

## Invited Review

# CROI 2017: HIV Epidemic Trends and Advances in Prevention

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*At the 2017 Conference on Retroviruses and Opportunistic Infections (CROI), trends in the HIV epidemic were highlighted, with decreasing HIV incidence reported across several countries, although key groups remain underdiagnosed and undertreated. In the United States, men who have sex with men (MSM) continue to comprise the largest number of new and undiagnosed HIV infections, with rising incidence in MSM 25 to 34 years old and Latino MSM. Phylogenetics are being used to identify rapidly growing HIV transmission clusters, which can inform prevention efforts. HIV testing is a crucial first step for accessing HIV prevention and treatment, and several innovative strategies to increase HIV testing show promise. Sexually transmitted infections (STIs) have been on the rise but predate widespread use of HIV preexposure prophylaxis (PrEP); enhanced STI screening and treatment coupled with PrEP could substantially reduce STI incidence in the United States. Several studies indicate increasing PrEP awareness and use, although disparities exist in vulnerable populations. PrEP persistence remains a challenge, and practitioner adherence to prescribing guidelines is suboptimal. Novel PrEP delivery models are being developed to increase PrEP knowledge, access, and support.*

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## Trends in the Epidemic

Singh and colleagues at the Centers for Disease Control and Prevention (CDC) estimated trends in HIV incidence, prevalence, and undiagnosed infections in the United States, using data from the National HIV Surveillance System (NHSS) (Abstract 30). Between 2008 and 2014, HIV incidence overall decreased by 3.6% per year, with approximately 37,600 new infections occurring in 2014. By transmission category, HIV incidence attributed to heterosexual contact and injection drug use declined during this period (7.3% and 13.8% per year, respectively), but remained stable among men who have sex with men (MSM) (0.7% per year). In 2014, MSM had the highest HIV prevalence (615,400) and the highest percentage of undiagnosed HIV infections (17.3%). By race or ethnicity, HIV incidence was relatively stable among black

MSM (0.7% per year) and declined among white MSM (3.1% per year), but increased among Latino MSM (2.4% per year). The percentage of undiagnosed infections decreased for all racial or ethnic groups from 2008 to 2014, but remained

*HIV incidence in the United States decreased overall by 3.6% per year from 2008 to 2014, but increased among Latino MSM (2.4% per year) and MSM aged 25 years to 34 years (4.8% per year) during this period.*

highest among black and Latino MSM (20%-21%) than with white MSM (13%) in 2014. By age, HIV incidence decreased among MSM aged 13 years to 24 years (3.2% per year), but increased among MSM aged 25 years to 34 years (4.8% per year), and was highest among those aged 25 years to 34 years in 2014. Although the percentage of undiagnosed infections decreased among MSM aged 13 years to 24 years (4.5% per year) and 25 years to 34 years (1.2% per year), MSM aged 13 to 24 years continued to have the highest proportion of undiagnosed infections in 2014 (52%). The researchers called for tailored testing, prevention, and treatment approaches in these groups to address disparities.

Johnson and colleagues at the CDC presented state-level estimates of HIV incidence, prevalence, and undiagnosed infections using the NHSS data (Abstract 899). During 2008

*Southern states accounted for one-half of new and one-half of undiagnosed HIV infections in the United States in 2014.*

to 2014, overall HIV incidence declines were driven by a decrease in HIV infections in 8 states and the District of Columbia. Five states (California, Georgia, Florida, New York, and Texas) accounted for 52% of new HIV infections. HIV prevalence increased by 2.4% per year during this period, driven by increases in 23 jurisdictions. Undiagnosed infections decreased by 3.4% per year, with decreases observed in 7 states. In 2014, Southern states accounted for 50% of annual HIV infections, 45% of persons living with HIV infection, and 50% of undiagnosed infections. These findings highlight the need for tailored prevention programs in this region and in states with high numbers of undiagnosed infections.

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Grabowski and colleagues reported data on the impact of combination HIV prevention on trends in HIV incidence in the population-based Rakai Community Cohort Study in Uganda (Abstract 34LB). Antiretroviral therapy was introduced in 2004, and coverage increased from 12% in 2006 to 69% in 2016. Expanding antiretroviral coverage was associated with an increase in HIV viral load suppression from 42% in 2009 to 75% by 2016 among all HIV-seropositive persons. Male circumcision scale-up efforts began in 2007, and coverage increased from 15% in 1999 to 59% in 2016. Between 1999 and 2016, the only substantial changes in sexual behaviors occurred in adolescents aged 15 years to 19 years, with the proportion reporting never having sex increasing among men and women. Compared with the preintervention period prior to scale-up of combination prevention efforts (1999-2004), HIV incidence decreased by 42% from 1.16 to 0.66 per 100 person-years of observation in 2016 (adjusted incidence rate ratio [aIRR], 58). Declines in HIV incidence were greater in men than women (54% vs 32%, respectively), likely due to the direct beneficial effects of male circumcision. Although these results indicate that combination HIV prevention can have a substantial population-level impact, the authors pointed out that HIV incidence remains above elimination levels and highlighted the need for higher coverage and additional prevention interventions, such as preexposure prophylaxis (PrEP).

Patel and colleagues presented data on the feasibility of using community-based testing to obtain sentinel population estimates of HIV incidence and viral suppression in the high HIV prevalence region of Zambezi in Namibia (Abstract 35). Leveraging routine HIV testing and linkage to care activities of an existing community-based organization (Total Control of the Epidemic), 2218 adults were enrolled into a sentinel surveillance study, 37% of whom were aged 15 years to 24 years. HIV prevalence in the cohort was 21%; 64% of HIV-seropositive persons were diagnosed, with the proportion diagnosed higher in women than men (70% vs 41%, respectively). HIV incidence over 1-year follow-up was 1.32 per 100 person-years, with incidence highest among young women in rural settings (3.52 per 100 person-years). Viral load suppression at follow-up was 75% among individuals who tested HIV seropositive at baseline. There were no HIV seroconversions among the 81 circumcised men or among the 34 participants who had a partner on antiretroviral therapy. The authors highlighted the need to focus prevention interventions on adolescent girls and young women as well as finding and diagnosing men.

### Risk Factors for HIV Infection

Kerani and colleagues described the epidemiology of HIV among foreign-born people living in the United States, using data from the NHSS (Abstract 851). Among 210,888 people diagnosed with HIV infection between 2010 and 2014, 17% were estimated to be foreign born. Compared with US-born people diagnosed with HIV infection, those who were foreign-born were more likely to be female (27% vs 20%), to have

acquired HIV through heterosexual transmission (men, 18% vs 10%; women, 91% vs 83%), and to have an AIDS classification within 3 months of HIV diagnosis (35% vs 26%). Migrants from Africa and the Caribbean were disproportionately affected by HIV infection, accounting for 39% of foreign-born HIV cases, but only 13% of the foreign-born population in the United States. Geographic distribution of foreign-born people

**Approximately 17% of people diagnosed with new HIV infections in the United States are foreign born. These individuals are more likely to be women, to have acquired HIV infection through heterosexual transmission, and to have an AIDS classification within 3 months of diagnosis.**

with HIV infection varied by region of birth, with approximately two-thirds of migrants from South America and the Caribbean living in 1 of 5 metropolitan areas with the largest number of cases.

Ivy and colleagues evaluated whether changes in risk behaviors and access to care among men who have sex with men and women (MSMW) could help explain a reduction in new HIV diagnoses among black women in the United States (46% decline between 2008 and 2014) (Abstract 852). Based on cross-sectional data from the National HIV Behavioral Surveillance System (NHBS) collected in 2008, 2011, and 2014, several high-risk sexual behaviors increased during this period. Among 1173 black MSMW who reported being HIV seronegative, vaginal sex without condoms (58%, 57%, and 67%, respectively;  $P = .02$ ) or anal sex without condoms (17%, 24%, and 27%, respectively;  $P = .02$ ) with a woman increased statistically significantly over time, as did the percentage who reported anal sex without condoms with a man in the past 12 months (43%, 39%, and 51%, respectively;  $P = .04$ ). HIV testing, HIV serostatus awareness, early linkage to care, and receiving antiretroviral therapy increased substantially between 2008 and 2014. Increases in awareness of serostatus and being on antiretroviral therapy may have helped drive down HIV infections among black women.

Holtz and colleagues assessed trends in HIV incidence and associated risk factors among MSM and transgender women in the Bangkok MSM Cohort Study (Abstract 854). Among 1744 participants followed up in this cohort between 2006 and 2015, 271 seroconversions were detected, for an overall HIV incidence density of 5.6 per 100 person-years. HIV incidence rose over time to a high of 8.2 per 100 person-years in 2008, and subsequently declined. Multivariable risk factors for incident HIV infection included being 21 years of age and younger (adjusted relative risk [aRR] 2.18; 95% confidence interval [CI], 1.49-3.19), use of drugs to enhance sex (aRR 2.59; 95% CI, 1.83-3.65), having group sex (aRR 1.60; 95% CI, 1.20-2.14), inconsistent condom use (aRR 1.73; 95% CI, 1.35-2.21), and history of syphilis infection (aRR 1.86; 95% CI, 1.12-3.06). From the same cohort, Wimonsate and colleagues reported on changes in risk behaviors among MSM after HIV seroconversion (Abstract 855). Among 183 participants followed up

before and after seroconversion, there was a 64% reduction in group sex, an 82% reduction in anal sex without a condom with a steady male partner, and a 79% reduction in anal sex without a condom with a casual partner. These decreases in high-risk sexual behaviors were sustained for at least 12 months after seroconversion.

Mobility can disrupt individuals from HIV prevention and care systems and intensify transmission. Oalwore and colleagues presented data on the relationship between migration and HIV incidence in the Rakai Community Cohort Study (Abstract 1015). Among 16,165 seronegative participants included in this study, 28% were migrants, of whom 68% were women. There were 849 HIV incidence events between 1999 and 2015, 28% of which occurred in migrants. HIV incidence was higher in the first 2 years following migration, and has

***Recent migration or mobility is associated with higher HIV incidence and prevalence in East Africa.***

not declined in recent migrants despite scale-up of combination HIV prevention: aIRR for HIV seroconversion was 1.97 for women and 2.42 for men. These findings highlight the need for timely prevention interventions prioritized for migrants in sub-Saharan Africa. Camlin and colleagues evaluated the relationship between mobility and HIV prevalence in Uganda and Kenya in the SEARCH (Sustainable East Africa Research in Community Health) study (Abstract 860). Mobility in the past month or past year was associated with higher HIV prevalence, with stronger effects for women.

Stigma is an important structural factor that may contribute to transmission and acquisition of HIV. Rodriguez-Hart evaluated the association between sexual stigma and the acquisition of HIV or other sexually transmitted infections (STIs) in a prospective cohort study among 1480 MSM in Nigeria (Abstract 918). Participants were classified into low- (43%), medium- (45%), and high-stigma (12%) subgroups, using a latent class analysis of 9 stigma indicators. As stigma increased in severity, STI incidence increased in a statistically significant dose-response relationship (8.1% in the low-stigma group, 12.2% in the medium-stigma group, and 16.3% in the high-stigma group;  $P = .003$ ). Incident HIV infections were less common and did not increase statistically significantly with increasing stigma severity (2.8%, 3.2%, and 3.8%;  $P = .798$ ). The authors demonstrated that the association between stigma and HIV and STI incidence was partially mediated by suicidal ideation and sex without condoms.

Several investigators presented data evaluating the use of risk scores to identify appropriate candidates for PrEP. Wahome and colleagues developed an empiric risk score to guide PrEP uptake among MSM in coastal Kenya (Abstract 856). In a cohort of 757 HIV-seronegative MSM followed up for a median of 14 months, HIV incidence was 6.9 per 100 person-years. Independent predictors (each worth 1 point in the risk score) included having sex exclusively with men, receptive anal sex, any unprotected sex, and group sex, and being 18 years to 24

years of age. A risk score of 1 or greater corresponded to an incidence rate of 3.6% or higher per year, and would identify 4 of every 5 MSM in the cohort for PrEP initiation. Burgess and colleagues sought to validate a previously developed risk score in women to predict HIV acquisition in young women in South Africa (Abstract 857). They assessed a 7-item risk score derived from women who participated in the VOICE (Vaginal and Oral Interventions to Control the Epidemic) trial and applied this risk score to young South African women aged 18 years to 30 years enrolled in the FACTS (Follow-on African Consortium for Tenofovir Studies) 001 study. Scores of 5 or higher identified 84% of incident infections in 77% of the cohort. The area under the curve (AUC) was 0.56, indicating poor discriminative accuracy. The authors posited that the poor performance may be due to the younger age of the cohort, in which risk was uniformly high, and other factors, such as intimate partner violence, may need to be incorporated to improve score performance. Ayieko and colleagues developed an HIV risk score based on the SEARCH HIV test-and-treat trial in Kenya and compared it with self-assessed risk (Abstract 858). An 8-item risk score was developed using machine learning and included age, sex, marital status, polygamy, education, circumcision, occupation, and alcohol use. Among 3973 HIV-uninfected adults, only 17% perceived themselves to be at risk for HIV acquisition. Among the 810 individuals identified to be high risk by the risk score, only 23% perceived themselves to be at risk. These data suggest that strategies to improve accurate risk perception may be needed to optimize the uptake of empirically targeted PrEP.

### Networks of HIV Risk

Two studies at this year's conference explored the role of risk networks in explaining racial disparities in HIV prevalence. Momplaisir and colleagues evaluated individual and network factors associated with HIV prevalence among people who inject drugs (PWID) in the HPTN (HIV Prevention Trials Network) 037 study (Abstract 842). In an analysis of 232 index participants and 464 network members, racial consistency (all members of a network sharing the same race) was high among blacks (79%) and whites (70%) and lower among Hispanics (31%). HIV prevalence was 27% within all-black networks, 14% in all-white networks, and 23% in mixed networks. Sexual risk was similar across networks, but needle-sharing behaviors were significantly lower in all-black networks (23%) than in all-white (48%) and racially mixed networks (46%) ( $P < .05$ ). In a multivariable model, being in an all-black network (adjusted odds ratio [aOR], 3.6) or racially mixed network (aOR, 2.0) were associated with being in an HIV-seropositive network; other associated factors included homelessness (aOR, 2.0), recent incarceration (aOR, 0.4), and cocaine injection (aOR, 1.7), although individual risk behaviors were not associated with being in an HIV-seropositive network. The investigators call for interventions at the network level, including offering treatment to HIV-seropositive individuals and PrEP to at-risk individuals.

Janulis and colleagues explored the role of concurrency (ie, sexual partnerships overlapping in time) in explaining racial disparities among young black MSM (Abstract 843). In an analysis of data from 659 young MSM participating in a longitudinal cohort study in Chicago, concurrency was uncommon, and there was little difference in concurrency rates by race or ethnicity. However, higher levels of racial homophily were observed among young black MSM than among young white MSM ( $P = .001$ ). Additionally, in simulated models, black participants were more likely to be at greater levels of HIV-specific network risk (they were more likely to be connected with an HIV-seropositive partner and closer to these individuals within the network), whereas white participants were more likely to be in larger networks, and more central in these components. These results suggest that concurrency is unlikely to explain racial disparities in HIV infection, whereas racial homophily and higher HIV prevalence in sexual networks of young black MSM may explain some of these disparities.

Several investigators described the role of phylogenetics in identifying rapidly growing HIV transmission clusters in HIV outbreaks. Mehta and colleagues presented data on real-time identification of a new transmission cluster in Tijuana, Mexico (Abstract 844). Among 2759 participants in 8 research studies in Tijuana between 2004 and 2016, 288 sequences from seroconverters were obtained and analyzed to identify phylogenetic clusters; 42% of sequences were linked to one or more sequences, forming 37 transmission clusters. In one of the study cohorts of people who inject drugs, 12 seroconversions occurred between January 2015 and July 2016, including 8 between April 2016 and July 2016. These seroconversions coincided with the implementation of a public safety policy to “clean” the homeless population from the region, leading to the displacement of these individuals. Qualitative interviews with these seroconverters revealed that all had encounters with police and many needed to change their location of residence and injection drug use. These findings highlight that changes in public safety policy can disrupt HIV prevention efforts and impact HIV transmission dynamics.

Monterosso and colleagues described efforts to identify and investigate a rapidly growing HIV transmission cluster in Texas (Abstract 845LB). Using data collected through the NHSS, the CDC identified a molecular cluster in Texas that grew rapidly between July 2015 and June 2016. From 27 confirmed cluster cases, 112 additional ones were identified through review of interview records from partner services. Among 76 confirmed cluster cases and other cluster cases with records available, all were born male; 79% were aged 17 years to 29 years; 87% were Hispanic; and 90% reported having sex with men. The median lifetime number of sex partners was 45 (range, 2-300); 72% indicated they had anonymous sex partners; only 7% reported always using condoms; and 18% had an STI within 12 months before HIV diagnosis. Although many cases had encounters with medical care, none were on PrEP, 50% had evidence of treatment interruptions or poor adherence, and 24% were not currently virally suppressed. Rapid growth of this cluster was likely a result of high-risk behaviors, limited PrEP access, and delayed viral

suppression in some cases; these findings highlight the need to prioritize linkage to care and PrEP referral for individuals associated with this cluster.

McVea and colleagues developed a framework for predicting HIV phylogenetic clusters at high risk for growth (Abstract 848). Using sequences from 9091 individuals in the British

***Phylogenetics can rapidly identify growing HIV transmission clusters. Clusters composed of over 50% MSM are more likely to grow rapidly.***

Columbia, Canada, drug treatment program, 47 distinct clusters were classified as large ( $\geq 20$  members) and small ( $> 20$  members) clusters and rapid ( $\geq 5$  new members in the past year) versus slow ( $> 5$  new members in the past year) growth. Growth of 1.8 members or more over 3 months characterized clusters that would become large, and a proportion of more than 50% MSM in the cluster categorized clusters that were growing rapidly.

Zheng and colleagues presented data on a cross-sectional analysis using social network information to predict HIV serostatus in 3 rural communities in Kenya in the SEARCH “Test and Treat” study (Abstract 36). During the census, 15,028 adults named social contacts in 5 social domains (health, emotional support, money, free time, and food), which were matched to enumerated residents to create community-wide social networks. Overall, testing coverage was 85%, and HIV prevalence was 16%. After adjusting for individual risk factors, men with an HIV-seropositive female contact in any domain were more likely to be HIV seropositive (aRR, 1.5), and women with an HIV-seropositive male contact in any domain were more likely to be HIV seropositive (aRR, 1.4), with higher risk if the HIV-seropositive contact was 10 years older or more (aRR, 1.6). Women with an HIV-seropositive female contact in the health domain were also more likely to be HIV seropositive (aRR, 1.6). Among young women aged 15 years to 24 years, higher risk was associated with having an older HIV-seropositive contact in the food (aRR, 4.1), free time (aRR, 7.9), health (aRR, 3.5), or any domain (aRR, 3.4). The authors suggest that social network information may be useful in informing targeted testing and prevention efforts and enhancing the HIV care cascade through peer-support networks.

## Youth

Hader presented an overview of the HIV epidemic in youth (Abstract 58). She pointed out that several countries in sub-Saharan Africa are projected to have substantial population growth over the next 35 years, and described the “youth bulge” in which a larger number of African youth will age into young adulthood, resulting from reductions in childhood mortality and slower accompanying declines in fertility. In Africa, the population of youth aged 15 years to 24 years is expected to grow from an estimated 200 million in 2016 to more than 300 million in 2030. Even with similar or declining

HIV infection rates, this growing population of sexually active young people will result in a greater number of new HIV infections, or epidemic growth. To reverse these trends, an understanding of HIV transmission dynamics is crucial. Hader reviewed data from South Africa showing cycles of HIV transmission in which women aged 25 years and under become infected from men 25 years to 40 years old, who are largely unaware of their HIV serostatus. As these women age, they form relationships with similarly aged men and then may transmit HIV infection to these partners, continuing the cycle. She also presented data from a population-based survey in Zimbabwe showing that young people were much less likely to know they were HIV-infected, and women more likely to be aware of their HIV serostatus than men. Although young people who knew their HIV serostatus had high rates of being on treatment and achieving viral suppression, overall rates of viral suppression among youth under 30 years of age were low (37%), much lower than levels needed to interrupt transmission in social networks.

Hader also described trends in urbanization in Africa, with the urban population projected to increase from 40% in 2016 to 58% in 2050. For young people who migrate from rural to urban areas, this may result in youth being disconnected from family and community support networks. Hader also emphasized the importance of providing quality education and employment opportunities for youth, which have been linked to decreased risk behaviors and better health. Sexual and physical violence are common in both girls and boys under the age of 18 years, and boys who experience violence are more likely to grow up and be a perpetrator of violence, highlighting the importance of interventions to address violence in both girls and boys. She pointed to data among adolescent girls in South Africa showing that structural factors such as hunger, community violence, and informal settlements lead to abuse, victimization, and school dropout, which all contribute to various HIV risk behaviors.

Although the growing youth population has often been characterized as a pending disaster, others have viewed the “youth bulge” as an asset or dividend, bringing a stronger workforce, economic growth, and decreased dependency as more young adults are able to care for children and the elderly. Hader expressed optimism that a number of HIV prevention tools are now available or under investigation for youth; however, she highlighted that these interventions must fit into the lives of these youth. She emphasized that young people are not a single, unified population but represent diverse, overlapping identities and are constantly in transition. Youth expect instant communication, transparency, and collaboration, and are facile at web-based self-learning; these expectations can be harnessed in developing prevention interventions for youth. Hader identified the need for context-specific data disaggregated by age and gender to understand the needs of youth and to guide targeting efforts to maximize reach and impact of interventions. She also pointed to the need for youth leaders to help design and deliver high quality interventions; for community and faith-based leadership to promote health and wellness social

norms and eliminate violence and stigma; and for political leaders to address policy and structural barriers to service delivery, education, and employment. She ended by highlighting the PEPFAR DREAMS (President’s Emergency Plan for AIDS Relief Determined, Resilient, Empowered, AIDS-free, Mentored, and Safe) initiative, a comprehensive program addressing a number of structural barriers faced by African youth that aims to decrease HIV infections by 40% in adolescent girls and young women by 2017.

## Substance Use

Hoots and colleagues presented data on changes in prescription opioid, methamphetamine, and cocaine use among MSM in 20 US cities, based on data from 2008, 2011, and 2014 cycles of the NHBS in MSM (Abstract 871). Overall use of each of the 3 drugs was relatively stable over that period, with 8% of MSM each reporting opioid or methamphetamine use in 2014, and 19% reporting cocaine use. Although rates of opioid use were lowest in black MSM than in other racial and ethnic groups, rates increased statistically significantly only in this subgroup over time, with 4.2% of black MSM reporting opioid use in 2008 and 5.9% reporting this in 2014. Opioid use also increased statistically significantly in persons with less than a high school education (from 7.1% to 10.1%) and among persons with incomes under \$20,000 per year (from 5.7% to 9.3%). The authors recommended early assessment and treatment of drug dependence for those using opioids to prevent transition to injection drug use.

Two studies reported on city-specific substance use patterns in NHBS surveys. Kuo and colleagues presented data from the same NHBS surveys in MSM that were completed in Washington, DC, from 2008 to 2014 to evaluate changes in patterns of substance use over that time (Abstract 872). They found an increase in crystal methamphetamine use among black MSM (from 4.4% to 9.9%) simultaneous with a decrease in crystal methamphetamine use in white MSM (from 9.5% to 4.7%). For white and black MSM, having 4 or more sex partners (aOR, 3.2 and 2.7, respectively) and being HIV seropositive (aOR, 10.6 and 4.2, respectively) were associated with crystal methamphetamine use. For white MSM, being 30 years or older (aOR, 2.5) and having an annual income of less

***Misuse of prescription opioid drugs has increased substantially and may be associated with new injection drug use.***

than \$20,000 (aOR, 8.5) were also associated with crystal methamphetamine use in the prior year. These authors urged the development of effective prevention interventions for crystal methamphetamine users.

Glick and colleagues presented data from the NHBS survey conducted in 2005, 2009, 2012, and 2015 in PWID in King County, Washington (Abstract 873). Of 1713 men and women participating in any of the 4 cross-sectional surveys,

they found statistically significant increases in methamphetamine injection reported in the past year among MSM, men who have sex with women, and women (88%, 69%, and 65% of PWID injecting methamphetamine in each group, respectively). Similar rates were reported among the 1381 men and women participating in the King County Syringe Exchange Program over the same period. The magnitude of the change has been greatest for men who have sex with women and for women in both studies. Most of the increase in methamphetamine injection among non-MSM PWID was attributable to injecting “goofballs” (a combination of methamphetamine and heroin). Sharing of injection equipment was relatively stable but substantially higher in non-MSM than MSM PWID. These investigators point to the relatively low rates of new diagnoses among non-MSM PWID in King County to date, but caution about the importance of providing clean injection equipment to PWID and ensuring viral suppression for PWID who are HIV infected.

Misuse of prescription opioid drugs has increased substantially in the United States since the early 2000s, with substantial negative consequences including HIV and hepatitis C virus (HCV) transmission outbreaks and drug overdoses. Broz and colleagues reported on the use of prescription opioids prior to first injection among the 7454 PWID recruited into the NHBS 2015 survey (Abstract 869). They reported that the proportion of PWID reporting prescription opioid use prior to their first injection has increased from 12% for persons reporting first injection prior to 1995 to 49% for persons reporting first injection from 2010 to 2015. The median time prior to injection use of first prescription opioid use was 4 years, and although 31% received the drugs from their physician, 47% either received, bought, or stole the medications from a friend, family member, or someone else. In a multivariable model, independent risk factors for prior prescription opioid use include first injection after 2000 (adjusted prevalence ratio [aPR], 2.5), female gender (aPR, 1.1), white race (aPR, 1.7), and being homeless in the past 12 months (aPR, 1.2); being HIV seropositive was less common among persons who had prior prescription opioid use (aPR, 0.6). Prior prescription opioid use was associated with several risky practices including sharing syringes (aPR, 1.3) or other injection equipment (aPR, 1.3) in the prior 12 months. The authors concluded that opioid prescription drug use is increasingly common prior to injection drug use, and that nearly one-third of these prescriptions are coming directly from health care professionals. They emphasized the importance of prescription drug monitoring programs to reduce potential misuse of opioid drugs and encourage prevention interventions, including opioid use disorder treatment and syringe programs to reduce further harm in these individuals. Mittal and colleagues reported an association of opioid substitution therapy (OST) with a decreased likelihood of initiating others into injection practices among 249 men enrolled in a cohort study of PWID in San Diego, CA (aOR, 0.52) (Abstract 870). This further supports the role of OST in harm reduction for PWID and their potential partners.

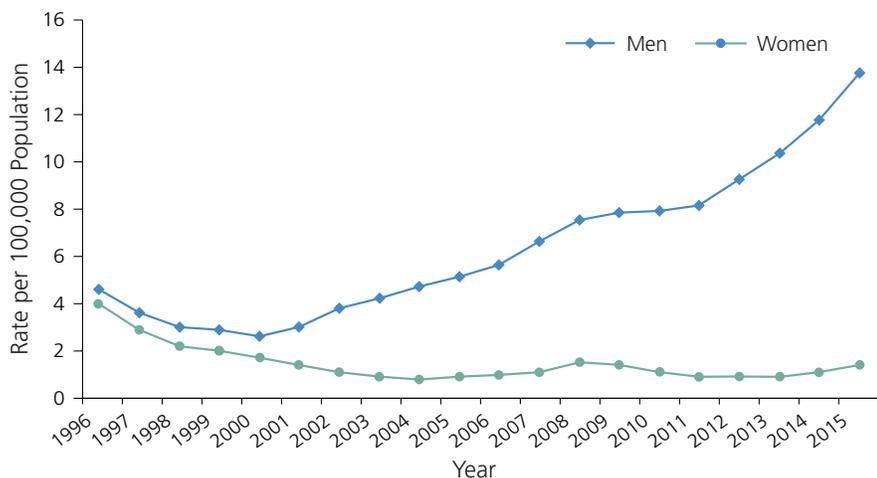
## Sexually Transmitted Infections

Golden provided an overview of syphilis epidemiology and implications for public health (Abstract 56). He began by showing the substantial increase in cases of primary and secondary syphilis in the United States from 1996 to 2015 (Figure), with the initial increase beginning in 2000, but with a further marked increase coincident with the Department of Health and Human Services (DHHS) guidelines for universal antiretroviral treatment in 2012. In 2015, 90% of syphilis in the United States occurred in men, with 82% of these cases occurring in MSM. Similar trends in syphilis have been seen globally. He notes that coincident with this increase have been increases in other STIs, including urethral gonorrhea,

*Syphilis has been on the rise since 2000, with 90% of cases in the United States occurring among men and 82% of cases among MSM.*

which is most often symptomatic and therefore not subject to the same biases seen in screening for asymptomatic STIs. However, as STIs have been increasing from 2007 to 2015 in King County (syphilis by 74%, urethral gonorrhea by 146%, and urethral chlamydia by 61%), rates of new HIV diagnoses have declined by 36%, likely the successful result of HIV treatment as prevention. Golden showed data from 4 US cities showing a decline of the proportion of syphilis cases occurring in HIV-seropositive MSM from approximately 60% to 40% in all 4 cities. Using data from King County, he made a compelling case that incident syphilis cases have moved from being concentrated in high-risk HIV-seropositive MSM to being seen in what he described as a lower-risk population of HIV-seronegative MSM who do not have a history of syphilis or methamphetamine use. This coincided with a decrease in condom use and serosorting among HIV-seropositive MSM and an increase in the number of sex partners in HIV-seronegative MSM. He hypothesized that syphilis has spread from the HIV-seropositive population into the HIV-seronegative population of MSM. He noted, however, that the increase in syphilis rates predates PrEP, as do increases in other STIs. He raised concern for the possibility of a bridge from MSM with syphilis into the increasing rates of congenital syphilis, as a substantial minority of MSM also report having female partners.

Golden closed with 4 public health recommendations arising from these trends in syphilis. First, he emphasized the importance of increasing syphilis screening. He gave an example of the Australian effort to order a syphilis test along with all viral load tests in their HIV-infected population, and showed that from 2007 to 2014, syphilis testing concomitant with viral load testing has increased from 27% to 73% of all tests. This has also been associated with an increase in the proportion of cases of syphilis in people who were diagnosed while asymptomatic from 21% to 85%. However, he warned that in the setting of frequent syphilis testing, clinicians should be aware that 28% of primary syphilis and 44% of secondary syphilis cases will continue to have



**Figure.** Trends in primary and secondary syphilis rates among men and women in the United States over time. Adapted from CROI Abstract 56, with permission from Matthew Golden, MD.

positive syphilis titers at 36 months. He recommended that any 2-fold increase in titer be repeated to rule out a false-positive diagnosis of incident syphilis in those previously diagnosed and treated.

His second point was that although ocular syphilis has been getting increasing attention of late, including in the lay media, ocular syphilis has been detected in 2.5% to 4.5% of all syphilis diagnoses and appears to be stable over time. He noted that 7.9% of syphilis diagnoses will be complicated with ocular, otic, or symptomatic neurosyphilis, and recommended screening for symptoms routinely at diagnosis. Screening tools can be found on the King County Department of Health website (<http://www.kingcounty.gov/depts/health.aspx>).

He recommended using a syphilis diagnosis as an opportunity for conducting HIV prevention, including provision of PrEP. Further details of the King County program are described later in the discussion about new PrEP implementation strategies. Golden closed by pointing to the importance of integrating condom messages into general sexual health messages, noting that the vast majority of MSM use condoms some of the time, and that using them less than all of the time should not be considered a failure.

Several studies presented at CROI 2017 documented increased rates of STIs over time. Ungsedhapand and colleagues reported on data from more than 10,000 clients who underwent HIV and syphilis testing at the Silom Community Clinic in Bangkok, Thailand (Abstract 862). HIV and syphilis coinfection increased from 1.3% of clients in 2006 to 9.5% of clients in 2015. Risk factors for coinfection included being older than 21 years (aOR, 1.8), having been born outside of Bangkok (aOR, 1.3), and being of Thai descent (aOR, 2.0). Hiransuthikul and colleagues reported on recurrent STIs among MSM and transgender women enrolled in the Thai Test and Treat Cohort (Abstract 863). Among 448 participants, they reported STI rates of 2.2 per 100 person-months, with statistically significantly higher recurrent STIs among

those who were HIV seropositive at baseline (aOR, 1.8).

Novak and colleagues reported on the incidence and risk factors for incident syphilis in 6888 HIV-infected persons in the HIV Outpatient Study from 1999 to 2015 (Abstract 864). Overall, 9.3% of participants acquired 1 or more syphilis diagnoses during a median follow-up of 5.2 years. In multivariable analysis, incident syphilis was associated with being 30 years of age or younger (aOR, 1.33) and non-Hispanic black (aOR, 1.6). MSM were statistically significantly more likely (aOR, 3.1) and heterosexual women statistically significantly less likely (aOR, 0.35) than heterosexual men to acquire syphilis. Syphilis incidence increased with each 5-year period compared with 1999 (aOR, 1.5 for 2000-2004; aOR, 2.1 for 2005-2009; aOR, 4.2 for 2010-2015).

In contrast, Ganesan and colleagues reported that among 2719 men and women enrolled in the US Military HIV Natural History Study, syphilis rates have been decreasing, with the highest incidence in 2004 to 2007 (3.2/100 person-years), and the lowest rates in 2012 to 2015

**Regular STI testing and treatment coupled with PrEP delivery in MSM could substantially decrease population-level STI incidence; quarterly vs biannual STI screening could further reduce STI incidence by 50%.**

(2.4/100 person-years) (Abstract 865). Although blacks in the United States have experienced the largest declines over time, in a multivariable model being black (aOR, 2.4) and reporting anal sex (aOR, 3.0) were independent risk factors for acquiring syphilis infection.

Jenness and colleagues presented a modeling study that suggests that regular STI testing and treatment offered to PrEP users could substantially reduce STI incidence at a population level (Abstract 1034). In their network-based mathematical model that takes into account transmission between different types of partners (main, casual, one-off), they found that with 40% PrEP coverage of a high-risk population, 42% of gonorrhea and 40% of chlamydia infections could be averted over the next 10 years, even with a 40% increase in risky sexual practices. Even a doubling of risk compensation would result in net STI prevention benefits relative to no PrEP, because of the 17% and 24% increases, respectively, in the detection of asymptomatic and rectal cases. They state that quarterly STI testing could result in a further 50% decrease in STI incidence over biannual screening intervals. However, these benefits would be realized only with the inclusion of routine STI screening and treatment as part of PrEP provision.

Molina presented an overview of antibiotic prophylaxis strategies for prevention of bacterial STIs (Abstract 55). He pointed out that more than 1 million bacterial STIs (such as

syphilis, gonorrhea, chlamydia, and trichomonas) are acquired each day in the world, the majority of which have no or mild symptoms. In 2015, the United States reported the second year in a row of increases in new cases of gonorrhea, chlamydia, and syphilis. Molina pointed out that antibiotic prophylaxis is not a new strategy, with the first reported study from 1943 of a single dose of sulfathiazole given to 450 US military men to prevent STIs following sex. Although this strategy was successful, with no cases of chancroid and 1 single case of gonorrhea seen in the treated men, the 1 breakthrough gonorrhea infection was caused by an antibiotic-resistant strain, a theme that recurred in Molina's reporting of this approach to preventing bacterial STIs. Of the various approaches outlined (postexposure prophylaxis, treatment of incubating STIs in sex partners, periodic presumptive treatment, mass drug administration, and daily prophylaxis), only treatment of incubating STIs is currently recommended, such as the treatment with penicillin of sexual contacts of persons diagnosed with syphilis, as recommended by the CDC.

In an oral abstract session, Molina and colleagues presented data from a randomized controlled trial (RCT) of post-exposure prophylaxis of bacterial STIs in MSM enrolled in the open-label component of the IPERGAY study (Abstract 91LB). In this study, 232 MSM were randomly assigned to take 200mg doxycycline or placebo 24 to 72 hours after each sexual episode, with a maximum of 6 pills in a 1-week period. Follow-up was 91% in each arm of the study through a median follow-up period of 9 months. They noted a statistically significant decrease in incident chlamydia and syphilis infections (hazard ratio, 0.30 and 0.27, respectively), but without a statistically significant decrease in gonorrhea rates. Men took an average of 7 pills per month and 21% discontinued use because of adverse effects or for other reasons. Testing for antibiotic resistance, a major concern with postexposure prophylaxis strategies, is currently underway. Molina cautioned that antibiotic prophylaxis for STIs is still not recommended because more data are needed, and the risk of development of antibiotic resistance is of great concern.

## HIV Testing

Knowledge of one's HIV serostatus is a crucial first step to accessing HIV prevention and treatment services, and several presentations at CROI 2017 focused on innovative strategies to increase HIV testing in different settings.

### HIV Self-Testing

In a themed discussion on HIV self-testing, Stekler provided an overview of this testing strategy. In the United States, an HIV home collection kit was approved in 1996, and a home self-test was approved by the US Food and Drug Administration (FDA) in 2012. Although these and other HIV tests are available globally, approximately 40% of HIV-seropositive persons worldwide remain unaware of their HIV infection in 2016. Home tests can offer more timely HIV diagnosis; however, they may be subject to test misinterpretation, have

longer window periods associated with lower sensitivity in high-incidence populations, and limit the opportunity for posttest counseling, which may delay linkage to care or PrEP as indicated. Prior research has shown that home HIV testing is acceptable, with preference for and greater ease of use with oral fluid testing. Studies have also demonstrated that home testing can increase testing among high-risk MSM, and in some settings can identify new cases and improve linkage to care. However, modeling studies have also shown that replacing clinic tests with home tests may increase HIV prevalence. Stekler pointed out several gaps in our knowledge of self-testing, including the best ways to implement this strategy, how to reach persons who would not otherwise test, how to link testers to HIV care or PrEP services, how to test for STIs, and the overall impact of home HIV testing on the epidemic.

Salcuni, Edelstein, and colleagues presented results of an HIV Self-Test Giveaway program to distribute free HIV self-tests online in New York City (Abstracts 891 and 898). Men and transgender people who have sex with men were recruited through dating mobile applications and websites over a 23-day period, and eligible participants were provided a code to have an HIV self-test kit mailed at no cost. Among 2497 eligible participants, 71% redeemed the code and 48% took a follow-up survey, of whom 92% reported receiving the

*HIV self-tests are highly acceptable across a number of settings and resulted in a higher proportion of undiagnosed HIV infection than clinic-based testing in a Kenyan study.*

HIV self-test and 80% reported using it. Among survey respondents, 85% were previously aware of the home HIV test, 57% had seen the home HIV test at a pharmacy, and 23% had used at least 1 home HIV test. Higher income and recent HIV testing were associated with awareness, pharmacy exposure, and use of the HIV self-test, and recent anal sex without condoms was associated with use of the HIV self-test. Having health insurance or not was not associated with any of the outcomes along this continuum, suggesting that self-testing can provide an alternative to those without adequate access to health care. Among 884 HIV self-test users, 72% were under 35 years of age, 41% identified as black or Hispanic, and 42% had never tested or had not tested in the prior year. Although only 5 individuals (0.6%) received reactive results with no prior HIV-seropositive results, 80% of these individuals reported a confirmatory test and had an HIV care appointment. Most (71%) of the self-test users reported testing sooner than usual or for the first time, and almost all (98%) reported being likely to recommend the HIV Self-Test Giveaway to a friend.

Sanders and colleagues presented results on a peer-led HIV–self-testing program among gay and bisexual MSM (GBMSM) in coastal Kenya (Abstract 893). Six GBMSM were trained in basic counseling skills, use of the oral HIV self-test, and the importance of confirmatory testing, and each

lay counselor distributed 4 to 5 kits per week with instructions to report for confirmatory testing at the clinic regardless of HIV test result. Over a 3-month period, 337 kits were extended to GBMSM with a median age of 26; 99% of GBMSM returned for confirmatory testing, with 29 (8.7%) confirmed HIV seropositive; 24 (82.8%) of these individuals started antiretroviral therapy on the day of HIV confirmation. These results were compared with traditional HIV testing and counseling done by peers in the clinic over a 6-month period, in which 690 GBMSM were mobilized and tested, and 24 (3.5%) were newly diagnosed, of whom 20 (83%) started antiretroviral therapy after a median of 5 days. The researchers concluded that peer-led oral self-testing followed by clinic-based confirmatory testing and immediate antiretroviral therapy initiation was feasible and acceptable in coastal Kenya and resulted in a higher proportion of undiagnosed HIV infection ( $P < .001$ ) than with clinic-based testing.

Providing HIV self-tests to women attending antenatal and postpartum clinics for distribution to their male partners is a novel strategy to increase HIV testing rates among men and couples in sub-Saharan Africa. Schaffer and colleagues evaluated the role of partner violence in women's ability to distribute self-tests to their male partners in Kisumu, Kenya (Abstract 894). Among 176 HIV-seronegative women with a primary partner, 21% reported a history of intimate partner violence in the 12 months prior to enrollment. Although there were high rates of couples self-testing (55%) and partner self-testing (34%) in 3 months, couples (aOR, 0.13; 95% CI, 0.03-0.54) and partner (aOR, 0.10; 95% CI, 0.02-0.46) self-testing were statistically significantly less likely to occur if a woman reported a history of recent intimate partner violence. The authors concluded that the benefits of secondary distribution of HIV self-tests by women to their male partners may not be fully realized in relationships in which partner violence occurs.

Indravudh and colleagues evaluated preferences for HIV self-testing services and linkage to care using Discrete Choice Experiments as part of baseline household surveys within a cluster randomized trial of HIV self-testing in rural Malawi (Abstract 895). Respondents preferred home delivery of HIV self-test kits to distribution through health facilities or mobile clinics, particularly among those never tested. There was also a preference for lay distributors of test kits rather than healthcare workers and intimate partners. Participants were indifferent to pretest assistance, but were averse to instruction leaflets as the only form of posttest support. Importantly, never testers preferred more extensive support. Cost, even at a low price, was a strong disincentive for testing, although men and those who had never tested were less averse to price. For linkage to care, participants preferred services at home or at the home of a health care worker, with short waiting times and a separate waiting room at health facilities.

In the same session, Indravudh presented data on providing user support for HIV self-testing in Malawi (Abstract 896). In the first phase of this study, cognitive interviews were conducted in 20 literate adults asked to use the HIV

self-test without any additional assistance. Although most participants were able to self-test accurately with only the instructions for use, many experienced difficulties affecting timeliness and confidence of use of the kit, including trouble using the equipment (15/20), not knowing how to interpret symbols and illustrations (8/20), not knowing how to open the package (7/20), and not understanding next steps after self-testing (15/20). This was followed by a feasibility evaluation of the HIV self-test in 2 rural villages in which participants were offered the option of self-testing (confirmed by standard testing), standard testing, or no testing; self-testers were provided a brief kit demonstration prior to use. Among 340 participants in this cross-sectional feasibility study, 86% chose to use the self-test, 4% tested through standard methods, and 11% declined to test. Self-read tests agreed with the reference standard for 12 of 13 HIV-seropositive participants (93% sensitivity) and 276 of 277 HIV-seronegative participants (99.6% specificity). Almost all participants (95%) reported the self-test was very easy to use, although the most common error was reading results before the specified time (which occurred in 5 participants).

### Additional Strategies to Increase HIV Testing

To address lower HIV testing rates among men in sub-Saharan Africa, Chamie and colleagues evaluated the comparative effectiveness of several novel incentive strategies to increase HIV testing uptake among 2530 men in rural Uganda (Abstract 33). Participants were randomized to 1 of 3 incentive types informed by behavioral economics: 1) gain-framed incentive, in which participants were told they would receive a prize for HIV testing; 2) loss-framed incentive, in which participants were told they had won a small prize at enrollment, asked to choose their prize, and told they would lose the prize if they did not come in for testing; and 3) lottery incentive, in which those who tested for HIV would be entered into a lottery to instantly win a large prize; each incentive type had a low and high amount (US \$1 vs \$5 per participant). Overall, 76% tested for HIV at the campaign, with a prevalence of 7.6%. HIV testing uptake did not differ across the groups overall: compared with the gain-framed control groups (74%), HIV testing uptake was 77% in the loss-framed groups ( $P = .24$ ) and 78% in the lottery groups ( $P = .08$ ). However, among participants in the low-cost groups, testing uptake was statistically significantly higher in the lottery group than in the gain-framed group (80% vs 72%,  $P < .01$ ), this finding was not seen in the high-cost groups. Testing uptake did not differ by low versus high cost amounts (75% vs 77%,  $P = .42$ ). Furthermore, rates of HIV seropositivity and the proportion of participants newly diagnosed with HIV infection did not differ between the lottery and the gain-framed groups. The researchers suggest that lottery-based incentives with low-incentive amounts may be more cost-effective than higher amounts.

Shanaube and colleagues presented data on the acceptability and uptake of a community intervention to increase HIV serostatus knowledge among adolescents in Zambia (Abstract 834). In the PopART (Population Effects of Antiretroviral

Therapy to Reduce HIV Transmission) for Youth study, adolescents were contacted in their homes by community HIV care practitioners during annual rounds of outreach and offered participation in the PopART intervention, which included home-based HIV counseling, testing, linkage to prevention such as voluntary medical male circumcision and prevention of mother-to-child transmission (PMTCT). Treatment included immediate antiretroviral therapy irrespective of CD4+ cell count as well as sexual health and tuberculosis services. Between October 2015 and September 2016, 15,456 adolescents aged 15 years to 19 years were enumerated, of which 72% agreed to participate; 1.6% refused, and 26% were not found at home. More men (33%) than women (20%) were not found at home, and younger adolescents (aged 15 years) were more difficult to contact. HIV prevalence was 1.3% and varied by sex (0.6% in men, 1.9% in women). Knowledge of HIV serostatus increased from about 27% to 88% among adolescents who consented to participate in the intervention. The authors conclude that delivering a community-level, door-to-door combination HIV prevention package is acceptable, but complementary strategies to reach more men are needed.

Besa and colleagues presented results on the impact of home-based testing among pregnant women in the same PopART study (Abstract 959). Among 55,291 women who had health data recorded in this study, 7.7% were pregnant. Of these, 7.8% self-reported they were HIV seropositive, and the remaining were offered HIV counseling and testing. The HIV prevalence among those tested by the community HIV care providers was higher for women who had not attended antenatal clinics (12.3%) than for those who had (6.3%). Knowledge of HIV serostatus among pregnant women increased from 60% before the intervention to 95% after.

Medley and colleagues reported on strategies to increase male-partner testing in antenatal care in South Africa (Abstract 958). This program promoted both facility-based and home-based testing through training of health care workers and lay counselors in couples' HIV testing and counseling, providing education to couples on the importance of partner HIV testing, and sending invitation letters to male partners. Among 1453 women who completed the postpartum assessment, 27% tested HIV seropositive. The proportion of women who reported their male partner tested for HIV infection increased from 20% to 43% ( $P < .0001$ ). Based on clinic records, 690 couples tested at one of the facilities, with 14% testing concordant positive and 9% serodiscordant, and 176 couples tested at home, with 3% concordant positive and 14% serodiscordant. In multivariable analyses, statistically significant correlates of partner testing included being married, being known to be HIV seropositive on treatment, and being in the postintervention cohort (OR 3.1). Focus group data suggested that the partner invitation letters were the most useful component of the intervention.

Haukoos and colleagues compared the effectiveness of several screening strategies in a pragmatic randomized trial of rapid HIV testing in emergency departments (Abstract 956). Across 4 urban emergency departments, 76,561 participants were randomized to 1) nontargeted, rapid opt-out

HIV screening; 2) enhanced targeted HIV screening, using the Denver HIV Risk Score as a validated HIV risk prediction tool; or 3) traditional targeted HIV screening, using conventional risk behaviors as defined by the CDC. A total of 14,405 HIV tests were completed across arms, with 25 (0.2%) confirmed new HIV infections. Enhanced targeted HIV screening ( $P = .37$ ) and traditional targeted HIV screening ( $P = .11$ ) were not superior to nontargeted HIV screening, with all 3 strategies identifying comparable numbers of new HIV diagnoses.

De la Flor and colleagues presented data on HIV and HCV testing among jail inmates (Abstract 957). Opt-out HIV and HCV testing was offered to individuals entering the Dallas County jail between October 2015 and July 2016. Of 3155 inmates tested for HIV infection, 41 (1.3%) had a positive HIV fourth-generation Ag/Ab screening test, of which 24% were false-positive results. Among the 30 participants with confirmed HIV infection, 6 were new diagnoses, all of whom were linked to care. Among those previously known to be HIV seropositive, one-third were not engaged in HIV care before incarceration, and 75% were linked to HIV care while in jail. For HCV testing, 16% (500/3042) had a positive antibody screening test; the mean age was 49, 80% were men, and one-third had a previously documented positive HCV antibody test. Only 52% of HCV infections were born in the "baby boomer" cohort (between 1945 and 1965), with some racial differences noted in this cohort (60% black vs 35% white). These data highlight that routine opt-out HIV/HCV testing among jail inmates can identify multiple HIV and HCV infections. Although new HIV diagnoses were rare, this testing provided an opportunity to link individuals to HIV care.

Two groups of investigators evaluated HIV testing motivations and patterns in MSM. Katz and colleagues evaluated HIV testing motivations in a national online survey of US MSM (Abstract 901). Among 1419 MSM, 78% reported prior HIV testing, of whom 9% had tested positive. Younger and non-gay/bi-identified men were more likely to have never been tested ( $P < .001$  for both). Among those who tested negative or did not know their test result, 51% tested on a regular schedule, of whom 33% tested quarterly, 38% tested every 6 months, and 22% tested annually. Regular testers had tested more recently than nonregular testers (median of 3 vs 10 months since the last test,  $P < .001$ ). Among those who had tested, reasons for the last test included regular testing (31%), having a potential exposure (28%), starting a new relationship (8%), and being recommended by a practitioner (7%); also, 24% reported ever having tested in response to symptoms they believed may be acute HIV infection. Men who had ever tested were more likely to think they should test on a regular schedule (86% for testers vs 63% for never testers,  $P < .0001$ ) and less likely to test after being exposed to HIV infection (22% for testers vs 49% for never testers,  $P < .0001$ ). The authors conclude that although messages regarding frequent, regular testing have reached most MSM, additional strategies are needed to help MSM translate this knowledge into practice.

An and colleagues evaluated trends in HIV testing frequency among US MSM in the NHBS (Abstract 902). From

2008 to 2014, the mean inter-test interval between 2 successive tests decreased from 8.6 to 6.5 months among those aged 18 years to 29 years, from 11.3 to 7.7 among those aged 30 years to 39 years, and from 14.0 to 10.8 among those aged 40 years or older. Within each age group, the inter-test interval decreased among black, Hispanic, and white MSM. Among MSM aged 18 years to 29 years and those 40 years and older, Hispanic MSM had higher mean inter-test intervals than black and white MSM in 2011 and 2014. Although most MSM surveyed adhered to CDC recommendations of annual testing, these results suggest that strategies to increase testing frequency among older and Hispanic MSM may be needed.

### Cost Effectiveness of HIV Screening Strategies

Several investigators provided data on the cost-effectiveness of different HIV testing approaches at this year's conference. Mabileau and colleagues evaluated the clinical impact, cost, and cost-effectiveness of different testing strategies in 3 European countries (Estonia, France, and Spain) (Abstract 1028). Testing strategies, in addition to current HIV testing practices, were evaluated for different transmission groups, and incremental cost-effectiveness ratios (ICERs) were calculated and considered cost-effective if the ICER was less than the annual per capita gross domestic product. Modeling results indicated that frequent HIV testing among high-risk groups increased life expectancy in people living with HIV infection. In France and Estonia, investigators recommended that MSM should have additional HIV testing every 12 months (ICERs, €16,200 and €18,600/year of life saved [YLS], respectively), and every 36 months in Spain (ICER €25,300/YLS). PWID should be tested every 3, 6, and 36 months in Estonia, Spain, and France, respectively (ICERs, €7000, €18,300, €19,700/YLS, respectively). For the overall population, one additional lifetime test was cost-effective for incidence below 0.009 per 100 person-years, and an additional test every 10 years was cost-effective for higher incidence levels.

Hutchinson and colleagues evaluated the cost-effectiveness of HIV screening for heterosexuals in the United States using a dynamic, compartmental model of the HIV epidemic (Abstract 1029). For high-risk heterosexuals, defined as those living in urban, high-poverty, white-minority areas with high HIV prevalence, annual screening was found to be cost-effective (ICER, \$70,579), and could be considered economically attractive at 6-month intervals (ICER, \$129,411). For the general heterosexual population, HIV screening was considered beyond the accepted threshold of cost-effectiveness when done more frequently than every 20 years (ICER, \$70,579).

Cambiano and colleagues evaluated the population level impact and cost-effectiveness of different delivery models for HIV self-testing using a dynamic model of the HIV epidemic in Zimbabwe (Abstract 1030). Five different delivery approaches were evaluated, including secondary distribution of HIV self-tests to partners of pregnant women; pharmacy-based distribution of HIV self-tests to people who had sex without a condom since the last test; and community-based

distribution (CBD) to young people, female sex workers, or adult men between the ages of 25 and 49. Based on an estimated 85% of people living with HIV infection in Zimbabwe knowing their HIV serostatus in 2016, several of the HIV self-testing strategies could increase rates of HIV serostatus knowledge to allow the first UNAIDS 90 goal to be reached. Furthermore, CBD could avert between 1200 (if introduced only in female sex workers) and 4500 (if introduced in all populations with 20% linkage to voluntary medical male circumcision) new HIV infections per year. However, due to high levels of HIV serostatus awareness, these strategies were unlikely to be cost-effective. The authors suggest that introduction of HIV self-testing into regions with lower testing coverage, more effective linkage of HIV prevention strategies (eg, PrEP and voluntary medical male circumcision), and lower kit costs could increase cost-effectiveness.

Sharma and colleagues evaluated the cost-effectiveness of assisted partner services to increase HIV testing and linkage in sub-Saharan Africa (Abstract 1032). Randomized clinical trial data in Kenya previously demonstrated higher rates of HIV testing of sexual partners in individuals who received assisted partner services compared with controls (41% vs 9%). In a dynamic HIV transmission model, it was projected that the population receiving partner services would increase to 11% and reduce HIV infections by 2.7% over the next 10 years. The ICER for implementing partner services was \$1,568/disability-adjusted life year (DALY) averted, and this decreased to \$1,156/DALY averted with task-shifting of intervention delivery from health care professionals to community health workers. This ICER falls below Kenya's gross domestic product per capita and is considered very cost-effective.

### Detecting Acute and Early Infection

Identifying individuals with acute HIV infection (AHI) is important to facilitate the immediate initiation of antiretroviral therapy and to reduce the likelihood of onward transmission. Dijkstra and colleagues developed and validated a risk score to assist in the detection of acute HIV infection among MSM (Abstract 886). Using data from 1562 HIV-seronegative MSM enrolled in the ACS (Amsterdam Cohort Study), an AHI risk score was developed that included 4 symptoms (fever, lymphadenopathy, oral thrush, and weight loss) and 3 risk factors (>5 sexual partners, gonorrhea, and receptive anal sex without a condom). This risk score identified 24% of MSM who would be indicated for AHI testing in the ACS, with a sensitivity and specificity of 76%. The risk score was then validated in the MACS (Multicenter AIDS Cohort Study) and showed comparative specificity of 89% but lower sensitivity (56%). The authors suggest that screening with this AHI risk score could increase efficiency of HIV-1 RNA testing and potentially facilitate early diagnosis and immediate treatment.

Dijkstra and colleagues also presented data on incorporating a point-of-care HIV-1 RNA test into a rapid diagnostic and referral strategy to identify acute HIV infections in the ACS (Abstract 887). MSM were referred to the study by an online media campaign, by their medical practitioner, or during

routine STI screening. Among 206 eligible men enrolled in the study with potential AHI symptoms, 19 (9.2%) MSM were newly diagnosed with HIV infection. Two participants had a positive point-of-care RNA and negative fourth-generation test (Fiebig I), 8 participants had a positive RNA and positive antigen but negative antibody on the fourth-generation test (Fiebig II), and 7 were recently infected with a positive RNA and a positive antigen/antibody fourth-generation test but negative HIV rapid test (Fiebig III–V). Additionally, 2 were diagnosed with established HIV infection (positive HIV rapid test). The median time from intake to delivery of results was 3.2 hours. All participants were referred to an HIV treatment center for immediate initiation of antiretroviral therapy. The authors concluded that their AHI strategy yielded a high proportion (8.3%) of those selected for testing having acute or recent HIV infection, and point-of-care RNA testing detected an additional 2 diagnoses of AHI.

Linley and colleagues evaluated the utility of HIV testing history in identifying AHI infection (Abstract 889). Using data from NHSS, they defined AHI cases as HIV infection in which the last reported date of negative test was 60 days or less before diagnosis, and compared cases based on a laboratory report with those from other sources (eg, individual self-reported or practitioner-reported). Among 220,195 diagnoses, 6% had a last negative test by laboratory report, of which 18% had AHI; 23% had a last negative report from other sources, and 6% had AHI. The proportion of AHI cases with a viral load of 100,000 copies/mL or more was higher for laboratory report–based AHI (65%) than for other source-based AHI (30%,  $P < .001$ ), and the proportion of AHI cases with incidence assay results indicating recent infection was higher for laboratory report–based AHI (85%) than for other source-based AHI (38%,  $P < .001$ ). From 2008 to 2014, the proportion of AHI among those with a laboratory-based report of last negative test date increased 145%. The researchers concluded that last negative test results based on laboratory reports are more accurate than those from other sources, and efforts to improve the collection of laboratory reports could increase the ability of HIV surveillance programs to identify AHI.

## Pre-Exposure Prophylaxis: What's New?

### Do Vaginal Microbiota Affect PrEP Efficacy?

Three presentations provided updated data addressing the impact of vaginal dysbiosis and inflammation on tenofovir levels in vaginal tissue and efficacy as a PrEP agent. At IAS 2016, Burgener and Klatt presented a secondary analysis of data from the CAPRISA (Centre for AIDS Programme of Research in South Africa) 004 study that found that tenofovir 1% vaginal gel was efficacious in women with a *Lactobacillus*-dominant vaginal microbiome (efficacy 61%,  $P = .01$ ), but not in women with *Lactobacillus*-deficient vaginal microbiome (efficacy 18%,  $P = .6$ ).<sup>1</sup> Hillier and colleagues explored this relationship between the vaginal microbiota and topical tenofovir administration by evaluating data from a phase I study of 41 noninfected, nonpregnant women administering 7 days of vaginal tenofovir gel or film (Abstract 86LB). They

found an association of higher levels of dysbiosis (as measured by *Gardnerella vaginalis* on polymerase chain reaction [PCR] or Nugent score on gram stain) and lower tenofovir levels in vaginal fluid, cervicovaginal biopsy tissue, and plasma. Conversely, women with high levels of 3 subtypes of *Lactobacillus*, a measure of healthy vaginal microbiota, had higher levels of tenofovir in vaginal fluid, cervicovaginal biopsy tissue, and plasma. These results confirm the findings of the

**Data suggest that vaginal dysbiosis can reduce the efficacy of topical, but not oral, PrEP.**

CAPRISA 004 study and suggest that vaginal dysbiosis could potentially reduce topical PrEP efficacy.

McKinnon and colleagues reported on the effect of genital tract inflammation on the efficacy of topical tenofovir gel among 774 women enrolled in the CAPRISA 004 trial (Abstract 949). Among women without inflammatory cervicovaginal lavage fluid, defined as having 3 or less elevated inflammatory cytokines, tenofovir gel was 57% effective (95% CI, 10%–80%); this estimate increased to 75% effectiveness (95% CI, 25%–92%) among women using gel for 50% or more of their sex acts. Women with inflammatory cytokines, on the other hand, had no effectiveness from tenofovir gel, regardless of whether or not they reported high levels of drug adherence.

Heffron and colleagues presented data suggesting that oral PrEP efficacy is not substantially altered by vaginal dysbiosis (Abstract 85). In the Partners PrEP study conducted in East Africa, women were randomized 1:1:1 to daily tenofovir disoproxil fumarate (TDF) alone, coformulated with emtricitabine (TDF/FTC), or placebo, and underwent monthly HIV testing and baseline and annual vaginal swabs for gram stain. The PrEP efficacy measurement was combined for the 2 active arms, and compared between women with and without bacterial vaginosis (BV), as determined by a Nugent score of 7 to 10 versus 0 to 3, respectively. Daily TDF-based PrEP was efficacious in both the BV (77%) and non-BV subgroups (73%), with no statistically significant difference in efficacy by BV status ( $P = .9$  for interaction). Similar levels of efficacy were seen when vaginal dysbiosis was measured by the presence versus absence of BV morphotypes and *Lactobacillus* morphotypes. Heffron concluded that because oral PrEP undergoes metabolism through systemic processes, local mediators may not influence the protective benefits of PrEP. She urged that future oral PrEP studies focus on improved adherence among women in sub-Saharan Africa, a population in whom HIV infection rates are high.

### Breakthrough HIV-1 Infections on PrEP

Previously, the only reports of breakthrough infections in persons believed to be highly adherent to PrEP occurred when TDF was administered alone in the treatment of hepatitis B virus infection,<sup>2,3</sup> or with multidrug resistant HIV-1 infection.<sup>4</sup> At CROI 2017, Hoornenberg and colleagues presented data on a man who appeared to acquire wild-type HIV-1 infection from high levels of sexual activity with men despite high adherence to daily TDF/FTC (Abstract 953). A 50-year-old man

who was HIV seronegative on HIV RNA and antigen/antibody testing at enrollment began daily TDF/FTC in a demonstration PrEP study in Amsterdam. The participant reported high levels of sexual activity, including an average of 38 to 75 anal sex partners per month through the first 7 months of follow-up, with anal sex without using a condom 12 to 21 days per month. At month 8, he reported an episode of fever and dysuria and was found to be HIV-1 antibody positive, but antigen and HIV-1 RNA negative, at that time. PrEP drugs were stopped, and HIV-1 was detected in his blood 3 weeks later. Tenofovir diphosphate (TFV-DP) levels were measured in dried blood spot (DBS) specimens at 6 and 8 months, and were commensurate with daily PrEP (> 2200 femtomoles/punch). Resistance testing revealed wild-type virus, making this the first reported case of an apparently highly adherent participant acquiring wild-type HIV-1 infection. The investigators questioned whether PrEP efficacy may have been reduced in this case because of the high level of sexual activity or whether high blood levels were not reflective of tissue drug levels in this individual. They also commented on the abnormal seroconversion pattern seen in this participant, with an HIV-1 antibody-positive, antigen-negative response. Sivay and colleagues also presented data that explored abnormal HIV-testing results among seroconverters on PrEP (Abstract 955). In HPTN 067, an RCT of daily versus event-driven versus time-driven TDF/FTC for PrEP in 622 participants, 2 simultaneous rapid HIV tests were negative in 9 of 12 seroconverters, all of whom had infrequent PrEP dosing or inadequate adherence. In 4 persons, follow-up rapid tests were also negative, including one person who continued to have negative rapid tests through 8 weeks after a positive fourth-generation HIV test turned positive. The investigators suggested that HIV-1 rapid tests may be insufficiently sensitive during early HIV infection, leading to rapid development of resistance if persons who are HIV-infected continue on PrEP.

Council and colleagues reported on breakthrough infections in participants in the Bangkok Tenofovir Study (Abstract 954). In the parent study, PWID were administered daily directly observed therapy (DOT) with TDF alone. Of 11 seroconverters evaluated in this study, 5 appeared to have high levels of adherence, as determined by DOT and plasma drug-level testing at the first HIV-1 positive blood draw. No drug resistance testing results were reported, so it is unclear whether

**Another breakthrough infection in the setting of high adherence to PrEP was reported, this time with wild-type virus.**

these breakthrough infections occurred because the route of exposure was likely through injection practices, which may present a higher barrier to protection, or whether TDF alone is inadequate as PrEP, particularly for parenteral exposure. An analysis of data from the Bangkok Tenofovir Study suggested that even with adherence levels in excess of 97.5% as measured by DOT, PrEP effectiveness of TDF in PWID was only 84%,<sup>5</sup> suggesting very high levels of adherence are required for protection in this group.

Cabotegravir, an investigational long-acting integrase strand transfer inhibitor (InSTI) is being evaluated for PrEP as a bimonthly intramuscular injection. Garcia-Lerma and colleagues presented data from a study assessing the development of drug resistance when cabotegravir was administered as 3 monthly injections to rhesus macaques acutely infected with simian immunodeficiency virus (SIV) (Abstract 84). Five of the 6 animals developed InSTI-resistant SIV variants in blood, vaginal, or rectal tissues, including the E92Q and E92G mutations at days 81 and 143, respectively, mutations known to confer resistance to InSTIs against HIV infection. Of particular concern was detection of mutations in vaginal and rectal fluid, suggesting that InSTI-resistant virus could theoretically be transmitted sexually. This reinforces the importance of ensuring that persons are HIV uninfected when initiating PrEP, particularly when administering long-acting PrEP agents, which may lead to suboptimal treatment for an extended period of time.

### PrEP Sustained Delivery Technologies Under Development

Because daily adherence to medication is quite challenging, new technologies are under development that would provide sustained delivery of antiretroviral medications, including for PrEP. Durham and colleagues presented data on a biodegradable implant containing tenofovir alafenamide (TAF) that can be implanted using existing trocar applications (Abstract 420). The investigators described prototype implants that range from 2 mm to 2.5 mm in diameter and 40 mm in length. Preliminary studies using these devices have achieved sustained plasma levels for 14 to 21 days, with rapid tapering and disappearance from the plasma, a favorable quality that avoids the long subeffective pharmacokinetic tail seen in some long-acting formulations of PrEP drugs. However, manufacturing has been challenging, and automated fabrication of these devices is under development, along with plans to evaluate tissue drug levels and additional animal study data.

Ying and colleagues presented initial data on a refillable nonfluidic implant for constant delivery of PrEP medication (Abstract 422LB). They microfabricated silicon nanochannel membranes in compliance with FDA requirements for implantable devices, which were incorporated into medical grade titanium implants. Separate reservoirs contained TAF and FTC. Although TFV-DP levels remained above protective levels in peripheral blood mononuclear cells (PBMCs) over 83 days, FTC-triphosphate levels were sustained only for 28 days, followed by a gradual decline resulting from drug depletion. Transcutaneous refilling was successful and the implants appeared to be well tolerated. The investigators plan future SIV challenge studies to evaluate the potential for these devices to deliver PrEP without requiring daily pill taking.

### Novel PrEP Implementation Strategies

Katz presented data from a novel program using STI partner services to identify HIV-seronegative men who may benefit from PrEP in King County, Washington (Abstract 89). Of 3936

HIV-seronegative MSM with a newly diagnosed STI, 956 received partner services and had PrEP use assessed. The proportion of MSM diagnosed with a rectal STI or early syphilis who reported that they were already on PrEP at the time of the partner services interview increased from 30% in 2014 to 58% in 2016. Racial and ethnic disparities were seen, with

**Identifying PrEP candidates through STI partner services and delivering PrEP through pharmacies are promising strategies for increasing PrEP access in the United States.**

statistically significantly lower proportions of black and Latino MSM reporting prior PrEP use, even after adjusting for year, age, STI type, and substance use. Of men not on PrEP who were referred to PrEP programs, 21% were seen for a first intake visit at a public health site; this number does not include persons who may have sought care with private practitioners. The investigators suggest that identifying high-risk persons through such programs may improve PrEP uptake among those at highest risk, and they have now prioritized inclusion of all black and Latino MSM identified through STI partner services.

Two investigators explored the possibility of having pharmacists deliver PrEP directly to patients. Tung and colleagues reported on the first year of operation of a pharmacist-run HIV PrEP clinic in a community pharmacy setting in Seattle (Abstract 961). Of 373 individuals initially contacting the clinic, 40% were linked with primary care and 245 were started on PrEP. Overall, 75% were retained on PrEP, with the main reasons for discontinuation being insurance restriction, transfer of care elsewhere, or being lost to follow-up. Virtually all of the individuals (97%) had no copay for medication, and the clinic costs were met at 9 months of operation. Broekuis and colleagues reported on Midwest pharmacists' interest in prescribing PrEP (Abstract 963). Of 140 pharmacists returning an email-based survey, only 42% were familiar with TDF/FTC PrEP, but 54% stated they were fairly or very likely to provide PrEP after additional training as part of a collaborative practice agreement.

Khosropor and colleagues reported on the successful use of text messaging to improve retention in a clinic-based PrEP program (Abstract 964). Their program had 3 components: 1) regular (weekly to monthly) check-in messages, 2) automated appointment reminders, and 3) bidirectional communication with disease intervention specialists. Of 275 individuals who filled their PrEP prescriptions, 79% opted into this optional program. Clinic retention was 76% in those opting to use the program versus 53% among those opting not to use the program. Although this was not a randomized trial and, therefore, improved retention cannot be definitively attributed to the program, the high degree of desirability among participants is promising, and suggests further evaluation of this tool is warranted.

Golub and colleagues reported modest, short-term improvement in PrEP adherence from a brief behavioral intervention among 300 PrEP users in New York City (Abstract

965). Participants were randomized to a brief sexual health intervention, a brief adherence intervention, both interventions, or neither. At 3 months, participants receiving either intervention were statistically significantly more likely to be adherent to PrEP, defined as having a TDF-DP level in DBS consistent with 4 or more doses per week, than individuals randomized to neither intervention (94% vs 85%,  $P = .005$ ). No statistically significant difference was seen at 6 months (92% vs 86%). The investigators suggest that brief counseling interventions should be explored and that ongoing counseling may be required.

### PrEP Awareness, Targeting and Uptake

Several presentations documented the increase in PrEP awareness and use among MSM. Khaketla and colleagues presented data on 528 HIV-seronegative MSM enrolled in the longitudinal Momentum Health Study in Vancouver, Canada (Abstract 966). PrEP awareness increased from 18% in 2012 to 80% in 2016. PrEP awareness was statistically significantly higher in men with an annual income of \$60,000 or greater (aOR, .24), in men with more than a high school education (aOR, 2.1), in men who practiced viral load sorting for prevention in the past 6 months (aOR, 2.56), in men with some markers of sexual risk (2 or more sexually transmitted infection diagnoses [aOR, 1.97]); and in those who used ecstasy in the past 6 months (aOR, 1.46). However, PrEP knowledge was lower in MSM who were Aboriginal (aOR, 0.36) or Latino (aOR, 0.40), and men who had previously received drugs for sex (aOR, 0.22). Despite high PrEP knowledge overall and the fact that 73% of men reported medical prescription insurance coverage, only 8 men reported PrEP use in any 6-month period. In fact, TDF/FTC PrEP was only licensed in Canada in February 2016 and is not currently publicly funded in British Columbia, suggesting that insurance coverage issues may be severely restricting PrEP access in British Columbia.

Buskin and colleagues compared several different methods for measuring PrEP uptake from 2014 to 2016 among MSM in Seattle (Abstract 973). Comparing an annual survey of health care practitioners about PrEP prescriptions with estimates from surveys of PrEP users (Seattle Pride surveys, the NHBS survey in MSM conducted in 2014, STI partner services, and the Seattle STI clinic) yielded similar results. These investigators estimate that 10% to 11% of MSM overall and 30% to 40% of high-risk MSM have used PrEP. As with other reported studies, PrEP use appears to be higher among white MSM than men of color, with the fewest disparities seen in the STI clinic patients (PrEP use 40% among white MSM, 31% among black MSM, 34% among Latino MSM, 33% among Asian/Pacific Islander MSM). The investigators report that their city-wide goal is to be administering PrEP to 50% of high-risk MSM by 2020, and suggest that they are on target to achieve that goal.

McMahan and colleagues focused on PrEP knowledge and uptake among 216 MSM and 5 transgender women who used methamphetamine in Seattle (Abstract 967). Although 97% of participants had heard of PrEP and 93% stated they

knew where to get it, only 7 participants (3%) stated they had used PrEP. Insurance did not appear to be a barrier, as 97% reported having insurance. In qualitative interviews and focus groups, issues around stigma of PrEP use, challenges with keeping clinic appointments, and self-perception of low risk appear to contribute to low uptake in this vulnerable population.

Raifman and colleagues reported on the impact of a 5-minute PrEP education session on PrEP awareness and uptake among HIV-seronegative STI clinic patients in Rhode Island (Abstract 968). They compared knowledge and uptake with a control group of men who have sex with women who also attended the clinic more than once during that time to account for temporal trends. PrEP awareness increased by 19% in the MSM compared with the control group, and uptake increased by 4%. Although PrEP awareness was high in 2015, they found that non-Hispanic black MSM had 0.35 the odds of being aware of PrEP compared with white MSM. They also point to the importance of translating knowledge of PrEP into PrEP uptake in high-risk populations.

Jancki and colleagues pointed to limitations in following the CDC guidelines<sup>6</sup> for identifying young black MSM who may benefit from PrEP (Abstract 969). They followed a cohort of 300 HIV-uninfected black MSM aged 16 years to 29 years during PrEP rollout in Chicago from 2013 to 2016. HIV-1 incidence was 85 per 100 person-years. The investigators report that following CDC guidelines for PrEP initiation, based on enrollment data, would have missed 48% of the seroconverters, while the HIV Incidence Risk Index for MSM<sup>7</sup> and the manufacturer's PrEP package insert<sup>8</sup> would have missed 15% and 6%, respectively. This speaks to the importance of being more inclusive of persons who may benefit from PrEP, particularly youth, who may underreport or change risk practices over time.

Mayer and colleagues reported on disparities in PrEP uptake in a national online sample of 4638 MSM adults recruited through 2 sexual networking mobile apps. Overall, 8% of men reported ever having used postexposure prophylaxis (PEP) and 15% ever having used PrEP. In a multivariable model, ever having used PrEP was associated with being 25 years of age or older (aOR, 1.9), having private (aOR, 3.8) or public (aOR, 2.0) health insurance compared with no health insurance, having 2 or more sex acts with no condoms in the past 3 months (aOR, 2.9), having been diagnosed with an STI in the past year (aOR, 3.1), and having ever used PEP (aOR, 6.5). Black men (aOR, 0.7) and men born outside of the United States (aOR, 0.7) were statistically significantly less likely to have ever used PrEP. These investigators urge attention to economic and social disparities to increase uptake of PrEP in vulnerable populations.

Rolle and colleagues presented data from an observational cohort of black MSM aged 16 years to 29 years in Atlanta, Georgia (Abstract 90). Of 184 men enrolled in this study, 53% had previously heard of PrEP, but only 34% initiated PrEP despite it being offered through the study without cost for practitioner or laboratory visits, although drug costs were to be paid through insurance or drug assistance programs. At the

time of study reporting, 17% of those initiating PrEP had already discontinued use, including 3 men who seroconverted while not taking PrEP. The investigators emphasized the importance and the challenges of providing PrEP to young, at-risk populations.

### **PrEP Persistence, Adherences, and Outcomes**

Huang and colleagues reported on laboratory monitoring in 2140 privately insured adult PrEP users from a national insurance claims database from 2011 to 2014 (Abstract 980). They reported that before the initiation of PrEP, only 53% of the cohort was tested for HIV infection, 32% for hepatitis B virus, 28% for serum creatinine, 49% for syphilis, and 37% for gonorrhea or chlamydia. Of those prescribed PrEP for 3 months or more, only 30% had a first monitoring test for HIV infection at 3 months and only 62% at 12 months. Rates of creatinine testing were also low, with 20% tested at 3 months and 49% at 1 year. They stated that testing rates for all measures except creatinine improved over time. If this database accurately represents testing of PrEP users nationally, this study indicates substantial nonadherence to PrEP prescribing guidelines, and points to the need to improve the routine screening and monitoring for HIV infection, STIs, and renal function in PrEP users.

Patel and colleagues reported on retention at the 3-month visit in PrEP clinics in Providence, Rhode Island; Jackson, Mississippi; and St. Louis, Missouri from January 2014 through December 2015 (Abstract 972). Overall, 18% of the 201 patients seen in these clinics missed their 3-month appointment. Individuals with private or public insurance were 4 times more likely to attend the 3-month visit than those who were uninsured, pointing to the crucial importance of health insurance on PrEP persistence.

Scott and colleagues reported on racial and ethnic disparities in persistence among PrEP users in San Francisco (Abstract 974). Of 148 persons receiving PrEP at the San Francisco Department of Public Health Primary Care Clinics from

*Racial and ethnic disparities are seen in PrEP awareness, use, and persistence; insurance barriers are associated with decreased PrEP uptake and persistence.*

March 2015 through February 2016, 67% remained on PrEP through April 1, 2016. The median duration on PrEP was substantially shorter for black (116 days) and Latino (183 days) individuals than for white (347 days) and Asian (279 days) individuals, indicating either earlier discontinuation or later initiation. They plan further studies to understand reasons for discontinuation among this user population.

Lalley-Chareczko and colleagues reported on PrEP adherence among 50 MSM and transgender women aged 18 years to 29 years in a Philadelphia cohort study (Abstract 975). Of the 70% retained at week 48 in the study, 70% demonstrated high levels of PrEP adherence as measured by urine tenofovir

levels, with levels over 1000 ng/mL, indicating use in the past 48 hours. Although this suggests that fewer than half of the participants initially recruited sustained high PrEP adherence through 1 year, they concluded that PrEP can be successfully delivered to a young, high-risk population. They also reported ongoing high rates of STIs in the population, pointing to the ongoing need for PrEP.

Hoenigl and colleagues reported that substance-using MSM on PrEP had better adherence than those without ongoing substance use in the CCTG 595 PrEP trial (Abstract 977). Among 394 participants enrolled in an RCT to promote adherence through texting via telephone versus standard of care, no difference between intervention and control arms in high PrEP adherence was seen as measured by TFV-DP levels in DBS consistent with taking 4 or more doses per week at week 48. However, participants reporting ongoing “heavy” substance use (5 or more times in the past 3 months at more than half of visits) were statistically significantly more likely to be highly adherent (OR, 2.1), as was ongoing “some” (1-4 times) or “heavy” (5 or more times) alcohol use (OR, 3.2 and 3.4, respectively). Because 39% of substance users were diagnosed with incident STIs during the study, they speculated that this subgroup may have been aware of their high risk, which may have motivated their high levels of adherence.

Gandhi and colleagues evaluated predictors of good adherence in a hair sample substudy of 280 participants enrolled in a PrEP demonstration project in San Francisco, Miami, and Washington, DC (Abstract 978). Hair samples were collected every 12 weeks and good adherence was indicated by tenofovir levels consistent with 4 or more doses of TDF/FTC PrEP per week. Factors associated with good adherence in 876 person-visits were age (OR, 1.42 per decade of age at baseline) and receptive anal sex without using a condom with an HIV-seropositive partner in the past 3 months (OR, 2.35). In support of the Hoenigl study, mentioned above, these investigators also found that amphetamine use in the past 3 months was marginally associated with high adherence (OR, 2.46,  $P = .07$ ). However, both older participants (those over 45 years at entry) and having high adherence on hair measures were associated with an increased risk of experiencing a drop in estimated glomerular filtration rate (eGFR) to 70 or lower (OR, 3.4 and 1.3, respectively); higher starting GFR was associated with a reduced risk (OR, 0.85 per unit of GFR > 70). This suggests that older participants and those with lower GFRs at PrEP initiation may require more frequent renal monitoring to avoid renal adverse events from TDF/FTC PrEP.

Safety data on PrEP use during pregnancy are limited, but 2 presentations at CROI 2017 addressed birth outcomes in women using PrEP at the time of conception. Heffron and colleagues presented data on 30 pregnancies that occurred in women on PrEP in the Partners Demonstration Project, and compared birth outcomes with 85 pregnancies occurring in 79 women receiving placebo tablets during the Partners

PrEP RCT (Abstract 934). The investigators found no differences in pregnancy outcomes in women on PrEP compared with women not on PrEP, including preterm delivery (0% vs 8%), pregnancy loss (17% vs 24%), or congenital anomalies (0% vs 8%). Although infant length and head circumference were marginally lower in the PrEP-exposed group than in the PrEP-unexposed group at month 3, infant growth characteristics were similar at 12 months. These data suggest that TDF/FTC PrEP taken during pregnancy did not adversely affect pregnancy- or birth-related outcomes. Makani and colleagues presented pregnancy incidence and outcome data among women using the dapivirine vaginal ring (Abstract 935). In the ASPIRE RCT, 2629 women were randomly assigned to a monthly dapivirine or placebo vaginal ring; 179 pregnancies occurred in 169 women. No differences were seen in pregnancy incidence (4.0 vs 4.3/100 person-years, respectively) or pregnancy outcomes between the 2 arms (preterm birth, 0% vs 10%; stillbirth, 2% vs 2%; spontaneous abortion, 21% vs 22%; birth anomaly, 8% vs 7%, respectively). These data are also reassuring that dapivirine use in the periconception period does not appear to be associated with adverse effects on pregnancy. 

**All cited abstracts appear in the CROI 2017 Abstracts eBook available online at [www.CROIconference.org](http://www.CROIconference.org).**

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