American Journal of
Preventive Medicine

RESEARCH ARTICLE

U.S. HIV Incidence and Transmission Goals, 2020 and 2025

Robert A. Bonacci, MD, MPH,[1,2] David R. Holtgrave, PhD[3]

Introduction: The recently updated U.S. National HIV/AIDS Strategy sets key HIV prevention and care targets for 2020, but the trajectory of the epidemic remains unclear. Authors modeled HIV incidence, prevalence, and mortality for the U.S. over 10 years to determine whether an ambitious trajectory toward "ending AIDS" by 2025 would be achievable.

Methods: Authors utilized recently published 2010–2013 Centers for Disease Control and Prevention surveillance data to model HIV incidence, prevalence, and mortality. Authors applied a 90/90/90 framework (90% awareness of serostatus, 90% of diagnosed individuals in care, and 90% of individuals on antiretroviral therapy virally suppressed) by 2020 and 95/95/95 by 2025 to assess the feasibility of meeting epidemiologic targets. Analyses were conducted in 2016.

Results: With a goal of reducing infections to 21,000 new HIV infections in 2020, authors project a transmission rate of 1.74, 12,571 deaths, and a total of 1,205,515 people living with HIV. By 2025, with a target of 12,000 new HIV infections (a 69% decrease in HIV incidence), authors project a transmission rate of 0.98, 12,522 deaths, and a total of 1,220,615 people living with HIV. With a 90/90/90 framework by 2020 and a 95/95/95 framework by 2025, these epidemiologic targets would be feasible.

Conclusions: Key programmatic milestones provide an ambitious, but important, pathway to reduce U.S. HIV incidence below 12,000 new infections by 2025. HIV incidence would decrease below mortality in 2025, marking a transition toward ending the HIV/AIDS epidemic. Such goals will require a sustained and intensified national commitment over the next decade.
Am J Prev Med 2017;53(3):275–281. *© 2017 American Journal of Preventive Medicine. Published by Elsevier Inc. All rights reserved.*

INTRODUCTION

President Obama released the first comprehensive National HIV/AIDS Strategy (NHAS) for the U.S. in 2010.[1] The creation of the NHAS was spurred by several key trends. First, the U.S. failed to significantly reduce the number of new HIV infections, stagnating at an estimated roughly 50,000 annually for much of the 2000s.[2] Second, the public's sense of urgency to address the HIV/AIDS epidemic waned.[3] Finally, HIV was increasingly disproportionately affecting some key populations, namely, gay and other men who have sex with men and black and Hispanic individuals, especially in the Southern U.S.

Hoping to mobilize a more coordinated national response, the President set ambitious goals to reduce new HIV infections; improve access to care and health outcomes for people living with HIV (PLWH); and reduce HIV-related disparities, all by 2015.[1] Among specific metrics, the NHAS called for a 25% reduction in HIV incidence and 30% reduction in transmission rate. At the launch of the NHAS, President Obama remarked, "The question is not whether we know what to do, but whether we will do it…whether we will marshal

From the [1]Department of Medicine, Brigham and Women's Hospital, Boston, Massachusetts; [2]Department of Medicine, Harvard Medical School, Boston, Massachusetts; and [3]Department of Health, Behavior, and Society, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland

Address correspondence to: Robert A. Bonacci, MD, MPH, Department of Medicine, Brigham and Women's Hospital, 75 Francis St., Boston MA 02115. E-mail: rbonacci@bwh.harvard.edu.
0749-3797/$36.00
https://doi.org/10.1016/j.amepre.2017.03.012

© 2017 American Journal of Preventive Medicine. Published by Elsevier Inc. All rights reserved.

our resources and the political will to confront a tragedy that is preventable."[4]

At the outset of the NHAS, economic evaluation research determined that 2010 resource and funding levels would be insufficient to meet NHAS incidence and transmission rate goals, but that rapid expansion of testing and prevention resources could reset the course toward achievement of the targets by 2015.[5] Recent modeling evaluating the NHAS concluded that the U.S. has made incremental, but insufficient, progress to achieve HIV incidence and transmission rate goals.[6]

With original targets set only through 2015, the White House Office of National AIDS Policy recently updated the NHAS, extending it through 2020.[7] The three overarching strategy goals of the original NHAS were maintained, but new quantitative indicators were selected for 2020. Among the primary indicators jettisoned were incidence and transmission rates, in favor of new HIV diagnoses. NHAS authors reasoned that HIV incidence was dependent on changing HIV testing technologies, making it difficult to provide timely and consistent monitoring, while HIV diagnoses were collected in a standardized manner. However, substituting HIV diagnoses as the principal indicator of new infections is challenging, given the high dependence of new diagnoses on testing trends.[8] A new method for estimating incidence and prevalence was recently released and can inform this study. Song et al.,[9] using a CD4-based model to estimate surveillance parameters that avoids the need for back-calculation across the epidemic, provide incidence estimates for the U.S. through 2013. In the present study, the authors aimed to project HIV incidence, transmission rates, prevalence, and mortality for the U.S. through 2025. The authors also modeled whether an ambitious trajectory toward "ending AIDS" by 2025 would be achievable if specific goal frameworks are implemented.

METHODS

Recent surveillance data on U.S. HIV incidence, prevalence, and all-cause mortality for 2010 to 2013 were utilized.[9] All analyses were conducted in 2016. This analysis was exempt from IRB review, only using publicly available national surveillance data.

Measures: Modeling Incidence, Mortality, and Prevalence

First, HIV incidence from 2014 through 2025 was estimated. Using modified targets from previously published work, HIV incidence goals of 21,000 and 12,000 new infections for 2020 and 2025, respectively, were set.[10] Then, incidence for the interval years 2014–2020 was estimated, incorporating a uniform decline via the formula: [year X incidence = year (X–1) incidence – ((2013 incidence – 2020 goal incidence) / 7)]. Similarly, this method was repeated for years 2021–2025: [year X incidence = year (X–1) incidence – ((2020 incidence – 2025 goal incidence) / 5)].

All-cause mortality for PLWH (hereto referred to as mortality) was modeled using the death rate goal in the updated NHAS, a 33% reduction for those with diagnosed HIV by 2020.[7] Because undiagnosed individuals do not realize the survival benefit of HIV diagnosis, care, and treatment, their differential contribution was noted. Per the updated NHAS, it was assumed that by 2020 90% of PLWH would be aware of their HIV serostatus, and thus the 2020 death rate was calculated using the formula: [(2013 death rate × 10%) + ((2013 death rate × 67%) × 90%)]. Using the 2020 death rate as the endpoint, a uniform annual decline in death rate was modeled from 2013 to 2020. Then, mortality was estimated for each year from 2014 to 2025 by multiplying the previous year's HIV prevalence by current year's death rate (i.e., mortality year X = prevalence year (X–1) × death rate year X).

Prevalence modeling has been previously described.[6] Briefly, prevalence from 2014 to 2025 was calculated by the formula: [prevalence year X = prevalence year (X–1) + incidence year X – mortality year X].

Measures: Transmission and Reproductive Rates

To investigate the possibility of eliminating HIV infection in the U.S. altogether, the transmission rate, T(x), defined as mean annual HIV transmissions to HIV seronegative individuals by 100 PLWH, and the basic HIV reproductive rate (R_0), defined as the number of HIV transmissions from one PLWH to HIV-seronegative partners over the PLWH's duration of potential infectiousness, were calculated from 2014 to 2025.[11,12] The transmission rate, reproductive rate, and elimination of HIV infection have been described previously.[6,13] In short, elimination of HIV infection would be achieved with a transmission rate of zero or eventually by a non-zero transmission rate if the reproductive rate drops below one. The relationship between R_0 and T(x) is the following: [R_0 = (T(x) / 100) × D], where (D) is duration of infectiousness. Because no well-established measure of D exists, average life expectancy in the U.S. after HIV diagnosis irrespective of treatment status (D* = 28.86 years) was substituted.[14]

Analytic Framework: Estimating HIV Incidence and Transmission Rates for 2020 and 2025

First, an overall HIV/AIDS epidemic goal framework was incorporated so that by 2020,

1. 90% of PLWH will know their HIV status;
2. 90% of people diagnosed with HIV will receive sustained, quality HIV care; and
3. 90% of people on antiretroviral therapy (ART) will achieve viral suppression.

These goals are consistent with the updated NHAS and United Nations' "90/90/90" HIV targets for 2020.[7,15] Beyond 2020, an accelerated "95/95/95" set of goals for 2025 (i.e., 95% of PLWH will know their HIV status; 95% of people diagnosed with HIV will receive sustained, quality HIV care; and 95% of people on ART will achieve viral suppression) was proposed.

With this framework in place for 2020 and 2025, whether incidence targets for 2020 (21,000 infections) and 2025 (12,000

Table 1. Proposed U.S. NHAS Goals With Accompanying Estimated HIV Surveillance Statistics, 2013 to 2025

Year	Incidence	Transmission rate	All-cause mortality	Death rate[a]	Prevalence	Serostatus awareness, %	Diagnosed, in care, %	Diagnosed, viral suppression, %
2013 (base year)[b]	39,000	3.53	16,500	1,494	1,104,600	83.6	56.5	54.7
2014	36,429	3.24	15,800	1,430	1,125,229	—	—	—
2015	33,857	2.96	15,382	1,367	1,143,704	—	—	—
2016	31,286	2.70	14,910	1,304	1,160,080	—	—	—
2017	28,714	2.45	14,388	1,240	1,174,407	—	—	—
2018	26,143	2.20	13,821	1,177	1,186,728	—	—	—
2019	23,571	1.97	13,214	1,113	1,197,086	—	—	—
2020 goal	21,000	1.74	12,571	1,050	1,205,515	90.0	90.0	81.0
2021	19,200	1.58	12,600	1,045	1,212,115	—	—	—
2022	17,400	1.43	12,609	1,040	1,216,906	—	—	—
2023	15,600	1.28	12,599	1,035	1,219,907	—	—	—
2024	13,800	1.13	12,570	1,030	1,221,137	—	—	—
2025 goal	12,000	0.98	12,522	1,025	1,220,615	95.0	95.0	90.3

[a]Death rate is per 100,000 persons living with HIV.
[b]CDC data extracted from Song et al. (2017)[9] and CDC (2016).[28]
NHAS, National HIV/AIDS Strategy.

infections) would be achievable was evaluated. Centers for Disease Control and Prevention (CDC) transmission rates across the HIV care continuum were applied to prevalence estimates, under the 2020 and 2025 goal frameworks.[16] Briefly, transmission rates were as follows:

1. PLWH undiagnosed (6.6);
2. diagnosed not in care (5.3);
3. diagnosed in care, not virally suppressed (2.1; weighted average of retained in care, no ART [2.6] and receiving ART, not virally suppressed [1.8]); and
4. diagnosed in care, virally suppressed (0.4).

For example, among those diagnosed in care who are virally suppressed for 2020 incorporating the 90/90/90 framework, incidence was calculated as follows: [HIV incidence = 2020 HIV prevalence × (0.9ˆ3) × (0.4/100)]. Incidence at each step of the care continuum was summed to produce the overall projected HIV incidence for 2020 and 2025, and then compared to previously set HIV incidence goals to evaluate whether those goals would be achievable.

RESULTS

Table 1 displays the results of the mathematical modeling analysis. With a goal of reducing infections to 21,000 new HIV infections throughout the U.S. in 2020, mortality would be 12,571 for all PLWH; the death rate would be 1,050 deaths per 100,000 PLWH; and HIV prevalence would be 1,205,515. By year 2025, assuming a target of 12,000 new HIV infections (a 69% decrease from 2013 incidence), mortality would decline to 12,522 for all PLWH, a 24% decrease from the 2013 base case; the death rate would be 1,025 deaths per 100,000 PLWH, a 31% decrease from the 2013 base case; and HIV prevalence would be 1,220,615, a 10% increase from the 2013 base case (Figure 1).

Based on CDC surveillance statistics, the 2013 HIV transmission rate was estimated at 3.53, and the reproductive rate was 1.02 (Figure 2). Similarly, for 2020, the transmission rate would be 1.74, and the reproductive rate would be 0.50. In 2025, the transmission rate would decrease to 0.98, resulting in a 72% decrease since 2013,

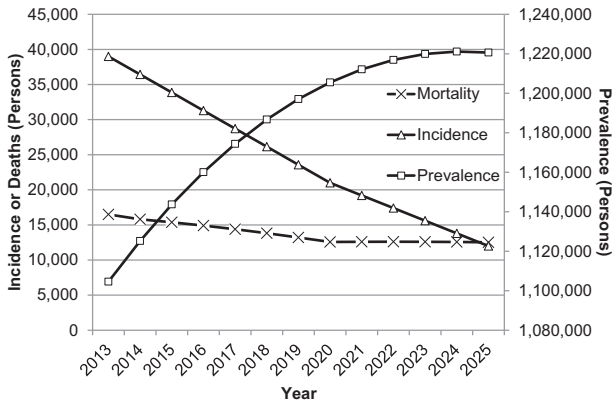

Figure 1. Estimated change in HIV prevalence, incidence, and mortality in the U.S., 2013 to 2025.

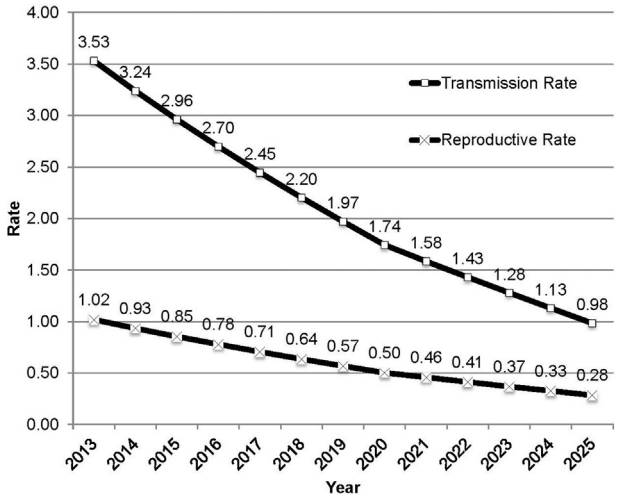

Figure 2. Estimated change in basic HIV reproductive rate and transmission rate in the U.S., 2013 to 2025.

and the reproductive rate would be 0.28, a 72% decrease over the same time course.

Table 2 displays the results of the secondary analysis examining the feasibility of the 2020 and 2025 HIV incidence goals. Breaking down new HIV infections across the HIV care continuum, in 2020 there would be 7,956 new infections from PLWH unaware of their serostatus, 5,750 from PLWH diagnosed but out of care, 2,042 from those in care but not virally suppressed, and 3,515 from those in care and virally suppressed. This would result in 19,264 new HIV infections in 2020. In 2025, the authors expect that 4,028 new infections would result from PLWH unaware of their serostatus, 3,073 from PLWH diagnosed but out of care, 1,152 from those in care but not virally suppressed, and 4,186 from those in care and virally suppressed. This would result in a total of 12,439 new HIV infections in 2025.

DISCUSSION

The study's mathematical modeling demonstrates that the U.S. could achieve an estimated 46% reduction in HIV incidence by 2020 and a nearly 70% reduction in HIV incidence by 2025, provided that the U.S. implements a 90/90/90 HIV program framework by 2020 and 95/95/95 framework by 2025.

Following the release of study authors' *Huffington Post* editorial, CDC researchers published new surveillance data, updating HIV incidence statistics that had not been released since 2012.[9,10] Based on these new data, the authors believe that goals of no more than 21,000 new HIV infections by 2020 and 12,000 by 2025 are ambitious but achievable. When the 2020 and 2025 HIV program frameworks are applied to transmission rate modeling in the secondary analysis, projected HIV incidence for 2020 and 2025 closely mirrors the authors' designated incidence targets, supporting their feasibility under the proposed framework (Table 2). Of note, the projected new infections from those in care and virally suppressed are substantial. It appears that although the transmission rate for this group is very low, the increase in the absolute size of this subpopulation as the 95/95/95 program framework is met (approximately 85% of PLWH would be virally suppressed) likely explains this community's contribution to overall transmission.

Regarding feasibility of the program targets generally, recent data from multiple jurisdictions provide evidence that the 90/90/90 goals are achievable. Xia and colleagues,[17] reporting the New York City experience, recently found that this framework has already been achieved for white PLWH, and that for PLWH of color, the first two goals have been met and New York City is nearing the viral suppression goal. Amsterdam has reached the diagnosis and viral suppression targets (and nearly the ART coverage goal).[18] Sweden recently became the first nation to achieve the 90/90/90 goals.[19]

Table 2. Achievability of Proposed U.S. NHAS Goals by Differential Transmission Rate Comparison, 2020 and 2025

	2020			2025		
Care continuum stage	**Proposed goal**	**Transmission rate[a]**	**HIV incidence**	**Proposed goal**	**Transmission rate[a]**	**HIV incidence**
Undiagnosed	0.1	6.6	7,956	0.05	6.6	4,028
Diagnosed, not in care	0.9 × 0.1	5.3	5,750	0.95 × 0.05	5.3	3,073
In care, not virally suppressed	(0.9ˆ2) × 0.1	2.1	2,042	(0.95ˆ2) × 0.05	2.1	1,152
In care, virally suppressed	0.9ˆ3	0.4	3,515	0.95ˆ3	0.4	4,186
Total	—	—	19,264	—	—	12,439

[a]Transmission rate is defined as the mean annual HIV transmissions to HIV-seronegative individuals by 100 people living with HIV.
NHAS, National HIV/AIDS Strategy.

These data suggest that with the appropriate investment and implementation of HIV program resources, jurisdictions can reach these. Of course, work needs to be done in other jurisdictions to meet these goals, but some locales seemingly have begun to achieve them.

If the U.S. does achieve a reduction to 12,000 new HIV infections by 2025, it would mark an important inflection point in the U.S. HIV epidemic: the first year that HIV incidence drops below the concurrently decreasing mortality for PLWH. Of note, this analysis indicates that a decrease in both incidence and mortality would occur simultaneously, though to different degrees (Figure 1). This is significant because the other ways to reach the point where HIV incidence drops below mortality would have negative consequences for the overall epidemic. For example, this point could be met by either an isolated rise in mortality or a rise in mortality that outpaces growth in HIV incidence. Thus, if incidence declines faster than the concurrently decreasing mortality as projected, HIV prevalence in the U.S. would begin decreasing. Of course, it would be highly desirable for both incidence and mortality to reach zero, not just incidence less than mortality.

The authors' modeling of transmission rates and basic HIV reproductive rates further supports the conclusion that the U.S. would be on track toward reversing the epidemic (Figure 2). For this to be the case, the reproductive rate would have to drop below one, meaning that less than one infection to an HIV-seronegative partner per PLWH is occurring during that HIV-seropositive person's lifetime. The reproductive rate drops below one immediately after 2014 and continues declining to 0.28 by 2025. With new infections decreasing, reproductive rate trends suggest that eventually, the U.S. can achieve elimination of the HIV/AIDS epidemic.

Though the literature on future modeling for the NHAS is limited, a recent study by Shah et al.[20] supports similar conclusions. They demonstrated that by meeting or exceeding updated NHAS targets for diagnosis, linkage to care, and retention in care by 2020, the U.S. could reverse the HIV prevalence trend between 2020 and 2025. They concluded that the retention in care target was the most impactful. An earlier study also demonstrated that it would be cost effective over 20 years to introduce comprehensive improvements in testing, linkage to care, and retention in care, reducing HIV incidence and mortality.[21]

Although this study indicates that the U.S. can bend the epidemic curve toward ending AIDS, progress toward a 95/95/95 framework by 2025 will not be realized without addressing many challenges of the epidemic. First, whether the 2015 targets set by the original NHAS were met and what the underlying drivers of that success or failure were must be understood. One recent study indicated that progress toward the original NHAS goals was incremental but insufficient, pointing to stagnating HIV prevention and housing funding as a key culprit.[6] Others identified key resource needs for black and Hispanic men who have sex with men that went unmet during the original NHAS time horizon.[5,22,23] Importantly, those studies used modeling to determine that meeting those needs would be cost effective (approximately $20,000 and $61,000 per quality-adjusted life year saved, respectively) and could avert approximately 10,000 HIV infections combined. Thus, independent estimates of cost and resource needs to achieve the NHAS and ambitious future targets should be completed, so that the newly elected presidential administration can partner with Congress to appropriate the necessary financial resources to deliver expanded HIV services.

Importantly, these epidemiologic goals must be achieved in a way that fully eliminates the pernicious health disparities that have led black and Hispanic communities, young gay and other men who have sex with men, transgender people, and residents of the Southern U.S. to be disproportionately affected by HIV. By striving to eliminate HIV-related health disparities, the U.S. will address fundamental issues of health equity, another key pillar of the NHAS.[7] Further, the U.S. government needs a real-time epidemiologic and service delivery dashboard to track progress toward national goals and allow for mid-course corrections in resource allocation. Finally, HIV implementation research must be expanded to maximize public health impact in an era of limited funding and competing priorities. Advances including early ART, treatment as prevention, and pre-exposure prophylaxis have fundamentally changed HIV care delivery.[24–26] With effective tools to address HIV, implementation science will optimize evidence-based service delivery to communities in a way that meets those communities' needs and achieves the desired impact.

Limitations

As a mathematical modeling study, this study is subject to key limitations. First, it relies on national surveillance data from a newly implemented CD4 depletion model.[9] Surveillance estimates are subject to model accuracy and timely CD4 testing. By using summary national statistics, this study only accounts for subgroup heterogeneity insofar as subgroups are appropriately captured by the national surveillance system. However, this model only depends on HIV cases diagnosed in recent years and is not subject to the incomplete reporting of prior surveillance methodologies relying on back-calculation.[27,28] To whatever extent there are uncertainties in CDC

surveillance statistics for HIV prevalence, mortality, and incidence, so too will there be modeling uncertainties. Notably, study results are a snapshot of the implications of achieving the 2020 and 2025 goal scenarios, and as national estimates are updated, it would be beneficial to serially refine this model and re-examine the implications.

Second, to calculate the reproductive rate (R_0) average life expectancy from HIV diagnosis in the U.S. (D*) was used as a proxy for duration of infectiousness (D).[14] Unfortunately, no well-established estimate of D exists in the literature. Using D* will tend to overestimate D, as it does not account for the fact that individuals on ART with suppressed viral loads have a near-zero probability of HIV transmission.[25,29] However, substituting D* is a conservative approach because it will tend to overestimate R_0.

Third, study projections rely on the assumption that a suitable environment exists to implement a 95/95/95 program framework. The literature suggests that key social determinants of health impede the healthcare delivery context for PLWH, among them HIV-related stigma, insurance status, homelessness, SES, and education.[1,30] If these are not addressed in conjunction with expanding HIV services, the U.S. will likely fall short of the goals.

CONCLUSIONS

This study provides evidence for an ambitious, but achievable, pathway for the U.S. (and future NHAS iterations) to reduce HIV incidence below 12,000 infections annually by 2025. With programmatic milestones to be realized stepwise by 2020 and 2025, HIV prevalence would begin to decline. Drawing on lessons from the original NHAS, the aggressive expansion of HIV diagnostic, prevention, and treatment programs will require the political will to further invest federal resources into HIV services. The authors encourage additional estimates of resources needed and their impact on the HIV/AIDS epidemic to enhance the modeling literature. The authors also emphasize that a sharpened focus on the distribution of HIV services to the most disproportionately affected communities is fundamental to future success. Ultimately, whether the U.S. manifests a sustained, intensified national commitment over the next decade will determine if the nation achieves these ambitious epidemiologic goals and accelerates the course toward ending the U.S. HIV/AIDS epidemic.

ACKNOWLEDGMENTS

RAB and DRH conceived and designed the study and executed the acquisition, analysis, and interpretation of the data. RAB led report writing, and RAB and DRH were responsible for revision and approval of the final version.

No financial disclosures were reported by the authors of this paper.

REFERENCES

1. The White House Office of National AIDS Policy. *National HIV/AIDS Strategy for the United States*. 2010.
2. CDC. New HIV Infections in the United States. *CDC Fact Sheet*. 2012.
3. Kaiser Family Foundation. HIV/AIDS at 30: a public opinion perspective. https://kaiserfamilyfoundation.files.wordpress.com/2013/07/8186-hiv-survey-report_final.pdf. Published 2011. Accessed September 21, 2016.
4. President Barack Obama. Remarks by the President on the National HIV/AIDS Strategy. https://obamawhitehouse.archives.gov/the-press-office/remarks-president-national-hivaids-strategy. Published 2013. Accessed January 30, 2017.
5. Holtgrave DR, Hall HI, Wehrmeyer L, Maulsby C. Costs, consequences and feasibility of strategies for achieving the goals of the National HIV/AIDS Strategy in the United States: a closing window for success? *AIDS Behav*. 2012;16(6):1365–1372. https://doi.org/10.1007/s10461-012-0207-0.
6. Bonacci RA, Holtgrave DR. Evaluating the impact of the U.S. National HIV/AIDS Strategy, 2010-2015. *AIDS Behav*. 2016;20(7):1383–1389. https://doi.org/10.1007/s10461-016-1416-8.
7. The White House Office of National AIDS Policy. National HIV/AIDS Strategy for the United States: updated to 2020. Published 2015.
8. Bonacci RA, Holtgrave DR. Simplified estimates of HIV incidence and transmission rates for the USA, 2008-2012. *AIDS*. 2016;30(2):332–333. https://doi.org/10.1097/QAD.0000000000000939.
9. Song R, Hall HI, Green TA, Szwarcwald CL, Pantazis N. Using CD4 data to estimate HIV incidence, prevalence, and percent of undiagnosed infections in the United States. *J Acquir Immune Defic Syndr*. 2017;74(1):3–9. https://doi.org/10.1097/QAI.0000000000001151.
10. Holtgrave D, Bonacci R. Shaping the next administration's response to HIV in the U.S. *Huffington Post*. www.huffingtonpost.com/david-holtgrave/shaping-the-next-administrations-response-to-hiv-in-the-us_b_9826962.html. Published May 3, 2016. Accessed September 21, 2016.
11. May RM, Anderson RM. The transmission dynamics of human immunodeficiency virus (HIV). *Philos Trans R Soc Lond B Biol Sci*. 1988;321(1207):565–607. https://doi.org/10.1098/rstb.1988.0108.
12. May RM, Anderson RM. Transmission dynamics of HIV infection. *Nature*. 1987;326(6109):137–142. https://doi.org/10.1038/326137a0.
13. Holtgrave DR. Is the elimination of HIV infection within reach in the United States? Lessons from an epidemiologic transmission model. *Public Health Rep*. 2010;125(3):372–376. https://doi.org/10.1177/003335491012500305.
14. Siddiqi AE, Hall HI, Hu X, Song R. Population-based estimates of life expectancy after HIV diagnosis: United States 2008-2011. *J Acquir Immune Defic Syndr*. 2016;72(2):230–236. https://doi.org/10.1097/QAI.0000000000000960.
15. UNAIDS. *90-90-90:* an ambitious treatment target to help end the AIDS epidemic. 2014:1–33.
16. Skarbinski J, Rosenberg E, Paz-Bailey G, et al. Human immunodeficiency virus transmission at each step of the care continuum in the United States. *JAMA Intern Med*. 2015;175(4):588–596. https://doi.org/10.1001/jamainternmed.2014.8180.
17. Xia Q, Lazar R, Bernard MA, et al. New York City achieves the UNAIDS 90-90-90 targets for HIV-infected whites but not Latinos/Hispanics and blacks. *J Acquir Immune Defic Syndr*. 2016;73(3):e59–e62. https://doi.org/10.1097/QAI.0000000000001132.
18. Fast-Track Cities. Global Web Portal: Ending the AIDS Epidemic by 2030—Amsterdam. www.fast-trackcities.org/cities/amsterdam. Published 2016. Accessed January 12, 2017.

19. Gisslen M, Svedhem V, Lindborg L, et al. Sweden, the first country to achieve the Joint United Nations Programme on HIV/AIDS (UNAIDS)/World Health Organization (WHO) 90-90-90 continuum of HIV care targets. *HIV Med*. 2017;18(4):305–307. https://doi.org/10.1111/hiv.12431.
20. Shah M, Perry A, Risher K, et al. Effect of the U.S. National HIV/AIDS Strategy targets for improved HIV care engagement: a modelling study. *Lancet HIV*. 2016;3(3):e140–e146. https://doi.org/10.1016/S2352-3018(16)00007-2.
21. Shah M, Risher K, Berry SA, Dowdy DW. The epidemiologic and economic impact of improving HIV testing, linkage, and retention in care in the United States. *Clin Infect Dis*. 2016;62(2):220–229. https://doi.org/10.1093/cid/civ801.
22. Bonacci RA, Holtgrave DR. Unmet HIV service needs among Hispanic men who have sex with men in the United States. *AIDS Behav*. 2016;20(10):2444–2451. https://doi.org/10.1007/s10461-016-1304-2.
23. Holtgrave DR, Kim JJ, Adkins C, et al. Unmet HIV service needs among black men who have sex with men in the United States. *AIDS Behav*. 2014;18(1):36–40. https://doi.org/10.1007/s10461-013-0574-1.
24. Group ISS, Lundgren JD, Babiker AG, et al. Initiation of antiretroviral therapy in early asymptomatic HIV infection. *N Engl J Med*. 2015;373(9):795–807. https://doi.org/10.1056/NEJMoa1506816.
25. Cohen MS, Chen YQ, McCauley M, et al. Prevention of HIV-1 infection with early antiretroviral therapy. *N Engl J Med*. 2011;365(6):493–505. https://doi.org/10.1056/NEJMoa1105243.
26. Grant RM, Lama JR, Anderson PL, et al. Preexposure chemoprophylaxis for HIV prevention in men who have sex with men. *N Engl J Med*. 2010;363(27):2587–2599. https://doi.org/10.1056/NEJMoa1011205.
27. Song R, Green T. An improved approach to accounting for reporting delay in case surveillance systems. *JP J Biostat*. 2012;7(1):1–14.
28. CDC. Monitoring selected national HIV prevention and care objectives by using HIV surveillance data—United States and 6 dependent areas—2014. *HIV Surveillance Supplemental Report*. 2016;21(4).
29. Rodger AJ, Cambiano V, Bruun T, et al. Sexual activity without condoms and risk of HIV transmission in serodifferent couples when the HIV-positive partner is using suppressive antiretroviral therapy. *JAMA*. 2016;316(2):171–181. https://doi.org/10.1001/jama.2016.5148.
30. Dean HD, Fenton KA. Addressing social determinants of health in the prevention and control of HIV/AIDS, viral hepatitis, sexually transmitted infections, and tuberculosis. *Public Health Rep*. 2010;125(suppl 4):1–5. https://doi.org/10.1177/00333549101250S401.