**Supplement**

**Quantifying the impact of the National HIV/AIDS strategy targets for improved HIV care engagement in the US**

**Model Details:** The Johns Hopkins HIV economic-epidemic model (JHHEM) represents a dynamic system in which individuals who acquire HIV infection transition through HIV disease stages and steps in the HIV care continuum as shown in Supplemental Figure 1 below. Transitions are defined by a system of linear differential equations which describe the rate of change and flow between compartments (representing HIV status, stage of HIV infection for those who are infected, and place in the HIV care continuum) in the model. Detailed explanation of equations and description has been previously published[1](#_ENREF_1), with an updated parameter list of key variables shown in Supplemental Table 1 below. Here we describe the model update (HIV economic epidemiologic model, version 2) which incorporates newer data on HIV epidemiology and the HIV continuum of care.

Model Populations

Our deterministic model subdivided the US population into several HIV risk groups: Heterosexuals, MSM (including MSM/PWID), and PWID, with population sizes updated based on recent published literature[1-6](#_ENREF_1). Heterosexuals and MSM risk groups were further stratified by age (young 18-30, older 30-78) to account for increased sexual risk behaviors among younger heterosexuals and younger MSM. The population remained in the model for a period of 60 years to represent the average life-expectancy among adults in the US[2](#_ENREF_2). We allowed for population growth at a rate of 0.7% yearly; the population was assumed to be HIV-negative at entry.

HIV continuum of care and HIV progression

Within our model, individuals transitioned through multiple steps in the HIV continuum of care seen in Figure 1. Individuals become aware of their HIV serostatus through either active or passive screening/testing[7](#_ENREF_7). Once aware, individuals either linked to care (defined as adherence to an HIV clinic visit within 3 months [for NHAS intervention scenarios improving linkage, this was changed to 1 month]), or remained out of care (those out of care were still eligible to subsequently engage into care at a later time). Once linked to care, individuals initiate ART based on current guidelines[8](#_ENREF_8). We accounted for reduced HIV transmission on ART, as well as immunological recovery with viral suppression [9-18](#_ENREF_9" \o "Long, 2010 #2931). Specific ART regimens were not modeled, but considered whether individuals were on their first regimen versus subsequent alternative regimens [19-21](#_ENREF_19" \o "Robbins, 2010 #3884). Individuals that were in the compartments defined as linked, treated or suppressed were considered to be ‘in care’. Individuals could leave care at a rate based initially on literature estimates of retention in care and then manually calibrated to the CDC estimates of the continuum of care[22](#_ENREF_22), [23](#_ENREF_23). Individuals not in care were assumed to not be receiving ART or OI prophylaxis, but were eligible to reengage into care.

After HIV infection, individuals experienced progressive CD4 decline if not on ART at rates shown in Supplemental Table 1. We incorporated increased non-opportunistic infection related HIV death for those not on ART in addition to increased mortality rates from immunosuppression[24-26](#_ENREF_24), and incorporated reductions in these rates with virologic suppression [27](#_ENREF_27), [28](#_ENREF_28).

HIV disease transmission

HIV transmission in the model occurs via opposite sex contact, male same-sex contact, and needle sharing[1](#_ENREF_1). For each risk group, we calculated an average number of sexual partnerships per year, and an average transmission probability per partnership (calibration described below) calibrated to yield model outputs consistent with current HIV epidemiology; injection drug users (and MSM/PWID) could additionally acquire HIV infection based on needle sharing partnerships. Transmission probabilities per sexual partnership were varied on the basis of sex and sexual behavior (e.g. male to female, female to male, male to male), stage of HIV infection (e.g. increased transmission per sexual partnership during acute HIV infection, ART usage (reductions in probability of transmission), and awareness of HIV serostatus (Supplemental Table 1). Our model allowed for selection of sexual partners from sub-populations of other risk groups. To allow a balanced number of partnerships among heterosexuals, the average number of partnerships per year for females was calculated based on the population size and number of female partners within each risk group being sought by males. The average number of yearly partnerships and mixing patterns after model calibration for the base-case scenario are shown below (Supplement Table 2).

**Supplement Figure 1: Model Schematic** ****

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**Figure legend:** Schematic of dynamic compartmental HIV model. The population is divided into compartments based on HIV status, S=susceptible and H=HIV-infected, and stage of HIV for HIV-infected, *y*, and engagement with HIV care, *x*. Each compartment is stratified further by gender and risk group (heterosexual, MSM, PWID). The model incorporates transmission through sex and injection drug use. People living with HIV (at any point in the HIV continuum of care) progress through a series of HIV stages from acute HIV to AIDS if not on antiretroviral therapy, shown in subset. Individuals experience immunologic recovery if on ART and virally suppressed. Variable and subscript descriptions are given in detail in Supplemental Table 1. Solid arrows at compartment corners represents rate of model exit.. b, birth rate; $σ\_{1}$=Annual HIV screening rates **;**$ σ\_{2}$=annual rate of symptomatic testing; π=rate of linkage to care; f=percentage linking to care; $τ$=rate of ART initiation; ε=rate of viral suppression; $l$=rate of loss from care; *r*=rate of care reengagement; μ= rate of virological failure; *δ*=rate of HIV progression

**Supplement Table 1: Model variable descriptions (Updated version 2, Sept 2015)**

|  |  |
| --- | --- |
| Variable | Description |
| Total adult population 18-78 | 222 million[2](#_ENREF_2)  |
| PWID | 3.9 million (Male); 1.8 million (female)[1-6](#_ENREF_1) |
| MSM | 4.3 million[1-4](#_ENREF_1) |
| *X* | Place in HIV care continuum (1 Unaware, 2 Aware, 3 Linked to care, 4 On treatment, 5 Virologic suppression, 6 Aware-out of care) (Supplement Figure 1) |
| *Y* | Stage of HIV infection (1 Acute HIV, 2 CD4>350, 3 CD4 201-350, 4 CD4≤200) (Supplement Figure 1) |
| *B* | Entry rate (Supplemental Figure 1) |
| $$d\_{i}$$ | *i-risk group.* Rate of maturation (e.g. median life expectancy of 78 years [young defined as age 18-30]) |
| $$d\_{y}$$ | HIV mortality rate at HIV stage *y* (e.g. excess HIV mortality not on ART CD4 >200 0.14% per year [range 0.1-1%per year) [24-26](#_ENREF_24) |
| PPY | Partnerships per year: See Supplement Table 2 |
| P | Probability of transmission per partnership: male to female (2.2-3.1% by risk group [1.7-3.9%]); female to male (2.0-2.7% by risk group [1.5-3.4%]; MSM 2.9% (2.2-3.7%) |
| $$σ\_{i}$$ | $σ\_{1}$=Annual HIV screening rates: young men 7.5% (range 5%-9%), young women 12.5% (range 9%-16%), older men 15%(range 11-19%), older women 17.5% (range 13-22%), young MSM 22.5% (range 16-28%), older MSM 27.5%(range 21-34%), PWID 25% (range 18-31%). [29](#_ENREF_29), [30](#_ENREF_30)$σ\_{2,y}$=annual rate of symptomatic testing. base-case: 5% per year CD4>200; 50% per 6 months for CD4≤200) [9](#_ENREF_9), [31](#_ENREF_31)\* |
| $$π\_{i}$$ | *i-risk group.* Rate of linkage to care (defined in base-case as 3 months) |
| *f* | Percentage of individuals with initial linkage to care: young men 40% (range 30%-50%), young women 45% (range 34-56%), older men 45%(range 33-56%), older women 55% (range 41-69%), young MSM 50% (range 37-62%), older MSM 55% (range 41- 69%), male PWID 35% (range 26-43%), female PWID 40% (30-50%)[32-38](#_ENREF_32)\* |
| $$τ\_{y}$$ | Rate of ART initiation dependent on CD4 count (i.e. stage of HIV infection): 0.115 per month for CD4 >350 (i.e. median 6 months), 0.23 per month for CD4 201-350 (median 3 months); .69 per month for CD4≤200(i.e. median 1 months)[39](#_ENREF_39)  |
| $$ε$$ | Rate of virologic suppression: 0.115 per month (i.e. median 6 months; range 0.08 to 0.5 per month) [14](#_ENREF_14), [18](#_ENREF_18), [40](#_ENREF_40) |
| $$l\_{i}$$ | Rate of disengagement from care (i.e. loss to follow-up) among those in HIV care among, by sex and risk group per year: young men 24% (18-30%), young women 22%(17-28%), older men 21% (16-27%), older women 17.5%(13-22%), young MSM 19.5%(15-24%), older MSM 18.5%(14%-23%), male PWID 25%(19-32%), female PWID 23%(17-29%)[35](#_ENREF_35), [41](#_ENREF_41), [42](#_ENREF_42) |
| *R* | Rate of reengagement in care among those aware of their HIV status and not in care: 12.5% per year (9%-16%) |
| *δ* | *δ1* = Rate of progression from acute HIV (i.e. 1/duration of acute HIV; duration 2.9months [range 1-4 months]) [43-45](#_ENREF_43); *δ 2*= Rate of progression from baseline CD4 to CD4 <350 (6.5 years [3-10 years]); *δ 3*= Rate of progression from CD4 350 to 200 (2.5 years [range 1-5 years] [46-48](#_ENREF_46); *δ 4*= Rate of progression to death among individuals with CD4<200 (median 2 years [range 1-5 years]) [27](#_ENREF_27), [40](#_ENREF_40), [43](#_ENREF_43), [44](#_ENREF_44), [48](#_ENREF_48), [49](#_ENREF_49) |
| $$γ$$ | $γ$=Rate of immunological recovery with ART and viral suppression (e.g. transition from CD4≤200🡪CD4201-350🡪CD4>350): 0.6 per year[16](#_ENREF_16), [50](#_ENREF_50) |

\*Rates of screening, linkage, and yearly retention and reengagement were calibrated (see text) to fit the CDC published HIV care continuum in 2011

**Supplement Table 2:** Average number of sexual partnerships per year—updated 9/01/2015 after calibration to latest epidemiologic estimates of HIV incidence and prevalence

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | *Partners*  | Young male ppy  | Young female ppy  | Older male ppy  | Older female ppy  | Young MSM ppy  | Older MSM ppy  | male PWID ppy | female PWID ppy  | Total partnerships per year (ppy) |
| *Risk group*  |  |  |  |  |  |  |  |  |  |  |
| Young male  |  | -- | 3.59 | -- | 0.85 | -- | -- | -- | .02 | 4.45 |
| Young female |  | 3.26 | -- | .32 | -- | .01 | -- | .015 | -- | 3.6 |
| Older male |  | -- | .10 | -- | 1.72 | -- | -- | -- | .01 | 1.83 |
| Older female |  | .23 | -- | 1.57 | -- | -- | .01 | .015 | -- | 1.825 |
| Young MSM |  | -- | .25 | -- | -- | 4.7 | 1.57 | -- | -- | 6.27 |
| Older MSM |  | -- | -- | -- | .25 | .52 | 4.41 | -- | -- | 4.93 |
| Male PWID |  | -- | .10 | -- | .35 | -- | -- | -- | 1.38 | 1.825 |
| Female PWID  |  | .23 | -- | .32 | -- | -- | -- | 3.0 | -- | 3.55 |

Abbreviation: ppy, partners per year; MSM, men who have sex with men; PWID, people who inject drugs

Model Initiation and Calibration (version 2, updated Sept 2015[1](#_ENREF_1)):

We determined the initial sizes of each model compartment by bringing the model to equilibrium in 2006, and then allowing population growth at a yearly rate of 0.7%. During model initiation and calibration, first all parameters were held fixed (Supplement Table 1) except the transmission probabilities (i.e. transmission probability per partnership, and partnerships per year) and rates of care engagement. ART initiation rates during model calibration reflected prior guidance targeting individuals with CD4<350; beginning in 2011 we incorporated ART initiation at any CD4 count. To determine transmission probabilities (average yearly partnerships and probability of transmission per partnership), we began with published estimates[17](#_ENREF_17),[51-53](#_ENREF_51), and identified values at which the model best reflected epidemiologic data on estimated HIV incidence and prevalence between 2007 and 2012 through an iterative process (R parameter optimization package, Optim, followed by manual calibration)[54](#_ENREF_54), [55](#_ENREF_55). We simultaneously calibrated parameters (e.g. rates of yearly testing, %linkage to care within 3 months, annual rate of care disengagement and reengagement) related to retention in care to yield model outputs consistent with most recent estimates of the HIV continuum of care published in 2015[22](#_ENREF_22), [23](#_ENREF_23), [33-35](#_ENREF_33), [41](#_ENREF_41), [56-59](#_ENREF_56). Model estimates after calibration of yearly HIV prevalence (people living with HIV) compared with latest CDC published data are shown below (Supplement Figure 2)[57](#_ENREF_57), [60](#_ENREF_60). The model estimated an average of 49,000 yearly incident cases between 2007-2012, which compares favorably to CDC estimates (45,000 to 53,200 during this period)[55](#_ENREF_55). Model estimates of current engagement in the HIV care continuum are shown in Supplement Figure 3.

**Supplement Figure 2:** Model Calibration-Baseline model estimates of People Living With HIV

1. **TOTAL PLWH**
2. **Men**
3. **Women**

**Figure Legend:** Model calibration showing model projections during calibration period compared with CDC estimates[54](#_ENREF_54) for a)total PLWH b)Male PLWH and c)female PLWH

**Supplement Figure 3:** Baseline model estimates of engagement in HIV care

Figure Legend: Baseline model projections of current engagement in HIV care compared with CDC estimates[22](#_ENREF_22), [23](#_ENREF_23)\*.

NHAS Intervention Scenarios:

We identified parameters that would allow achievement of the NHAS indicators as outlined below.

* **NHAS Indicator 1--Enhanced screening:** We modeled scenarios of increased annual testing rates for high-risk individuals (MSM, PWID, and heterosexuals aged 18-30 years old)[61](#_ENREF_61) in order to achieve NHAS Indicator 1 (“Increase the percentage of PLWH who know their serostatus to at least 90%”) by 2020. To ascertain the minimum frequency of testing to achieve NHAS Indicator 1, we iteratively increased the baseline annual testing rates among high risk groups and found that an approximate 50% increase (compared to base-case rates) among young heterosexuals (11% per year and 19% per year among men and women, respectively), MSM (34% per year and 41% per year for younger and older MSM, respectively), and PWID (37.5% testing per year for men and women), allowed achievement of NHAS Indicator 1 in 2020.
* **NHAS Indicator 4--Increased linkage to care:** We model scenarios in which the current proportion of newly diagnosed persons completing an HIV care visit within 1 month from current levels to 85%. We modeled this scenario independently, and in conjunction with NHAS indicator 1 (increased screening). Individuals linked to care could still disengage from care at later time points. Individuals not initially linked to care could access care at later time points.
* **NHAS Indicator 5--Improved engagement in care:** We modeled scenarios of improved yearly retention in care (with improved reengagement in care of those not in care) to achieve NHAS target of retaining at least 90% of persons with diagnosed HIV. To achieve this indicator, we began with the base-case rates of loss to follow up, and iteratively decreased this rate (in 1% increments) until we reached a parameter set in which 90% of individuals (cross-sectionally) in 2020 that were aware of their serostatus were engaged in care (the rates utilized in the final parameter set were 4.4-6.1% [depending on risk group] loss to follow up yearly, and a rate of reengagement in care [for those out of care] of 0.5 [i.e. reengage at rate of once per 2 years]). We modeled this scenario independently, as well as with NHAS indicator 1 and 4.

The model calibrations depicting the HIV Care Continuum in 2020 (target year for achieving NHAS indicators) are shown below for each NHAS scenario.

Supplemental Figure 4a

Figure legend: Continuum of care in 2020 under the scenario of continued current rates of care engagement. Vertical axis represents all PLWH.

Supplemental Figure 4b

Figure legend: Continuum of care in 2020 under the scenario of achieving National HIV/AIDS Strategy (NHAS) indicator 1 of 90% of PLWH aware of their diagnosis by 2020. In this scenario, rates of initial linkage, yearly retention are constant from the base-case scenario, but incorporates increased annual testing among high risk groups. Vertical axis represents all PLWH.

Supplemental figure 4c

Figure legend: Continuum of care in 2020 under the scenario of achieving National HIV/AIDS Strategy (NHAS) indicator 4 of linking 85% of those newly diagnosed to care within 1 month. This scenario assumes continuation of current rates of HIV testing and annual care disengagement, but incorporates improvement in initial linkage after diagnosis. Vertical axis represents all PLWH.

Supplemental Figure 4d

Figure legend: Continuum of care in 2020 under the scenario of achieving NHAS indicator 5 of retaining at least 90% of persons with diagnosed HIV in care (in the year 2020). Percentages shown in figure are among all PLWH. This scenario assumes continuation of current rates of HIV testing and linkage, but incorporates improvement in yearly retention in care, and improvement in the rate at which individuals not in care reengage with HIV care.

Supplemental Figure 4e

Figure legend: Continuum of care in 2020 under the scenario of achieving National HIV/AIDS Strategy (NHAS) indicator 1 of 90% of PLWH aware of their diagnosis by 2020 in conjunction with indicator 4 of linking 85% of those newly diagnosed within 1 month. This scenario assumes continuation of current rates of retention in medical care. Vertical axis represents all PLWH.

Supplemental Figure 4f

Figure legend: Continuum of care in 2020 under the scenario of achieving National HIV/AIDS Strategy (NHAS) indicator 4 of linking 85% of those newly diagnosed within 1 month in conjunction with indicator 5 of retaining at least 90% of persons with HIV in care (cross-sectionally in 2020). This scenario assumes continuation of current rates of HIV testing. Vertical axis represents all PLWH.

Supplemental Figure 4g

Figure legend: Continuum of care in 2020 under the scenario of achieving National HIV/AIDS Strategy (NHAS) indicator 1 of achieving 90% of PLWH aware of their diagnosis by 2020, in conjunction with indicator 4 of linking 85% of those newly diagnosed to care within 1 month, in conjunction with indicator 5 of retaining at least 90% of persons with diagnosed HIV in care. Vertical axis represents all PLWH.

Costs parameters

Total health-system costs generated by the adult US population were calculated based on time spent per individual in each compartment and during transitions between compartments, based on HIV status and place in the HIV care continuum. Future costs were discounted 3%. Details of costing methods have been published previously[1](#_ENREF_1), with key costs shown in Supplemental Table 3. We incorporated costs for HIV testing for all individuals unaware of their HIV status at screening rates shown in Supplemental Table 2 and allowed for additional HIV testing on the basis of symptomatic presentation to health care facilities. We incorporated a cost of $25 per patient linking to care ($10-$150) to represent ancillary costs for referral process and post-test counseling[62](#_ENREF_62)*.* We assumed that individuals out of care who are reengaging in care incurred similar costs to new linkage to care (i.e. HIV provider visit, CD4, genotype, viral load testing*).* In the standard of care arm, we estimated the current cost of “retention services” based on staffing and salaries for social work, nurse-managers, and case-managers involved in care coordination and adherence promotion currently available at local HIV clinics (base-case, $300 per patient per year [$50-$1500])[63](#_ENREF_63). We assumed HIV-infected individuals in care receive baseline HIV viral load, CD4 count, and genotype, and incur costs of ongoing clinical visits and laboratory monitoring (Supplement Table 3). We utilized average annual ART costs based on current DHHS guidance recommending Integrase strand inhibitors (INSTI) or Protease Inhibitor based regimens (with boosted Durunavir) as first line therapy, most of which are not currently available in generic formulations[8](#_ENREF_8). Costs were based on published estimates of average wholesale pricing (AWP), with consideration for 340b pricing available to many clinics and patients through AIDS Drug Assistance Programs [64](#_ENREF_64), [65](#_ENREF_65). We included additional health care costs for HIV infected individuals not on ART to account for hospitalizations, ED visits, and other increased health care utilization (Supplement Table 3).

For the NHAS scenarios, there is limited published literature on the incremental costs to improve the HIV continuum of care. In the primary analysis, we included costs related to increased health system utilization (e.g. increased testing, greater linkage, and increased ART usage), but did not incorporate any intervention ‘program’ costs (i.e. our estimates represent the lower bound of achieving NHAS indicators). In a secondary analysis, we explored potential programmatic costs to implement HIV care strengthening interventions. We evaluated an increase in per test costs of 20% to account for added resources to achieve NHAS 1, costs of $500 per individual linking to care to achieve NHAS target 4, and an incremental cost (above status quo retention services) of up to $5000 per individual per year in care to represent an intensified case-management or social work or behavioral intervention program that results in a decline in the yearly rate of care disengagement sufficient to reach NHAS 5 targets, coupled with an incremental cost of $1000(range $10-$500) per patient that reengages in care for an intervention that increases reengagement rates sufficient to reach NHAS 5 target [66](#_ENREF_66), [67](#_ENREF_67).

**Supplement Table 3: HIV care costs and additional model parameters**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **COSTS**  |  | **Lower** | **Upper** | **Sources:** |
| Cost of HIV test | $33 | $10 | $51 | [68-70](#_ENREF_68) |
| Confirmatory HIV test | $30 |  $5 | $200 | [68-70](#_ENREF_68) |
| HIV viral load | $116 | $ 55 |  $164 | [71](#_ENREF_71) |
| Genotype | $384 |  $27 | $547 | [70](#_ENREF_70) |
| Outpatient Visit | $129 | $55 | $274 | [65](#_ENREF_65), [71](#_ENREF_71) |
| CD4 Test | $49 |  $20 | $90 | [71](#_ENREF_71) |
| Linkage to care costs |  $25 |  $10 | $150 |  Assumption |
| Current retention in care costs | $300 | $50 | $1500 | Assumption |
| Annual ART costs | $32,000 | $10000 | $45000 | [64](#_ENREF_64) |
| Cost of additional [inpatient,ED] care per year—HIV CD4>200 (untreated) | $3,025 |  $200 | $5000 | [71](#_ENREF_71) |
| Cost of additional [inpatient,ED] care—AIDS (untreated)  |  $21,124 | $2000 | $50000 |  [71](#_ENREF_71) |
| Costs of OI prophylaxis (CD4≤200) | $925 | $100 | $2000 | [71](#_ENREF_71) |

Additional Model Results and sensitivity analyses:

*Estimates of HIV prevalence:* Based on current trends, our model projects an average annual HIV incidence of 52,000 cases between 2015 and 2025 despite initiation of early or immediate ART for HIV infected individuals in care, if current rates of HIV care engagement continue (with ~40% of all PLWH and 45% of those aware of serostatus achieving viral suppression in 2025). At this annual incidence, the model projects growth in the overall number of PLWH over the next decade, reaching 1.47 million people living with HIV in 2025 (Supplemental Figure 5). While improvements in HIV screening and linkage (NHAS 1 and 4) reduce the annual incidence (by an average of 2.0% and 3.9%, respectively), as well as overall deaths among PLWH (Table 1, main text), overall prevalence of HIV rises over time. Alternatively, all scenarios in which a higher percentage of PLWH achieve viral suppression leads eventually to reductions in HIV prevalence (77% of all PLWH suppressed and 81% of those diagnosed suppressed, if achieving NHAS 5 target alone). If the NHAS 5 target of 90% of individuals (who are aware of their diagnosis) are in care by 2020, the model projects sharp declines in both annual HIV incidence (52% reductions) and HIV deaths, such that the overall prevalence of HIV begins to decline by 2025. Supplemental figure 5 shows the trajectory of PLWH over the next decade in varying scenarios of HIV care engagement.

*Additional cost analysis:* Costs of HIV care are also projected to increase as a result of higher rates of care engagement in the scenarios that NHAS targets are met. In the base-case scenario without change in HIV care engagement, we project 719,000 PLWH on ART in 2025 (49% of PLWH); by contrast, despite lower overall HIV prevalence, in the scenario of achieving NHAS 5 (90% in care by 2020), a greater number of PLWH are expected to be on ART (1.07 million, 81% of all PLWH). We show the cumulative costs over time in Supplemental Figure 6. In sensitivity analysis, we evaluated the factors most influencing total costs, and found that the ART regimen costs accounted for the majority of overall health system costs. In Supplemental Figure 7 we show results of a one-way sensitivity analysis for the scenario of achieving all NHAS care continuum targets (1, 4, and 5).

*Additional sensitivity analyses:* We conducted one-way sensitivity analyses on projections of incidence, mortality and costs for all scenarios. When key parameters were varied across their ranges, projections of incident HIV infections (with current continuum of care) were found to be most sensitive to the probability of transmission per needle-sharing partnership among PWID (490,000 to 715,000 new infections), annual number and probability of transmission per MSM partnership (454,000 to 610,000), and relative risk of transmission during acute versus chronic HIV infection (462,000 to 665,000). By contrast, estimates of the relative epidemiologic impact of achieving NHAS targets varied minimally across parameter uncertainty ranges (less than 5% change in estimates of HIV infections with variation of any individual parameter).

Supplemental Figure 5

Figure legend: Total people living with HIV at varying levels of HIV care engagement at the beginning of each year. In the base-case scenario, the current rates of HIV care engagement (screening, linkage, retention in care) persist. In the NHAS scenarios, we project improvements in care engagement (through increased yearly screening, improved linkage to care after diagnosis, and reduced care disengagement) that allows achievement of NHAS indicators 1, 4, and 5 by 2020.

Supplemental Figure 6

Figure legend: Undiscounted cumulative costs over the next decade under varying levels of HIV care engagement. In the base-case scenario, the current rates of HIV care engagement (screening, linkage, retention in care) persist. In the NHAS scenarios, we project improvements in care engagement (through increased yearly screening, improved linkage to care after diagnosis, and reduced care disengagement) that allows achievement of NHAS indicators 1, 4, and 5 by 2020.

Supplemental Figure 7



Figure legend: One way sensitivity analysis depicting top parameters influencing total health care costs. Baseline retention in care costs (i.e. current costs associated with retention efforts in current HIV care continuum) are shown separately from the potential costs of interventions to achieve NHAS care targets. In the base-case scenario, we did not include incremental retention intervention costs but explored a range of costs in sensitivity analysis shown here.

Supplemental Figure 8: Total Health Care Costs if achieving all NHAS care continuum targets (1 and 4 and 5)

Figure Legend: Cumulative undiscounted costs over time in the scenario that NHAS targets for screening, linkage and percent in care are achieved by 2020. Testing and linkage costs include costs of increased tests and referral to HIV care (but do not include costs of testing or linkage interventions); ART costs are based on yearly ART regimen costs in supplemental table 3. Non-ART costs includes costs of clinical care (viral loads and other lab tests), including base-case costs for ancillary services to retain individuals in care ($300 per person per year), but excludes any intervention costs for care strengthening.

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