J Urban Health (2018) 95:499–507
https://doi.org/10.1007/s11524-018-0255-5

Assessing the Effect of Recent Incarceration in Prison on HIV Care Retention and Viral Suppression in Two States

Michael Costa · Brian T. Montague · Liza Solomon · Cara Sammartino · Roee Gutman · Chava Zibman · David Rosen · Josiah D. Rich

Published online: 1 May 2018

Abstract The prevalence of HIV among people in correctional facilities remains much higher than that of the general population. Numerous studies have demonstrated the effectiveness and acceptability of HIV treatment for individuals incarcerated in US prisons and jails. However, the period following incarceration is characterized by significant disruptions in HIV care. These disruptions include failure to link in a timely manner (or at all) to community care post-release, as well as not being retained in care after linking. We used a retrospective, propensity-matched cohort design to compare retention in care between HIV-positive individuals recently released from prison (releasees) who linked to care in Ryan White HIV/AIDS Program (RWHAP) clinics and RWHAP patients without a recent incarceration history (community controls). We also performed analyses comparing viral load suppression of those retained in both groups. This study shows that even for those who do successfully link to care after prison, they are 24 to 29 percentage points less likely to be retained in care than those already in community care. However, we found that for those who did retain in care, there was no disparity in rates of viral suppression. These findings provide valuable insight regarding how best to address challenges associated with ensuring that HIV-positive individuals leaving prison successfully move through the HIV care continuum to become virally suppressed.

Keywords HIV/AIDS · Prisoner re-entry · HIV care continuum · Retention in HIV care · HIV viral suppression · Ryan White HIV/AIDS program · Health disparities

M. Costa (✉) · L. Solomon · C. Zibman
Abt Associates, Inc., Cambridge, MA, USA
e-mail: michael_costa@abtassoc.com

B. T. Montague · C. Sammartino · R. Gutman · J. D. Rich
School of Public Health, and Warren Alpert School of Medicine, Brown University, Providence, Rhode Island, USA

D. Rosen
University of North Carolina at Chapel Hill, Chapel Hill, NC, USA

Background

Prisoners are among the groups most heavily impacted by HIV. The prevalence of HIV among people in correctional facilities remains three to five times higher than that of the general population [1]. Numerous studies have demonstrated the effectiveness and acceptability of HIV treatment for individuals incarcerated in US prisons and jails [2, 3]. However, the period following incarceration is characterized by significant disruptions in HIV care. These disruptions include failure to link in a timely manner (or at all) to community care post-release, as well as not being retained in care after linking. Studies from the prison and jail systems in Texas, California, North Carolina, and Rhode Island showed substantial levels of delayed and failed linkage to community HIV care following release from correctional facilities [4, 5]. A systematic review of studies describing retention in care following release from incarceration also demonstrated significant declines following release, with only 30% of individuals

retained in care (as defined by two medical visits over 6 months) in the post-incarceration period [6].

One of the goals of the National HIV/AIDS Strategy–Updated to 2020 is to reduce new HIV infections. This can be achieved by engaging and retaining people living with HIV from the time of testing and across care transitions [7]. The outcomes of these efforts have been depicted as the HIV care continuum (or treatment cascade) [8]. Individuals who are retained in care are more likely to be virally suppressed and can access other health care services, such as counseling and treatment for sexually transmitted diseases [9–11]. Not being in consistent and effective care places HIV-positive individuals at higher risk for HIV-related illnesses and death, while also contributing to ongoing HIV transmission [12, 13]. Studies have shown that individuals who are retained in care and maintain viral suppression can reduce the likelihood of transmitting HIV to an uninfected partner to near zero [13]. It is estimated that more than 60% of all new infections in the USA may be attributed to individuals who have been diagnosed with HIV, but are not retained in care and virally suppressed [14].

In spite of the importance of a national emphasis on retaining vulnerable populations in care, few studies exist that examine the difference in retention between HIV-positive individuals leaving corrections and HIV-positive individuals already receiving care in the community [6]. Such comparisons are needed in order to understand whether the retention experience is different and if so, to determine the magnitude of the difference. In an environment of limited resources, this information is necessary for programs that need to prioritize defined populations for targeted interventions. Most published studies have focused on linkage to care post-release. Fewer studies have focused on retention following linkage to care, and only two published studies have focused on clinical outcomes post-release [6]. Building on our earlier linkage to care analysis, this paper seeks to address this gap in the literature through analysis of state-level post-release retention and viral suppression outcomes in two states [15]. Our goal is to distinguish the impact of recent incarceration on rates of retention and viral suppression in community care. To provide such information, the objective of this study was two-fold: (1) to examine differences in retention in care between HIV-positive individuals leaving corrections and HIV-positive individuals already receiving care in the community, and (2) to determine whether there is a difference in rates of viral suppression between those two groups among those who are successfully retained in care.

Methods

We used a retrospective, propensity-matched cohort design to compare retention in care between Ryan White HIV/AIDS Program (RWHAP) patients recently released from prison (releasees) and RWHAP patients without a recent incarceration history (community controls). The releasees were released from state prison between January 1, 2010 and December 31, 2013. The community controls were individuals who also received RWHAP care over that same period of time. The RWHAP provides HIV/AIDS care and treatment to uninsured and underinsured HIV-positive individuals in all 50 states and US territories [16]. Because releasees were unlikely to have access to third-party payer health care coverage immediately after release from prison, the RWHAP is the most likely source available to them for HIV/AIDS care. The releasees for this study were those who had at least one visit at a RWHAP-funded clinic post-release. Released individuals for this study were chosen based upon their initial linkage to care post-release. Our study did not allow for the inclusion of the same case more than once during the study period if they were re-incarcerated and re-linked. Community controls had to have at least one visit at a RWHAP funded clinic from 2010 to 2013. The analysis was conducted using data from Rhode Island and North Carolina.

Data Sources Releasees were identified using Rhode Island and North Carolina's 2010–2013 annual administrative data files created for the Bureau of Justice Statistics' (BJS) National Corrections Reporting Program (NCRP). The data include demographics, conviction offenses, sentence length, time served, date of release, and type of release. Community HIV medical service and viral load data were obtained via annual Ryan White Services Report (RSR) data for participating RWHAP providers for the years 2010–2013. Data elements in the RSR include demographics, dates and results of viral load and CD4 monitoring, and service utilization, including dates of outpatient ambulatory medical care visits. The RSR files for this study were provided by RWHAP provider sites that chose to make their data available. In North Carolina, files were obtained from 15 of the 19 RWHAP-funded grant recipients, including data from all of the providers with which they subcontract. The Charlotte-Mecklenburg County Transitional Grant Area (TGA) data were not made

available; therefore, the data for that area of the state are missing. In Rhode Island, data for all RWHAP providers were available. Complete detail on these data sources has been previously reported [15, 17]. The analytic sample was created by merging individual-level data from the NCRP and the RSR data files. The files were merged based upon a previously validated confidential method that employs the use of an encrypted unique client identifier (UCI) drawn from RSR data reporting system [18]. This method blinds the study team to the identity of the individuals whose data was analyzed for the study and prevents re-identification of individuals.

Cohorts Propensity score matching was used to match a cohort of releasees with a cohort of community controls. A propensity score is defined as the conditional probability of receiving a treatment given pretreatment characteristics. Treatment in this case refers to recent incarceration. After matching on the propensity scores, the distributions of observed covariates for incarcerated and non-incarcerated cohorts were similar on average. The variables used for propensity score matching were the demographic variables of race/ethnicity, gender, age, and HIV primary risk factor.

Outcomes Retention in care was assessed as two medical care visits at least 90 days apart within a 365-day period [12, 19]. For releasees, the 365-day observation began on the date of the first post-release clinic visit. For community controls, the observation period began on the date of the first clinic visit during the study observation period. We also measured viral load suppression as an additional outcome focusing solely on those who were retained during the measurement year. Viral load suppression was defined as having a viral load value of < 200 copies/ml [20]. Individuals whose first visit occurred after January 1, 2013 were excluded from the data set because they could not be followed for at least 365 days and therefore could not have adequate follow-up time to meet the retention definition.

Statistical analyses

Propensity matching was performed separately for the data from each state. We performed a one-to-one greedy matching between the two groups [21]. In this approach, an individual from the community control group is chosen as a matching partner for a releasee that is closest in terms of propensity score. The algorithm matched the pairs, with a caliper that restricts the maximum allowed difference in propensity score between releasees and community controls to be 2. The covariates' bias, variance ratios of the logit transform of the propensity scores, and the ratio of the variances of the residuals of the covariates after adjusting for the propensity score were used to assess the balance in the releasees and community controls. Variance ratios between 0.5 and 2 will yield accurate model estimates [22].

Analyses were conducted to determine the average treatment effect of having been recently released from prison on retention in care as compared to those who were already receiving care in the community at a RWHAP clinic. The dependent variable in the regression was retention in care. The independent variables were race, ethnicity, gender, age, and HIV risk factor. We calculated the average treatment effect on the treated (ATT) on retention for each state. ATT represents the average difference in retention in care for those individuals who were recently released from prison compared to their expected retention in care had they not been incarcerated.

Analyses of viral load suppression were performed on retained individuals, using the full community and corrections data set, not the matched. This is because the matched releasee and community control populations no longer resembled each other once we omitted the non-retained subjects. We performed chi-squared tests to determine which variables were associated with differences in suppression. For each variable, we omitted categories with fewer than 10 subjects in order to preserve meaningful comparison. Consequently, in our analysis of race, we omitted those four subjects (all in North Carolina) with unknown race. Within the Rhode Island cohort, we did not include eight subjects with unknown status in the housing analysis, and we also did not include transgender subjects ($n = 2$) in our analysis of gender.

All analyses were completed using STATA/SE 13.1.

The study was reviewed and approved by the Institutional Review Boards at the Miriam Hospital, Abt Associates, the University of North Carolina, Duke University Medical Center, as well as the Rhode Island and North Carolina prison systems and the Office for Human Research Protections.

Results

Population Characteristics

The total number of individuals that received RWHAP medical care in time to be followed for 1 year in North Carolina was 10,410 individuals and the total in Rhode Island was 1787 (Table 1). There were differences in the recently released and community populations both within and between states. Rhode Island had a larger Hispanic/Latino population in both the recently released and community populations (17%/23%), whereas the North Carolina Hispanic/Latino population was less than 10% in both cohorts. North Carolina had a larger Black population than Rhode Island in both cohorts (79%/62% compared with 30%/30%). In both Rhode Island and North Carolina, the recently released sample had a larger percentage of males compared to the community group (NC 82%/66%, RI 85%/69%). Persons recently incarcerated as compared to those linking in the community more commonly identified IDU as the risk factor for HIV transmission (NC 9 vs 5%, RI 30 vs 13%). Male to male sexual contact as risk factor for HIV was reported less commonly among those released

Table 1 Unmatched study sample

	North Carolina			Rhode Island		
	Recently released *n* (%)	Community controls *n* (%)	*p* value	Recently released *n* (%)	Community controls *n* (%)	*p* value
Gender			< .001			.015
Male	328 (82)	6564 (66)		78 (85)	1170 (69)	
Female	71 (18)	3286 (33)		14 (15)	510 (30)	
Transgender	0 (0)	65 (1)		0 (0)	< 5 (0)	
Missing	2 (0)	94 (1)		0 (0)	12 (1)	
Race			< .001			< .001
White	66 (16)	3269 (33)		53 (58)	1008 (59)	
Black	318 (79)	6215 (62)		28 (30)	506 (30)	
Other	15 (4)	415 (4)		0 (0)	169 (10)	
Missing	2 (0)	110 (1)		11 (12)	12 (1)	
Ethnicity			< .001			.314
Non-Hisp/Non-Lat	394 (98)	9243 (92)		76 (83)	1293 (76)	
Hisp/Latino	< 5 (1)	669 (7)		16 (17)	390 (23)	
Missing	3 (1)	97 (1)		0 (0)	12 (1)	
HIV primary risk factor			< .001			< .001
MSM	70 (17)	3641 (37)		43 (47)	900 (53)	
IDU	38 (9)	474 (5)		28 (30)	228 (13)	
Heterosexual contact	278 (69)	5326 (53)		18 (20)	418 (25)	
Other risk	13 (3)	568 (6)		< 5 (3)	149 (9)	
Missing	2 (0)	0 (0)		0 (0)	0 (0)	
Housing status			< .001			< .001
Permanent/stable	291 (73)	8515 (85)		42 (46)	1272 (75)	
Unstable/temporary	100 (25)	621 (6)		49 (53)	404 (24)	
Unknown	8 (2)	780 (8)		< 5 (1)	7 (0)	
Missing	2 (0)	93 (1)		0 (0)	12 (1)	
Age			.023			.348
Under 34	72 (18)	2283 (23)		20 (22)	303 (18)	
34 and over	329 (82)	7726 (77)		71 (78)	1392 (82)	

in North Carolina (17 vs 37%) but in Rhode Island the frequency of reporting was similar between the recently released and community cohorts (47% vs 53%). There was a corresponding higher rate of reported heterosexual HIV transmission among the recently released cohort in North Carolina (69 vs 53%) with similar proportions reporting heterosexual transmission risk in Rhode Island (20%/25%). In both states, releasees experienced higher rates of unstable housing (NC 25%/6% and RI 53%/24%).

Retention

Drawing upon the total sample, the propensity score matching algorithm yielded a final sample of 245 matched pairs in North Carolina and 81 matched pairs in Rhode Island. Table 2 shows that almost all of the variables in both Rhode Island and North Carolina fell within the acceptable guidelines indicating that the covariates in the matched sample met the criteria for a balance. Only the HIV primary risk factor in Rhode Island fell outside of the 0.5–2 range with a variance ratio of 2.04.

Table 3 reports the estimated propensity score-adjusted ATT for Rhode Island and North Carolina, respectively. In Rhode Island, there were 62% of releasees retained in care as compared to 91% of the community controls. In North Carolina, releasees retained at 66%, and community controls retained at 90%. Using the propensity score-matched pairs, the ATT for the Rhode Island-matched sample demonstrated a negative effect of −0.29, and for the North Carolina matched sample it was −0.24.

Table 2 Propensity score-matched sample

	North Carolina			Rhode Island		
	Recently released [$n = 245$]	Community controls [$n = 245$]		Recently released [$n = 81$]	Community controls [$n = 81$]	
	n (%)	*n* (%)	Variance ratio [v(t)/v(c)]	*n* (%)	*n* (%)	Variance ratio [v(t)/v(c)]
Gender						
Male	198 (81)	198 (81)	1.1	67 (83)	69 (85)	0.94
Female	47 (19)	47 (19)	1.1	14 (17)	12 (15)	0.94
Transgender	–	–				
Race						
White	40 (16)	44 (18)	0.92	53 (65)	55 (68)	0.94
Black	197 (80)	191 (78)	0.98	28 (35)	25 (31)	1.01
Other	8 (4)	10 (4)	1.6	0 (0)	< 5 (1)	–
Ethnicity						
Non-Hisp/ Non-Lat	242 (99)	243 (99)	1.1	66 (81)	68 (84)	1.34
Hisp/Latino	< 5 (1)	< 5 (1)	1.1	15 (19)	13 (16)	1.34
HIV primary risk factor						
MSM	43 (18)	44 (18)	0.91	38 (47)	48 (59)	0.98
IDU	18 (7)	21 (8)	1.3	27 (33)	13 (16)	2.04
Heterosexual contact	170 (69)	171 (70)	0.96 0.55	13 (16)	17 (21)	0.65 0.48
Other risk	14 (6)	9 (4)		3 (4)	< 5 (4)	
Age*	42 (9.5)	42 (9.4)	0.7	43 (9.73)	45 (10.72)	0.8
logit (propensity score)*	−2.91 (0.63)	−2.91 (0.63)	1	−2.89 (0.71)	−2.89 (0.71)	1

*Mean (SD)

Table 3 Average treatment effect of prison stay (treated) on retention

Rhode Island	Sample	Recently released	Community	Difference	SE
	Unmatched	.62	.92	− .30	.03
	ATT	.62	.91	− .29	
North Carolina	Unmatched	.66	.90	− .24	.03
	ATT	.66	.90	− .24	

Suppression

In both states, among the patients who were retained, releasees were less likely to be suppressed compared to community controls (NC 68%/72%, RI 69%/76%); however, the difference was not statistically significant (Fig. 1). Although not the focus of this paper, we observed that the characteristics significantly associated with VL suppression in both sites included being male, stably housed and over 34 years of age.

Discussion

The results of this study indicate that HIV-positive individuals reentering the community after release from prison experience greater difficulty staying retained in HIV care compared with those already receiving care in the community. This situation creates a serious threat to the health of HIV-positive releasees. It also increases the overall viral load of the community into which they released, creating increased opportunities for transmission of HIV. However, this study also indicates that once retained, releasees can achieve and maintain viral suppression as successfully as individuals in the community without recent incarceration. This suggests that efforts to increase retention in this key population can result in multiple downstream benefits such as reduced morbidity and mortality of HIV-positive releasees, reduced health care costs associated with stabilizing releasees who become very ill due to unsuppressed viral loads, and reduction in HIV transmission in the community.

The risk of interruption in HIV care upon reentry into the community after release from prison has been well established. As other analysis involving this cohort of releasees has shown, individuals often fail to link to care in the community in a timely manner after release [15] and many do not link at all. A recent study by Wohl et al. recruited a population of HIV-positive individuals being released from prison in North Carolina and Texas. Even among individuals motivated to join the study, 33% did not reach the study 24-week end point due to re-incarceration or loss to follow-up [23]. Our study shows that even for those who do successfully link to care, they are 24 to 29 percentage points less likely to be retained in care than those already in community care. However, for those who are retained, recent incarceration is not a statistically significant characteristic associated with failure to attain viral suppression. The primary characteristics for being unsuppressed among retained patients were being non-Hispanic, non-White, female, or unstably housed. In both states, the overall suppression rates for those retained in care were 72–76%. Although suppression was somewhat lower for releasees, the difference was not statistically significant. These suppression rates may be lower than the overall clinic suppression rate because only patients who had two visits within the same year were included in this analysis. The overall clinic suppression rate may be different based upon individuals who only had a single visit. This observation highlights that if barriers to retention can be addressed, virologic suppression can be achieved in this high-risk population. Case management interventions often target the immediate post release period (up to 3–6 months). The gaps in retention observed may suggest that longer-term follow-up is needed for persons post release.

Given the observed impact of recent incarceration on retention, developing targeted interventions for persons with HIV on reentry would align with and support the goals of the NHAS 2020 to increase rates of retention and viral suppression and the Joint United Nations Programme on HIV/AIDS (UNAIDS) “90-90-90” initiative. The 90-90-90 initiative promotes achieving the following goals by 2020: diagnosis of 90% of all HIV infections, 90% of diagnosed cases on antiretroviral treatment, and 90% of those cases being virally suppressed [24]. These seem like ambitious goals for the general population and even more so for a high-risk group like recently released individuals. However, the community controls in the two study states achieved (or nearly achieved) the 90% retention goal. While

challenges remain to achieving the 90% retention goal for those recently released from prison, they track closely together with the community comparison in viral suppression rates. If 90% suppression could be achieved for the retained community patients, it does not appear unrealistic that retained releasees could also achieve that suppression goal.

Limitations

This study has a few limitations including a relatively small sample size. The results of this study are limited to the outcomes in two states and are not generalizable to the USA as a whole. Within the state of North Carolina, we did not have clinic data for releasees that received services in the Charlotte-Mecklenburg area. While we only followed releasees that linked to services in the clinics for which we did have data, it is possible that an individual in our study could have received follow-up care in a Charlotte-Mecklenburg clinic for which we did not have data. Additionally, given that the study did not gain access to re-incarceration data, we do not know what portion of releasees failed to meet the retention threshold due to re-incarceration. A recent study by Wohl et al. examining the effect of post-release HIV care engagement programs in North Carolina and Texas showed that 63 of the 381 study participants did not complete the 24-week study period due to re-incarceration [23]. Similarly, we do not know if any of the controls were arrested and incarcerated during the observation period. In addition, the elevated risk for mortality in the post release period has been well established, which may explain a portion of non-retention. For example, in 2010, as part of an unpublished validation study in Rhode Island, we found that four out of 102 released individuals did not link to care due to death in the post-release period. There were also four deaths among the 381 post-release study participants involved in the Wohl et al. study [23].

While the HHS 2013 clinical guidelines recommended follow-up viral load testing every 3 to 6 months, retention in HIV care is a complex concept and has been measured in a myriad of ways. A variety of metrics for retention have been evaluated ranging from assessments of visit frequency, persistence in care over time and viral load suppression [25]. The metric used for the analysis was concordant with the HHS 2013 clinical guidelines [12]. While patients stable in care may be seen less frequently than every 90 days, it is standard of care for both individuals newly linking to care and individuals with significant social instability to be monitored more frequently. The two visits greater than 90 days apart reflect a minimal standard which may underestimate

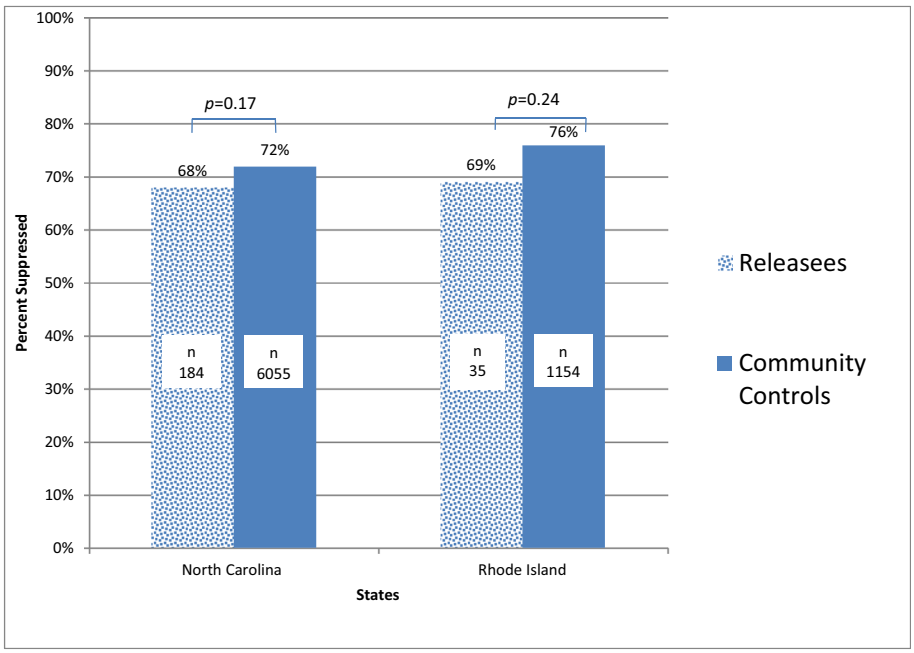

Fig. 1 Within state comparison of viral load suppression among individuals retained in care

the number of individuals who are seen less frequently than required for optimal care. Therefore, some of the community controls may be well-established patients in the study clinics and may only be seen once annually. If this is the case, it would understate the treatment effect of a prison stay and imply that the study results are even more significant than stated here.

It is possible that a portion of the treatment effect attributed to incarceration relates to unmeasured and correlated confounders, particularly the presence of substance use disorders or mental health diagnoses. Though substance use and mental health disorders are prevalent among persons who have been incarcerated, it is important to also note that the rates of these are higher in the general HIV population as well [26]. Given that these data are not present in the NCRP release or RSR datasets, it is not possible to distinguish the portion of the treatment effect of incarceration attributable to these factors. Despite this limitation, the results are still important as they illustrate the increased challenges faced by HIV-positive individuals who experienced recent incarceration and the clinics that seek to serve them.

Acknowledgments We gratefully acknowledge the support of the personnel at the Rhode Island and North Carolina prison systems who facilitated this project, including Fritz Vohr, MD, Jeff Renzi, Jacquelyn Clymore and David Edwards. We also would like to acknowledge the LINCS advisory board for its support of this work including Joanna Buffington, MD, Peter Leone, MD, A. T. Wall, JD.

Funding Information This research was supported by the NIDA Grant R01DA 030778.

References

1. Spaulding AC, Seals RM, Page MJ, Brzozowski AK, Rhodes W, Hammett TM. HIV/AIDS among inmates of and releasees from US correctional facilities, 2006: declining share of epidemic but persistent public health opportunity. *PloS one*. 2009;4(11):e7558.
2. Mostashari F, Riley E, Selwyn PA, Altice FL. Acceptance and adherence with antiretroviral therapy among HIV-infected women in a correctional facility. *JAIDS J Acquir Immune Defic Syndr*. 1998;18(4):341–8.
3. Altice FL, Mostashari F, Friedland GH. Trust and the acceptance of and adherence to antiretroviral therapy. *JAIDS J Acquir Immune Defic Syndr*. 2001;28(1):47–58.
4. Baillargeon J, Giordano TP, Rich JD, et al. Accessing antiretroviral therapy following release from prison. *JAMA*. 2009;301(8):848–57.
5. Clements-Nolle K, Marx R, Pendo M, Loughran E, Estes M, Katz M. Highly active antiretroviral therapy use and HIV transmission risk behaviors among individuals who are HIV infected and were recently released from jail. *Am J Public Health*. 2008;98(4):661–6.
6. Iroh PA, Mayo H, Nijhawan AE. The HIV care cascade before, during, and after incarceration: a systematic review and data synthesis. *Am J Public Health*. 2015;105(7):e5–e16.
7. White House Office of National AIDS Policy. National HIV/AIDS strategy for the United States National HIV Updated to 2020. In: Policy WHOoNA, ed. Washington D.C.: The White House; 2015.
8. Gardner EM, McLees MP, Steiner JF, Del Rio C, Burman WJ. The spectrum of engagement in HIV care and its relevance to test-and-treat strategies for prevention of HIV infection. *Clin Infect Dis*. 2011;52(6):793–800.
9. Giordano TP, Gifford AL, White AC, et al. Retention in care: a challenge to survival with HIV infection. *Clin Infect Dis*. 2007;44(11):1493–9.
10. Yehia BR, French B, Fleishman JA, et al. Retention in care is more strongly associated with viral suppression in HIV-infected patients with lower versus higher CD4 counts. *J Acquir Immune Defic Syndr*. 1999). 2014;65(3):333.
11. Mizuno Y, Julia Z, Crepaz N, et al. Receipt of HIV/STD prevention counseling by HIV-infected adults receiving medical care in the United States. *AIDS (London, England)*. 2014;28(3):407.
12. Panel on antiretroviral guidelines for adults and adolescents. Guidelines for the use of antiretroviral agents in HIV-1-infected adults and adolescents. Department of Health and Human Services; 2016.
13. 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.
14. 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 Int Med*. 2015;175(4):588.
15. Montague BT, Rosen DL, Sammartino C, et al. Systematic assessment of linkage to care for persons with HIV released from corrections facilities using existing datasets. *AIDS Patient Care STDs*. 2016;30(2):84–91.
16. Health Resources & Service Administration. About the Ryan White HIV/AIDS Program. 2016; https://hab.hrsa.gov/about-ryan-white-hivaids-program/about-ryan-white-hivaids-program.
17. Montague BT, Rosen DL, Solomon L, et al. Tracking linkage to HIV care for former prisoners: a public health priority. *Virulence*. 2012;3(3):319–24.
18. Gutman R, Sammartino C, Green T, Montague B. Error adjustments for file linking methods using encrypted unique client identifier (eUCI) with application to recently released prisoners who are HIV+. *Stat Med*. 2016;35(1):115–29.
19. Doshi RK, Milberg J, Isenberg D, et al. High rates of retention and viral suppression in United States HIV safety net system: HIV care continuum in the Ryan White HIV/AIDS Program, 2011. *Clin Infect Dis*; 2014:ciu722.
20. Health Resources & Service Administration. *Performance Measure Portfolio*. Ryan White & Global HIV/AIDS Programs; 2016.
21. Cormen TH, Leiserson CE, Rivest RL, Stein C. *Introduction to algorithms. Vol 6*. Cambridge: MIT press; 2001.

22. Rubin DB. Using propensity scores to help design observational studies: application to the tobacco litigation. *Health Serv Outcome Res Methodol*. 2001;2:169–88.
23. Wohl DA, Golin CE, Knight K, et al. Randomized controlled trial of an intervention to maintain suppression of HIV viremia after prison release: the imPACT trial. *JAIDS J Acquir Immune Defic Syndr*. 2017;75(1):81–90.
24. Joint United Nations Programme on HIV/AIDS. 90-90-90: an ambitious treatment target to help end the AIDS epidemic; 2014. JC26842015.
25. Mugavero MJ, Westfall AO, Zinski A, et al. Measuring retention in HIV care: the elusive gold standard. *J Acquir Immune Defic Syndr*. 1999). 2012;61(5):574.
26. Orlando M, Burnam MA, Beckman R, et al. Re-estimating the prevalence of psychiatric disorders in a nationally representative sample of persons receiving care for HIV: results from the HIV cost and services utilization study. *Int J Methods Psychiatr Res*. 2002;11(2):75–82.