A New Trend in the HIV Epidemic Among Men Who Have Sex With Men, San Francisco, 2004–2011

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Background: In San Francisco, men who have sex with men (MSM) have historically comprised 90% of the HIV epidemic. It has been suggested that given the ongoing HIV transmission among this population, there is the possibility of a high-level endemic of HIV into the future. We report on the possibility of another phase in the HIV epidemic among MSM in San Francisco.

Methods: Behavioral surveillance systems monitor HIV prevalence, HIV incidence, and behaviors among populations at high risk for HIV infection. Among MSM, time–location sampling is used to obtain samples for standardized behavioral surveys, HIV-antibody and incidence testing. We analyzed National HIV Behavioral Surveillance data from MSM sampled in 2004, 2008, and 2011.

Results: Three hundred eighty-six, 521, and 510 MSM were enrolled in each of the waves. Only slight changes were seen in demographics over time. We detected significant declines in unrecognized HIV infection and methamphetamine use, a significant increase in HIV testing in the past 6 months, and no changes in HIV prevalence, history of gonorrhea infection, or having multiple sex partners. Among HIV-infected men, current antiretroviral treatment (ART) use seems to have risen from 2008 to 2011.

Conclusions: The trends of the last 7 years point to stable HIV prevalence as rising ART coverage results in improving survival coupled with decreasing incidence as ART use achieves viral load suppression at levels more than sufficient to offset ongoing sexual risk behavior. "Treatment as prevention" may be occurring among MSM in San Francisco.

Key Words: men who have sex with men, HIV trends, San Francisco

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INTRODUCTION

San Francisco is one of the cities hit earliest by the HIV epidemic in the United States. Since the beginning of the epidemic, >19,000 San Franciscans have died prematurely due to AIDS, and at present, nearly 19,000 San Franciscans are estimated to be living with HIV.[1] Men who have sex with men (MSM) have borne the heaviest burden of the epidemic; approximately 90% of all cases have been and continue to be among MSM.[1]

The course of the epidemic, pieced together by retrospective data, can be described in distinct phases. The first phase of a very rapid spread of HIV through a vulnerable and largely unaware population for the years up to 1982 is evidenced by the peak in reported AIDS cases 10–11 years later and peak HIV incidence in cohort studies straddling the late 1970s and early 1980s.[1–3] The next phase to 1989 witnessed a decline in HIV transmission as awareness took hold, prevention efforts accelerated, and a large part of the susceptible population was already infected.[1,2] The next phase to 1996, the realization set in that the epidemic was not over, HIV transmission persisted among young and especially minority MSM.[1,4] The period culminated in an optimism that antiretroviral treatment (ART) would improve the lives of persons living with HIV/AIDS and dampening onward transmission.[5] However, the hoped-for prevention dividend from the 7 years of the first ART scale-up, 1996 to 2003 did not materialize for MSM. On the contrary, evidence of resurging HIV incidence emerged from San Francisco and other cities with large MSM populations around the world.[6,7] We previously hypothesized that the resurging or persistently high incidence of HIV coupled with improved survival would create a "hyperendemic" state among MSM that would maintain and, if not checked, grow HIV prevalence for years to come.[8]

We now hypothesize that the most recent phase, from 2004 to 2011 encompasses yet a new trajectory, a trajectory where increased rates of recognized HIV infection and ART use has resulted in decreased HIV incidence despite no changes in risk behaviors. Several factors and policies have changed in this interval. HIV testing is advocated for MSM on a very frequent basis, every 6 months, and is delivered by multiple modalities and settings. ART is more effective at suppressing viral load and initiated ever earlier in the course of infection. The shifting guidelines constitute a "second scale-up" that may have greater prevention effect. Moreover, the phenomenon of seroadaptation or serosorting (ie, the selection of sexual partners of the same HIV serostatus to prevent HIV transmission) has been widely documented, especially among MSM and may have impacted the trajectory of the HIV epidemic in San Francisco.[9,10]

Monitoring trends in the HIV epidemic requires standardized, reproducible methodologies that are focused

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in the segments of the population most at risk for HIV infection. Through most of the epidemic the core activity of HIV surveillance in the United States has been AIDS and more recently HIV case reporting. Although case reporting is a crucial component to monitoring the epidemic, it is not as well suited to monitor the behaviors that put persons at risk for HIV infection nor can it estimate the number of persons infected but not yet reported to the case reporting system.[11] To fill this important gap in core HIV surveillance activities, behavioral surveillance systems have been developed in the United States and around the world. In many cases, these systems follow guidelines for second-generation HIV surveillance promoted by the World Health Organization and the Joint United Nations Programme on HIV/AIDS.[12] Starting in 2004, San Francisco, in collaboration with Centers for Disease Control and Prevention, developed a behavioral surveillance system to monitor trends in behaviors and HIV among populations at high-risk for HIV infection.[13] We present findings from the first 3 rounds of behavioral surveillance among MSM in San Francisco to explore our theorized new trajectory in the HIV epidemic among MSM.

METHODS

Data were collected across 3 waves of National HIV Behavioral Surveillance (NHBS) conducted in 2004 (MSM1), 2008 (MSM2), and 2011 (MSM3). A description of NHBS as a surveillance system and the specific methods for NHBS for MSM have been previously published.[13] All waves employed time–location sampling to sample MSM frequenting venues.[14] A formative phase was employed to identify venues where MSM congregate regardless if the venue was a gay identified venue. Venues included bars, dance clubs, parks, cafes, street locations, and social organizations (ie, gay softball league). Men were eligible to participate in MSM1 and MSM2 if they were 18 years or older and were attending a venue that was randomly sampled by study staff. Being MSM was not an eligibility criterion in the first 2 waves. In MSM3, men were eligible if they were 18 years or older, were attending a venue that was randomly sampled by study staff, and reported ever having anal or oral sex with a man. Men in all 3 waves provided verbal consent, completed an interviewer-administered survey, and provided a blood sample for HIV antibody and HIV incidence testing. Men had the option to receive their HIV test results in person or by telephone 1 week later. All participation was anonymous. All waves of data collection had ethical review and clearance or approval from Centers for Disease Control and Prevention and the University of California, San Francisco's Committee on Human Research.

The survey covered a large number of domains. For the purposes of this trend analysis, we focus on behavioral and other measures closely associated with HIV infection, including multiple sex partners ($>$1 sex partner in 12 months), self-reported gonorrhea infection, and methamphetamine use in the past 12 months.[15] We also asked men to report the result of their most recent HIV test. We used the response to this question in conjunction with the result of the HIV test performed in each wave of surveillance to classify HIV-positive men as aware or unaware of their status. Being aware of one's HIV infection has been reported as contributing to a decrease in onward infections among MSM through behavior change and viral load suppression through ART.[16–19] Men who reported that their most recent HIV test was positive were also asked whether they had ever taken ART in MSM1 only and whether they were currently taking ART in MSM2 and MSM3.

HIV prevalence was determined by standard HIV antibody testing. Initial reactive results were confirmed with a second test. All tests were performed at the San Francisco Public Health Laboratory on serum samples collected through venipuncture. HIV incidence was estimated using serologic testing algorithm to detect recent HIV seroconversion. In MSM1 the Vironostika HIV-1 Microelisa System (Biomeriux Inc, Durham, NC) was used. In MSM2 and MSM3 the BED HIV-1 capture enzyme immunoassay (Calypte Inc, Portland, OR) was used. In addition to the laboratory test results for recency of infection, we ruled out recent infection if participants reported using ART at any point in their history. Data for trend analyses were limited to observations with behavioral surveys and HIV tests collected during the study period when HIV testing was offered. We calculated point estimates for trend indicators and their related 95% confidence intervals (CIs). We tested demographic trends across the 3 samples using χ^2 tests. Of note, analysis of time–location sampling data has at times utilized various weighting schemes to address probability of inclusion biases. Consistent with previous publications using NHBS data at the national level and because our focus is on the trends across the comparable survey waves, we have not used weighting in the current analysis.[20–23]

RESULTS

Data collection took place from July or August through December in 2004, 2008, and 2011 for MSM1, MSM2, and MSM3, respectively (Table 1). The sampling frames

TABLE 1. Sampling and Recruitment Outcomes for 3 Waves of the NHBS Among MSM in San Francisco, 2004–2011

Sampling and Recruitment Stage	MSM1 August–December 2004	MSM2 July–December 2008	MSM3 July–December 2011
Number of venues included in the sampling frame	150	101	86
Number of venues randomly sampled	45	56	45
Number of recruitment events	67	112	103
Number of men enumerated at venues	19,670	10,279	14,325
Number of men intercepted	804	1269	1007
Number determined eligible	651	781	634
Number enrolled for interview	525	552	510
Number of MSM by self-reported behavior or sexual identity	386	521	510
Number of MSM tested for HIV	386	507	478

comprised 150 venues in 2004, 101 in 2008, and 86 in 2011, of which 45, 56, and 45 were randomly sampled, respectively. A total of 44,274 men were enumerated (range 10,279 in 2008–19,670 in 2004) during 282 recruitment events (range 67 in 2004–112 in 2008), of whom 804 in 2004, 1269 in 2008, and 1007 in 2011 were intercepted and assessed for eligibility. In 2004, 80.6% of eligible men (n = 525) were enrolled and interviewed, as were 70.7% in 2008 (n = 552) and 80.4% in 2011 (n = 510). The present analyses include only the MSM who were enrolled (n = 386 in 2004, 521 in 2008, and 510 in 2011). Of these, serological testing was conducted on 386 in 2004 (100%), 507 in 2008 (97.3%), and 478 in 2011 (93.7%).

Differences were noted in the sample composition by race/ethnicity and age between the survey waves (Table 2) which, although statistically significant, were not substantial. No consistent temporal increase or decrease was noted by race/ethnicity over time, although whites comprised a smaller proportion in 2008 (52.8%) compared with 2004 or 2011 (56.7% and 58.8%, respectively, $P = 0.02$). Over the 3 survey waves, the proportion MSM in the oldest groups increased (46–50 years and >50, $P < 0.001$). There were no differences between survey waves in terms of education and sexual identity, with more than half having a college degree and 99% identifying as gay or bisexual in each time period.

HIV prevalence determined by serological testing was stable from 2004 (24.0%) to 2011 (23.0%; Table 3 and Fig. 1). Meanwhile, the proportion of HIV-positive MSM who were previously unaware of their status (ie, "unrecognized HIV infection") significantly decreased from 21.7% in 2004 to 7.5% in 2011 ($P = 0.025$). The decrease in undiagnosed HIV infection is paralleled by a significant increase in the proportion of HIV-uninfected MSM testing in the previous 6 months, from 44.1% in 2004 to 57.8% in 2011 ($P < 0.001$). HIV incidence as measured by the BED assay decreased from 2.6% per year in 2004 (95% CI: 0.8% to 4.3%) to 1.0% per year in 2011 (95% CI: 0.02% to 1.9%), the trend was borderline significant ($P = 0.06$). Measures of ART use among HIV-positive MSM were 71.2% ever using ART in 2004 and 88.2% currently using ART in 2011. Three indicators or markers of HIV risk showed mixed trends: gonorrhea history and having multiple sexual partners were statistically stable from 2004 through 2011, whereas methamphetamine use decreased significantly from 22.8% in 2004 to 11.9% in 2011 ($P < 0.001$).

DISCUSSION

Data from 3 waves of NHBS provide a robust characterization of the HIV epidemic among MSM in San Francisco for the last 7 years. The period is characterized by remarkably stable HIV prevalence, high frequency of testing, few undiagnosed infections, high coverage of ART, but a persistent high level of sexual risk behavior as indicated by multiple partners and self-reported history of gonorrhea. Yet, encouragingly, the rate of new HIV infection seems to be decreasing. More good news is that methamphetamine use, a noted predictor of HIV

TABLE 2. Sample Characteristics for 3 Waves of the NHBS Among MSM in San Francisco, 2004–2011

	MSM1 2004 (n = 386)			MSM2 2008 (n = 521)			MSM3 2011 (n = 510)			
Variable	**n**	**%**	**95% CI**	**n**	**%**	**95% CI**	**n**	**%**	**95% CI**	***P***
Race/ethnicity										0.02
Asian	45	11.7	8.4, 14.9	34	6.5	4.4, 8.7	37	7.3	5.0, 9.6	
Black	23	6.0	3.6, 8.3	37	7.1	4.9, 9.3	31	6.1	4.0, 8.2	
White	219	56.7	49.4, 59.4	275	52.8	48.6, 57.2	300	58.8	54.8, 63.3	
Latino	78	20.2	16.8, 24.2	128	24.6	20.9, 28.3	99	19.4	16.0, 22.9	
Other	21	5.4	5.1, 10.5	47	9.0	6.4, 11.3	43	8.4	5.7, 10.4	
Age group (yrs)										<0.001
18–20	14	3.6	1.8, 5.5	13	2.5	1.2, 3.8	5	1.0	0.1, 1.8	
21–25	59	15.3	11.7, 18.9	74	14.2	11.2, 17.2	87	17.1	13.8, 20.3	
26–30	63	16.3	12.6, 20.0	96	18.4	15.1, 21.8	74	14.5	11.4, 17.6	
30–35	59	15.3	11.7, 18.9	71	13.6	10.7, 16.6	70	13.7	10.7, 16.7	
36–40	67	17.4	13.6, 21.2	68	13.1	10.1, 15.9	59	11.6	8.8, 14.4	
41–45	55	14.2	10.7, 17.8	90	17.3	14.0, 20.5	61	12.0	9.1, 14.8	
46–50	24	6.2	3.8, 8.6	46	8.8	6.4, 11.3	52	10.2	7.6, 12.8	
50+	45	11.7	8.4, 14.9	63	12.1	9.3, 14.9	102	20.0	16.5, 23.5	
Education completed										0.08
Postgraduate	64	16.6	12.9, 20.3	89	17.1	13.8, 20.3	110	21.6	18.1, 25.2	
College graduate	161	41.7	36.8, 46.7	179	34.4	30.3, 38.4	179	35.1	31.1, 39.4	
Some college	108	28.0	23.5, 32.5	175	33.6	29.5, 37.7	145	28.4	24.6, 32.5	
High school or less	53	13.7	10.3, 17.2	78	15.0	11.9, 18.0	76	14.9	11.5, 17.6	
Sexual identity										
Straight	2	0.5	0, 1.2	5	1.0	0.1, 1.8	3	0.6	0, 1.3	0.60
Bisexual	33	8.5	5.7, 11.4	57	10.9	8.3, 13.6	45	8.8	6.4, 11.3	
Gay	343	88.9	85.7, 92.0	459	88.1	85.2, 90.9	457	89.6	87.3, 92.6	

TABLE 3. HIV- and Risk-Related Variables in 3 Waves of the NHBS Among MSM in San Francisco, 2004–2011

	MSM1 2004		MSM2 2008		MSM3 2011		χ^2 Test for
Variable	**%**	**95% CI**	**%**	**95% CI**	**%**	**95% CI**	**Trend *P***
HIV positive (by serological test in this study)	24.0	19.6, 28.1	23.0	19.0, 26.3	23.0	18.9, 26.6	0.73
Unrecognized HIV infection*	21.7	13.2, 30.3	18.0	10.9, 25.2	7.5	2.4, 12.7	0.025
Tested for HIV in the last 6 mos (if not known HIV+)	44.1	35.6, 49.6	55.2	50.4, 59.9	57.8	52.9,62.6	<0.001
HIV incidence (by BED assay, percent per year)	2.6	0.8, 4.3	0.7	0, 1.5	1.0	0.02, 1.9	0.06
Ever on ART*	71.2	60.6, 81.9	—	—	—	—	—
Currently on ART*	—	—	79.3	70.6, 87.3	88.2	82.1, 94.3	—
Gonorrhea history in the last year (by self-report)	6.5	4.0, 8.9	7.7	5.4, 9.9	9.2	6.7, 11.7	0.15
Multiple sexual partners in the last year	79.3	75.2, 83.3	77.5	73.9 81.1	76.5	72.8, 80.2	0.31
Methamphetamine use in the last year	22.8	18.6, 27.0	13.2	10.3, 16.2	11.9	9.1, 14.8	<0.001

*Percent of HIV positives by serological test.

transmission,[24,25] continues a previously noted a downward trend among MSM.[26]

We interpret the stable prevalence from 2004 to 2011 as the net balance of several factors: new HIV infections with the size of the population engaging in risk, AIDS mortality with survival and inmigration with outmigration of persons living with HIV/AIDS. The results from incidence testing point to a decrease in the rate of new HIV infections. The measure of

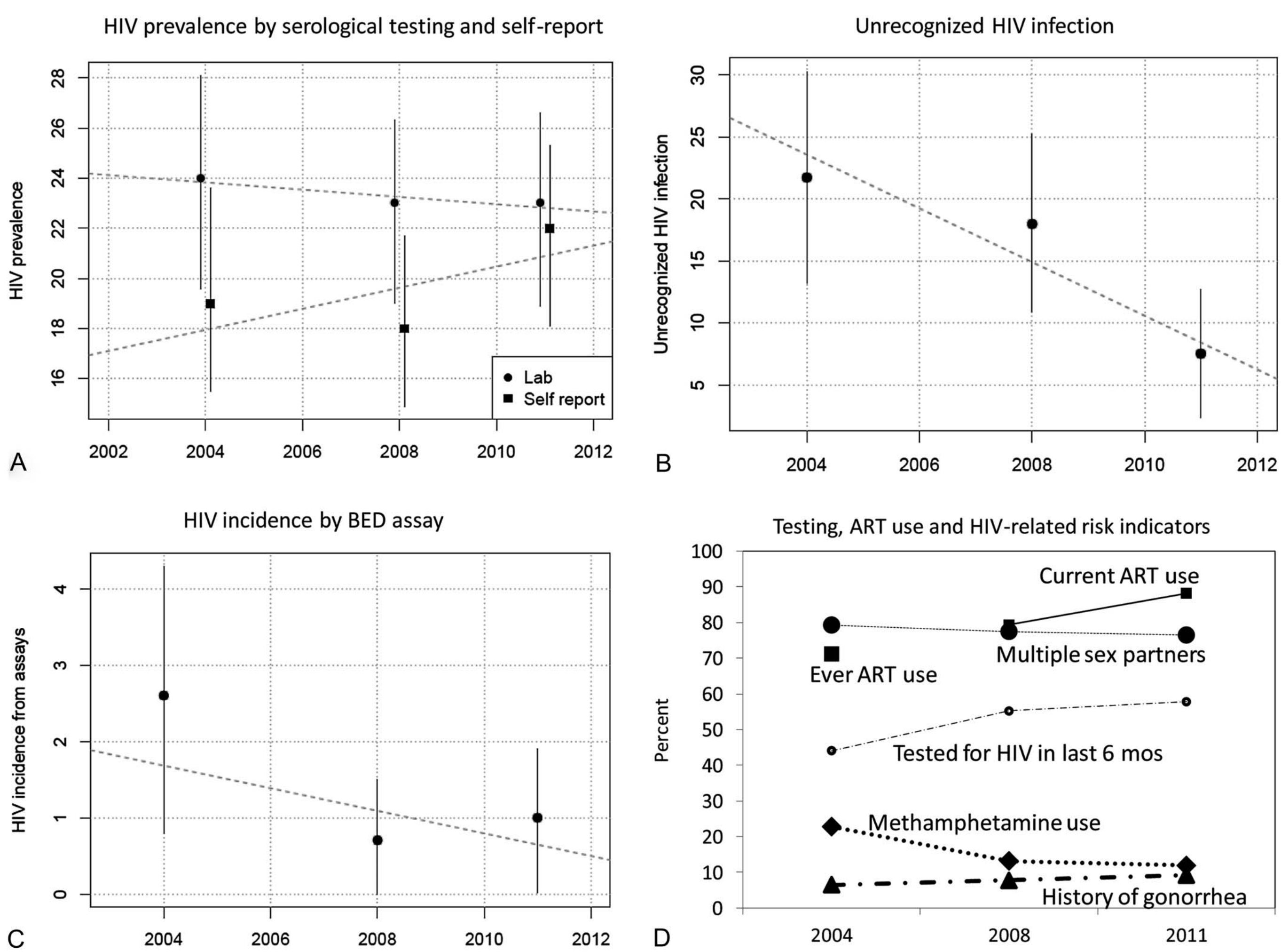

FIGURE 1. Trends in HIV- and risk-related variables in 3 waves of the NHBS among MSM in San Francisco, 2004–2011. A, HIV prevalence by serological testing and self-report. B, Unrecognized HIV Infection. C, HIV incidence by BED assay. D, Testing, ART use, and HIV-related risk indicators.

2.6% per year in 2004 is consistent with the 2%–3% HIV incidence rate among MSM for the period of 1995–2005 found in a systematic review of the literature.[27] We are cautiously encouraged by the decrease in incidence to 0.7% in 2008 and 1.0% in 2011—both estimates excluding 2% from their upper confidence limits. The decrease in incidence measured in our study is corroborated by declining numbers of new HIV diagnoses among MSM reported to our health department: from 650 cases in 2004 to 306 in 2010.[1,28] The incidence data from this current analysis in 2011 also extends our previous analysis of the association between decreasing community viral load and new HIV diagnoses from 2004 to 2008.[29] The persistently high level of multiple partners and gonorrhea, however, do not support decreased sexual risk for HIV transmission (ie, unprotected sex). New cases of sexually transmitted disease (STD) reported to the city surveillance system corroborate high levels of sexual risk behavior among MSM: male rectal Chlamydia cases have increased from 2004 to 2010 and male rectal gonorrhea and syphilis cases among MSM have remained at a high plateau during the same period.[30] Two hypotheses can explain the apparent discrepancy: a high level of HIV serosorting could foster STD transmission but not HIV and/or a high level of ART use would suppress HIV transmission but not STD transmission.[31] We also interpret the increased use of ART as improving survival, corroborated by decreases in HIV/AIDS related deaths in our city.[1] Therefore, unless the rate of new infections was decreasing, we would expect to observe a rising prevalence of HIV with improved survival. Stable prevalence in the face of declining mortality infers a decreasing incidence of new infection. San Francisco's local policy of offering ART to all HIV-positive persons regardless of CD4 or clinical criteria was declared in 2010, ahead of national policy, and already widely in practice a few years before 2010[32]—events consistent with our NHBS data showing increased ART coverage between 2008 and 2010. As for inmigration and outmigration, we find no evidence of a net gain or loss of cases from outside our jurisdiction in our HIV/AIDS case registry.

Taken together, the trends of the last 7 years point to stable HIV prevalence in San Francisco as the outcome of improving survival coupled with decreasing incidence brought about by rising ART coverage and viral load suppression achieving levels more than sufficient to offset ongoing sexual risk behavior, which is also mitigated by serosorting which has been documented to be engaged in by 20%–30% of MSM in San Francisco.[10] We believe that this situation contrasts the previous 7-year period (1996–2003) of resurging HIV incidence where any prevention effect of ART was overwhelmed by higher levels of unrecognized infection (which lowers effective ART coverage and precludes viral load suppression and serosorting) and sexual risk behavior.[6,31] An era of rising HIV incidence among MSM may persist to this day in other populations of MSM in the United States and worldwide where HIV testing, ART treatment and serosorting remain too low.[7] For example, the 2008 NHBS reported for all 21 US cities indicated that San Francisco had achieved a higher level of diagnosed infection than all other cities except Seattle.[21] Thus, "treatment as prevention" may be in evidence among MSM in San Francisco due to the higher level of ART coverage, viral load suppression, lower level of undiagnosed infection, and effective lower level of sexual risk due to serosorting in San Francisco compared with elsewhere.

These conclusions are subject to limitations of the data and alternative hypotheses. First, our case registry cannot assess major outmigration trends among persons with HIV/AIDS, and we have not directly measured them in this study. Second, the BED assay as a means to measure HIV incidence in a population has many noted challenges. We therefore rely on multiple data sources to draw conclusions on the direction of HIV incidence. Third, as with all interviewer-administered surveys, there is the possibility that participants were more likely to give socially desirable responses (eg, underreporting their drug use), and this bias may have changed across waves. Lastly, the sampling methodology, although employed as rigorously and consistently as possible, is not a gold standard but rather an approximation of probability-based sampling from the population who visits the identified venues. The data may not be representative of all MSM.

Despite these limitations, we posit that the last 7 years of the epidemic among MSM in San Francisco is a plausible paradigm for what is also underway or on the horizon elsewhere in the world. Our city was among the first to document the appearance of AIDS among MSM, to gauge the rapid course of the early epidemic, to garner a measure of success in the initial response, and to signal the recent resurgence. We now propose setting the bar higher for testing, early ART use and reductions in risk behavior to reverse the epidemic. That is, greater levels of treatment and prevention need to be achieved than we have been able to so far, if HIV prevalence among MSM is to decrease below one-fourth of the entire population.

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