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Closing the gaps in the continuum of depression care for persons with HIV: Modeling the impact on viral suppression in the United States

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Abstract

Objective: Depression is prevalent among persons with HIV (PWH) and is associated with poorer adherence and lack of viral load suppression (VLS). When treated for depression, PWH are more likely to stay in HIV care and adhere to medications; however, for many PWH, depression is not adequately diagnosed or treated. We adapted Progression and Transmission of HIV (PATH 3.0), a U.S. agent-based dynamic stochastic simulation model, by incorporating a continuum of depression care and estimating the impact on VLS of an enhanced depression diagnosis and care scenario (EDC).

Methods: We compared EDC—whereby every PWH is assessed for depression, gets treatment if diagnosed, and of those, half achieve remission—to a status quo scenario (SQ) on VLS. Based on published findings, assumptions for SQ were: 34.7% depressed, 45% diagnosed, 55.3% treated and 33% of treated achieving remission. Compared to PWH without depression, we assumed the probability of being non-virally suppressed increased by 1.57 times for PWH with depression (PWH-D), and by 0.95 times for PWH with remitted depression.

Results: There was an average increase of 14.6% (11.5–18.5) in the proportion of PWH-D who achieved VLS in EDC compared to SQ. Among all PWH, there was a 4.7% (3.4–6.0) increase in the proportion who achieved VLS in EDC compared to SQ.

Conclusions: Fully diagnosing and adequately treating depression would improve health and quality of life for a substantial proportion of PWH-D and result in a nearly 5% increase in expected rates of VLS in the United States, supporting national prevention goals.

Keywords

Human Immunodeficiency Virus (HIV); Depression; Mental Health; Mental Health Services; Viral Suppression

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Introduction

Mental health conditions are prevalent among persons with HIV (PWH),[1–4] with depression the most common mental health diagnosis. Estimates of depression prevalence among PWH range from about 27% to 44% in large samples and cohorts[4–6] and are estimated to be at least three times that of the general population.[5,7] Chronic or untreated depression carries a high burden of disability and suffering, compromising functioning and quality of life.

For PWH, depression is also a barrier to controlling disease progression. A substantial body of research documents the negative association between depression and HIV care continuum outcomes. Depression has been associated with increased odds of lower antiretroviral therapy (ART) use or poorer adherence[8–11] and poorer retention in HIV care.[12] Longitudinal studies demonstrate the harmful impact of depression over time. For example, among non-depressed PWH on ART in the Nutrition for Healthy Living study, those who became depressed had nearly two times the risk of becoming non-adherent to ART relative to those who remained non-depressed.[13] Other research indicates that risk of missing HIV care appointments and losing viral load suppression (VLS) increases with the number of days that depression continues. In one study, chronic depression was associated with a 37% increase in missed care appointments, a 23% increase in detectable viral load, and a doubling of the mortality rate.[14]

Viral suppression is key to protecting the health of PWH, and it is also crucial for prevention efforts. Because persons who achieve and maintain a suppressed viral load won't transmit HIV to their sexual partners,[15] treatment is a fundamental component of both the *Ending the HIV Epidemic in the U.S* (EHE) initiative and the National HIV/AIDS Strategy (NHAS), with VLS rate a national progress indicator.[16,17] At year-end 2019, 65.5% of persons with diagnosed HIV in the United States were virally suppressed,[18] indicating the important work needed to reach the NHAS VLS target of 95%.[17]

Depression symptom remission can be achieved in HIV patients with antidepressant medication[19–22] or cognitive-behavioral therapy.[23–27] Treatment for depression and other mental health symptoms has been associated with retention in HIV care, ART adherence and VLS.[12,21,28–30] Nevertheless, many individuals with both HIV and depression (PWH-D) are not benefitting from depression treatment, either because their depression is unrecognized, recognized but untreated, or not treated according to guidelines.[6, 31–33] Estimates suggest that only about 45% of HIV patients with depression are diagnosed,[31] just over half (55%) with indications for depression receive antidepressants, and only one-third of those had evidence of remission.[6] Even among treated patients, only a small minority with high remaining symptoms receive the indicated antidepressant dose adjustments.[32,33] Thus, only a small proportion of PWH-D may ultimately achieve remission of their depression symptoms. These gaps have been linked to less viral control. Among a large clinic-based sample of PWH, there were no differences in risk for non-suppression among those with treated depression relative to those never diagnosed with depression and without depression symptoms.[34] Odds of non-suppression were

significantly higher among PWH who did not receive depression treatment but who had clinical indications of depression.

These findings suggest that shoring up the gaps in the depression continuum of care–that is, missed diagnoses, absence of prescribing or receiving treatment, or absence of evidence-based treatment—should positively impact VLS. Greater attention to depression would improve patient well-being, quality of life, and HIV control. By extension, given the high prevalence of depression in the population, its negative impact on VLS, and the small proportion of patients with HIV and depression who achieve depression remission, fully addressing depression would not only increase the proportion of PWH-D who are virally suppressed, it could increase the overall proportion of persons with diagnosed HIV who are virally suppressed. Thus, fully addressing depression could help us make progress in reaching our national VLS target.

Toward this end, we conducted a modeling study to estimate the extent to which fully identifying depression among PWH and providing high-quality depression care could be expected to impact rates of VLS among PWH-D and among the national population of PWH. We adapted Progression and Transmission of HIV (PATH 3.0),[35–38] an agent-based dynamic stochastic simulation model, by incorporating a continuum of care for depression and estimating the impact on VLS of an enhanced scenario of depression diagnosis and treatment for PWH.

Methods

PATH Model

PATH 3.0 initiates in 2006 with 10,000 persons, calibrated to be representative of the 1.1 million persons living with HIV in 2006 in the United States, and simulates HIV transmission and disease progression over time, representative of the HIV epidemic over the period 2006 to 2015. PATH 3.0 was created in Netlogo and has been previously used to investigate HIV prevention interventions and lifetime costs associated with HIV.[35–38] Details of the version of the model used in this analysis can be found in the appendix of Bingham et al. 2021.[38] A brief overview is below.

Disease stages and HIV care continuum

The PATH model simulates HIV transmission among six transmission groups (heterosexual male, heterosexual female, men who have sex with men [MSM], persons who inject drugs [PWID]-female, PWID-male, and PWID-MSM). Sexual and injection behavioral data were derived from the National HIV Behavioral Surveillance (NHBS) system.[39] The model tracks individual-level natural HIV progression through the following disease stages (Figure 1): acute infection, asymptomatic infection, symptomatic infection/acquired immune deficiency syndrome (AIDS), and death. The model tracks individual-level changes in HIV care through the following HIV care continuum stages: acutely infected, but not aware; non-acutely infected, but not aware; aware, but not in care; in care, but not on ART; in care/on ART but not virally suppressed; and in care and virally suppressed. As per 2012 guidelines

for ART initiation,[40] we assumed that after 2012 all PWH in care were prescribed and on ART.

Rates for transitioning through care continuum stages, including testing, linkage to care, and care drop-out rates were estimated each month, for the period 2006 to 2015, by calibrating the care continuum distribution to match the NHBS[39] estimates for that period.

Analytic period for the simulation

The analytic period for the simulation was 2016 to 2025. For this period, we used fixed rates for HIV care continuum transitions, including testing and dropping out of care. In the base case scenario, we kept these rates fixed at 2015 values, by assuming a median time from infection to diagnoses of three years for testing[38,41] and a baseline drop-out probability of 3%[38] (Table 1). The model calculates a probability of dropping out of HIV care and treatment each month, which is directly proportional to baseline drop-out probability and is inversely related to the number of years previously spent virally suppressed.

Incorporating the depression care continuum in the PATH model

Just before the beginning of the analytic time period (end of 2015), we assigned a depression status to a certain percentage of PWH in the model (PWH with Depression [PWH-D]). Based on data from the Center for AIDS Research (CFAR) Network of Integrated Clinical Systems (CNICS) cohort, we assumed that 34.7% of aware PWH would experience depression.[6] Based on Lesko et al., we assumed that at the start of the analytic time period, among aware PWH the risk ratio of being non-VLS for those with depression relative to those without depression was 1.57.[34] This was implemented by sampling aware PWH to be assigned a depression status in such a way that the probability of being non-VLS among the PWH-D subgroup was 1.57 times the probability of being non-VLS among PWH without depression. We also assumed that the prevalence of depression among PWH unaware of their HIV status was 34.7%. As persons become newly infected, the number of PWH in the model increased. Therefore, we assigned depression to new PWH, so as to maintain a depression prevalence of 34.7% among all PWH, every month.

We incorporated a multi-step depression care continuum where the model determined the chance of PWH-D moving from getting diagnosed for depression, to getting treated for depression, if diagnosed, and experiencing remission from depression for those who were on treatment for depression (Figure 2, Table 1). We assigned probabilities of being in each of those steps at the end of 2015. Subsequently, the model moved persons along the depression care continuum every month, as needed, to maintain those probabilities.

Modeling depression diagnosis and treatment

We modeled two different scenarios for depression care continuum—the status quo scenario (SQ) and the enhanced diagnosis and care scenario (EDC). In SQ, we used data from the literature to represent the current levels of depression diagnosis and treatment. We assumed that in this scenario, 45% of all PWH-D were diagnosed with depression.[31] Additionally, of PWH-D diagnosed with depression, we assumed that 55.3% were treated, and of those treated for depression, 33% achieved remission.[6] In EDC, we assumed that

the depression care continuum was different for PWH-D aware of their HIV status (“aware”) and PWH-D unaware of their HIV status (“unaware”). We assumed that aware PWH-D would be screened for depression at clinic visits and thus assumed no missed depression diagnoses, and all persons with depression offered depression treatment. EDC presumed that the proportion of PWH-D with treated depression who achieved remission was 50%. We selected this proportion based on findings from the STAR*D pragmatic depression treatment trial, a large-scale clinical trial which aimed to develop and evaluate feasible treatment strategies to improve clinical outcomes for more representative “real-world” outpatients.[42] Fifty percent is the proportion of patients in STAR*D who entered remission after the first two treatment steps (step two involved changing or augmenting treatment if step one medication was not successful)[43] and could be addressed without specialty psychiatric care.[43] In EDC, we also assumed that the probabilities of diagnosis, treatment, and achieving remission from depression for unaware PWH-D were the same as those in SQ.

PWH-D are less likely to attain and maintain VLS. Compared to PWH without depression, we assumed the probability of being non-virally suppressed increased by 1.57 times for PWH-D, and by 0.95 times for PWH with remitted depression.[34] This was modeled by decreasing the probability of achieving VLS and increasing the probability of losing VLS and dropping out of care for PWH-D as compared to PWH without depression. Further details are discussed in the technical appendix.

We ran the model for both the SQ and EDC scenarios and reported the additional PWH on VLS in EDC compared with SQ. We calculated the relative difference in percentage of those with VLS among PWH-D and among all PWH. We simulated ten runs for years 2016 to 2025, and took the mean and range for each year. We then generated box plots of the outcomes from all years, and all runs, to visualize the ranges we report.

Scenario analysis by HIV care continuum parameters

We investigated the impact of the underlying HIV parameters on diagnosis and treatment of depression by simulating the analytic period under two different HIV care continuum scenarios in addition to the base case (Table 1). In the least favorable scenario, we assumed the median delay from HIV infection to diagnosis was 5 years and the baseline drop-out probability from HIV care was 5%. A longer time from HIV infection to diagnosis and a higher drop-out probability from HIV care implies that the percentage of PWH who have VLS would increase at a slower rate over the years, as compared to the HIV base case scenario. We also defined a most favorable scenario for which the median delay to diagnosis was 1 year and baseline drop-out probability was 1%. In this scenario, we expect the percentage of PWH who have VLS will increase over the years at a faster rate compared to the HIV base case scenario.

Results

Evaluation metric

Our primary outcome was the relative difference in the percentage of persons who have VLS in the EDC scenario compared to the SQ scenario. This was calculated as

$$\%\ difference\ in\ VLS\ = 100 \times \frac{(\%\ of\ PWH\ that\ have\ VLS\ in\ the\ EDC\ scenario\ -\ \%\ of\ PWH\ that\ have\ VLS\ in\ the\ SQ\ scenario)}{(\%\ of\ PWH\ that\ have\ VLS\ in\ the\ SQ\ scenario)}$$

We calculated the above outcome both for PWH-D and for all PWH. We calculated the mean across 10 runs for each year and observed minimal variation over the years. Therefore, we took an average across the years.

In the base case scenario, there was an average increase of 14.6% (11.5–18.5) in the proportion of PWH-D who achieved VLS in EDC compared with SQ (Table 2). Among all PWH, our model showed a 4.7% (3.4–6.0) average increase in the proportion of all PWH who would have achieved VLS in EDC compared with SQ.

In the least favorable scenario for the HIV care continuum, the average relative increase in percentage of persons who achieved VLS was 18.0% (13.7–23.0) in the PWH-D subgroup, and 5.7% (3.5–7.8) for all PWH in EDC compared with SQ. In the most favorable HIV care-continuum scenario, the average relative increase in percentage of persons who achieved VLS was 11.4% (8.9–14.1) in the PWH-D subgroup and 3.5% (2.4–4.5) for all PWH in EDC compared to SQ.

Because the ranges of outcomes appeared to be large, we generated box plots showing the percentage difference in proportion of persons who achieved VLS in the EDC compared to the SQ scenario for all years and all runs. The medians and interquartile ranges presented in Figure 3 demonstrate that there is a much narrower interquartile range than the ranges reported in Table 2. This suggests that the wide ranges in Table 2 are due to a few outliers, which can be attributed to stochasticity in the model.

Discussion

Depression is among the most common mental health conditions in the US[44] and the leading cause of mental health-related disease burden globally.[45] Hopelessness, fatigue, concentration impairment, and feelings of worthlessness often interfere with ability and motivation to carry out important life activities. For PWH, this can include adherence to medication and care activities that prevent comorbidities and HIV disease progression.

Just as achieving VLS has both health and prevention benefits, effectively treating depression improves quality of life for PWH and can also help achieve national HIV prevention goals at the population level. Because primary research has identified the nature and frequency of gaps in depression treatment among PWH, we were able to model the estimated national impact of closing those gaps on VLS. The PATH 3.0 model projected that over 10 years, adequately addressing depression would lead to a substantial (14.7%) increase in the proportion of PWH-D who were virally suppressed. Moreover, even though PWH-D represent a minority of all PWH, closing gaps in depression care should result in a nearly 5% increase in the overall proportion of PWH who are virally suppressed beyond anticipated levels. Results from the scenario analysis show that should baseline conditions in the HIV care continuum become less favorable—for example, as occurred during the COVID-19

pandemic when HIV testing decreased[46,47]—the impact of enhanced depression care will be greater. The prevention benefits of treatment are well established.[48] However, given that only 65.5% of diagnosed persons in the US are virally suppressed,[18] it is essential to identify actionable and practical approaches to increasing VLS rates.

Parameters for EDC were selected based on feasibility within the current HIV care environment. The depression identification parameter was based on the availability of brief, clinically validated screening tools (e.g., the Patient Health Questionnaire [PHQ]-9[49] or PHQ-2[50]), which make universal screening within HIV care feasible and consistent with recommendations for integrated HIV and behavioral health care.[51] The model's assumption that 50% of those offered and receiving intervention would achieve remission is in line with findings that remission rates associated with 'treatment as usual' are low (33%),[52] including trials which did not exclude patients with chronic illnesses such as HIV or other mental health conditions.[42] The anticipated remission rate for our model was based on clinical findings[43] and reflects a reasonable increase in remission among PWH-D compared to current estimates. Nevertheless, our model may overestimate the impact of EDC on VLS if these expected outcomes cannot be reached.

Antidepressant medications represent the most common form of treatment for PWH-D.[53] Because primary care and HIV specialty providers can manage depression with medication, and because model-relevant inputs were available for this intervention, our model only included the impact of psychopharmacologic treatment. However, psychological interventions, particularly those with a cognitive-behavioral focus or component, are also effective for treating depression among PWH.[1,23–27,54,55] As an adjunct to medication, many persons are better able to utilize psychotherapy to address the impacts of complicated life circumstances once physical manifestations of depression (e.g., lethargy, lack of cognitive focus or motivation) are alleviated, which may be particularly relevant for PWH, for whom trauma experiences and trauma-related comorbidities are high.[1,3, 56–59] Thus, not including impact of non-pharmacologic mental health interventions may have resulted in an underestimation of the impact of fully addressing depression among PWH on VLS.

Even when mental health services are available to PWH, mental health stigma may act as a barrier to their use. Although stigma around depression has been decreasing,[60] negative perceptions remain and are more common among older persons and those of minority race or ethnicity.[60,61] In the US, where African American or Black (hereafter referred to as Black) persons account for over 40% of all persons with HIV,[62] negative perceptions about mental health (e.g., 'depression equates to weakness')[63,64] may account for hesitancy to report symptoms or utilize services. Other social, structural or historic factors–such as racial incongruity between providers and patients, experiences of mistreatment or discrimination leading to mistrust of medical providers, and preferences for other forms of coping (e.g., religious coping, social support) or sources of resilience (e.g., ethnic identification) in lieu of medical treatment—may also contribute to the underreporting of depression and greater mental health treatment attrition by Black persons with socioeconomic stress.[65,66] Regular and sensitive provider discussion about mental health may help foster a trusting relationship in which PWH feel comfortable disclosing symptoms. However, structural approaches, such as diversifying the mental health workforce,[67–69] educating mental health and other

providers with training in culturally sensitive approaches to patient engagement[65] and ensuring that mental health services are accessible and covered[70] can help enhance the likelihood that racial and ethnic minority PWH benefit from mental health interventions.

To our knowledge, this is the first attempt to model nationally the impact of improved mental health care for PWH. Nevertheless, this analysis is not without limitations. As with all models, certain assumptions were made that could have influenced our findings. First, our model did not consider vicissitudes of depression. Our model may have overestimated the impact of treatment if some PWH-D effectively treated for depression had recurrent episodes during the period being modeled. Similarly, our model did not account for spontaneous remission. About 23% of persons with untreated depression will spontaneously remit within 3 months,[71] the typical period between HIV care visits. Although this may be more common among persons with milder depression and less common among PWH for whom psychiatric comorbidities and social stressors are prevalent,[1–4] spontaneous remission would have a greater impact on those in SQ. Recurrent episodes and/or spontaneous remission may have led to an overestimation of the impact of EDC.

In addition, our model assumed that the wait period for PWH-D who have not achieved remission from depression to re-enter HIV care after dropping out is the same as PWH without depression. Although we have no data to indicate otherwise, the fact that PWH-D are at increased risk for dropping out of HIV care[12] suggests that we may have underestimated the impact of untreated depression, given the increased likelihood that PWH-D, compared to PWH without depression, have fallen out of care. Finally, although our model is more likely to assign depression to PWH who are non-VLS than those who have VLS, once a PWH is assigned a depressed status, the depression care continuum probabilities are the same for them irrespective of where they are on the HIV care continuum. That means, for example, a PWH who has been on ART for many years is as likely to be assigned depression that has not been treated effectively (as opposed to remitted depression) as someone who has recently acquired HIV. This can introduce stochasticity that leads to the wide range of outcomes reported in Table 2. Recent cohort data suggest that prevalence of depression among persons with HIV increases with time since initiation of ART.[4] However, other evidence suggests that depression onset may be less common among older persons and more common in the years immediately following diagnosis.[72,73] Thus, research needs to determine whether fully addressing depression would have greater impact if focused on younger persons and/or in the early years following HIV diagnosis.

Conclusion

Routinely screening patients for depression has clear benefits.[74] In the HIV care setting, identifying and then adequately treating for depression all PWH-D would not only advance progress towards our national prevention goals through its impact on viral suppression, but it would advance progress on new NHAS targets for quality of life for PWH.[75] Specifically, by addressing unmet mental health needs, closing the gaps in the depression care continuum would improve health and subsequently quality of life for a notable proportion of PWH-D.

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LK conceptualized the research question, conducted the literature review, and wrote the first draft of the manuscript. NK led the modeling analysis and drafted the results section of the paper. NK and MI revised the PATH 3.0 model to accommodate the depression data. MI developed visualizations illustrating the methods and results. CG and PF provided oversight and consultation on the modeling methods and analyses. All authors edited the paper for important intellectual content.

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Appendix: Technical details on how HIV care continuum transitions are modified for PWH with depression (PWH-D) and PWH-D who have achieved remission from depression.

The model considers the following HIV disease stages: acutely infected, but not aware (stage 1); non-acutely infected, but not aware (stage 2); aware, but not in care (stage 3); in care, but not on ART (stage 4), in care/on ART, but not virally suppressed (stage 5); and in care and virally suppressed (stage 6). The model assumes that after 2012 everyone in care is also on ART.

We assumed that the probabilities of getting diagnosed with HIV and getting linked to care for HIV are the same for PWH, PWH-D, and PWH-D who have achieved remission from depression. However, for the analytic time period, we modified the following probabilities for PWH-D and PWH-D with remission from depression: achieving VLS, dropping out of care, losing VLS while still being in care, and achieving VLS again for those who had either dropped out of care or lost VLS. This document describes how these probabilities were modified.

a) Probability of transition from stage 5 to stage 6 (achieving VLS)

For PWH without depression, the model assumes that the percentage of those who achieved VLS was associated with the CD4 count at the initiation of treatment. For the first ART regimen, we assumed viral suppression occurred immediately for those who achieved it. For subsequent regimens, attaining viral suppression (among those who achieved it) took six months after virological rebound.

For PWH-D, we did not change the baseline percentage of those who achieved VLS. But among those who qualified to achieve VLS, the probability of achieving it was decreased by a factor of 1.57 (following the risk ratio of being non-VLS for those with depression relative to PWH without depression from Lesko et al). PWH with remitted depression achieved VLS with probability 1, as those for PWH without depression

b) Probability of transition from stage 5/6 to stage 3 (dropping out of care)

The model assumed that for PWH without depression, dropout probability was inversely proportional to the time previously spent virally suppressed. Probability of dropping out

of care every month was calculated as $f(y) = \frac{k}{1 + \frac{y}{2}}$, Here k denotes baseline drop-out probability and y denotes the number of years this person has spent virally suppressed. In the HIV base case scenario, k = 3%. It is varied to be 1% and 5% for sensitivity analysis.

For PWH-D, we increased the above probability by a factor of 1.57.[34] For PWH-D with remission from depression, we decreased the above probability (multiplied by a factor of 0.95[34]).

c) Probability of transition back from stage 3 to stage 6 (Re-entering care/ treatment for those who had dropped out)

For PWH without depression, we assumed persons who dropped out of care could re-enter care after 1 year, with 50% of re-entering before 2 years, and the other 50% re-entering after 2 years. We made the same assumption for PWH-D as we did for PWH without depression. We assumed that PWH-D who have had effective treatment of depression can re-enter care as soon as they get remission from depression. They do not have to wait the full wait time as described above.

d) Probability of transition from stage 6 to stage 5 (losing VLS, while staying in care)

For PWH without depression, we assumed that viral suppression was sustained until a person dropped out of care/treatment. In other words, the probability of going from stage 6 to stage 5, for PWH without depression is zero.

For PWH with depression, we assumed the probability of going from stage 6 to stage 5 follows a similar function as discussed in section *c*. Probability of dropping from stage 6 to stage 5 every month was calculated as $f(y) = \frac{k}{1 + \frac{y}{2}}$. Here k denotes baseline drop-out probability and y denotes the number of years spent virally suppressed. We chose k such that the cumulative probability of going from stage 6 to stage 5 within six months for PWH with depression was 0.048 (risk difference taken from Lesko et al). Since the baseline probability of going from stage 6 to stage 5 for PWH without depression was zero, in this case we considered the risk difference reported in Lesko et al, 2020[34] as opposed to the risk ratio.

We assumed that the probability of going from stage 6 to stage 5 for PWH with remitted is zero (as is the case for PWH without depression).

e) Probability of transmission back from stage 5 to stage 6 (achieving VLS again for those who had lost it)

Only PWH with depression (not remitted) go from stage 6 to stage 5. We assume they stay at stage 5, until their depression is remitted.

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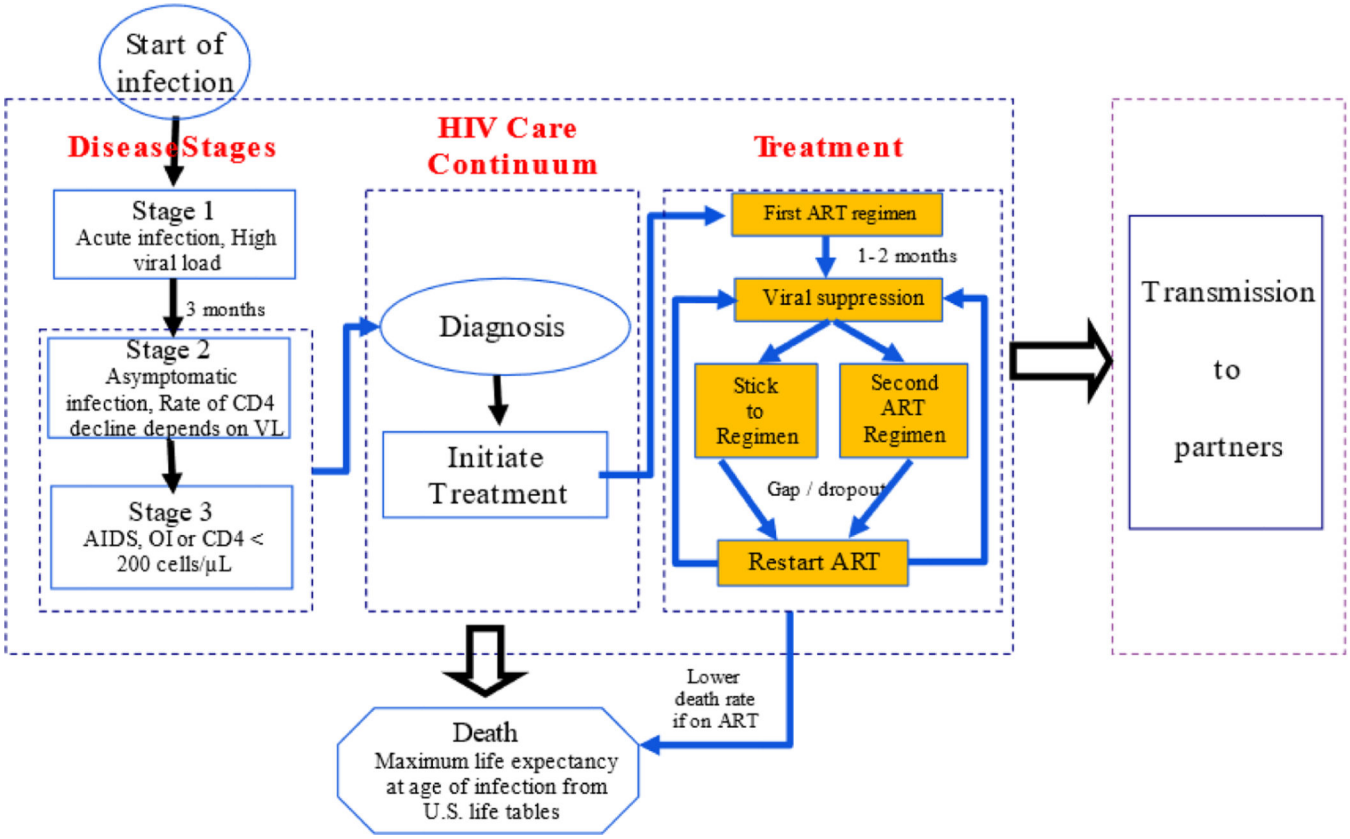


Figure 1:
Schematic of Progression and Transmission of HIV (PATH 3.0) model

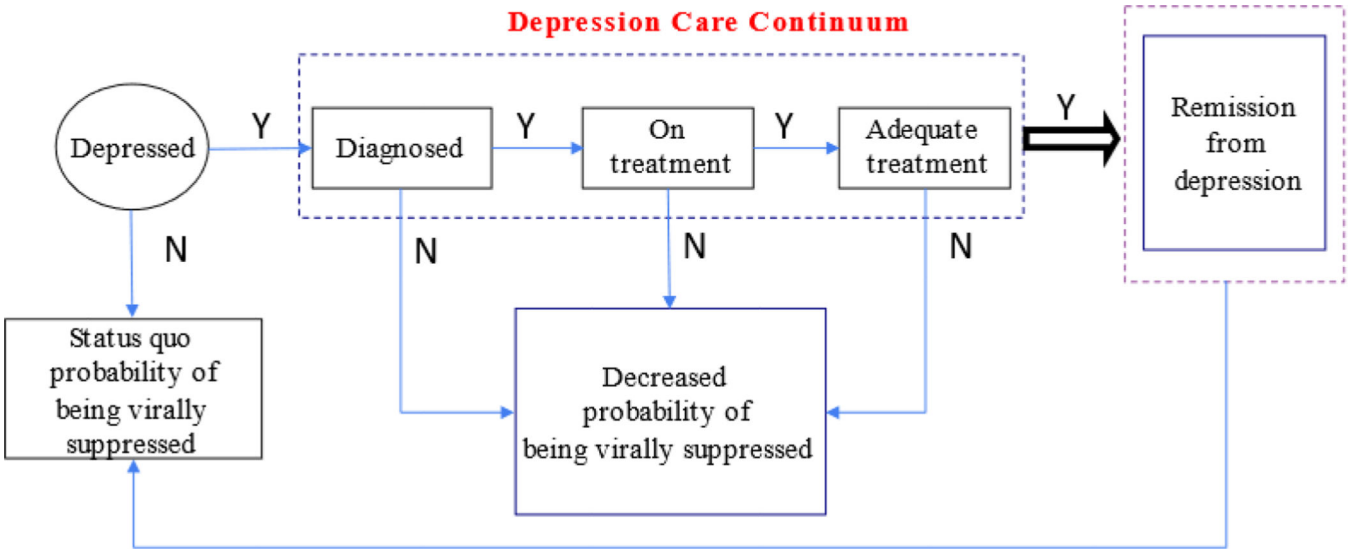
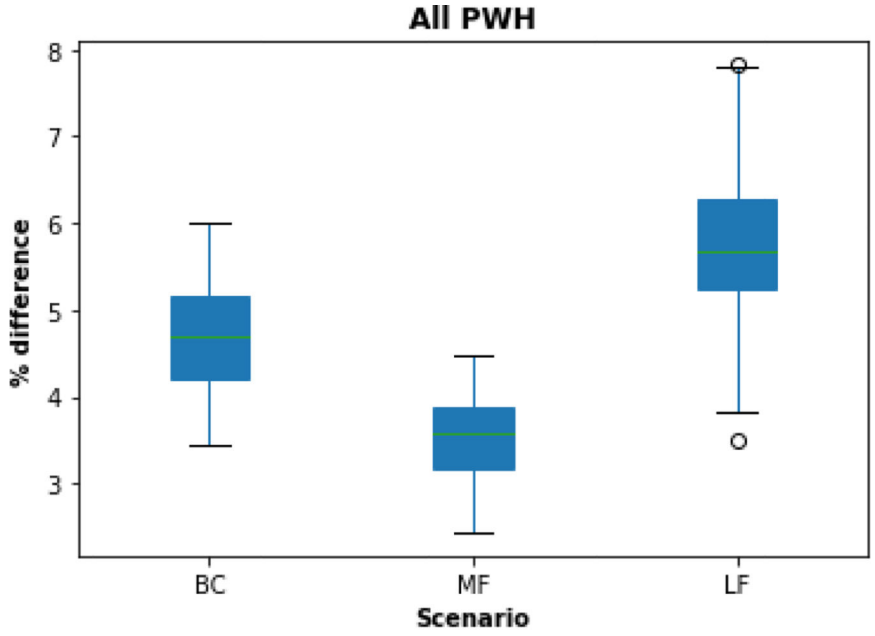


Figure 2:
Depression Care continuum

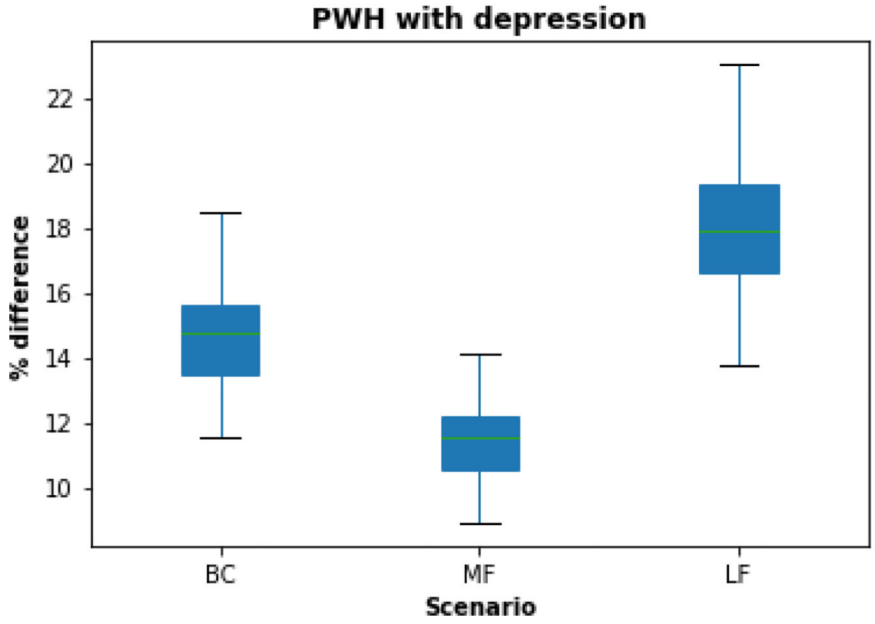


Median (Interquartile range)

BC: 4.7% (4.2-5.2)

MF: 3.6% (3.2-3.9)

LF: 5.7% (5.2-6.3)



Median (Interquartile range)

BC: 14.7% (13.5-15.6)

MF: 11.6% (10.6-12.2)

LF: 17.9% (16.6-19.3)

Figure 3:

Box plots* showing the percentage difference in proportion of persons that have VLS in the EDC scenario compared to the SQ scenario by HIV care continuum parameter scenarios – adapted Progression and Transmission of HIV (PATH 3.0) model

BC: Base case, MF: most favorable, LF: least favorable

* The green line shows the median and the blue region shows the interquartile range.

Table 1:

Relevant input parameters

Depression Parameters		
Parameter Name	**Parameter Value**	**Source**
Prevalence of depression among persons with HIV (PWH)	34.7%	DiPrete et al., 2019
Probability of diagnosis of depression	45% among all PWH (SQ scenario) 45% among unaware PWH (EDC scenario)	Pence et al., 2012
	100% among aware PWH (EDC scenario)	Assumption
Probability of treatment for depression among those depressed	55.3% among all PWH (SQ scenario) 55.3% among unaware PWH (EDC scenario)	DiPrete et al., 2019
	100% among aware PWH (EDC scenario)	Assumption
Probability of remission from depression for those getting treatment	33% among all PWH (SQ scenario) 33% among unaware PWH (EDC scenario)	DiPrete et al., 2019
	50% among aware PWH (EDC scenario)	Gaynes, Rush et al, 2008
Risk ratio of viral non-suppression for PWH-D for whom treatment may be indicated relative to PWH without depression	1.57	Lesko et al., 2020
Risk ratio of viral non-suppression for PWH-D who achieved remission from depression due to adequate treatment relative to PWH without depression	0.95	Lesko et al., 2020
HIV Parameters		
Baseline drop-out probability	3% (Base Case)	
	5% (Least favorable Scenario) 1% (Most favorable Scenario)	Bingham et al. 2021
Median diagnosis delay	3 years (Base Case)	
	5 years (Least favorable Scenario) 1 year (Most Favorable Scenario)	Bingham et al. 2021

Table 2:

Relative difference in the proportion of persons who have achieved VLS in the EDC scenario compared to the SQ -- adapted Progression and Transmission of HIV (PATH 3.0) model

	All PWH			PWH-D		
	% VLS in 2025 : SQ	**% VLS in 2025: EDC**	**% Difference in proportion of PWH that are VLS (average over 2016 through 2025)**	**% VLS in 2025: SQ**	**%VLS in 2025: EDC**	**% Difference in proportion of PWH-D that are VLS (average over 2016 through 2025**
Base Case	64.2% (63.7 – 64.6)	67.1% (66.7–67.4)	4.7% (3.4–6.0)	54.0% (53.1–54.5)	61.7% (61.0–62.6)	14.6% (11.5–18.5)
Least Favorable	48.6% (47.9–49.1)	51.6% (51.1–52.4)	5.7% (3.5–7.8)	40.4% (39.2–41.6)	47.9% (47.3–48.8)	18.0% (13.7–23.0)
Most favorable	80.6% (80.3–81.1)	83.5% (83.2–83.9)	3.5% (2.4–4.5)	68.0% (67.6–68.9)	76.2% (75.7–76.7)	11.4% (8.9–14.1)

*The average baseline percentage VLS in 2015 was 51.2% for all PWH, and 40.7% among those with depression, for all three HIV care continuum parameter scenarios (base case, least favorable, and most favorable).

**Results presented are mean (and ranges) across 10 runs.