

The Cost and Threshold Analysis of Retention in Care (RiC): A Multi-Site National HIV Care Program

Catherine Maulsby¹ · Kriti M. Jain¹ · Brian W. Weir¹ · Blessing Enobun¹ · Maura Riordan² · Vignetta E. Charles² · RiC Intervention Team · David R. Holtgrave¹

Published online: 21 November 2016
© Springer Science+Business Media New York 2016

Abstract Persons diagnosed with HIV but not retained in HIV medical care accounted for the majority of HIV transmissions in 2009 in the United States (US). There is an urgent need to implement and disseminate HIV retention in care programs; however little is known about the costs associated with implementing retention in care programs. We assessed the costs and cost-saving thresholds for seven Retention in Care (RiC) programs implemented in the US using standard methods recommended by the US Panel on Cost-effectiveness in Health and Medicine. Data were gathered from accounting and program implementation records, entered into a standardized RiC economic analysis spreadsheet, and standardized to a 12 month time frame. Total program costs for from the societal perspective ranged from \$47,919 to \$423,913 per year or \$146 to \$2,752 per participant. Cost-saving thresholds ranged from 0.13 HIV transmissions averted to 1.18 HIV transmission averted per year. We estimated that these cost-saving thresholds could be achieved through 1 to 16 additional person-years of viral suppression. Across a range of program models, retention in care interventions had highly achievable cost-saving thresholds, suggesting that retention in care programs are a judicious use of resources.

Keywords Cost analysis · Threshold analysis · Retention in HIV care

✉ Catherine Maulsby
cmaulsb1@jhu.edu

¹ Department of Health Behavior and Society, Johns Hopkins Bloomberg School of Public Health, 624 North Broadway, Baltimore, MD 21205, USA

² AIDS United, 1424 K Street, N.W., Washington, DC 20005, USA

Introduction

Retention in HIV care increases access to antiretroviral therapy, promotes viral suppression, and decreases HIV transmission [1, 2]. However, the Centers for Disease Control and Prevention estimates that among the 1.2 million people living with HIV only 30% are engaged in HIV care [3]. A recent modeling study estimates that persons who were diagnosed but not retained in HIV medical care accounted for 61.3% of HIV transmission in the US in 2009, with a transmission rate of 5.3 per 100 person-years [4]. In contrast, only 8.5% of transmissions are estimated to be from individuals engaged in HIV medical care, with transmission rates of 2.6, 1.8, and 0.4 per 100 person-years not on antiretroviral therapy (ART), on ART and not virally suppressed, and on ART and virally suppressed, respectively [4]. In response to the urgent need to promote linkage and retention in HIV care (LRC), public health practitioners have developed a number of program models that are effective at increasing retention in HIV care, including HIV patient navigation, care coordination, enhanced personal contacts, buprenorphine treatment, and strengths-based case management [5–12].

While these models have been found to increase HIV LRC, there is limited knowledge about the cost of implementing HIV retention in care programs. A recent literature review identified substantial gaps in knowledge about the cost-effectiveness of interventions that focus on improving the outcomes along the HIV continuum of care and noted a particular dearth of knowledge for interventions that focus on HIV LRC [13].

The majority of studies on the cost of LRC interventions are derived from programs that focus exclusively on linkage to care or a combination of linkage and retention. These studies suggest that linkage to care programs can be delivered at fairly low cost and have highly achievable cost

effectiveness thresholds [9, 14, 15]. For example, a study that assessed the cost effectiveness of increasing early linkage to care from 65 to 85% in the US estimated that costs of up to US \$8900 to link an individual to care would be cost effective [16]. Findings from EnhanceLink, a linkage to care intervention for people living with HIV (PLWH) leaving jail, provide further evidence of cost-effectiveness of linkage to care programs even when the more inclusive social perspective is considered. (The cost per QALY saved for EnhanceLink was estimated to be US \$72,285.) [15] While additional studies are needed on the cost and cost-effectiveness of linkage to care programs, there is even less information on retention in care programs. An analysis of CDC/HRSA's Retention in Care trial, a multisite randomized control trial of an intervention to retain PLWH in HIV care, estimated an average cost per patient to be US \$393 [17].

To document and evaluate innovative program models and to improve retention in HIV care, AIDS United and the M-A-C AIDS Fund (MAF) partnered to establish Retention in Care (RiC) and to fund diverse retention programs in seven locations throughout the US. To address the current gaps in the literature, this paper will (a) estimate the cost of implementing the RiC programs and (b) calculate the cost-savings thresholds for the RiC programs.

Methods

To estimate the cost and effect thresholds for the RiC programs, we employed standard methods of cost and threshold analyses, as recommended by the US Panel on Cost-effectiveness in Health and Medicine [18], and as adapted to HIV/AIDS programs by Holtgrave [19]. We conducted our analyses from the societal perspective to account for costs to all parties, to acknowledge the value of competing uses for societies' resources, and to maximize comparability with other cost-effectiveness analyses [20]. For each site, data collected in the following five areas were used to complete the economic analysis: Step 1: The time period for the analysis; Step 2: A description of the retention services delivered by the program; Step 3: Summary participant data including number of individuals served, number of participant contacts, and costs to the individual for participating in the program; Step 4: Implementation costs including, staff (including sub-contracts), materials and other consumables; and Step 5: The overhead rate. Sites had the option to include indirect expenses either in Step 4 or as an overhead rate in Step 5. Step 3 was used to calculate the cost of the program from the societal perspective [14, 21, 22]. While there was no fee for participating in the programs, we wanted to account for costs accrued by participants. These costs included:

transportation to and from program services, participants' time for travel and intervention services, and costs incurred by the participant for dependent care. We used the state minimum wage for each intervention location to estimate the cost of time for participants [23].

The time period for the analyses ranged from 6 to 16 months (Table 1). All cost data were standardized to a twelve-month time frame for ease of interpretation and are in 2014 dollars. Steps 1–3 were completed by program and administrative staff using process-oriented records which tracked indicators such as the number of participants enrolled, number of contacts, and duration of contacts. Costs to the participant (time, transportation costs, and dependent care) were estimated based on interview data from a subset of program participants at each intervention location as well as program implementation forms. Program costs for Steps 4 and 5 came from accounting records. Data were then entered into a standardized RiC economic analysis spreadsheet [14]. Prior to data collection, site staff attended a web-based training on cost analysis, threshold analysis, and completing the economic analysis spreadsheet. In addition, RiC program sites had access to a manual that provided detailed information on how to complete the five steps included in the spreadsheet. One-to-one technical assistance was available from faculty at Johns Hopkins University, who were the national evaluators of the RiC project. For quality control, all spreadsheets were reviewed separately by two members of the evaluation team using a standardized form. Any questions that arose were discussed with the RiC grantees and resolved. The national evaluators reviewed the results of the cost analysis with site-level evaluation and program staff to ensure the validity of findings.

This economic analysis includes a cost analysis and a threshold analysis. The cost analysis determined the costs incurred through delivering the programs, expressed both as the total cost (C) for a twelve-month time frame and the cost per participant served. Given an estimate of the discounted lifetime treatment costs for HIV (T), the cost-saving threshold analysis estimated the number of transmissions that would need to be averted (A) such that the total program costs would be exceeded by the total discounted savings ($C < AT$). Based on the literature, we assumed lifetime cost of HIV treatment of \$330,000 (2011 USD), and this estimate of T takes into account varying treatment costs at different stages of infection [24]. We adjusted "T" to 2014 dollars (US Department of Labor's Consumer Price Index <http://data.bls.gov/pdq/SurveyOutputServlet>) (Price index for all urban costumers (not seasonally adjusted, US city average, medical care) (435.292/400.258*330,000)). Program costs, C, were calculated for each site using information from Steps 3, 4, and 5 described above. Specifically, the total costs to the participant were added to the implementation costs times one plus the

Table 1 Description of RiC programs

| Program name | Location | Program components | Population served | Time period for analysis ^a |
|------------------------|---------------------------|---|--|---------------------------------------|
| Living Well | Birmingham, AL | Assessment of barriers to care Peer navigation Transportation | African–Americans | 2/1/14 to 1/31/15 |
| Positive Links | Charlottesville, VA | Smart phone application Strength-based case management Priority access to HIV clinical care | Rural residents | 10/01/13 to 9/30/14 |
| Bronx Health Connect | Bronx, NY | Health navigation Wrap around services Harm reduction | Individuals who use substances and the homeless | 1/1/14 to 12/31/14 |
| Trans Wellness Project | Philadelphia, PA | Peer navigation Wrap around services | Transgender women | 7/1/13 to 10/31/14 |
| The Open Door | Pittsburgh, PA | Client-centered residential housing program Representative payee services | Individuals who use substances and the homeless | 12/31/13 to 1/1/14 |
| Total health partners | Prince Georges County, MD | Community health workers Wrap around services Housing and financial planning counseling | Individuals living in poverty and sub-optimally housed | 7/1/14 to 12/31/14 |
| CHANGE for women | San Diego, CA | Trauma-informed wrap around services | Women who have experienced trauma | 3/1/14to 8/31/14 |

^a Standardized to 12 months for analyses presented in this manuscript. Due to rolling enrollment for the Trans Wellness and Total Health Partners programs, twelve-month standardization was done by calculating the average client enrollment and costs for 1 month and multiplying this by twelve. For CHANGE for Women, due to fixed enrollment into an 18-month intervention, client enrollment was kept constant and cost per client was used to standardize to 12 months

overhead rate [$C = \text{total participant cost} + (\text{implementation costs} \times (1 + \text{overhead rate}))$].

For each site, the number of infections that would need to be averted per year to reach the cost-saving threshold was given by the ratio C/T , or the cost of the program per year over the discounted lifetime cost for HIV care. To aid the interpretation of the cost-saving threshold, we calculated number of transmissions that would need to be prevented per 100 participants. We also estimated the additional number of person-years with viral suppression required to prevent that many transmissions. For the latter calculation, we assumed a transmission rate of 5.3 per 100 person-years for individuals not in care and a transmission rate of 0.4 per 100 person-years for persons who are virally suppressed ($0.053 - 0.004 = 0.049$ estimated transmissions prevented per person-year with viral suppression) [4].

Results

RiC was a national HIV retention in care program implemented in seven locations throughout the US from June 2013 to February 2016. Each program employed an

evidence-based program model that was adapted to meet the needs of the population being served (Table 1). Two programs were implemented in the Southeastern US, the Living Well Program and Positive Links. The Living Well program provided the following services: a comprehensive, individualized assessment of participants' most urgent patient-identified needs; linkage to social services to address participant needs; culturally competent health navigation by trained peers, and no-cost transportation to social and medical services. Twelve-month program delivery costs for the Living Well Program were \$203,943. Just over half of the costs were staffing and personnel, including case managers, a project manager, a retention coordinator, peer support specialists, and clinic partners. The program served 107 participants at a cost of \$1906 per participant. The cost-saving threshold was 0.57 HIV transmissions averted.

The Positive Links program provided participants living in rural Virginia access to a custom smartphone application and priority access to HIV clinical care. The total program cost was \$148,635. Total staffing and personnel costs were 51% of total costs for the study co-investigator and project coordinator. Materials and consumable costs (39%) were

largely comprised of costs associated with providing phones and phone service to participants, support for the phone application, and adaptation. The program served 54 participants over twelve months at a cost of \$2752 per participant. The cost-saving threshold was 0.41 HIV transmissions averted.

Bronx Health Connect, which served individuals living in NYC who use substances or who are homeless, provided peer navigation services using a harm reduction model. Total program cost for Bronx Health Connect was \$65,361. The majority of program costs were for staffing and personnel (62%) for case management and program management. Bronx Health Connect served 110 participants at the cost of \$594 per participant. The cost-saving threshold was 0.18 HIV transmissions averted.

In Philadelphia, trans peer outreach staff employed by Mazzoni Center's Trans Wellness Project provided health education, outreach, and support to transgender women living with HIV. Twelve months of program cost for the Trans Wellness Project was \$157,619. Costs associated with staffing case managers, outreach workers, clinicians, volunteers and project supervisors accounted for 62% of costs. The Trans Wellness Project reached 1081 individuals at the cost of \$146 per participant. The cost-saving threshold for the program was 0.44 HIV transmission averted.

The Open Door was a harm reduction, client-centered program that aimed to reduce homelessness by offering client-centered residential housing and representative payee services [25]. Total cost for the Open Door's program was \$47,919 for 12 months of program delivery. The majority of costs were staffing and personnel (72%). Implementation costs were 19% of total costs and included costs such as staff travel, participant travel and incentives. The Open Door served 27 participants at a cost of \$1775

per individual. The cost-saving threshold was well below one at 0.13 HIV transmissions averted.

Total Health Partners used a peer-workforce of community health workers in Prince Georges County, MD to retain PLWH in care and to address the social determinants with a focus on housing and financial planning. Total program costs were \$423,913. Thirty-six percent of program costs were participant costs, 55% of program costs were staffing and personnel and the remaining 9% of costs were materials and consumables. The program served 176 participants at a cost of \$2409 per participant. The cost-saving threshold was just over 1 at 1.18 suggesting the program would need to avert two HIV transmissions per year.

The Coordinated HIV Assistance and Navigation for Growth and Empowerment (CHANGE) for Women program (C4W) incorporated a trauma-informed model of care into the provision of holistic wrap around social services. Program cost for twelve months of program delivery from the societal perspective was \$271,834. Forty-three percent of program costs were cost to the participant, 48% were staff and personnel costs and 6% were costs for materials and consumables. C4W cost \$2639 per participant and the cost-saving threshold for the program was 0.76, indicating that to be cost-saving the program would need to avert 1 HIV transmission per year (Tables 2, 3).

Discussion

For the seven HIV retention in care programs implemented in the United States from 2012 to 2015, the costs for twelve months of implementation varied considerably from program to program (from \$47,919 to \$423,913). This variation is to be expected given that the RiC interventions

Table 2 Twelve month RiC program costs (% of total cost)

| Site | Living well ^a | Positive links ^a | Bronx health connect ^a | Trans wellness ^a | The open door | Total health partners | CHANGE for women ^a |
|---|--------------------------|-----------------------------|-----------------------------------|-----------------------------|----------------|-----------------------|-------------------------------|
| Total program cost (societal perspective) ^b | \$203,943 | \$148,635 | \$65,361 | \$157,619 | \$47,919 | \$423,913 | \$271,834 |
| Total participant costs (%) | \$13,653 (7%) | \$2576 (2%) | \$16,623 (25%) | \$39,647 (25%) | \$4404 (9%) | \$154,491 (36%) | \$117,645 (43%) |
| Implementation costs: staff/personnel costs (%) | \$106,463 (52%) | \$75,228 (51%) | \$40,629 (62%) | \$97,519 (62%) | \$34,313 (72%) | \$232,035 (55%) | \$130,954 (48%) |
| Implementation costs: materials and other consumables (%) | \$12,468 (6%) | \$57,552 (39%) | \$1752 (3%) | \$5066 (3%) | \$9202 (19%) | \$37,386 (9%) | \$16,173 (6%) |

^a Overhead rate used to capture additional implementation costs. Overhead rates and percentage of total cost: Living Well 0.60 (35%); Positive Links 0.10 (8%); Bronx Health Connect 0.15 (10%); Trans Wellness 0.15 (10%); CHANGE for Women 0.048 (3%)

^b C = total participant cost + [implementation costs*(1 + overhead rate)] (Results presented might vary slightly from equation presented due to rounding.)

Table 3 RiC program threshold analysis for 12 months of program delivery

| Location | Number of participants served ^a | Cost per participant (societal perspective) ^b | Cost-saving threshold (per 12 months of program operation) ^c | Cost-saving threshold (per 100 participants) ^d | Cost-saving threshold additional person-years with viral suppression (per 100 person-years) ^e |
|------------------------|--|--|---|---|--|
| Living Well | 107 | \$1906 | 0.57 | 0.53 | 11 |
| Positive Links | 54 | \$2752 | 0.41 | 0.77 | 16 |
| Bronx Health Connect | 110 | \$594 | 0.18 | 0.17 | 3 |
| Trans Wellness Project | 1081 | \$146 | 0.44 | 0.04 | 1 |
| The Open Door | 27 | \$1775 | 0.13 | 0.49 | 10 |
| Total Health Partners | 176 | \$2409 | 1.18 | 0.67 | 14 |
| CHANGE for Women | 103 | \$2639 | 0.76 | 0.74 | 15 |

^a Number of participants served by the program during a 12 month timeframe

^b Cost per client. Calculated as: Total program cost/number of participants served

^c Number of infections that would need to be averted for 12 months of program deliver to be cost-saving. Calculated as: total program cost/\$358,884

^d Number of infections that would need to be averted per 100 participants (enrolled for 1 year). Calculated as: Cost per client*100/\$358,884

^e Number of additional person-years of viral suppression that need to occur for the program to be considered cost-saving. This assumes 5.3 infections per 100 person years for individuals not retained in care and 0.4 infections per 100 person years for individuals who are virally suppressed. Calculated as: 100*Cost-saving threshold per 100 participants/(5.3–0.4)

varied in the models they employed, the location of services, and the populations served. Given these differences, the cost results from the RiC programs should not be compared to each other.

Cost-saving thresholds estimate the number of HIV transmissions that would need to be averted to assert that the interventions were cost-saving. The cost-saving thresholds for the RiC programs were 1.18 or less, indicating that six of the programs would be cost-saving if they averted one transmission per year, and the seventh would be cost-saving if it averted two transmissions per year.

This study adds to a small but growing body of research which suggests that retention in HIV care programs are a productive use of resources. The CDC/HRSA Retention in Care trial assessed the effectiveness of an intervention that included brief face-to-face meetings with participants during primary HIV care visits, brief phone calls halfway between scheduled primary care visits, and appointment reminder calls for scheduled and missed visits. The CDC/HRSA Retention in Care trial costs \$241,565 annually across the six study sites and the average cost per patient

was \$393 [17]. Most of the RiC programs had comparably higher average costs per participant. However, the RiC programs provided participants with intensive intervention services and focused on highly underserved populations with competing basic needs. In addition, the costs presented in this paper are from the societal perspective and thus include costs to the client. Both studies found that the majority of the costs associated with intervention delivery were labor costs. Further, the RiC programs seem to have highly achievable thresholds for consideration as cost-saving.

This study is not without limitations. First, the RiC implementing agencies self-reported the costs associated with program delivery. Second, this study does not take into consideration other benefits. For example, quality-adjusted life-years saved through engagement in care or prevention of HIV infection have not been estimated. Third, data sources and methods for reporting estimates may have varied across sites based on available data and program structure. In addition, for the cost analysis of the Positive Links application, it is important to note that the

cost analysis was based on the actual number of participants served in the demonstration project ($n = 54$). Anticipated Positive Links intervention services expenses do not increase with replication for upwards of 700 participants which is important when considering economies of scale. At this time, we are not able to determine the number of transmissions that were actually averted by the programs because the data needed to complete those analyses are not available, and therefore we cannot make claims about whether or not the programs are cost-saving at this time. However, we are currently gathering data on viral suppression, and we plan to estimate if the programs are cost-saving once the RiC programs are completed and final data are available. Still, the low thresholds reported here appear to be readily achievable.

Conclusions

Only 30% of PLWH are engaged in HIV care [3] and individuals who are diagnosed by not retained in care may account for over 60% of HIV transmissions [4]. This study provides valuable information on the costs associated with implementing HIV retention in care programs and the corresponding cost-saving thresholds. The findings from this study suggest that retention in care programs can be delivered at fairly low costs and appear to be an efficient use of HIV prevention funds given seemingly achievable thresholds. These findings will be useful to program implementers and policy makers and ultimately inform the allocation of public health resources for HIV prevention and care as outlined in the National HIV/AIDS Strategy [26].

Acknowledgements The authors would like to express their gratitude to the RiC intervention staff for their dedication and to the individuals who participated in the RiC intervention. We would also like to acknowledge those who took time to review the manuscript. The evaluation of the RiC initiative was supported by a grant from AIDS United, in partnership with the M-A-C AIDS Fund. In addition, K. M. Jain was supported by the National Institute of Allergy and Infectious Disease (T32 A1050056-12). The findings and conclusions in this article are those of the authors and do not necessarily represent the views of AIDS United, Johns Hopkins Bloomberg School of Public Health, or the grantees of the RiC initiative.

Funding This study was funded by AIDS United in partnership with the M-A-C AIDS Fund (90054915).

Compliance with Ethical Standards

Conflict of interest Catherine Maulsby, Kriti Jain, Brian Weir, Blessing Enobun, Maura Riordan, Vignetta Charles, the RiC Intervention Team, and David Holtgrave have no conflicts of interest to disclose.

Ethical Approval This article does not contain any studies with human participants performed by any of the authors.

References

1. Del Romero J, Castilla J, Hernando V, Rodriguez C, Garcia S. Combined antiretroviral treatment and heterosexual transmission of HIV-1: cross sectional and prospective cohort study. *BMJ*. 2010;340:c2205.
2. Donnell D, Baeten JM, Kiarie J, Thomas KK, Stevens W, Cohen CR, et al. Heterosexual HIV-1 transmission after initiation of antiretroviral therapy: a prospective cohort analysis. *Lancet*. 2010;375(9731):2092–8.
3. Bradley H, Hall HI, Wolitski RJ, Van Handel MM, Stone AE, LaFlam M, et al. Vital Signs: HIV diagnosis, care, and treatment among persons living with HIV—United States, 2011. *MMWR Morb Mortal Wkly Rep*. 2014;63(47):1113–7.
4. Skarbinski J, Rosenberg E, Paz-Bailey G, Hall HI, Rose CE, Viall AH, et al. Human immunodeficiency virus transmission at each step of the care continuum in the United States. *JAMA Intern Med*. 2015;175(4):588–96.
5. Davila JA, Miertschin N, Sansgiry S, Schwarzwald H, Henley C, Giordano TP. Centralization of HIV services in HIV-positive African-American and Hispanic youth improves retention in care. *AIDS Care*. 2013;25(2):202–6.
6. Enriquez M, Farnan R, Cheng AL, Almeida A, Del Valle D, Pulido-Parra M, et al. Impact of a bilingual/bicultural care team on HIV-related health outcomes. *J Assoc Nurses AIDS Care*. 2008;19(4):295–301.
7. Gardner LI, Giordano TP, Marks G, Wilson TE, Craw JA, Drainoni ML, et al. Enhanced personal contact with HIV patients improves retention in primary care: a randomized trial in 6 US HIV clinics. *Clin Infect Dis*. 2014;59(5):725–34.
8. Gardner LI, Marks G, Craw JA, Wilson TE, Drainoni ML, Moore RD, et al. A low-effort, clinic-wide intervention improves attendance for HIV primary care. *Clin Infect Dis*. 2012;55(8):1124–34.
9. Gardner LI, Metsch LR, Anderson-Mahoney P, Loughlin AM, del Rio C, Strathdee S, et al. Efficacy of a brief case management intervention to link recently diagnosed HIV-infected persons to care. *AIDS*. 2005;19(4):423–31.
10. Hightow-Weidman LB, Smith JC, Valera E, Matthews DD, Lyons P. Keeping them in “STYLE”: finding, linking, and retaining young HIV-positive black and Latino men who have sex with men in care. *AIDS Patient Care STDS*. 2011;25(1):37–45.
11. Irvine MK, Chamberlin SA, Robbins RS, Myers JE, Braunstein SL, Mitts BJ, et al. Improvements in HIV care engagement and viral load suppression following enrollment in a comprehensive HIV care coordination program. *Clin Infect Dis*. 2015;60(2):298–310.
12. Lucas GM, Chaudhry A, Hsu J, Woodson T, Lau B, Olsen Y, et al. Clinic-based treatment of opioid-dependent HIV-infected patients versus referral to an opioid treatment program: a randomized trial. *Ann Intern Med*. 2010;152(11):704–11.
13. Nosyk B, Krebs E, Eyawo O, Min JE, Barrios R, Montaner JS. Cost-effectiveness analysis along the continuum of HIV care: how can we optimize the effect of HIV treatment as prevention programs? *Curr HIV/AIDS Rep*. 2014;11(4):468–78.
14. Kim JJ, Maulsby C, Zulliger R, Jain K, Charles V, Riordan M, et al. Cost and threshold analysis of positive charge, a multi-site linkage to HIV care program in the United States. *AIDS Behav*. 2015;19(10):1735–41.
15. Spaulding AC, Pinkerton SD, Superak H, Cunningham MJ, Resch S, Jordan AO, et al. Cost analysis of enhancing linkages to HIV care following jail: a cost-effective intervention. *AIDS Behav*. 2013;17(Suppl 2):S220–6.
16. Gopalappa C, Farnham PG, Hutchinson AB, Sansom SL. Cost effectiveness of the National HIV/AIDS Strategy goal of

- increasing linkage to care for HIV-infected persons. *J Acquir Immune Defic Syndr*. 2012;61(1):99–105.
17. Shrestha RK, Gardner L, Marks G, Craw J, Malitz F, Giordano TP, et al. Estimating the cost of increasing retention in care for HIV-infected patients: results of the CDC/HRSA retention in care trial. *J Acquir Immune Defic Syndr*. 2015;68(3):345–50.
 18. Gold M, Siegel JE, Russel LB, Weinstein MC, editors. *Cost-Effectiveness in health and medicine*. New York: Oxford University Press; 1996.
 19. Holtgrave D, editor. *Handbook of economic evaluation of HIV prevention programs*. New York: Plenum Publishing Corporation; 1998.
 20. Russell LB, Gold MR, Siegel JE, Daniels N, Weinstein MC. The role of cost-effectiveness analysis in health and medicine. Panel on cost-effectiveness in health and medicine. *JAMA*. 1996;276(14):1172–7.
 21. Jain KM, Maulsby C, Brantley M, Kim JJ, Zulliger R, Riordan M, et al. Cost and cost threshold analyses for 12 innovative US HIV linkage and retention in care programs. *AIDS Care*. 2016;28(9):1199–204.
 22. Kim JJ, Maulsby C, Kinsky S, Riordan M, Charles V, Jain K, et al. The development and implementation of the national evaluation strategy of Access to care, a multi-site linkage to care initiative in the United States. *AIDS Educ Prev*. 2014;26(5):429–44.
 23. Weinstein MC, Siegel JE, Gold MR, Kamlet MS, Russell LB. Recommendations of the panel on cost-effectiveness in health and medicine. *JAMA*. 1996;276(15):1253–8.
 24. Farnham PG, Holtgrave DR, Gopalappa C, Hutchinson AB, Sansom SL. Lifetime costs and quality-adjusted life years saved from HIV prevention in the test and treat era. *J Acquir Immune Defic Syndr*. 2013;64(2):e15–8.
 25. Davis D, Hawk M, McLaughlin J, Brincko T, King M, Farmartino C. Despite initial “kicking and screaming” unstably housed persons report high satisfaction with representative payee program. *Hous Care Support*. 2015;18(2):56–61.
 26. White House Office of National AIDS Policy. *National HIV/AIDS Strategy for the United States*. Washington, DC: The White House; 2010. <http://www.whitehouse.gov/administration/eop/onap/nhas>. Accessed 27 March 2014.