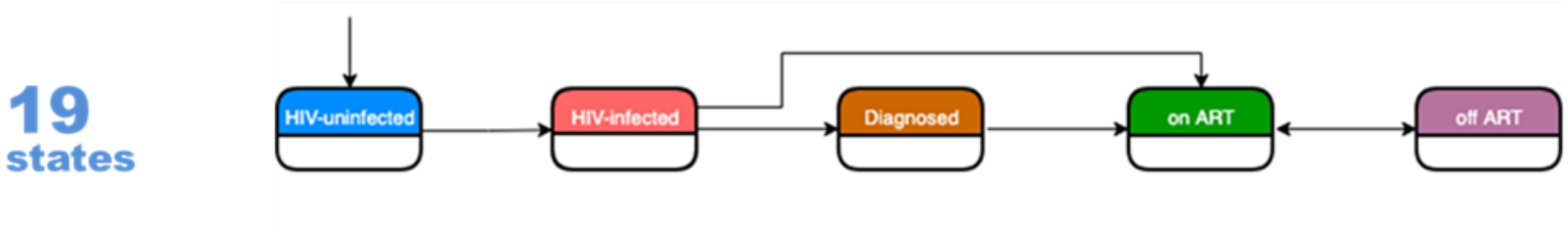
Our focal cities: Home to 24.1% of the US population of people living with HIV/AIDS

Total adult 15-64 Population (% projected change to 2040)						
Total population (2016)	3,812,143 (37%)	1,874,601 (-1%)	6,964,983 (-2%)	1,821,311 (16%)	5,865,683 (3%)	1,503,497 (15%)
Adult 15-64 Population by race/ethnicity (% projected change in proportion by 2040)						
Black / African American	1,336,469 (-1%)	553,665 (5%)	568,815 (-1%)	296,354 (-2%)	1,304,687 (-1%)	95,550 (1%)
Hispanic / Latinx	391,265 (10%)	102,495 (3%)	3,385,948 (4%)	1,246,583 (7%)	1,703,286 (4%)	137,818 (7%)
Non-Hispanic White and others	2,084,409 (-9%)	1,218,441 (-8%)	3,010,220 (-3%)	278,374 (-5%)	2,857,710 (-3%)	1,270,129 (-8%)
People Living with HIV (rate/100,000) †						
Prevalence	31,961 (670)	16,931 (718)	48,100 (564)	26,128 (1,120)	117,260 (959)	7,768 (312)
New diagnoses	1,618 (33)	441 (19)	1,720 (20)	1,150 (49)	2,608 (21)	248 (10)
National Rank Δ	2	25	27*	1	21*	75*

Replicating city-level HIV epidemics among adults aged 15 to 64

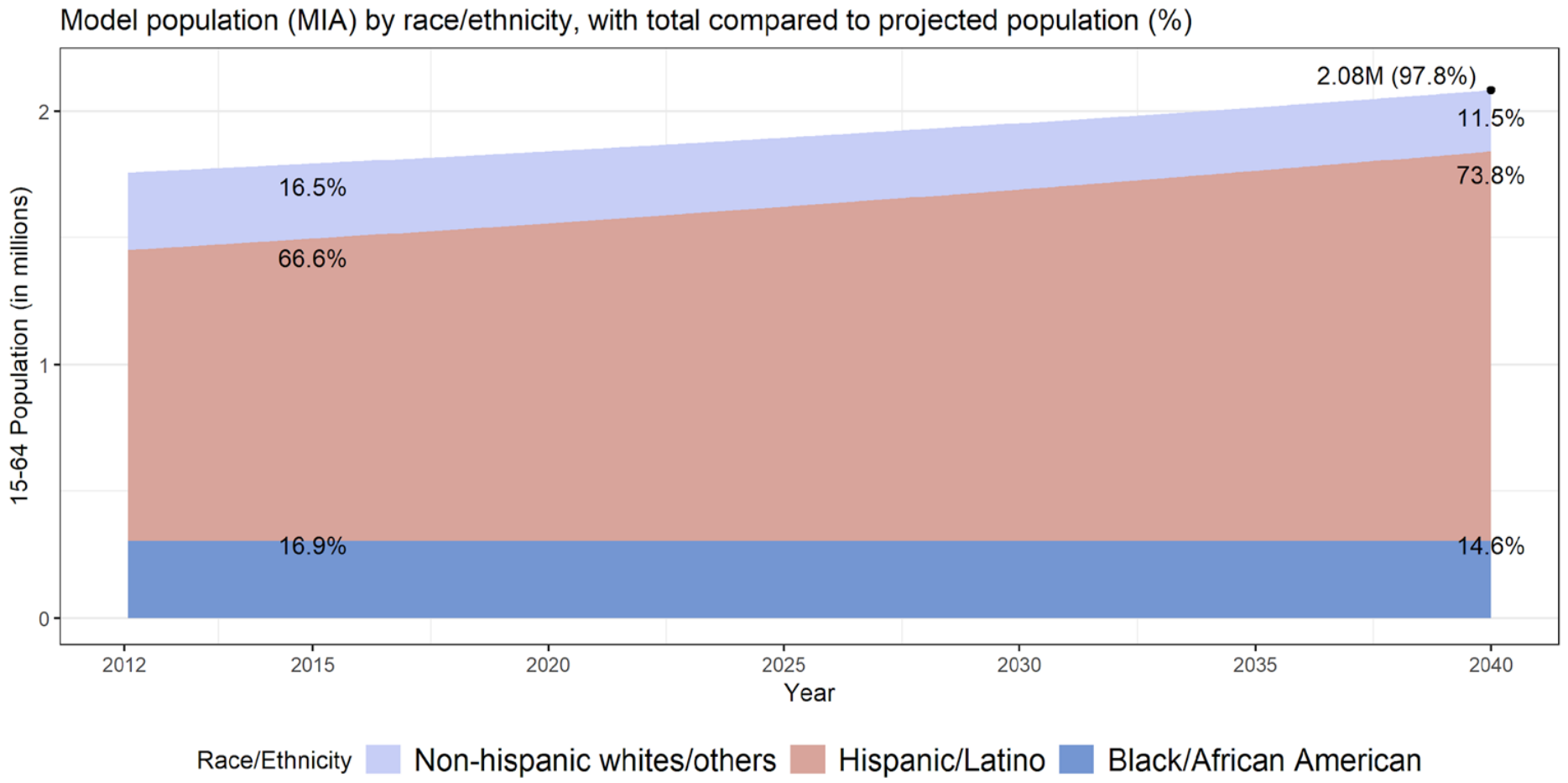
The population aged 15-64 was stratified according to:





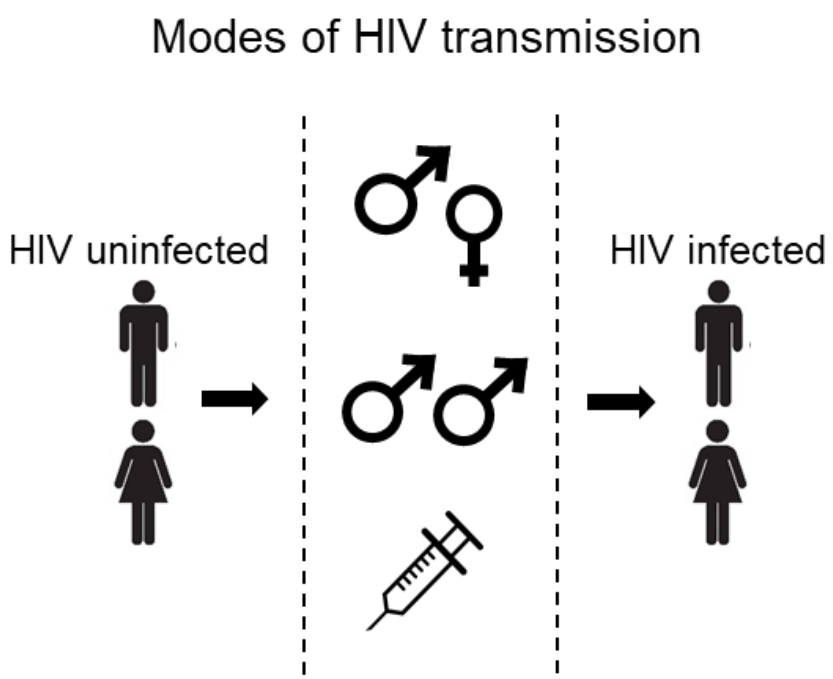
Health states were also separated by CD4 cell count among HIV-infected, acute HIV among newly infected individuals, and included HIV-infected individuals cycling between on and off ART states.

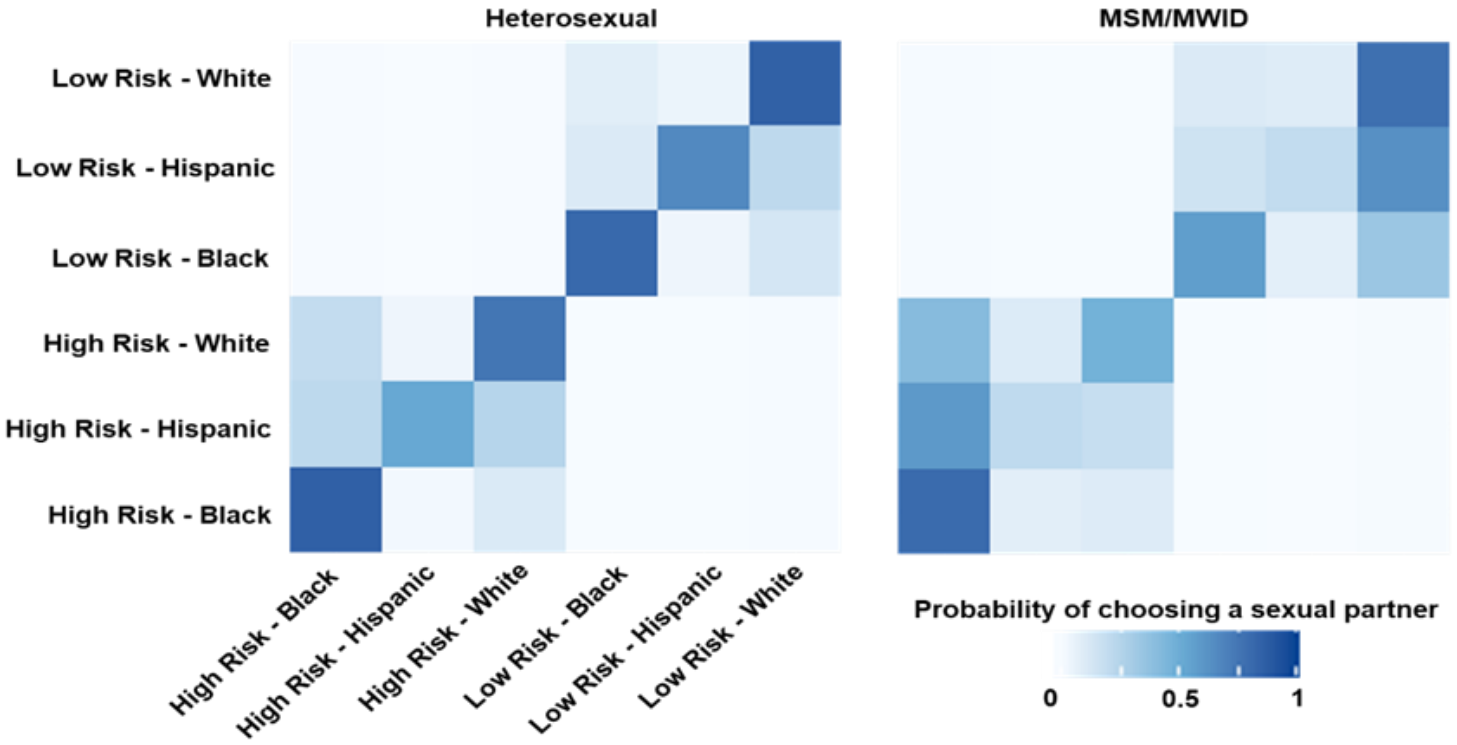
Miami's projected population, demographic shift in 2040



- According to University of Florida - Bureau of Economic and Business Research[1], Miami's adult population (15-64) is projected to grow to 2.08 million in 2040.
- The Hispanic population is expected to increase in proportion during that time (66.6% to 73.8%).

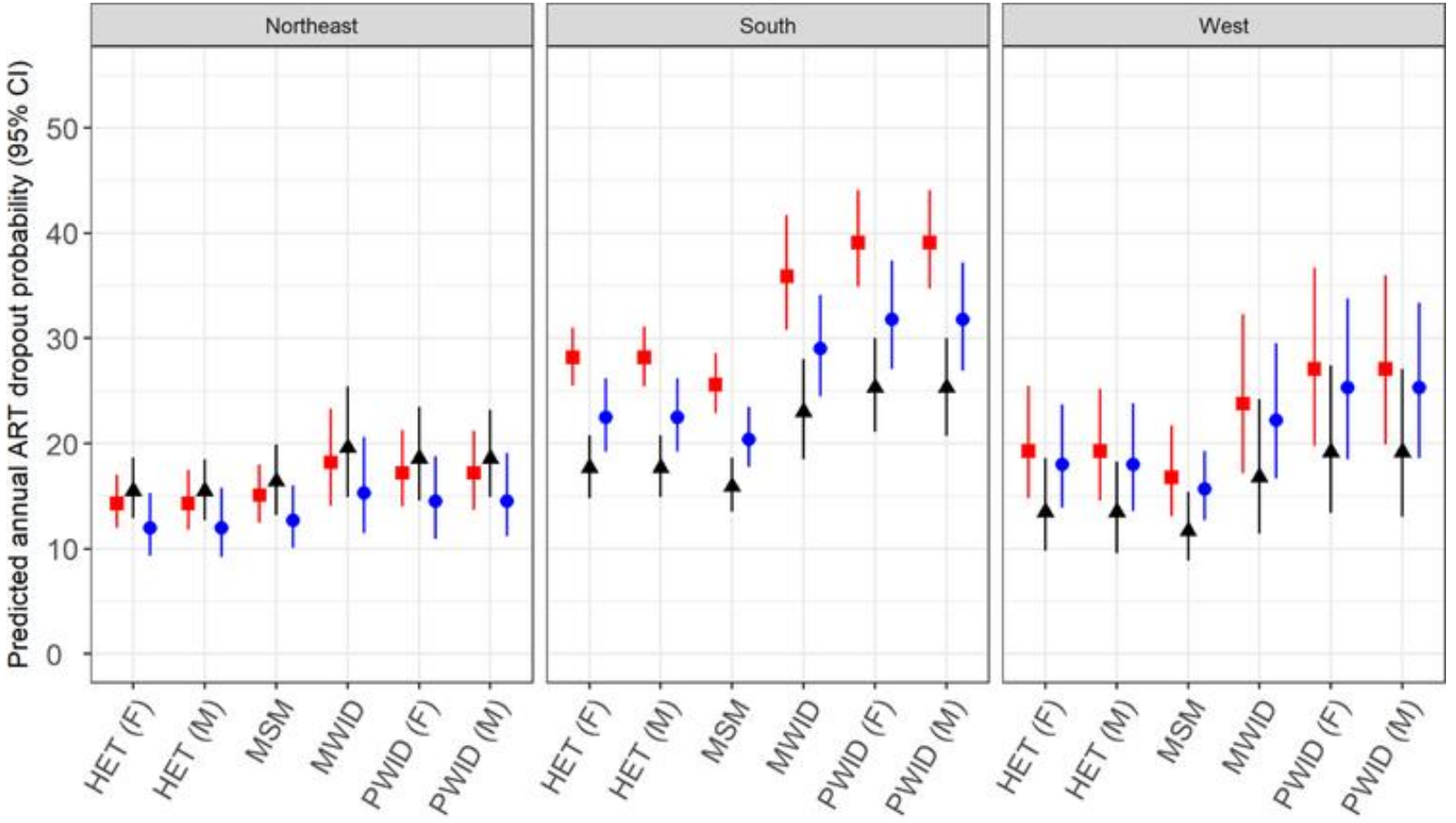
How did we capture the force of HIV infection?





Assortative sexual mixing imposed: HIV-infected and uninfected individuals had a higher probability of mixing within the same race/ethnic groups, informed by literature estimates for MSM[9], and Southern regional estimates derived from the National Survey of Family Growth for Heterosexuals[10].

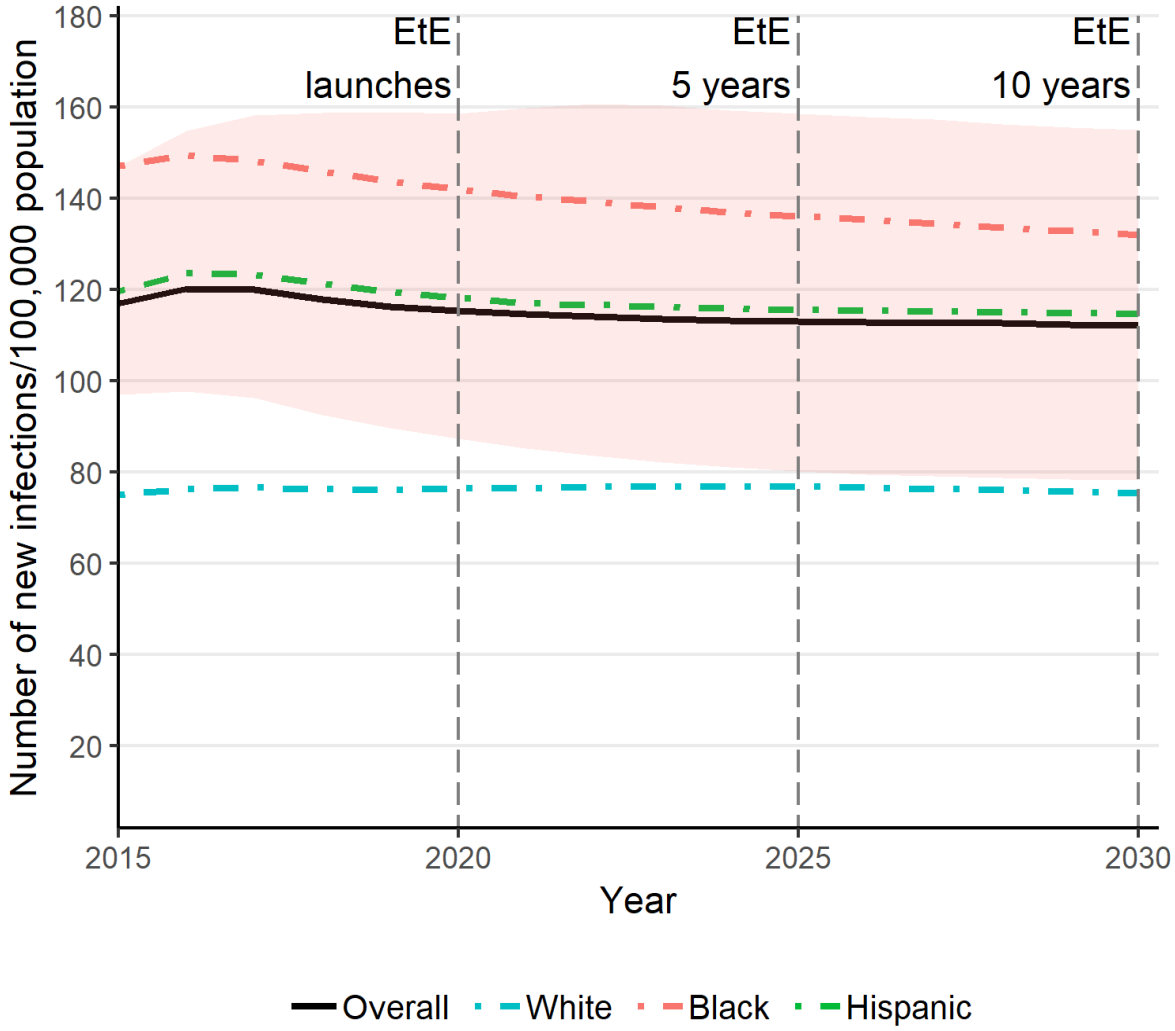
ART discontinuation in the Northeast, South and West



- PLHIV from the South had an increased hazard of ART dropout (aHRs from 1.91–2.45) compared to the Northeast.
- Black PLHIV had an increased hazard of ART dropout across risk groups; the difference was greatest in the South

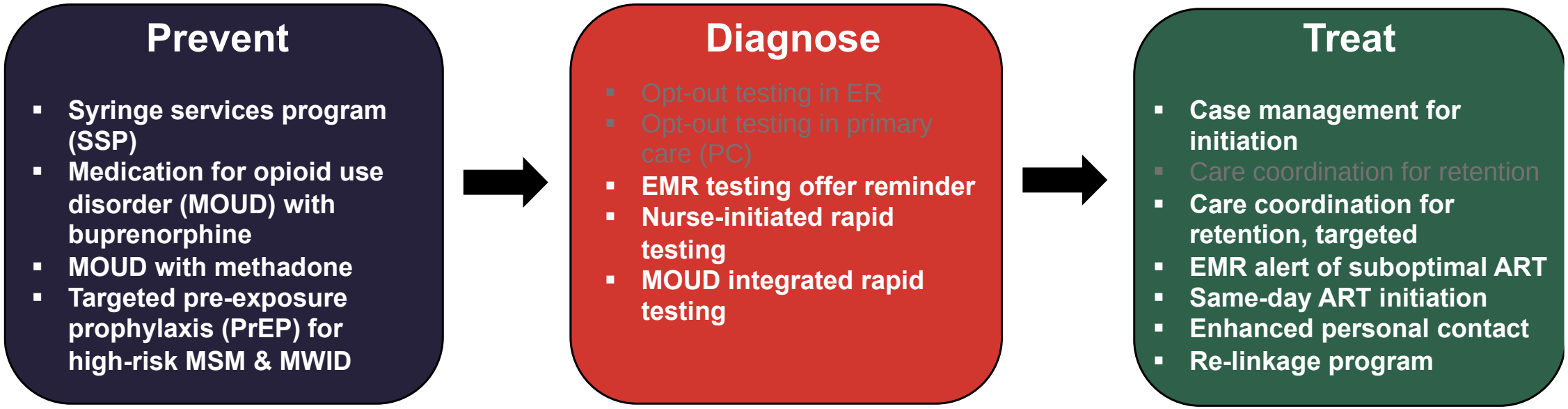
Wang et al. Lancet HIV. 2019; 6(8): e531–e539.

What will the HIV epidemic in Miami look like maintaining status quo (2015/17) service levels?



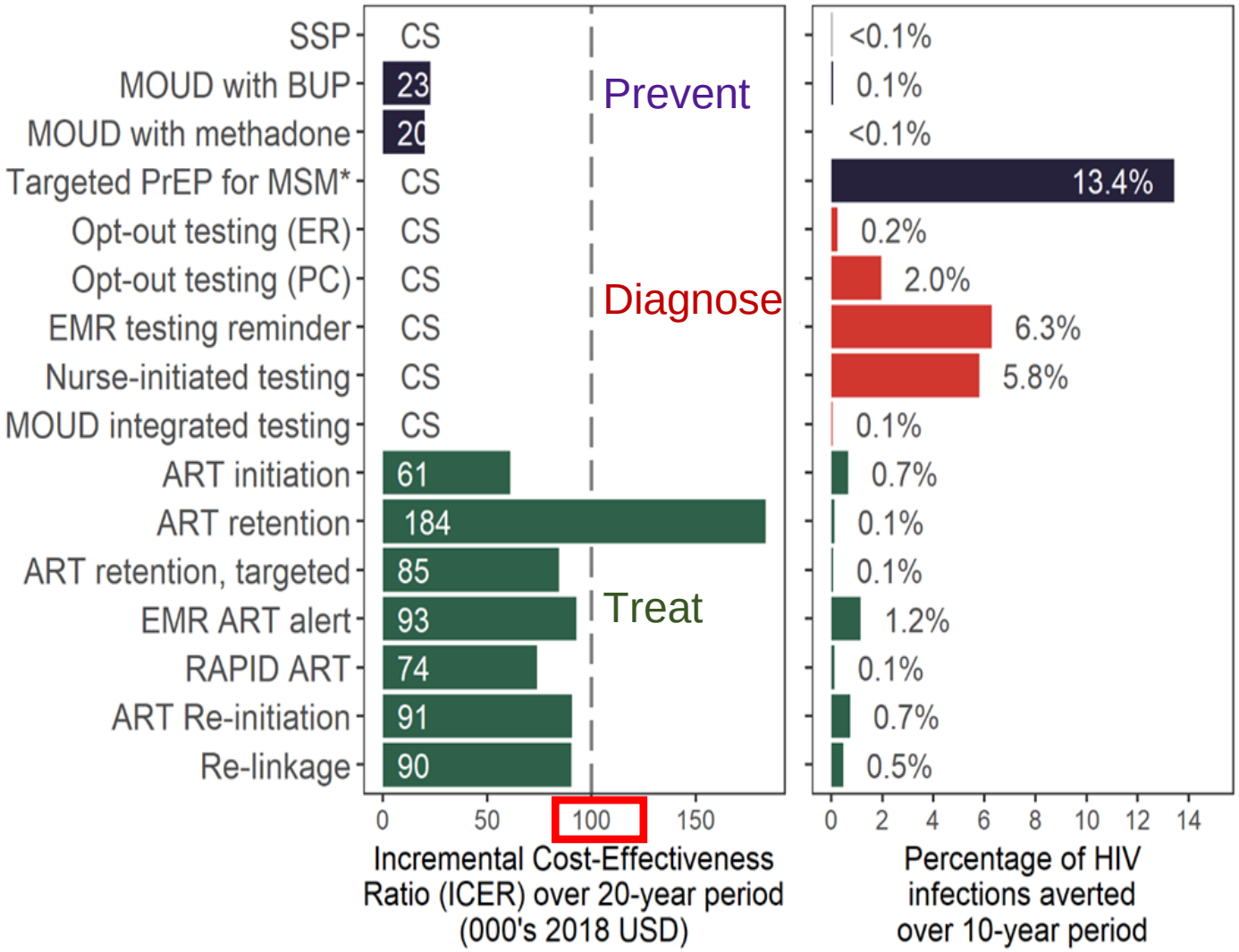
We projected stable overall HIV incidence with a decline among black individuals (due to saturation in Black MSM) and an increase among Hispanic MSM which we estimate will drive HIV incidence.

What can be achieved with combinations of evidence-based interventions?



13 evidence-based interventions were included in Miami's health-maximizing strategy

Cost-effectiveness of interventions and infections averted

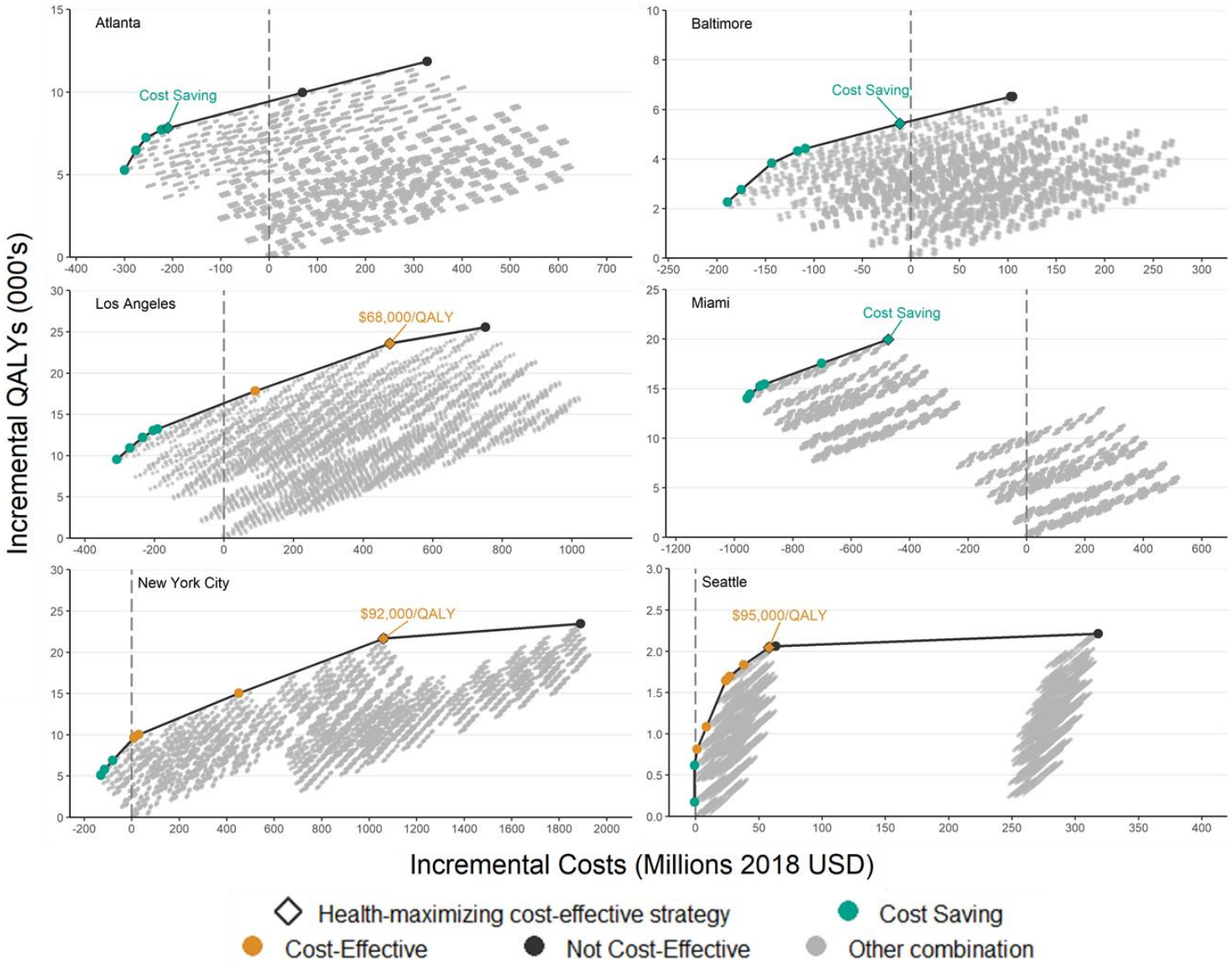


- Scale-up of interventions to ***Prevent*** and ***Diagnose*** HIV/AIDS were cost-saving at conventional levels excluding MOUD.
- Scale-up of interventions to ***Treat*** HIV were cost-effective, excluding ART retention.
- **No single intervention will reduce HIV incidence by more than 13.4%** between 2020 and 2030.

ICER<$100(000) USD= Cost-effective; **CS: cost-saving**

Krebs et al. *AIDS*. 2020;34(3):447-458.

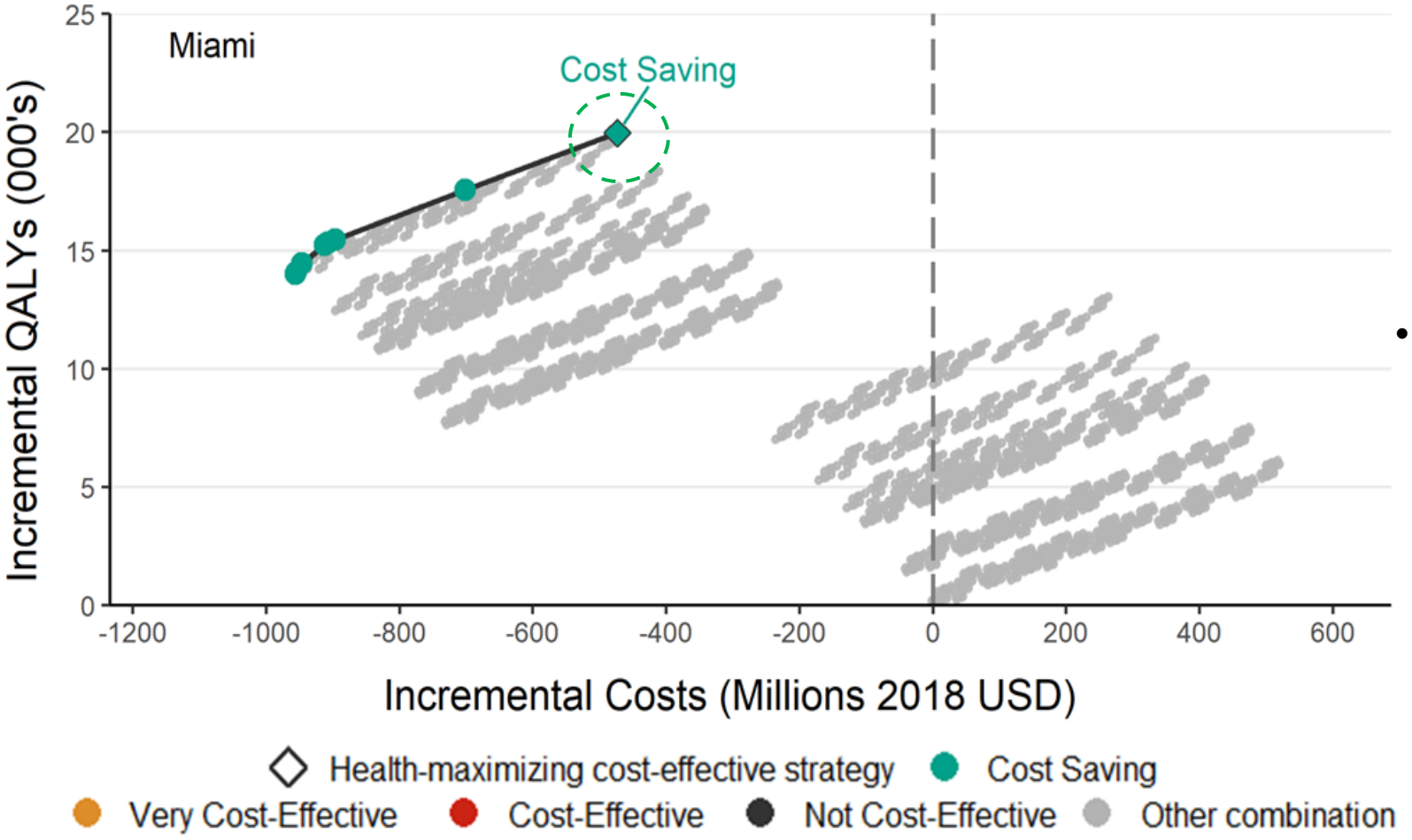
Highest-valued combination implementation strategies across cities



- Each city's health-maximizing combination implementation strategy was unique; between 9 and 13 individual evidence-based interventions included
- Health impacts and associated costs differed substantially across cities
- Greatest value in intervening in cities with greatest need

Nosyk et al. Lancet HIV, 2020;7(7):e491-e503.

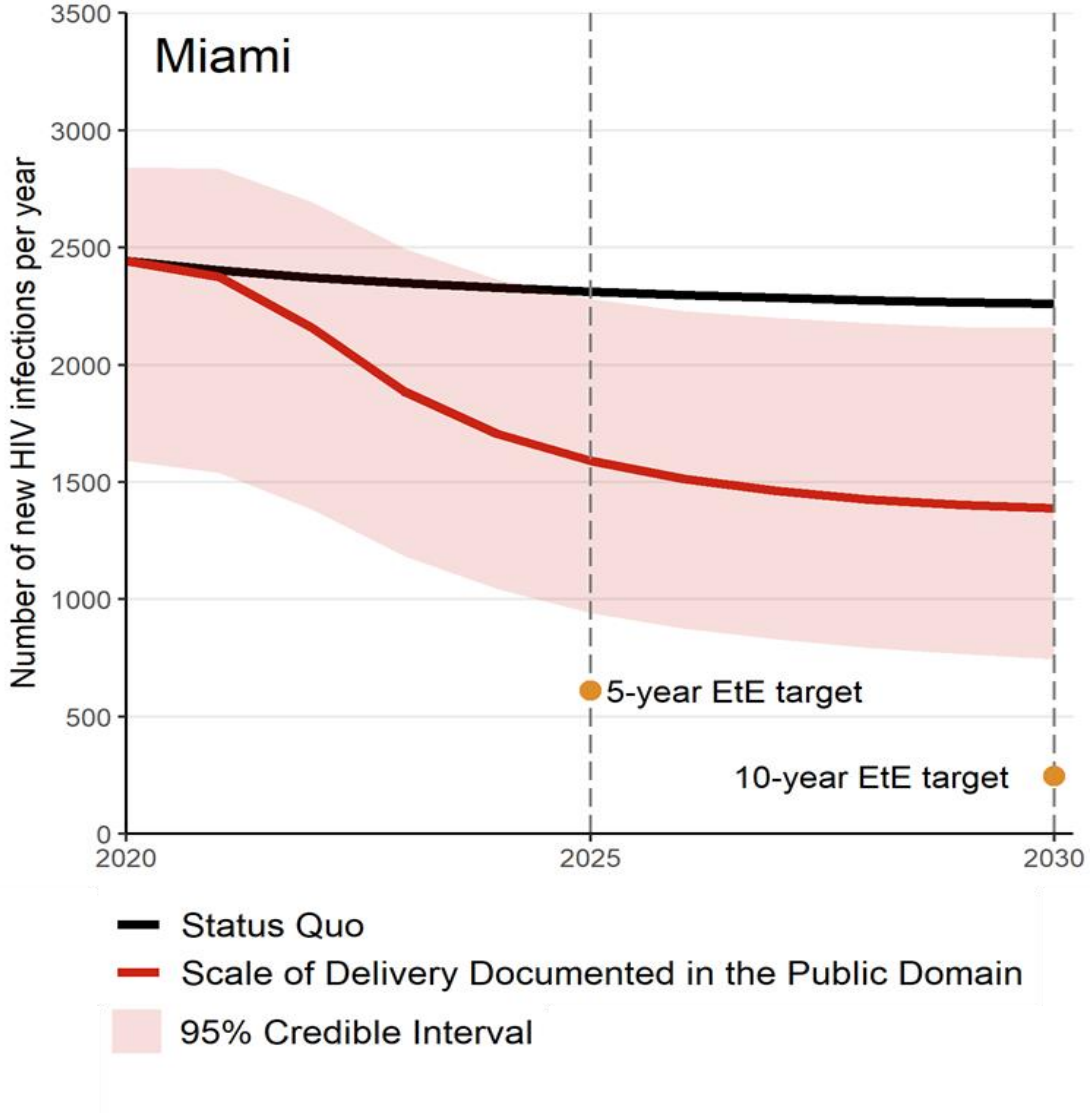
What can be achieved with combinations of evidence-based interventions?



- The green circled strategy includes **13 evidence-based interventions** will deliver a gain of 19,973 QALYs at a savings of $473.7M in present value over a 20-year time horizon.
- The costliest strategy (ltd testing, no SSP or PrEP) is estimated to cost an additional $994.2M over 20 years while delivering only 30.1% of the QALY gain of the selected strategy (31.4% fewer infections averted in 2030).

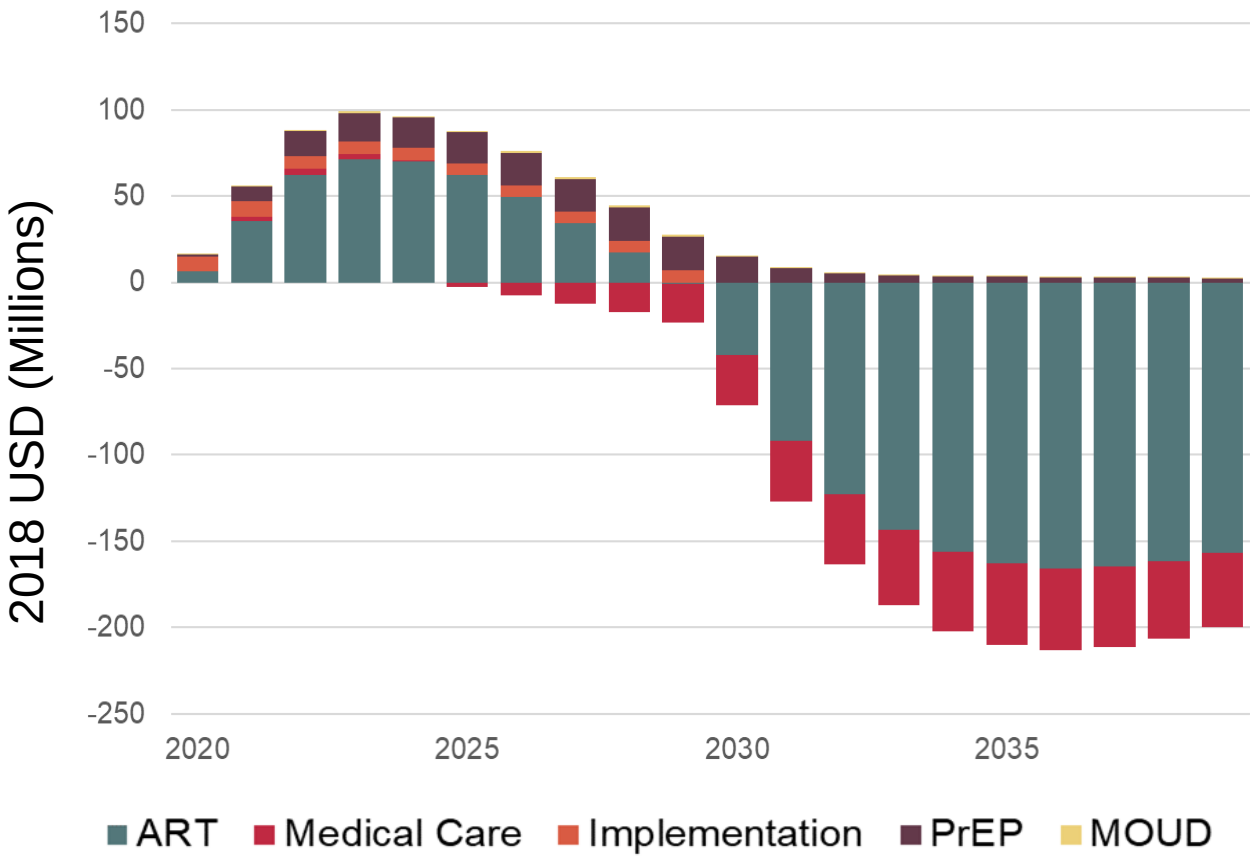
Nosyk et al. *Lancet HIV*. 2020;7(7):e491-e503.

What can be achieved with combinations of evidence-based interventions?



Implementing the **highest-valued combination implementation strategy** delivered at scales documented in the public domain, would reduce HIV incidence by **43%** (21% - 56%) by 2030.

What will it cost to implement this strategy?



- Up-front investments from 2020-2030, peaking at $99M in 2023, resulted in **lower incremental costs post-2029**, due to averted HIV infections and lower medical care/ART medication costs.

- Total incremental costs from 2020 to 2030 were an estimated **$573M** (in present value, using a 3% annual discount rate; or $590M undiscounted).

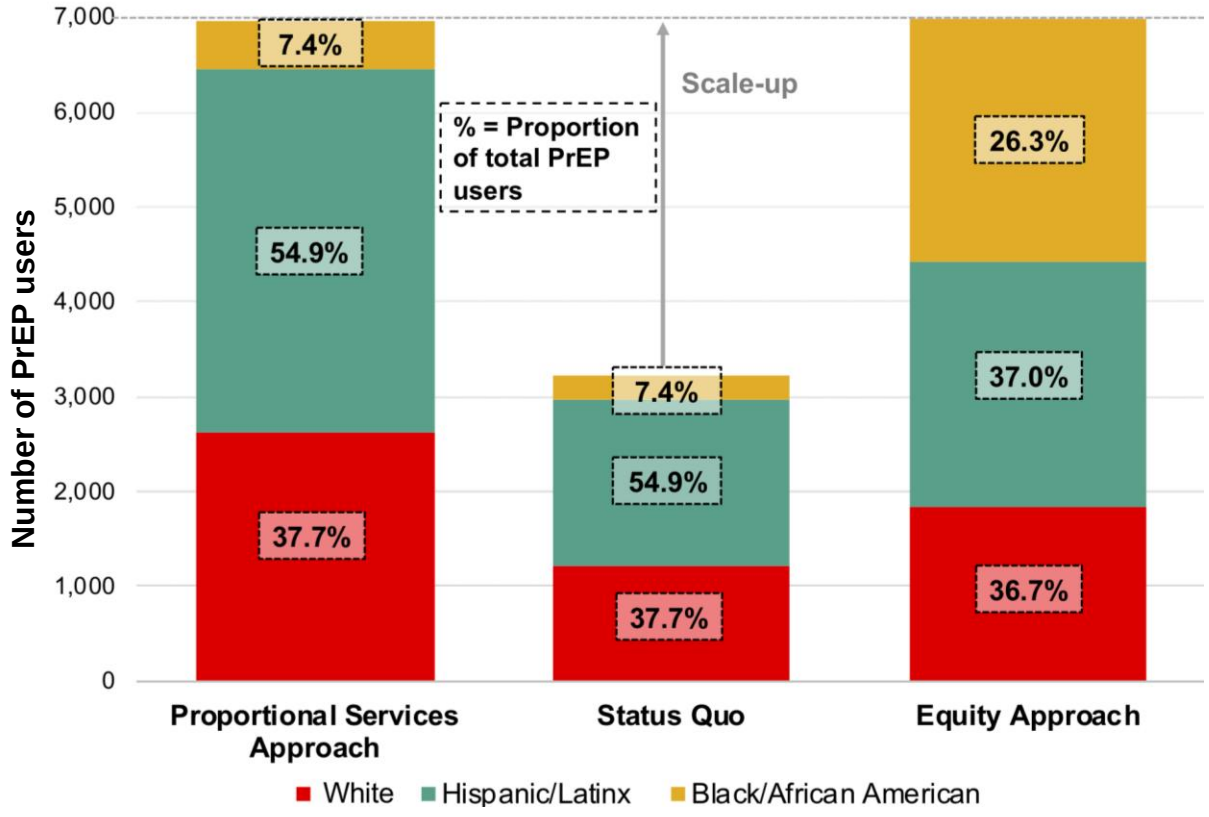
The impact of improving health equity: A distributional cost-effectiveness analysis (DCEA)

Using a novel framework **(DCEA),** we scaled-up interventions under two approaches, identified the most efficient strategies for each, and quantified their impact on racial/ethnic health inequality, HIV incidence, and cost-effectiveness.

Scale-up approaches:

1. **Proportional services approach:** Scale-up across race/ethnic groups was *proportional to baseline levels* reflecting current social and structural constraints on access to care.
2. **Equity approach:** Scale-up across race/ethnic groups was *proportional to their new HIV diagnoses* in 2019. The increase for each group was the weighted total difference between proportional services and baseline.

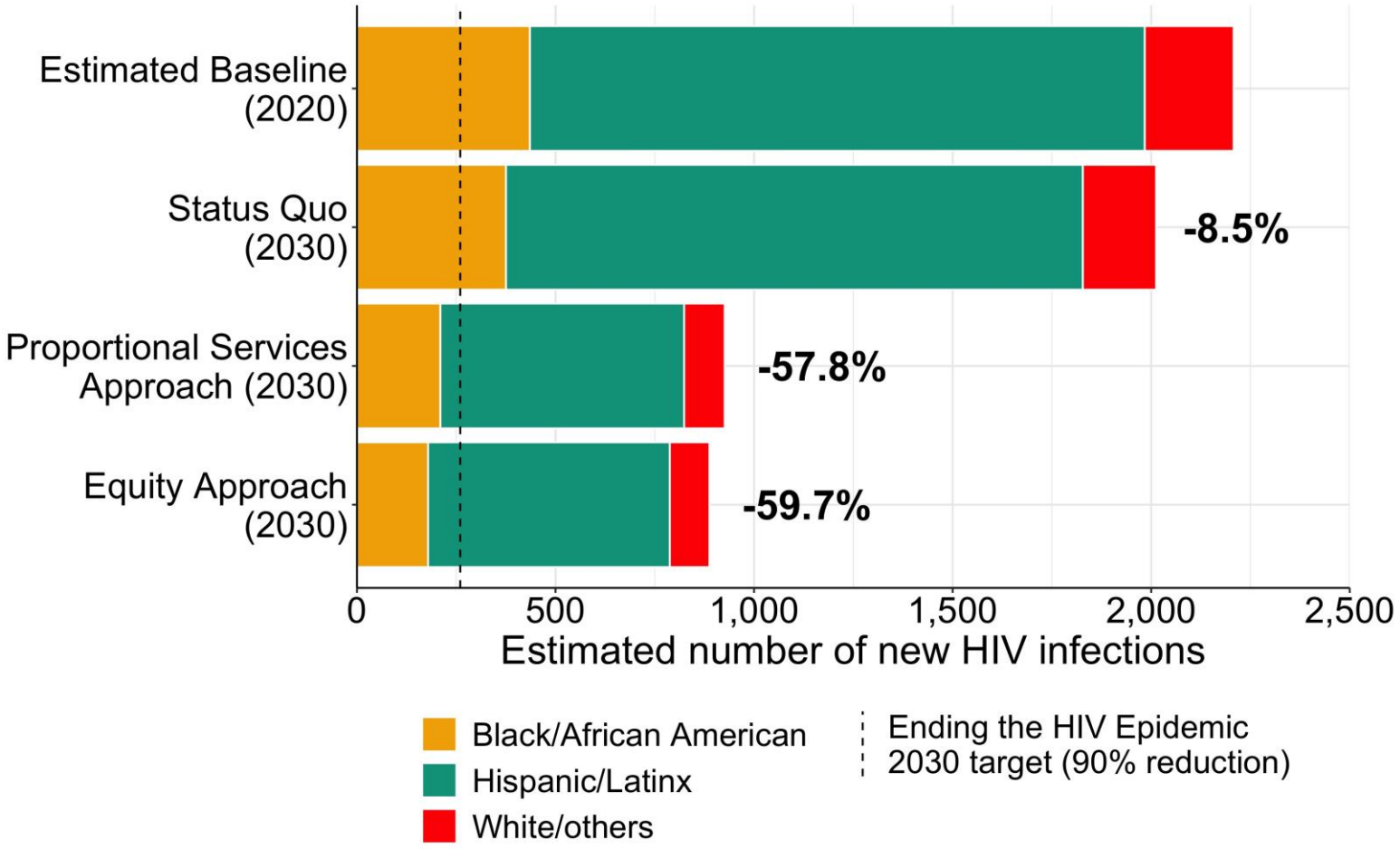
E.g. PrEP scale-up in Miami, by approach



Quan et al. *Lancet HIV*. 2021;71(11):2968-2971.

The impact of improving health equity

HIV incidence reduction under each approach

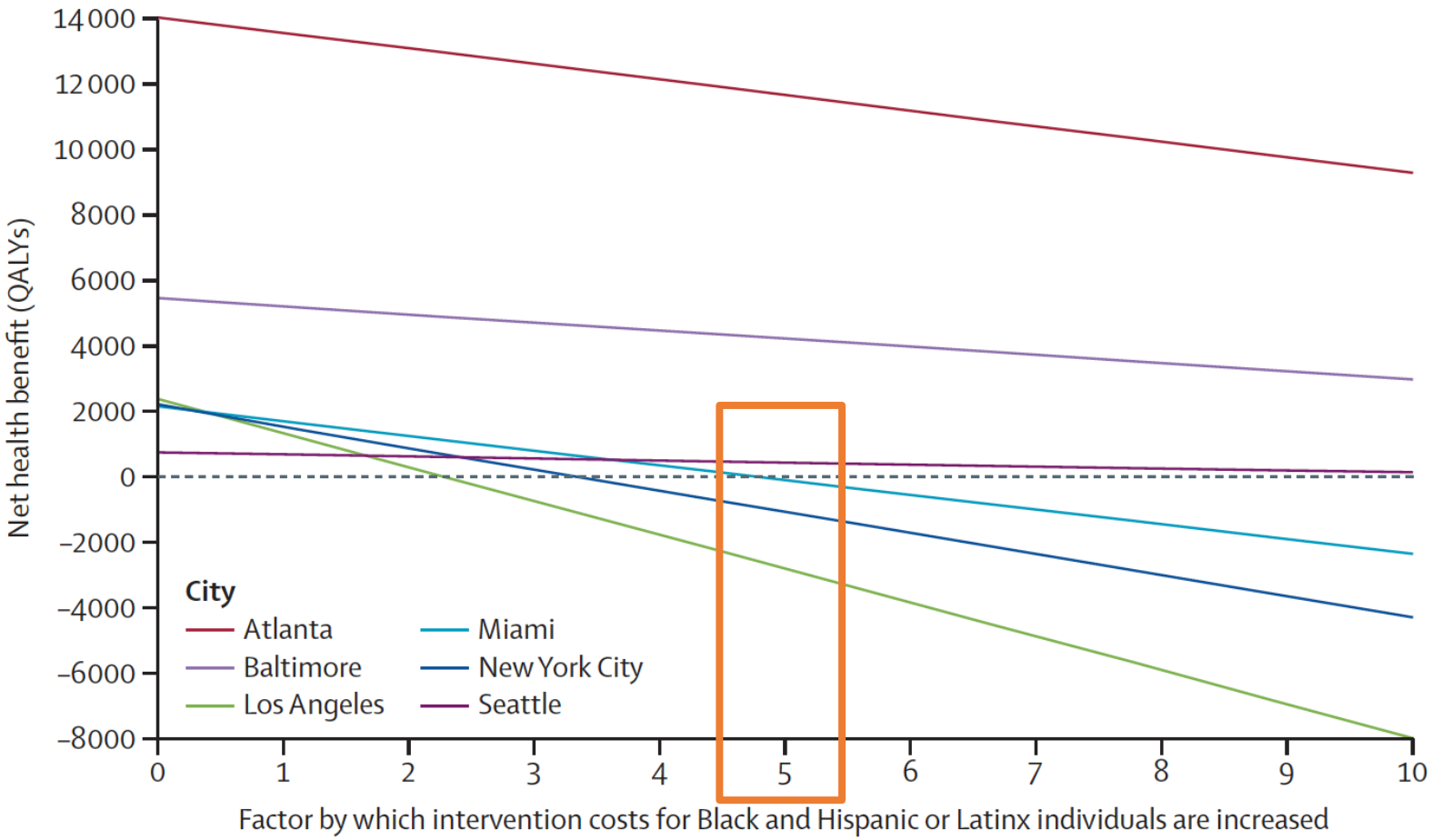


We found that the same combination of interventions, but scaled-up under an equity approach:

- Further reduced HIV infections
- Generated more health gains (QALYs)
- Reduced inequality
- Costed ***$77.6M less*** over 20 years

Quan et al. *Lancet HIV*. 2021;71(11):2968-2971.

What are the costs of improving health equity?



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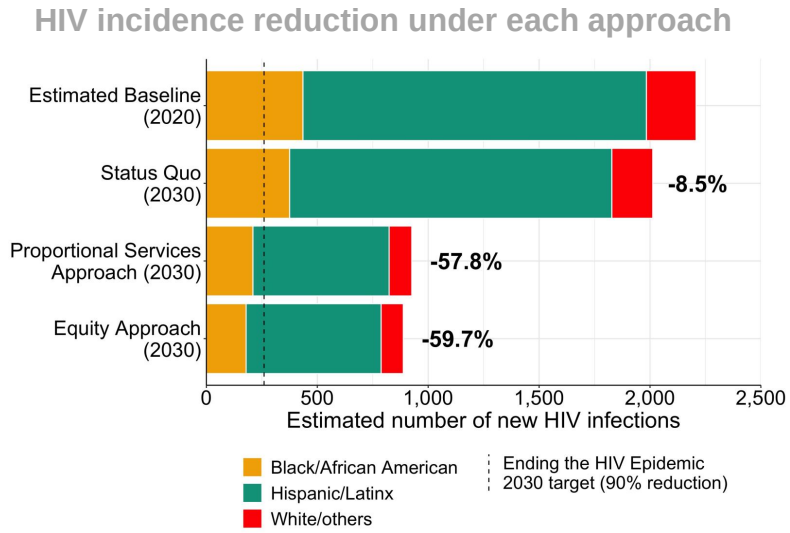
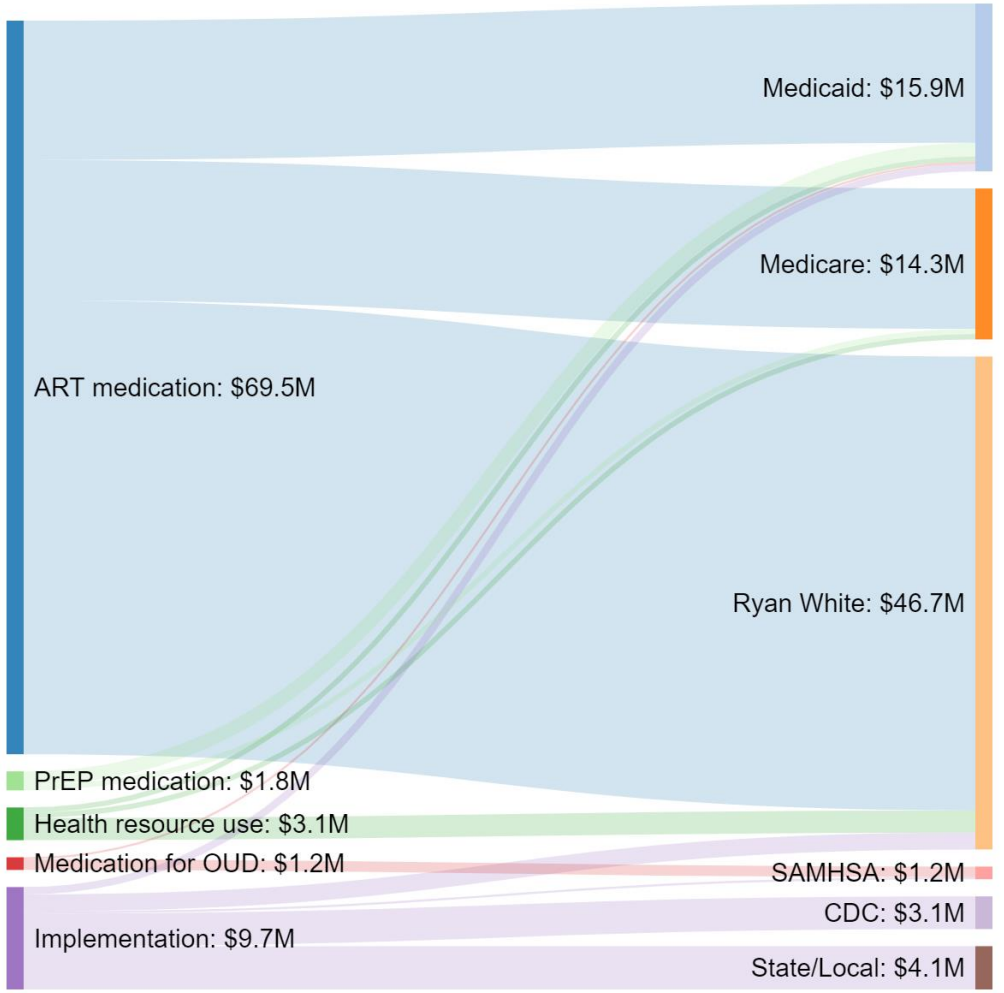


Quan et al. Lancet HIV, 2021;8(9):e581-590

Budget Impact of Local Strategies to End the HIV Epidemic

- We determined the public health resources required for implementation of these strategies through attribution of costs by payer
- Total incremental costs peaked in 2023 for Miami, with ART medication as the largest cost component and Ryan White the biggest payer
- Compared to prior estimates of yearly spending for each funding agency, additional costs in 2023 required increases of:
  - **+9%** Medicaid
  - **+18%** Medicare
  - **+19%** Ryan White (ADAP); **+4%** Ryan White (non-ADAP)
  - **+1%** SAMHSA
  - **+6%** CDC

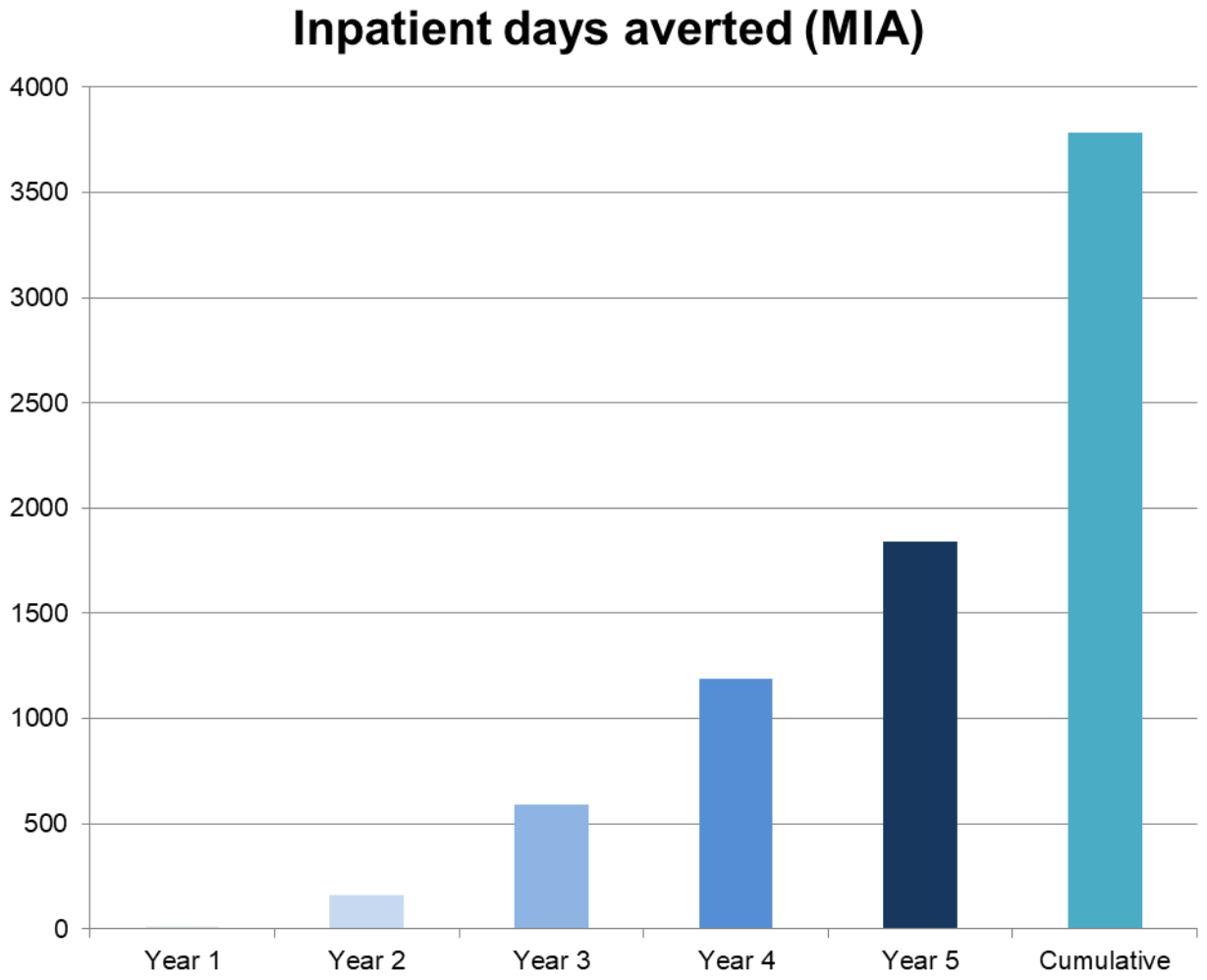
Cost attribution to funding agencies (Miami 2023)



Averted inpatient days among people living with HIV

- We projected the number of **inpatient days** averted among PLHIV aged 15-64 in Miami over the first 5 years of intervention implementation

- Total number of inpatient days averted between intervention scenario and status quo (i.e. total days in hospital regardless of number of individual hospitalizations)



Our next steps (1): Projections on Reaching Florida's Integrated Prevention and Care Plan, 2022-2025

Florida's 4 Key Component Plan to eliminate HIV Transmission and reduce HIV-related deaths, 2020

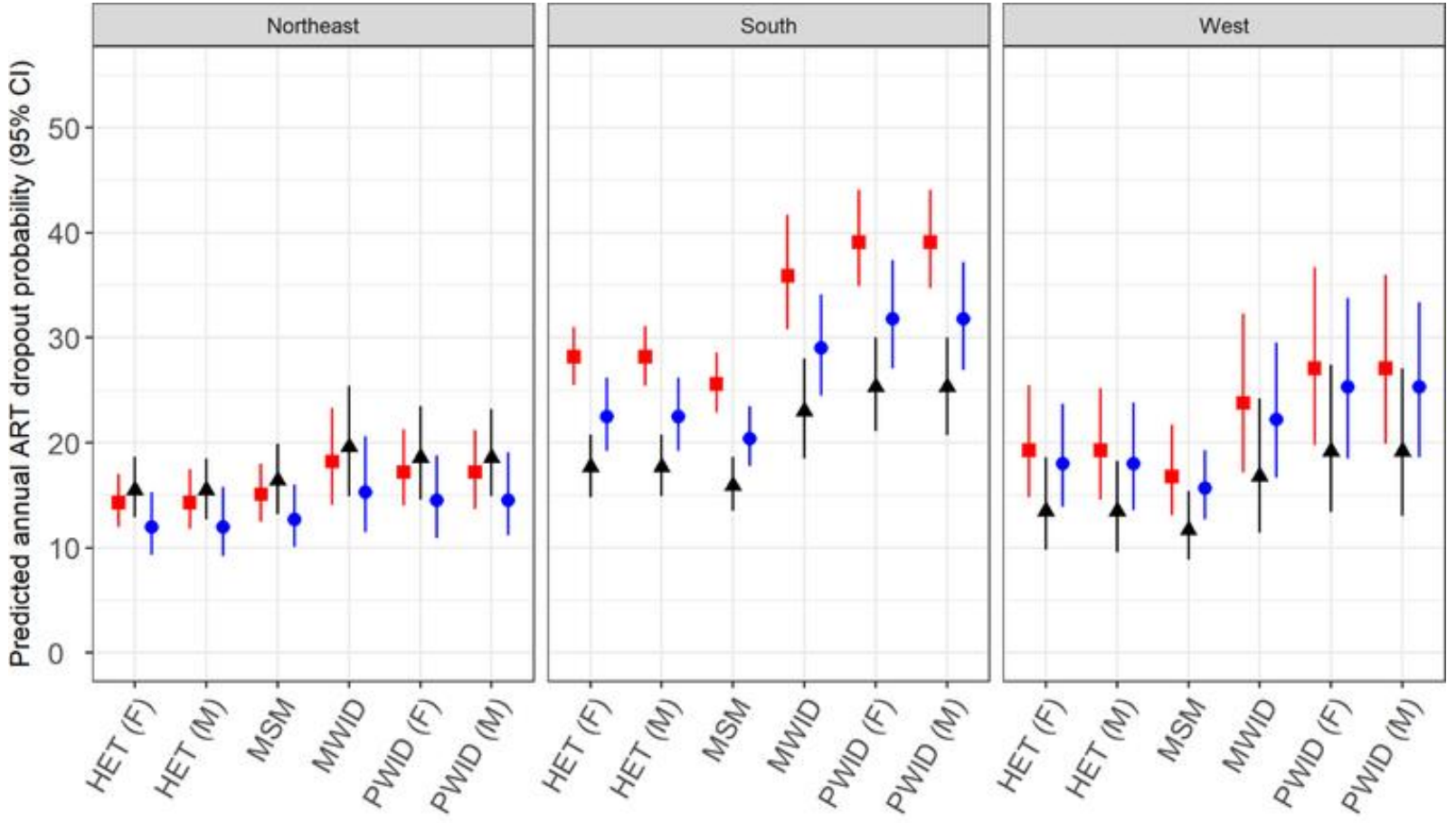
- Routine HIV and STI screening in health care settings and priority non-health care settings
- Provide rapid access to treatment and ensure retention in care (Test and Treat)
- PrEP and nPEP implementation in risk reduction strategy
- HIV awareness, community outreach and messaging to targeted communities

Considerations for 2022-25 plan objectives

- Testing: expanding routine testing & self-testing (using county-level data by risk factor and race/ethnicity to assess impact and inform targets and activities needed)
- PrEP: Equitable expansion of PrEP across high-risk groups by race/ethnicity
- Social supports: food security, housing (goals to improve % PLHIV in stable housing), transportation, linkage to care after incarceration
- Care access and capacity: explicit goals on the # of physicians engaged in HIV care and training programs and within underserved areas and populations including outside of 7 EHE counties
- Workforce infrastructure: # peer support workers, outreach workers, care navigators

Equity: specific, tangible goals- uptake/adherence targets by race/ethnicity; linguistically inclusive advertising/care providers etc.

Our next steps (2):Focusing on ART engagement in MIA



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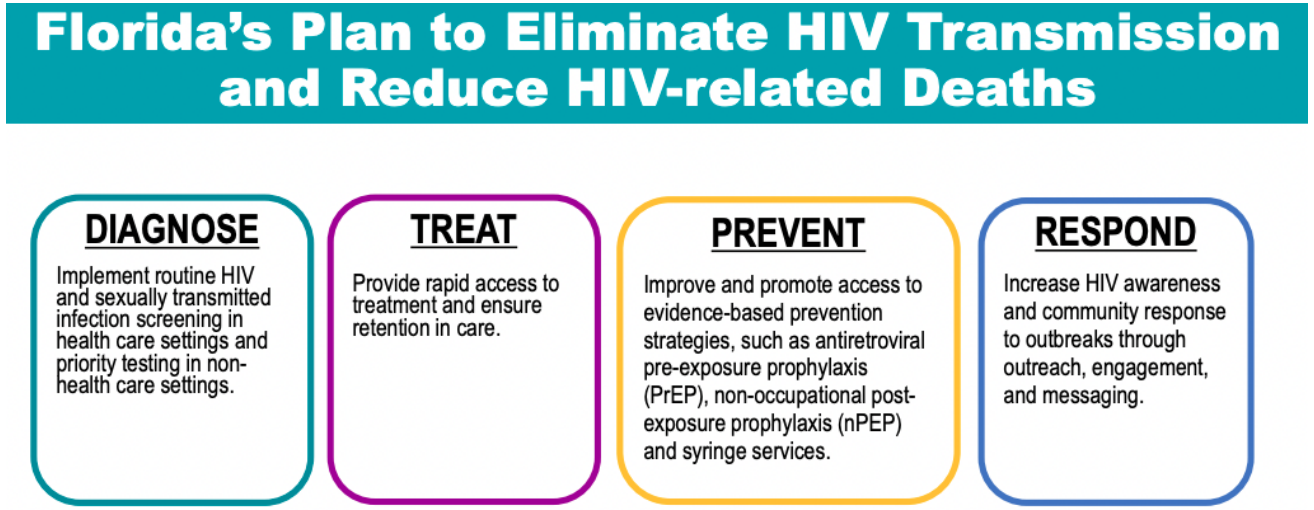
- Black PLHIV had an increased hazard of ART dropout across risk groups; the difference was greatest in the South

Wang et al. Lancet HIV. 2019; 6(8): e531–e539.

Our next steps (3)

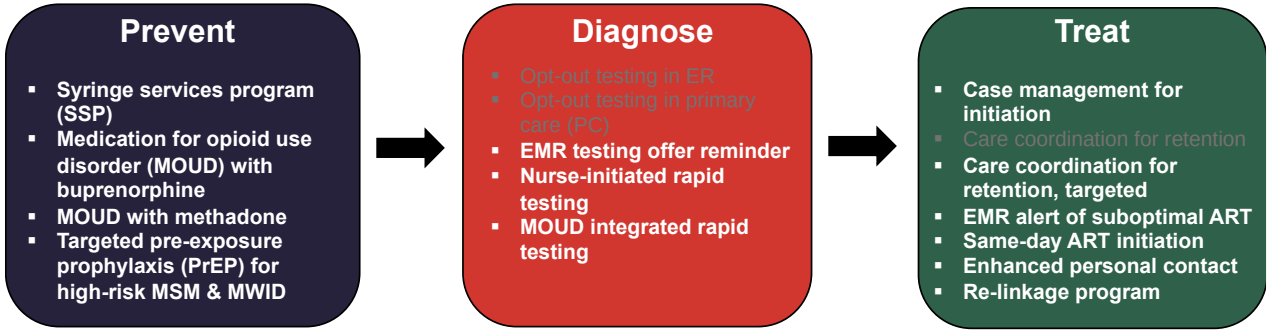
Expand to all FL EHE counties

- 7 EHE jurisdictions in FL (Broward, Miami-Dade, Palm Beach, Hillsborough, Pinellas, Duval, Orange)
- Utilizing data from NA-ACCORD, PH surveillance, CDC sources, peer-reviewed literature



Future interventions under consideration:

- Long-acting ART and PrEP, nPEP, non-healthcare setting testing initiatives, treatment in correctional facilities, Respond pillar: partner services: partner notification and counseling



We want to work with you!

- What interventions or initiatives would you like to see modeled?
- Are there opportunities to collect real-world data in Miami for ongoing initiatives that have been (or will be) scaled-up?
- ***How can we support your planning and ongoing evaluation efforts towards the EHE initiative?***

Acknowledgements

- The HERU team
- Our gracious Scientific Advisory Committee
- HIVRN, the US CDC and other partners who have shared data
- The National Institutes of Health/National Institute on Drug Abuse

Our Scientific Advisory Committee

- Keri N Althoff, PhD, (Co-I), Johns Hopkins University
- Wendy S Armstrong, MD, Emory University
- Czarina N Behrends, PhD, Weill Cornell Medical College
- Caroline Colijn, PhD, Simon Fraser University
- Carlos del Rio, MD, Emory University
- Julia C Dombrowski, MD, University of Washington
- Eva A Enns, PhD, University of Minnesota
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- William C Goedel, MD, (Co-I), Brown University
- Matthew Golden, MD, University of Washington
- Brandon DL Marshall, PhD, (Co-I), Brown University
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- Lisa R Metsch, PhD, University of Miami
- Ankur Pandya, PhD, Harvard University
- Bruce R Schackman, PhD, Weill Cornell Medical College
- Steven Shoptaw, PhD, University of California, Los Angeles
- Steffanie A Strathdee, PhD, University of California San Diego
- Patrick Sullivan, PhD, Emory University
- Hansel E Tookes, MD, University of Miami
- Janet Weiner, PhD, University of Pennsylvania

Links to our completed and ongoing work

- LEM Code repository
- Project development and results documentation
- Previously published papers
- Submitted papers
- LEM “Optimizing Investments in the Miami-Dade County HIV/AIDS Response” full report for stakeholders

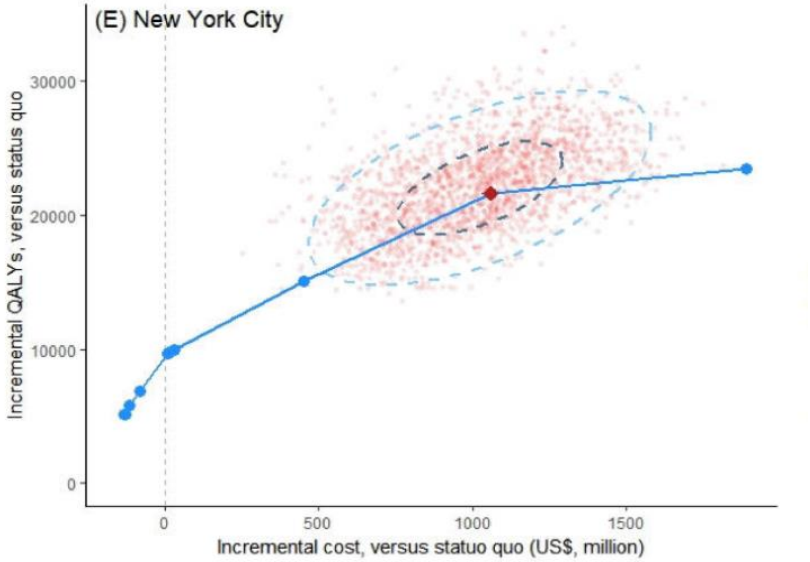
Questions?

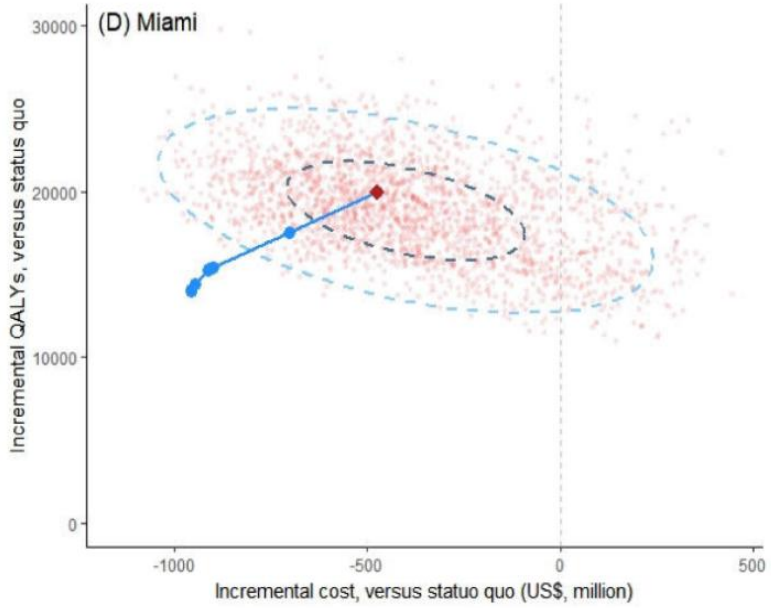
bnosyk@sfu.ca

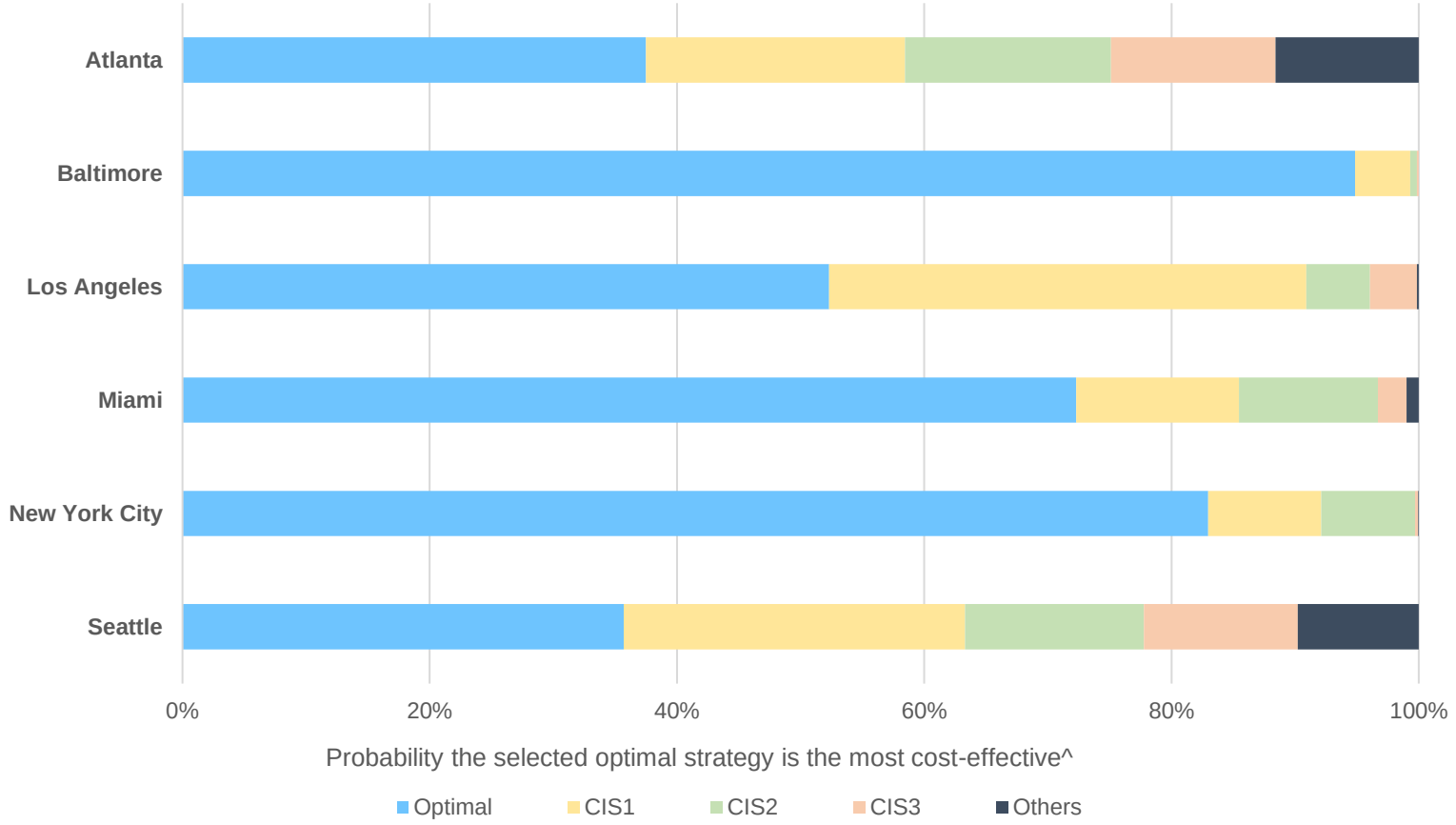
Supplemental slides

How certain are we in our recommendations?

Zang et al. Med Decis Making. In press.





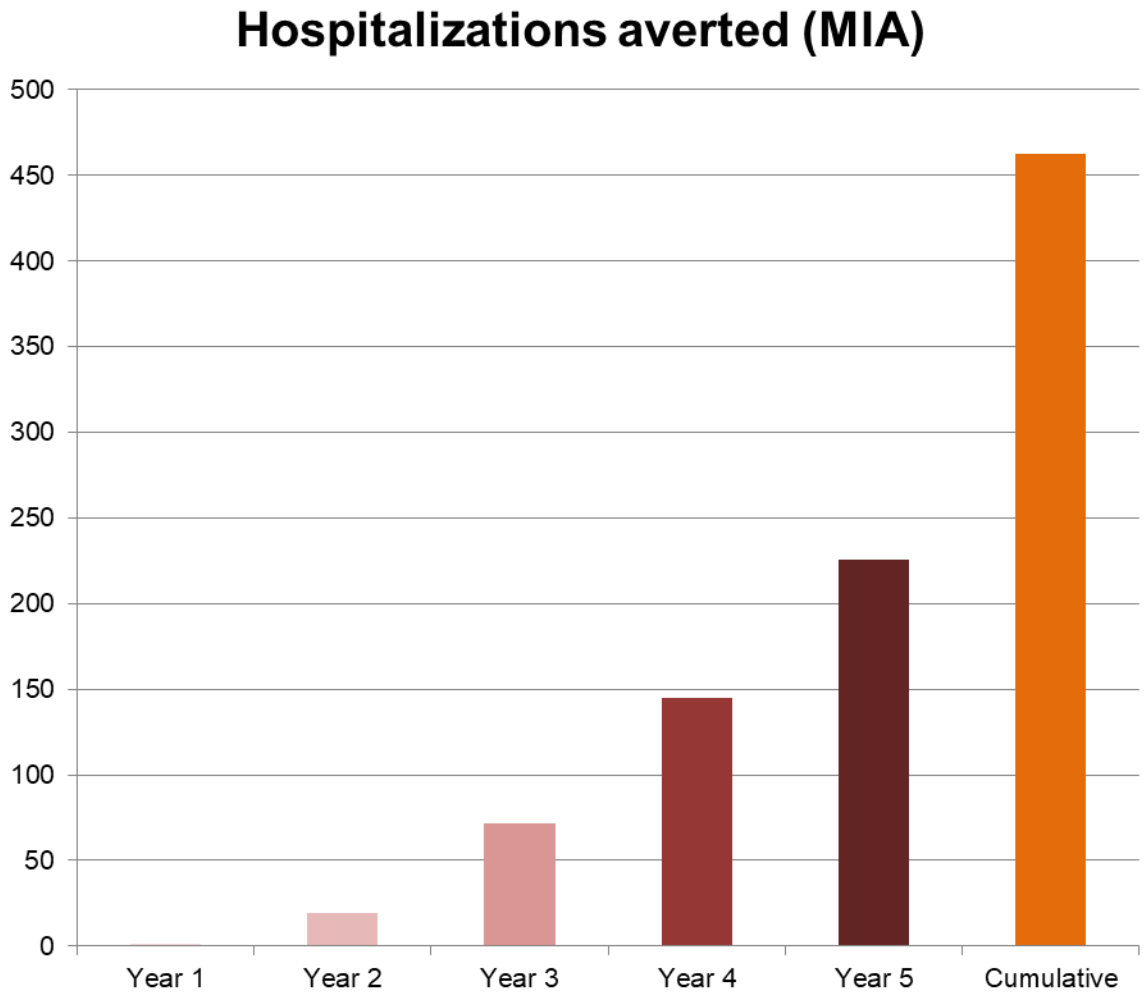


The selected strategies had a high probability of providing the greatest health gains compared to the most proximal competing strategies, with probabilities ranging from 35.7% (Seattle) to 94.9% (Baltimore).

Averted hospitalizations among people living with HIV

- We projected the number of **hospitalizations** averted among PLHIV aged 15-64 in Miami over the first 5 years of intervention implementation

- Total unique hospitalizations averted between intervention scenario and status quo (i.e. unique hospitalizations regardless of length of stay)



Expanding routine HIV testing is critical for improving health equity

In Florida, of the 4,584 HIV diagnoses in 2019, 19% were late diagnoses (diagnosed with HIV/AIDS simultaneously).

By race/ethnicity late diagnoses were highest among Black/African Americans:

- Black/African Americans: 21%
- White: 18%
- Hispanic/Latinx: 18%

(Source: Florida Department of Health Division of Disease Control and Health Protection Bureau of Communicable Diseases HIV/AIDS Section, Florida's Unified Ending the HIV Epidemic Plan. 2020)

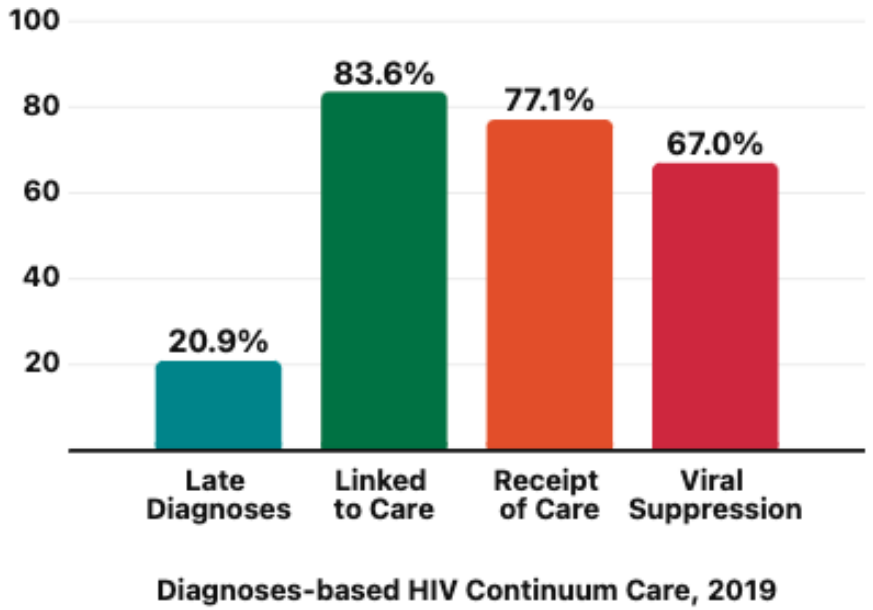


Figure from AIDSvu, 2019. Late diagnosis defined as having an AIDS diagnosis within three months of initial HIV diagnosis.

PROVIDENCE HEALTH CARE Research Institute

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A focus on testing

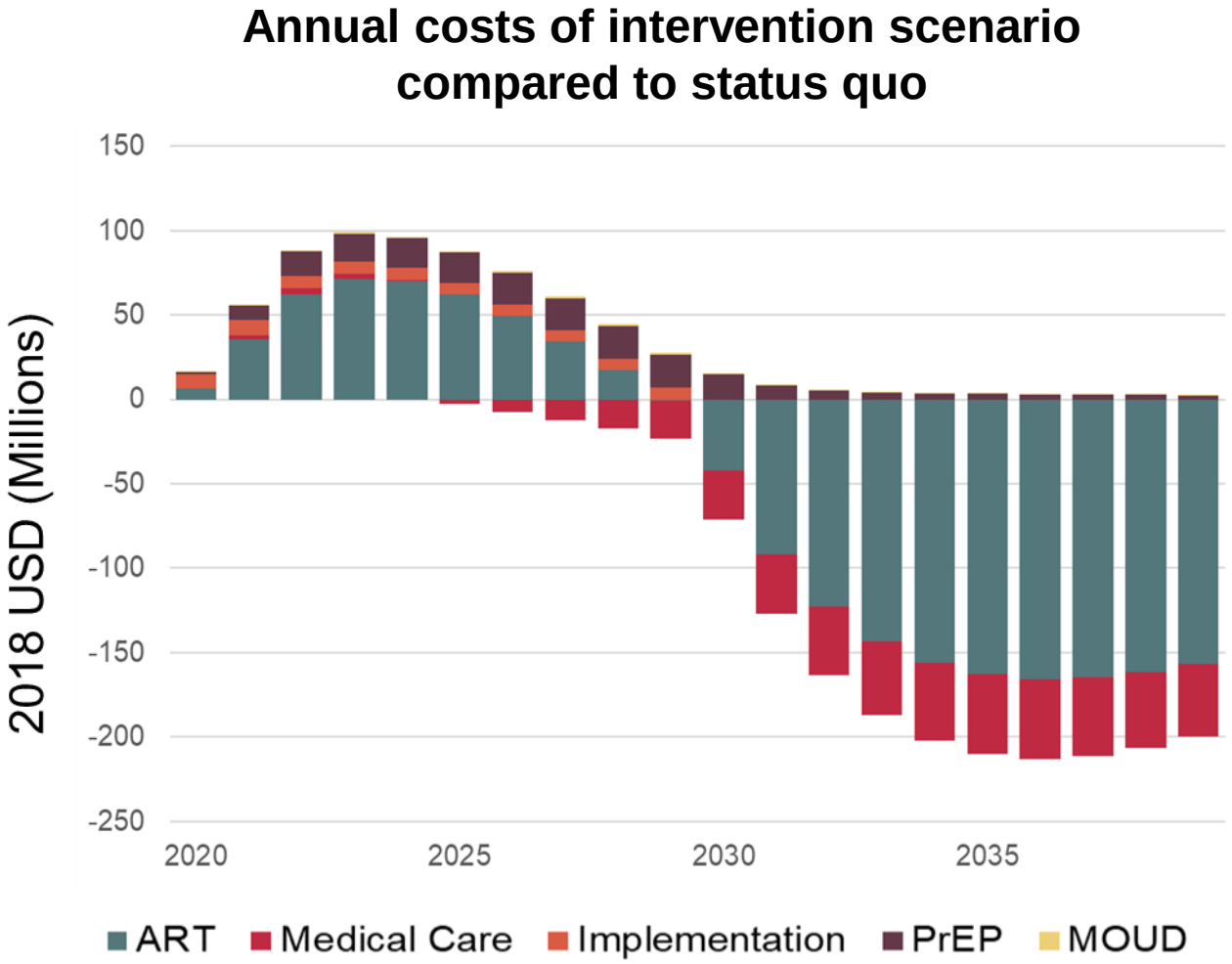
- Improving estimates of testing rates and volumes is a key component for the next phase of our LEM evidence synthesis

- Florida annually conducts ~350,000 publicly funded HIV tests, with an average positivity rate of 0.9–1.0 percent, with additional 131,235 HIV tests performed by Gilead FOCUS partners

- Testing rates obtained from survey data overestimated testing rates in our model, but after calibration we projected over 285,000 tests in Miami alone in 2015

A focus on testing

- 68% (59%-76%) reduction in unprotected sexual contacts after becoming aware of HIV-positive status[1]
- Lifetime cost savings of $229,800 (2012 USD) per HIV infection averted[2]
- Average costs of ART medication increased 34% from 2012 to 2018[3]



ART costs represent the largest segment of long-term savings

1. Marks et al. *AIDS* vol. 20,10 (2006): 1447-50.
2. Schackman et al. *Medical care* vol. 53,4 (2015): 293-301.
3. McCann et al. *JAMA internal medicine* vol. 180,4 (2020): 601-603.

Proposed Community Partnership in Florida

- *Engagement*
  - Initial engagement and planning supported by Miami local Dr. Hansel Tookes
  - Expanding engagement efforts via organizations identified in living database, and supported by EHE points of contact from official jurisdictional directory
- *Collaboration*
  - Develop small working group to begin shared leadership with community groups
- *Shared leadership*
  - Implementation planning and ongoing leadership

Living database: Miami contacts

Miami-Dade County (FL)	Miami-Dade HIV/AIDS Partnership	http://aidsnet.org/
	League Against AIDS Inc. (Miami-Dade County)	http://leagueagainstaids.com/
	Care Resource Community Health Center (Miami-Dade; Broward County)	https://careresource.org/
	IDEA Exchange (The Infectious Disease Elimination Act; Miami-Dade)	https://ideaexchangeflorida.org/
	South Florida AIDS Network (SFAN; Miami-Dade)	https://jacksonhealth.org/south-florida-aids-network-sfan/#gref

EHE jurisdictional directory: Miami contacts

Miami-Dade, FL (Miami-Dade County)

Kira Villamizar
Pronouns: she/her/hers
STD/HIV Director-HIV/AIDS Program Coordinator
Florida Department of Health in Miami-Dade
1350 NW 14 Street
Miami, FL 33125
Phone: 305-575-5424
kira.villamizar@flhealth.gov
EHE Prevention Initiative (CDC PS19-1906/PS20-2010)

Abril Sarmiento
Pronouns: she/her/hers
EHE Jurisdictional Coordinator
Florida Department of Health in Miami-Dade
1350 NW 14 Street
Miami, FL 33125
Phone: 786-734-2928
abril.sarmiento@flhealth.gov
EHE Prevention Initiative (CDC PS19-1906/PS20-2010)

Objectives of the Renewal Study

- To evaluate the potential impact and cost-effectiveness of partner services interventions across diverse settings.

- To estimate the context-specific value of interventions prioritized by local health departments and community members and to disseminate our results to multiple stakeholders across all phase 1 EHE-targeted jurisdictions.

- To identify the highest-valued combination implementation strategies for HIV treatment and prevention in all jurisdictions included in phase 1 of the EHE initiative.

Our new targets: All EHE jurisdictions

Counties

Arizona
- Maricopa County

California
- Alameda County
- Sacramento County
- San Francisco County
- ***Los Angeles County****
- Orange County
- Riverside County
- San Bernardino County
- San Diego County

Florida
- Broward County
- ***Miami-Dade County****
- Palm Beach County
- Hillsborough County
- Pinellas County
- Duval County
- Orange County

Georgia
- ***Cobb County****
- ***DeKalb County****
- ***Fulton County****
- ***Gwinnett County****
- *Barrow†*
- *Carroll†*
- *Cherokee†*
- *Clayton†*
- *Coweta†*
- *Douglas†*
- *Fayette†*
- *Forsyth†*
- *Henry†*
- *Newton†*
- *Paulding†*
- *Pickens†*
- *Rockdale†*
- *Spalding†*
- *Walton†*

Illinois
- Cook County

Indiana
- Marion County

Louisiana
- East Baton Rouge Parish
- Orleans Parish

Maryland
- ***Baltimore City****
- Montgomery County
- Prince George's County
- *Baltimore County†*
- *Carroll†*
- *Harford†*
- *Howard†*
- *Queen Anne's†*

Massachusetts
- Suffolk County

Michigan
- Wayne County

Nevada
- Clark County

New York
- ***Bronx County****
- ***Kings County****
- ***New York County****
- ***Queens County****
- *Richmond County†*

North Carolina
- Mecklenburg County

Ohio
- Cuyahoga County
- Franklin County
- Hamilton County

New Jersey
- Essex County
- Hudson County

Pennsylvania
- Philadelphia County

Tennessee
- Shelby County

Texas
- Dallas County
- Tarrant County
- Bexar County
- Harris County
- Travis County

Washington
- ***King County****

Washington, D.C.

Territories

Puerto Rico
- San Juan Municipio

States

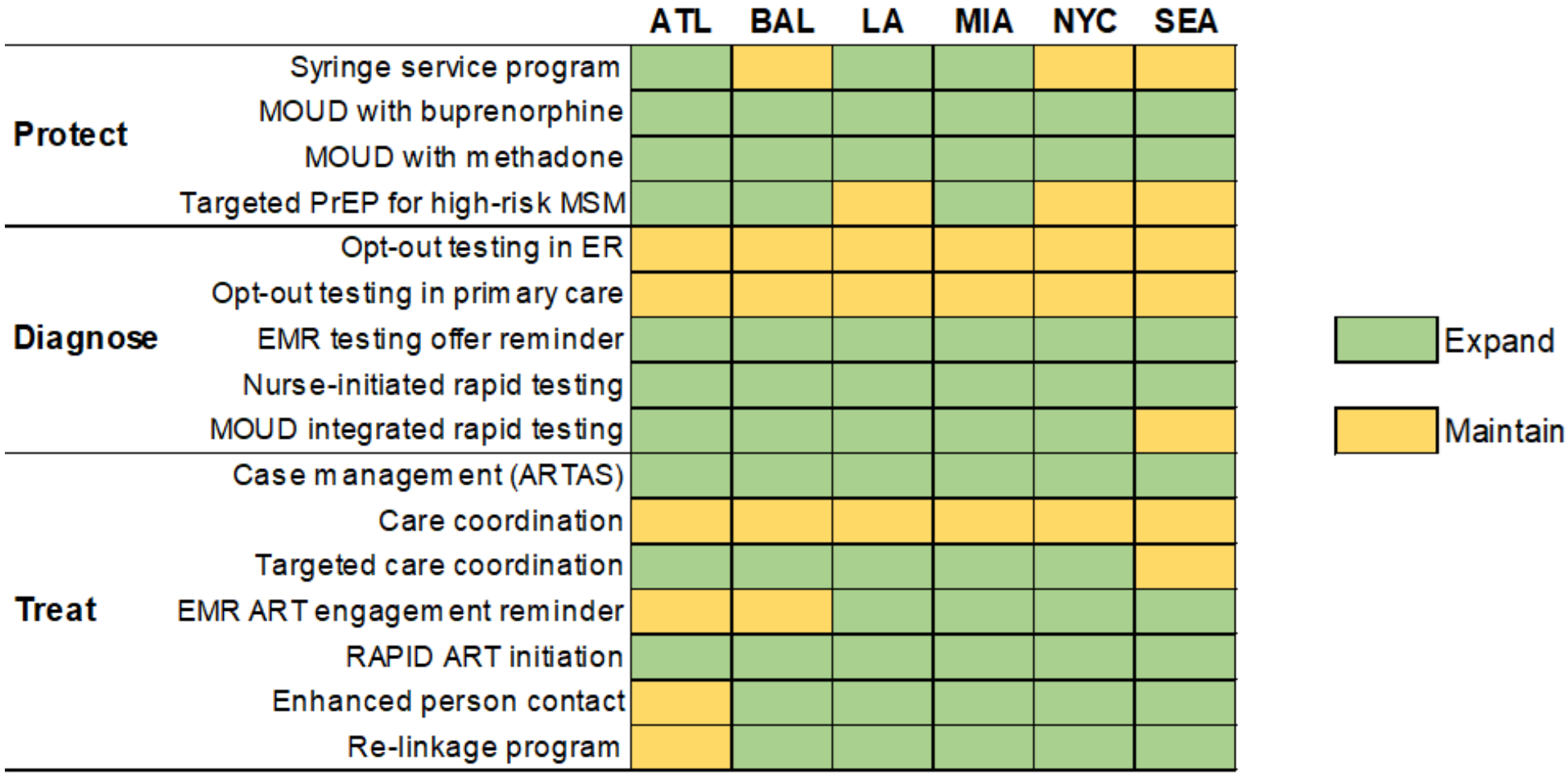
- Alabama
- Arkansas
- Kentucky
- Mississippi
- Missouri
- Oklahoma
- South Carolina

† - Non-EHE jurisdiction (included in original LEM project)

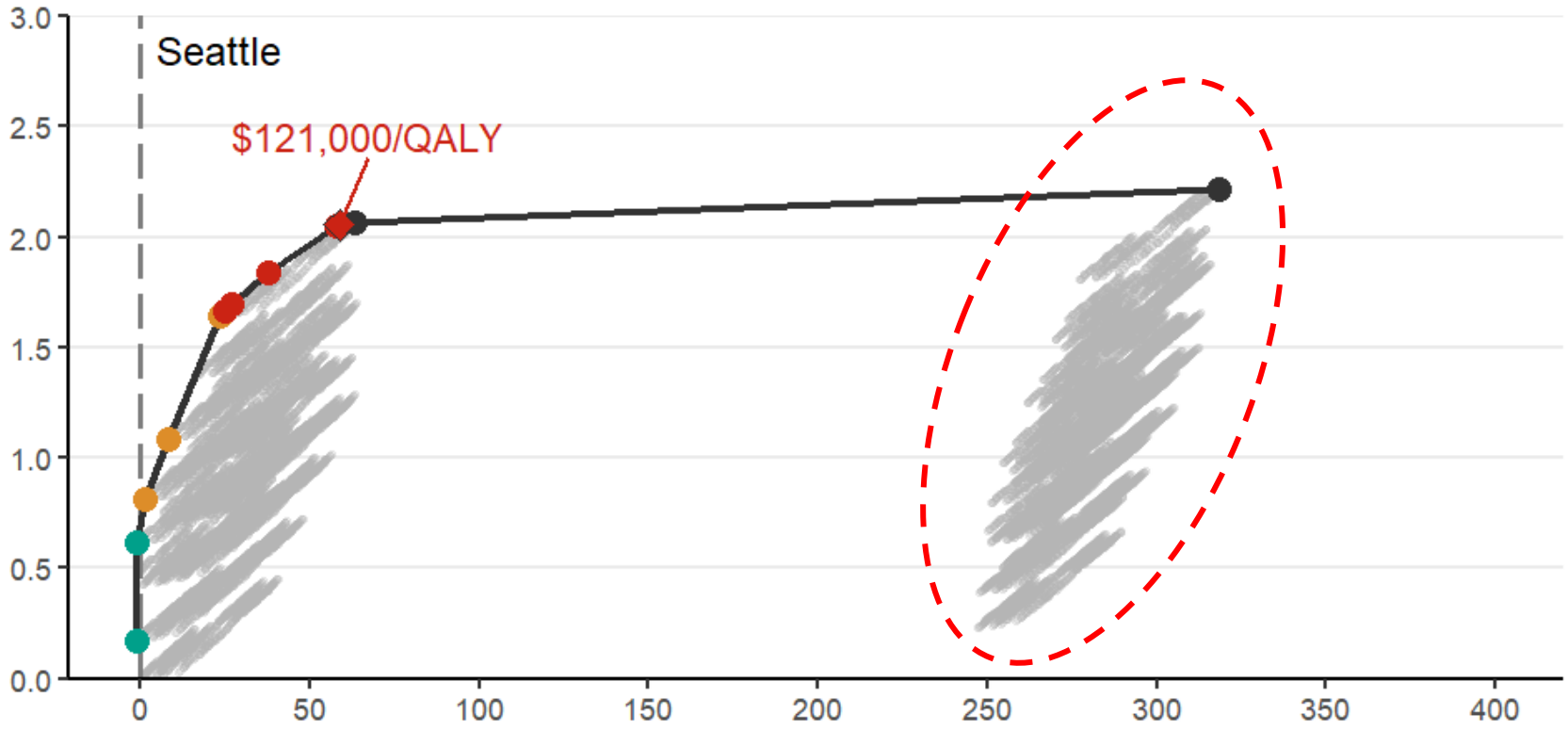
- ***- EHE jurisdiction (included in original LEM project)***
- ***Indicates proposed combination of jurisdictions for modeling local epidemics***

Proposed: 43 regions, total

Composition of optimal combination implementation strategies delivered at previously documented scale-up



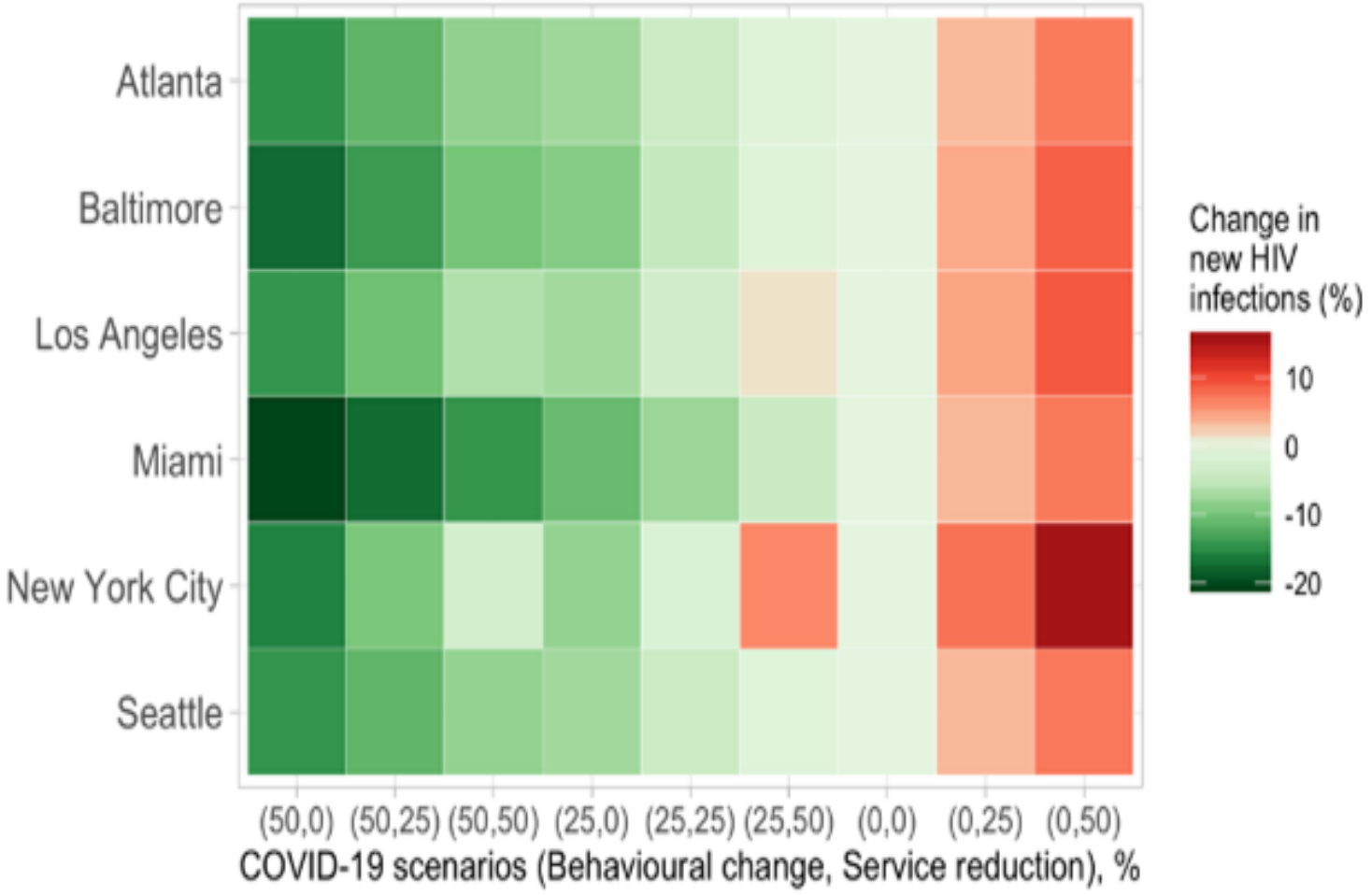
A case study: Seattle's Health Production Function



- **Selected strategy**: will deliver a gain of 2,046 QALYs at an additional investment of $57.9M in present value over a 20-year time horizon, resulting in an ICER of $95,416 per QALY .
- The strategy including PrEP generated an additional 168 QALYs (5.7% more infections averted in 2030), but at an incremental cost of $260.2M; ICER: $1.54M/QALY gained

Modeling the epidemiological impact of COVID-19 on HIV

- What if we offered linked, opt-out HIV testing alongside SARS-CoV-2 testing and contact tracing accounting a range of effects of COVID-19 on risk behaviors and interruptions to HIV health service provision?



- Compared to holding service levels constant, the addition of linked opt out HIV testing offered to 90% of the adult population could avert **9.1%** of infections over 5 years (under the 'best-case' scenario of 50% reductions in sexual and drug injection risk behavior and no disruptions to health service provision due to COVID-19)
- The intervention would be cost-saving over a 20-year time horizon

Nosyk et al. CID 2020; 71(16)

Case-study: Atlanta's capacity to reach the 'EHE' targets

- Implementing a scale of 10 EBIs in Atlanta can reduce HIV incidence by 32% by 2030 and an equity-oriented approach could reduce incidence by 69% with cost reductions of $579.8M over 20 years

- Information on the availability and distribution of services, workforce infrastructure and extent to which local agencies can scale-up services to reach EHE goals is not publicly available

- **Objective:** To assess the availability of health care services, stated needs of communities, and local workforce capacity in Atlanta needed to reach EHE targets

- Collection of local quantitative and qualitative data (January - December 2022):
  - **Service availability** (currently delivered, perceived priority and unmet needs for local population served)
  - **Agency staffing and infrastructure** (number of staff by occupation, FTEs, salary ranges)
  - **Organizational readiness for implementing change** (perceived implementation climate to expand/scale-up services to address unmet needs)

The value and impact of PrEP expansion

We estimated the impact and cost-effectiveness of expanded PrEP under different levels of HIV diagnosis and ART engagement, defined by:

Expanded PrEP: 50% coverage for high-risk MSM, for each racial/ethnic group
95% Diagnosis: among PLHIV
95% on ART: of diagnosed PLHIV

We found:

- The marginal impact of PrEP on incidence reduction decreased as higher levels of diagnosis and treatment engagement were acheived
- Equitable **PrEP expansion was cost saving under all conditions** over 20 years

Reduction in cumulative HIV infections compared to maintaining the status quo (2021-2031)