Supplementary Information

Supplement to

A Modeling Study of Pre-exposure Prophylaxis to Eliminate HIV in Taiwan by 2030

Huei-Jiuan Wu, Ya-Ping Cheng, Yi-Hsuan Chen, Chia-Chen Chang, Tung Lo, Chi-Tai Fang

Supplementary Information

Supplementary Figures

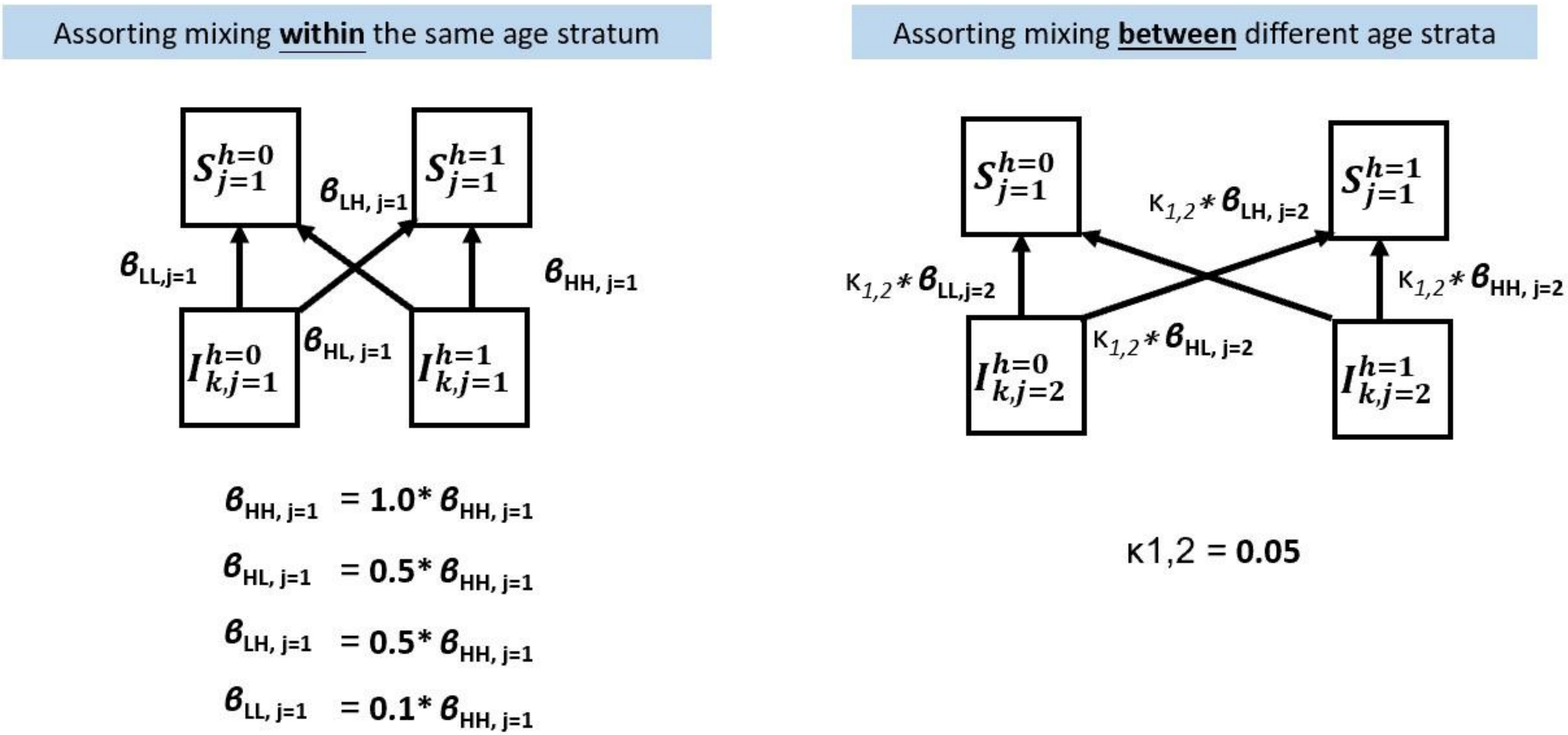
Supplementary Tables

Supplementary Notes

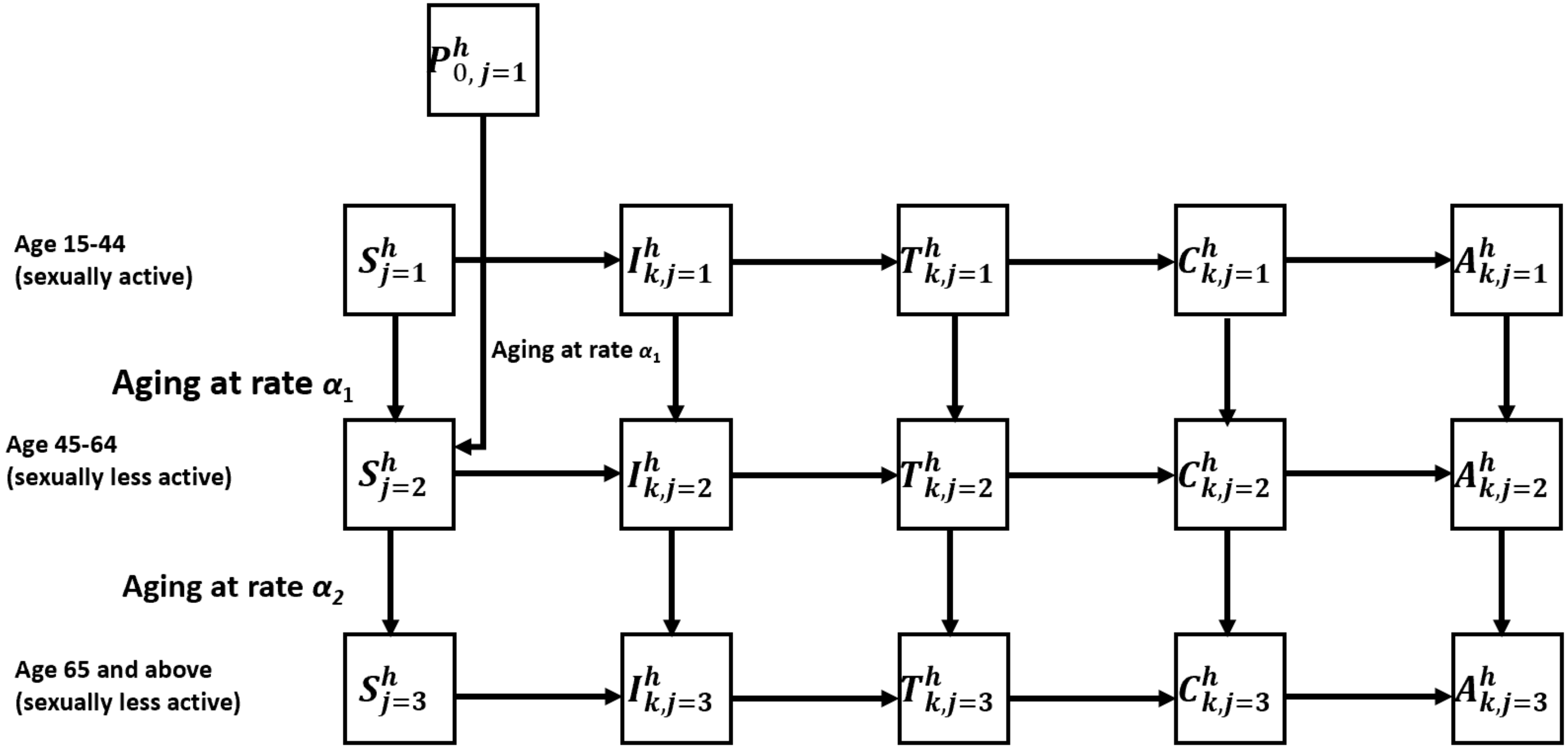
Supplementary References

Supplementary Figure 1. **Schematic diagram of the deterministic model**

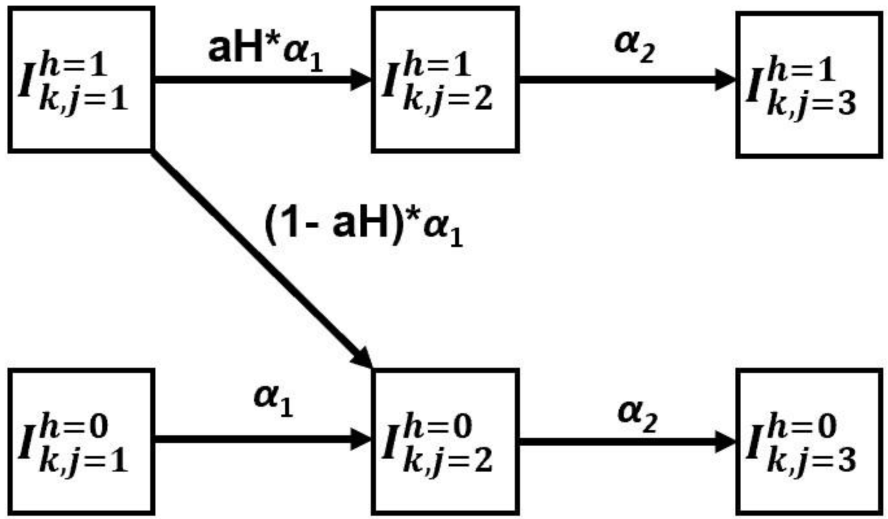
(A) **Risk structure and age structure with assortative mixing**. The model assumes host heterogeneity with risk structure (marked by superscript h, h=1 for high-risk group, h=0 for low-risk group) with assortative mixing with the same age straum (left panel, using 15-44 years old age stratum as an example) and age structure (marked by subscript j, j=1 for 15-44 years, j=2 for 45-64 years, and j=3 for ≥65 years) with assortative mixing between different age strata (righ panel, using 15-44 years and 45-64 years age groups as an example). β_{HH}, β_{HL}, β_{LH}, and β_{LL} are transmission coefficients between risk groups. κ is the ratio of assortative mixing between age strata. Subscript k indicates stage of HIV infection (Figure 1).



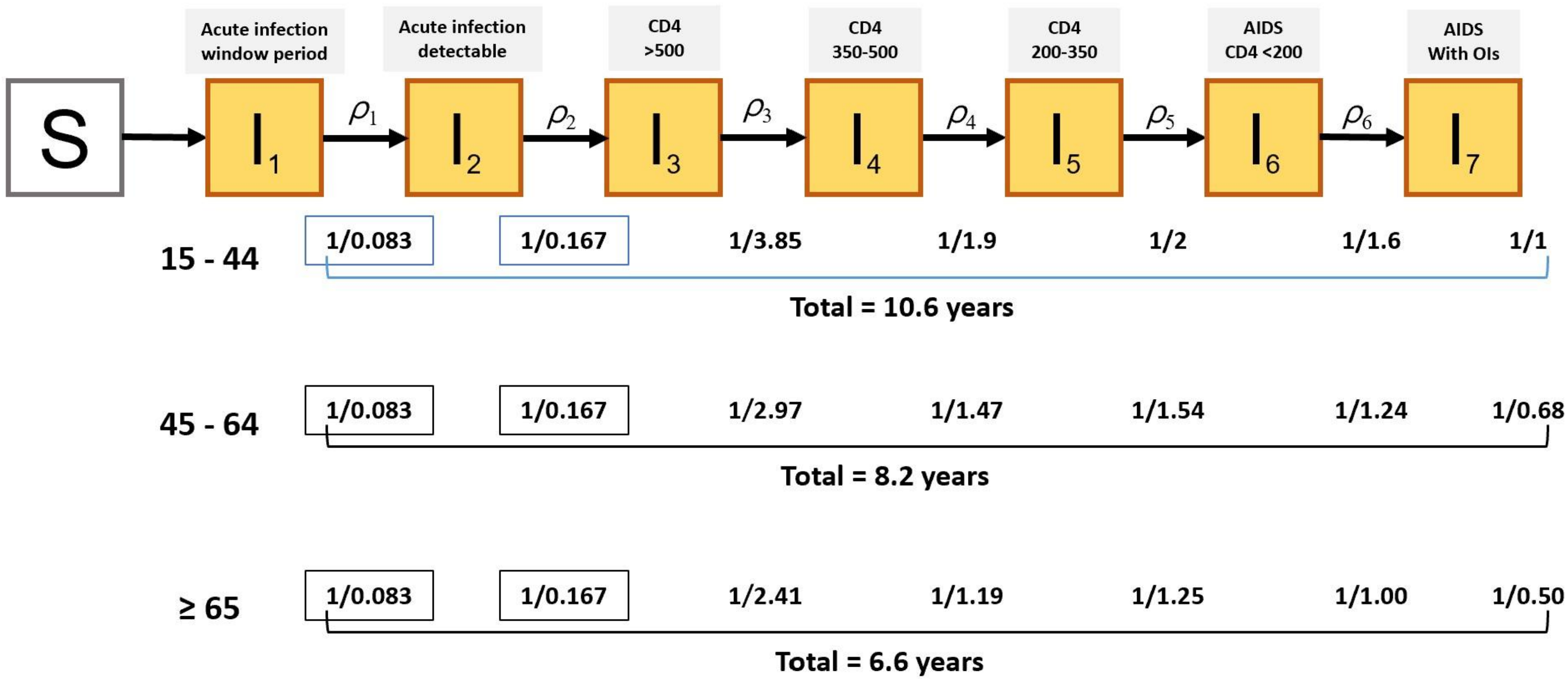
(B) **Progression of people into older age classes.** Individuals in a compartment (Figure 1, subcript k indicates the stage of HIV infection,) of a risk group (using high-risk group, marked with superscript h, as an example) progress iinto the corresponding compartment in the same risk group of increasing older age strata (j=1 for 15-44 years, j=2 for 45-64 years, and j=3 for ≥65 years) at rates α_1 and α_2, respectively. The model assumes that preexposure prophylaxis (PrEP) is only provided to young high-risk men who have sex with men aged 15-44 years. When PrEP users reach 45 years old, they will stop to get PrEP and progress to the susceptible compartment in the 45-64 years age stratum.



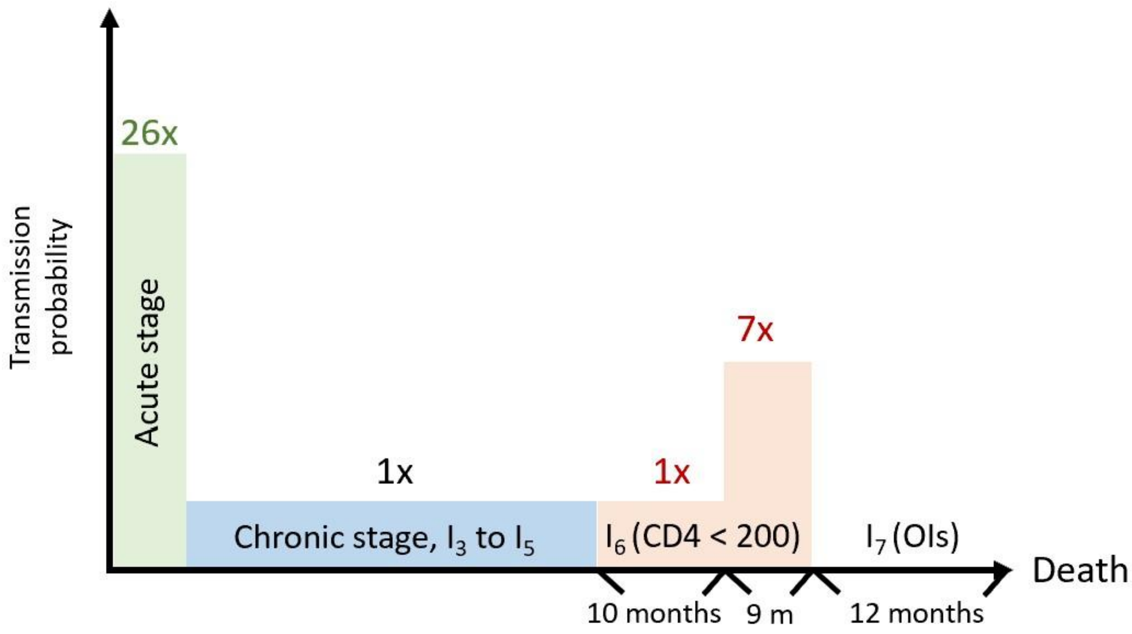
(C) **Aging of risk structure.** The model assumes that only a proportion, aH, of young high-risk men who have sex with men aged 15-44 years will still stay at high-risk group when progress to less-sexually-active 45-64 years age stratum (using I, the infectious but undiagnosed compartment as an example, superscript h=1 for high-risk group, h=0 for low-risk group, subcript k for different stages of HIV infection as illustrated in Figure 1, and subscript j=1 for 15-44 years, j=2 for 45-64 years, and j=3 for ≥65 years). The model assumes that individuals aged 45-64 years will stay in the same risk groups when they progress to ≥65 years age stratum.



Supplementary Figure 2. **Natural history of HIV infection**. The disease progression rates, ρ1 - ρ6, are represented as the reciprocal of the mean duration (in years) that patients remain in an HIV stage prior to progression, for individuals aged 15-44 years, are based on Longini et al.[1]. For individuals aged 45-64 years, and individuals aged 65 years and older, the disease progression rates are derived from the hazard ratios between age strata in HIV disease progression as reported by Veugelers et al.[2].



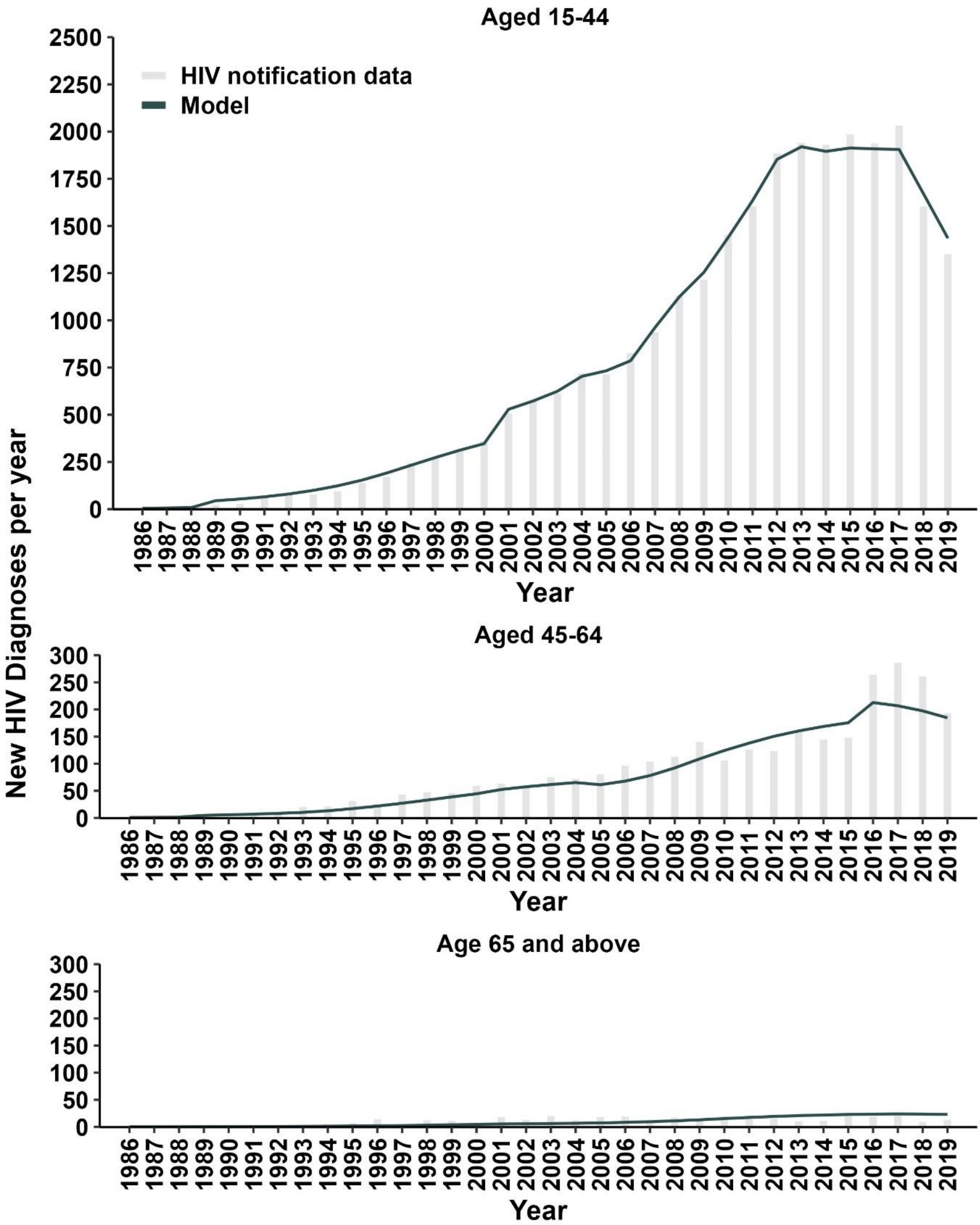
Supplementary Figure 3. **Infectiousness of HIV infection, by stage.** Increased infectiousness during acute HIV infection I_1-I_2 and AIDS stage I_6 (with CD4 count <200 cells/mm³ but without any opportunistic infections) are based on the work of Hollinworth et al.[3]. The model assumes that no HIV transmissions occur during stage I_7 (AIDS, after the onset of opportunistic infections), as the untreated patients became too ill to have sexual behaviors. OIs: opportunistic infections.



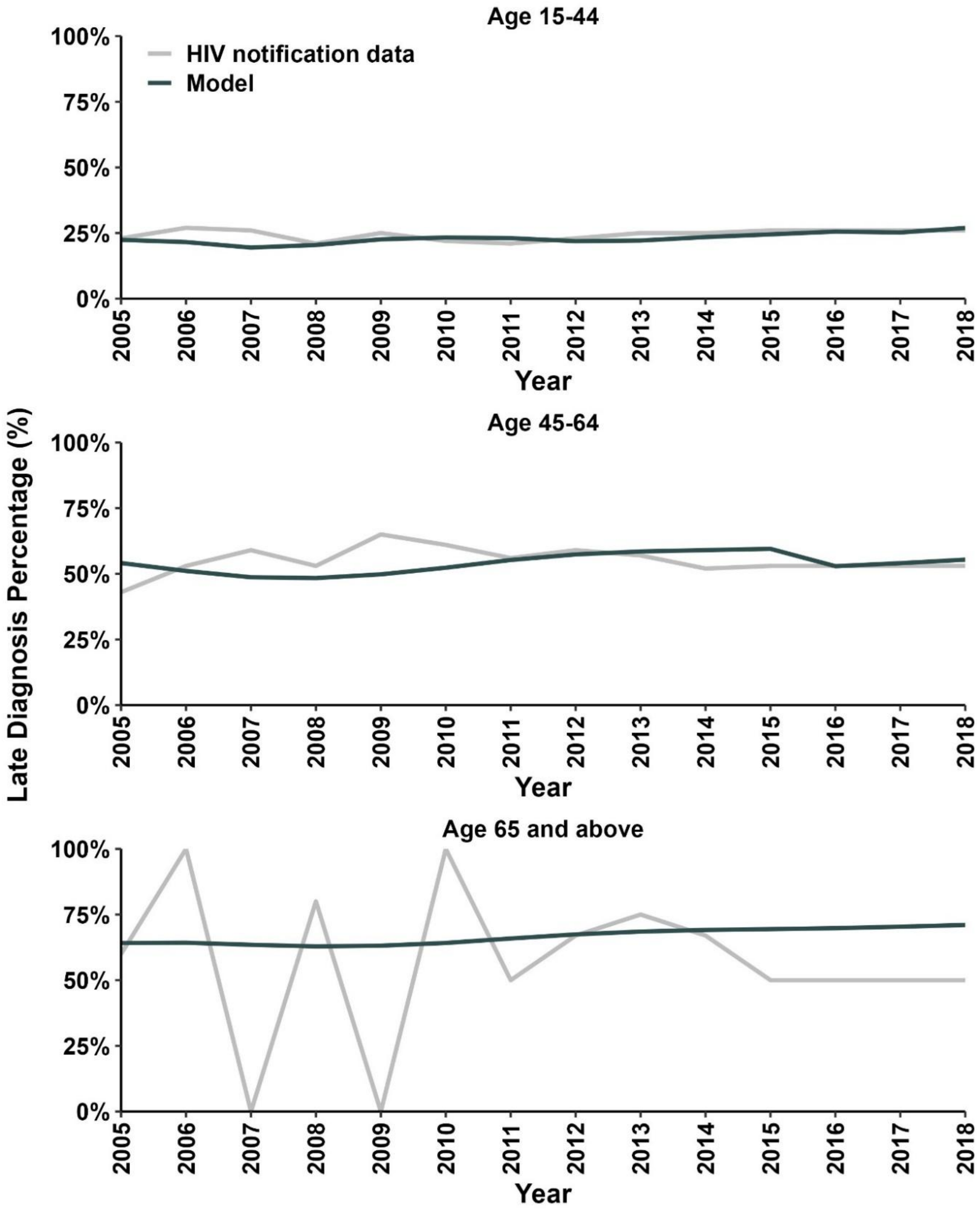
Weighted HIV transmission probability in I_6 stage

$$= [1 \times (\frac{10}{10+9})] + [7 \times (\frac{9}{10+9})] = 3.8 \fallingdotseq 4$$

Supplementary Figure 4. **The HIV epidemic among men who have sex with men (MSM) in Taiwan, 1990 to 2019, by age strata (15-44 years, 45-64 years, and ≥65 years).** HIV notification data are presented in bars; model fitting are presented in lines. Refer to the Methods section and the footnote of Figure 2, for details in model fitting.

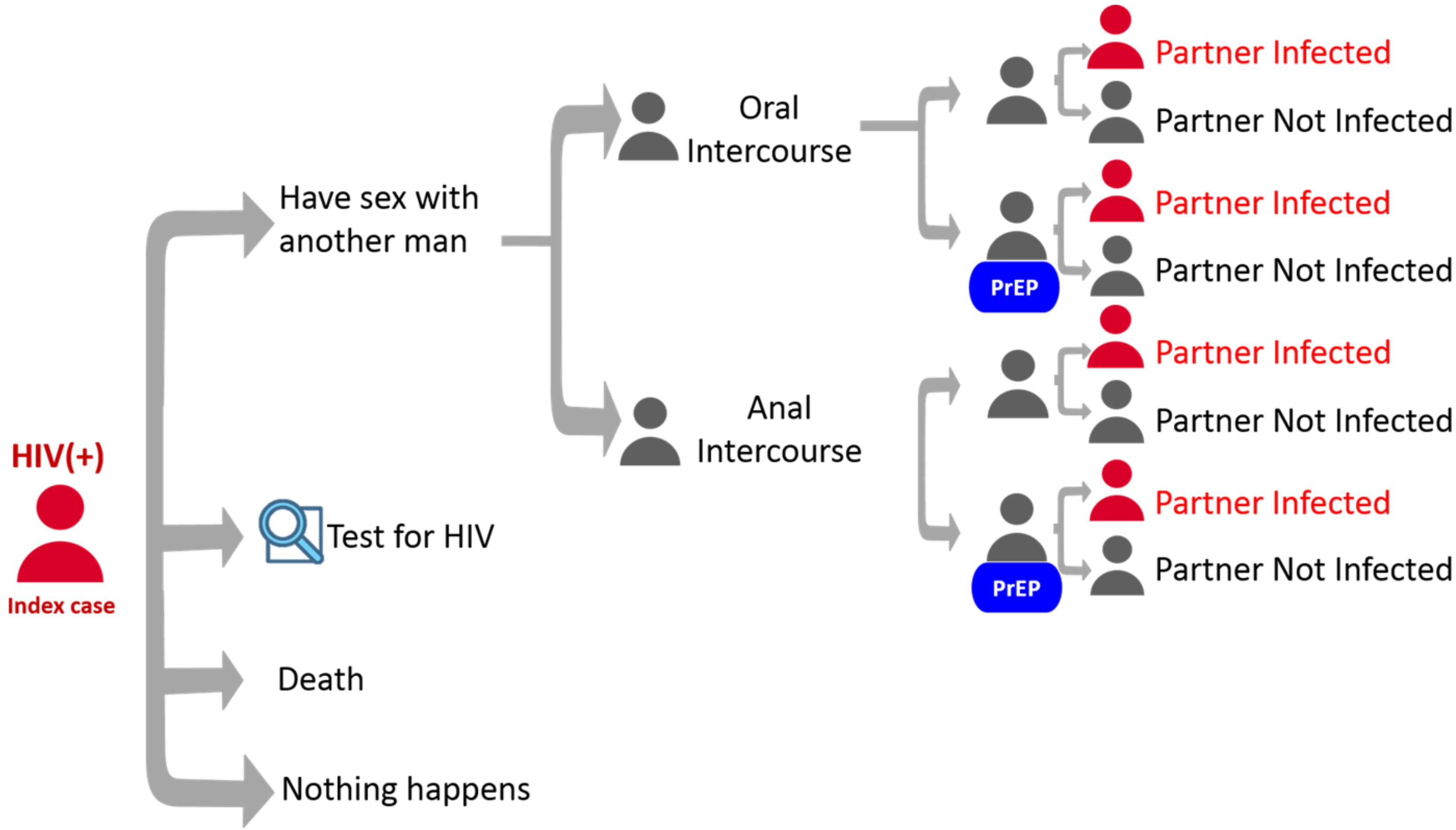


Supplementary Figure 5. **Real-world and model predicted percentages of late diagnoses among new HIV cases in Taiwan from 2005 to 2018, by age strata (15-44 years, 45-64 years, and ≥65 years)** under the status quo scenario. The real-world and model-predicted percentages of late diagnoses among total new HIV cases from 2005 to 2018 are identical within each age stratum.

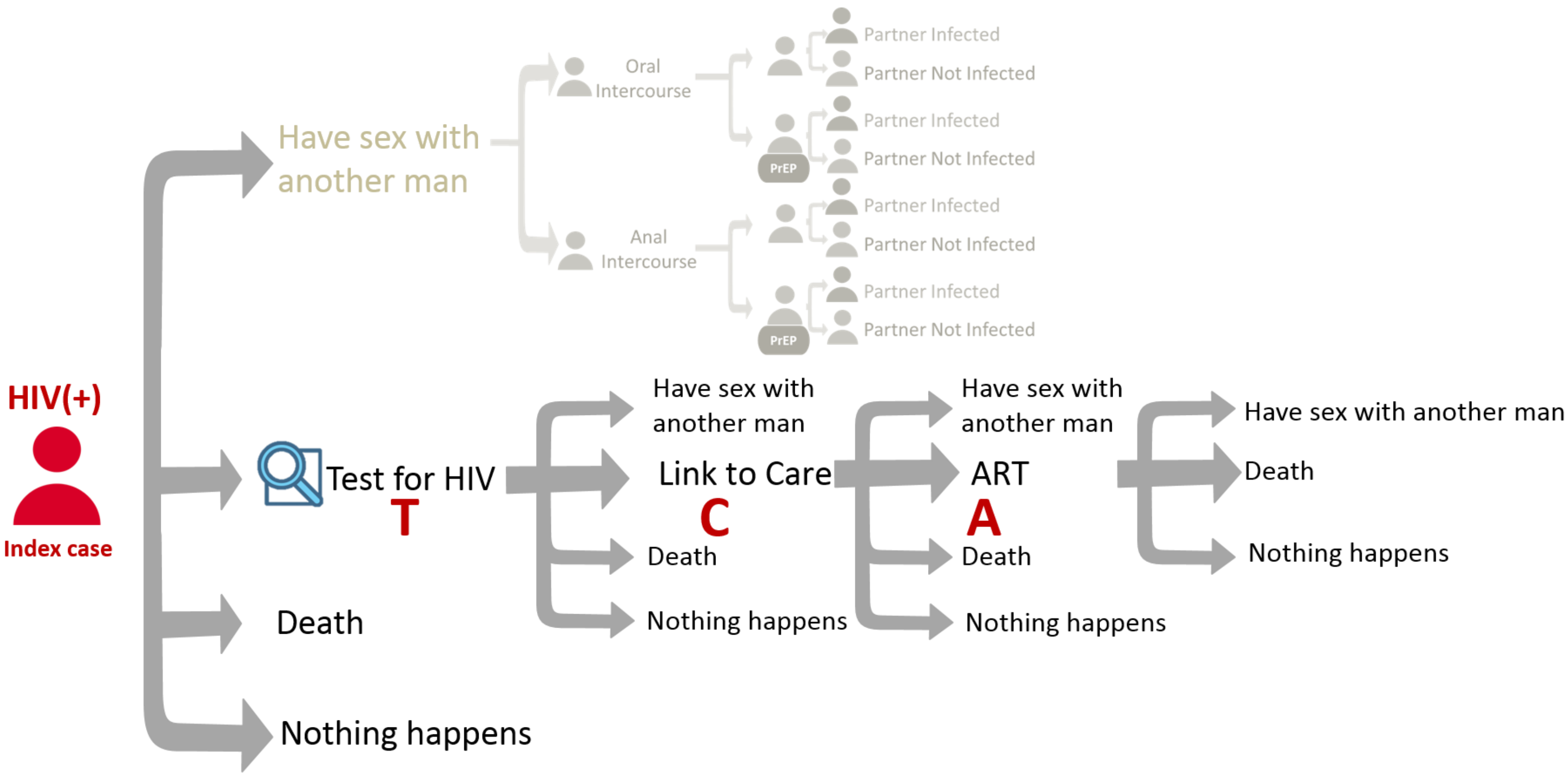


Supplementary Figure 6. **Schematic diagram of the stochastic model**

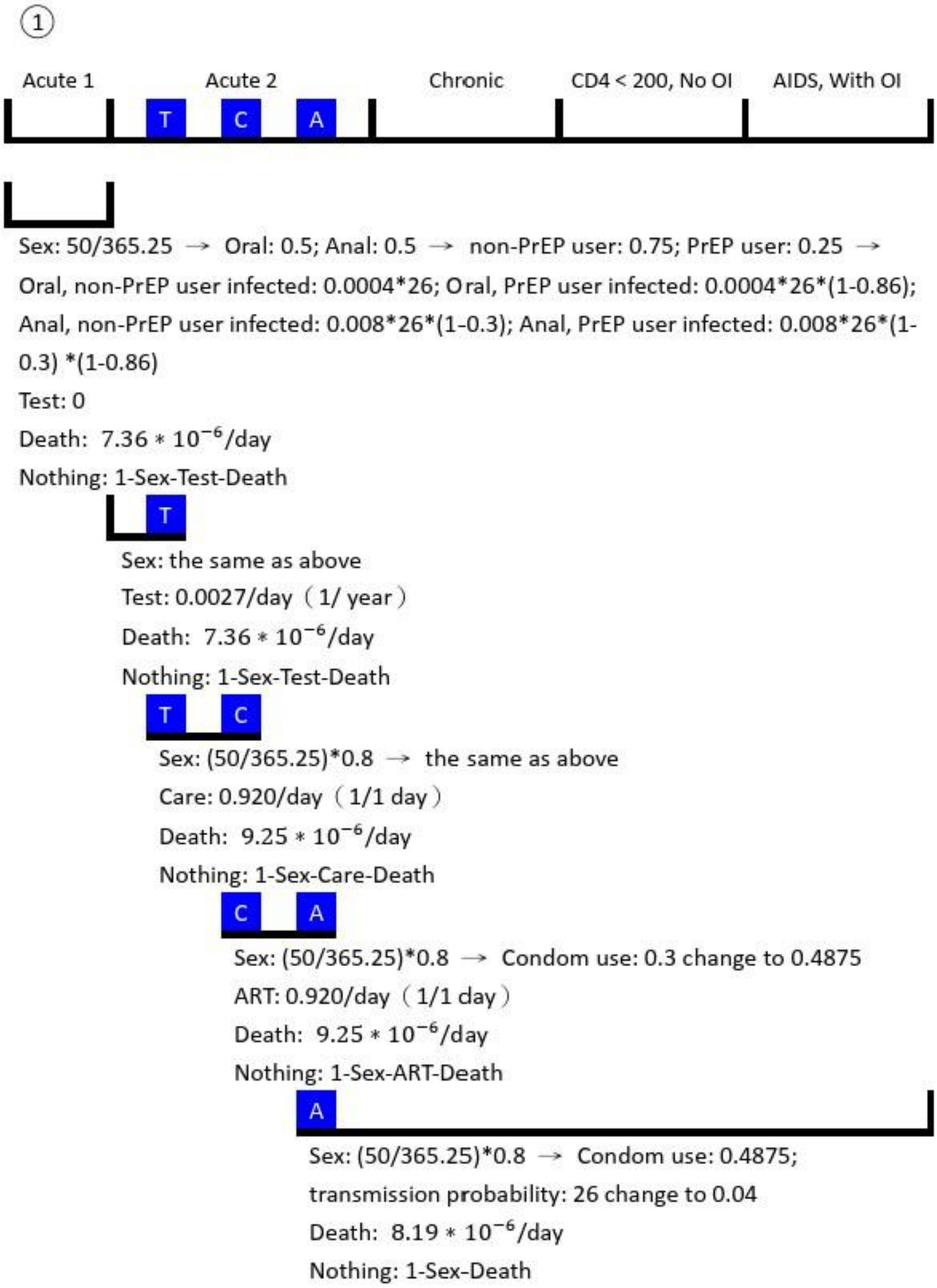
(A) **Prior to testing HIV-positive**: PrEP: pre-exposure prophylaxis



(B) **Following a positive HIV test**: T: test for HIV; C: linkage to care; A: initiation of antiretroviral therapy (ART)



Supplementary Figure 7. **The 35 scenarios for HIV testing, linkage to care, and initiation of antiretroviral therapy (ART), either occurring or not at various HIV stages**. T: testing for HIV; C: linkage to care; A: initiation of ART; Acute 1: the window period; OI: opportunistic infections. See Supplementary Figure 3 for the HIV stages. This example assumes a scenario with 50 sexual partners per year, a 26-fold higher infectiousness of the acute stage compared to chronic HIV infection, a pre-exposure prophylaxis (PrEP) coverage rate of 25%, and annual HIV testing followed by immediate ART initiatio.



②

Sex: 50/365.25 → Oral: 0.5; Anal: 0.5 → non-PrEP user: 0.75; PrEP user: 0.25 → Oral, non-PrEP user infected: 0.0004*26; Oral, PrEP user infected: 0.0004*26*(1-0.86); Anal, non-PrEP user infected: 0.008*26*(1-0.3); Anal, PrEP user infected: 0.008*26*(1-0.3) *(1-0.86)

Test: 0

Death: $7.36 * 10^{-6}$/day

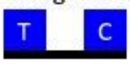
Nothing: 1-Sex-Test-Death

Sex: the same as above

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death



Sex: (50/365.25)*0.8 → the same as above

Care: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-Care-Death

Sex: (50/365.25)*0.8 → Condom use: 0.3 change to 0.4875

ART: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-ART-Death

Sex: (50/365.25)*0.8 → Condom use: 0.4875;

transmission probability: 26 change to 1

ART: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-ART-Death

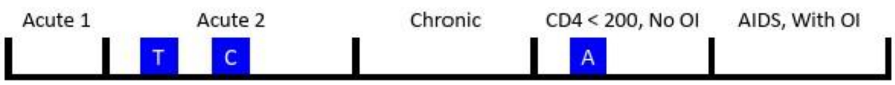
Sex: (50/365.25)*0.8 → Condom use: 0.4875;

transmission probability: 1 change to 0.04

Death: $8.19 * 10^{-6}$/day

Nothing: 1-Sex-Death

③



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ART: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-ART-Death

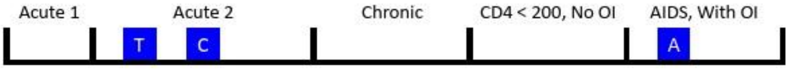
A

Sex: (50/365.25)*0.8 → Condom use: 0.4875; transmission probability: 4 change to 0.04

Death: $8.19 * 10^{-6}$/day

Nothing: 1-Sex-Death

④



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ART: 0.920/day（1/1 day）

Nothing: 1-Sex-ART

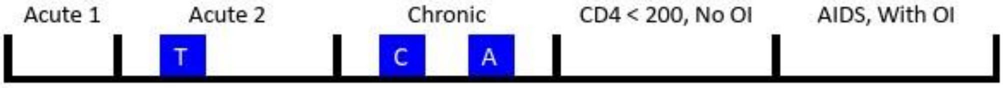
A

Sex: (50/365.25)*0.8 →
Condom use: 0.4875;
transmission probability: 0.04

Death: $4.44 * 10^{-5}$/day

Nothing: 1-Sex-Death

⑤



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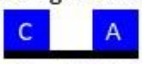


Sex: (50/365.25)*0.8 → Condom use: 0.3 change to 0.4875; transmission probability: 1

ART: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

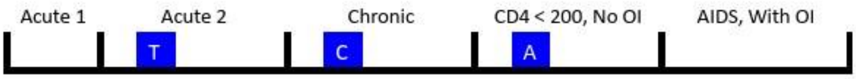
Nothing: 1-Sex-ART-Death

Sex: (50/365.25)*0.8 → Condom use: 0.4875; transmission probability: 0.04

Death: $8.19 * 10^{-6}$/day

Nothing: 1-Sex-Death

⑥



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ART: 0.920/day（1/1 day）

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Nothing: 1-Sex-ART-Death

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Sex: (50/365.25)*0.8 → Condom use: 0.4875; transmission probability: 1 change to 4

ART: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-ART-Death

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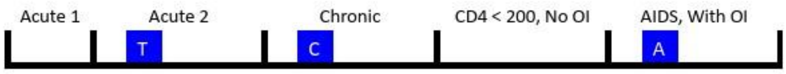
Death: $8.19 * 10^{-6}$/day

Nothing: 1-Sex-Death

⑦



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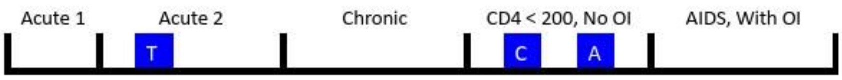
Death: $4.44 * 10^{-5}$/day

Nothing: 1-Sex-Death

⑧



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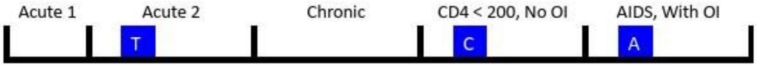
⑨



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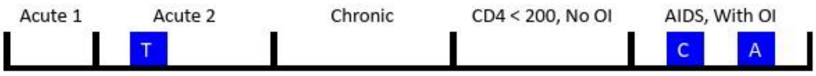
⑩



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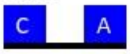


Sex: 0

ART: 0.920/day（1/1 day）

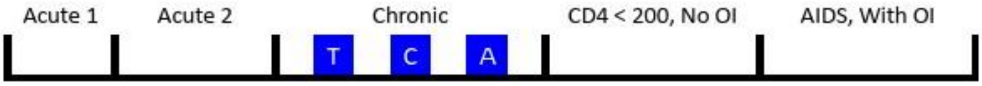
Nothing: 1-Sex-ART

Sex: (50/365.25)*0.8 →
Condom use: 0.4875;
transmission probability: 0.04

Death: $4.44 * 10^{-5}$/day

Nothing: 1-Sex-Death

⑪



Sex: 50/365.25 → Oral: 0.5; Anal: 0.5 → non-PrEP user: 0.75; PrEP user: 0.25 → Oral, non-PrEP user infected: 0.0004*26; Oral, PrEP user infected: 0.0004*26*(1-0.86); Anal, non-PrEP user infected: 0.008*26*(1-0.3); Anal, PrEP user infected: 0.008*26*(1-0.3) *(1-0.86)

Test: 0

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: the same as above

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

T

Sex: 50/365.25 → transmission probability: 26 change to 1

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

T C

Sex: (50/365.25)*0.8 → transmission probability: 1

Care: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-Care-Death

C A

Sex: (50/365.25)*0.8 → Condom use: 0.3 change to 0.4875; transmission probability: 1

ART: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-ART-Death

A

Sex: (50/365.25)*0.8 → Condom use: 0.4875; transmission probability: 0.04

Death: $8.19 * 10^{-6}$/day

Nothing: 1-Sex-Death

⑫

Sex: 50/365.25 → Oral: 0.5; Anal: 0.5 → non-PrEP user: 0.75; PrEP user: 0.25 → Oral, non-PrEP user infected: 0.0004*26; Oral, PrEP user infected: 0.0004*26*(1-0.86); Anal, non-PrEP user infected: 0.008*26*(1-0.3); Anal, PrEP user infected: 0.008*26*(1-0.3) *(1-0.86)

Test: 0

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: the same as above

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

T

Sex: 50/365.25 → transmission probability: 26 change to 1

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

T C

Sex: (50/365.25)*0.8 → transmission probability: 1

Care: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-Care-Death

C

Sex: (50/365.25)*0.8 → Condom use: 0.3 change to 0.4875; transmission probability: 1

ART: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-ART-Death

A

Sex: (50/365.25)*0.8 → Condom use: 0.4875; transmission probability: 1 change to 4

ART: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-ART-Death

A

Sex: (50/365.25)*0.8 → Condom use: 0.4875; transmission probability: 0.04

Death: $8.19 * 10^{-6}$/day

Nothing: 1-Sex-Death

⑬

Sex: 50/365.25 → Oral: 0.5; Anal: 0.5 → non-PrEP user: 0.75; PrEP user: 0.25 → Oral, non-PrEP user infected: 0.0004*26; Oral, PrEP user infected: 0.0004*26*(1-0.86); Anal, non-PrEP user infected: 0.008*26*(1-0.3); Anal, PrEP user infected: 0.008*26*(1-0.3) *(1-0.86)

Test: 0

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: the same as above

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: 50/365.25 → transmission probability: 26 change to 1

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

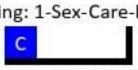
Nothing: 1-Sex-Test-Death

Sex: (50/365.25)*0.8 → transmission probability: 1

Care: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-Care-Death



Sex: (50/365.25)*0.8 → Condom use: 0.3 change to 0.4875; transmission probability: 1

ART: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-ART-Death

Sex: (50/365.25)*0.8 → Condom use: 0.4875; transmission probability: 1 change to 4

ART: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-ART-Death

Sex: 0

ART: 0.920/day（1/1 day）

Nothing: 1-Sex-ART

Sex: (50/365.25)*0.8 → Condom use: 0.4875; transmission probability: 0.04

Death: $4.44 * 10^{-5}$/day

Nothing: 1-Sex-Death

⑭

Sex: 50/365.25 → Oral: 0.5; Anal: 0.5 → non-PrEP user: 0.75; PrEP user: 0.25 → Oral, non-PrEP user infected: 0.0004*26; Oral, PrEP user infected: 0.0004*26*(1-0.86); Anal, non-PrEP user infected: 0.008*26*(1-0.3); Anal, PrEP user infected: 0.008*26*(1-0.3) *(1-0.86)

Test: 0

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: the same as above

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

T

Sex: 50/365.25 → transmission probability: 26 change to 1

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

T

Sex: (50/365.25)*0.8 → transmission probability: 1

Care: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-Care-Death

C

Sex: (50/365.25)*0.8 → transmission probability: 1 change to 4

Care: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-Care-Death

C A

Sex: (50/365.25)*0.8 → Condom use: 0.3 change to 0.4875; transmission probability: 4

ART: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-ART-Death

A

Sex: (50/365.25)*0.8 → Condom use: 0.4875; transmission probability: 0.04

Death: $8.19 * 10^{-6}$/day

Nothing: 1-Sex-Death

15

Sex: 50/365.25 → Oral: 0.5; Anal: 0.5 → non-PrEP user: 0.75; PrEP user: 0.25 → Oral, non-PrEP user infected: 0.0004*26; Oral, PrEP user infected: 0.0004*26*(1-0.86); Anal, non-PrEP user infected: 0.008*26*(1-0.3); Anal, PrEP user infected: 0.008*26*(1-0.3) *(1-0.86)

Test: 0

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: the same as above

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: 50/365.25 → transmission probability: 26 change to 1

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: (50/365.25)*0.8 → transmission probability: 1

Care: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-Care-Death

Sex: (50/365.25)*0.8 → transmission probability: 1 change to 4

Care: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-Care-Death

Sex: (50/365.25)*0.8 → Condom use: 0.3 change to 0.4875; transmission probability: 4

ART: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-ART-Death

Sex: 0

ART: 0.920/day（1/1 day）

Nothing: 1-Sex-ART

Sex: (50/365.25)*0.8 → Condom use: 0.4875; transmission probability: 0.04

Death: $4.44 * 10^{-5}$/day

Nothing: 1-Sex-Death

⑯

Sex: 50/365.25 → Oral: 0.5; Anal: 0.5 → non-PrEP user: 0.75; PrEP user: 0.25 → Oral, non-PrEP user infected: 0.0004*26; Oral, PrEP user infected: 0.0004*26*(1-0.86); Anal, non-PrEP user infected: 0.008*26*(1-0.3); Anal, PrEP user infected: 0.008*26*(1-0.3) *(1-0.86)

Test: 0

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: the same as above

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

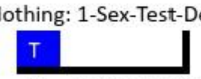
Nothing: 1-Sex-Test-Death

Sex: 50/365.25 → transmission probability: 26 change to 1

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death



Sex: (50/365.25)*0.8 → transmission probability: 1

Care: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-Care-Death

Sex: (50/365.25)*0.8 → transmission probability: 1 change to 4

Care: 0.920/day（1/1 day）

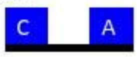
Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-Care-Death

Sex: 0

Care: 0.920/day（1/1 day）

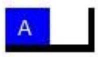
Nothing: 1-Sex-Care



Sex: 0

ART: 0.920/day（1/1 day）

Nothing: 1-Sex-ART



Sex: (50/365.25)*0.8 → Condom use: 0.4875; transmission probability: 0.04

Death: $4.44 * 10^{-5}$/day

Nothing: 1-Sex-Death

⑰

Sex: 50/365.25 → Oral: 0.5; Anal: 0.5 → non-PrEP user: 0.75; PrEP user: 0.25 → Oral, non-PrEP user infected: 0.0004*26; Oral, PrEP user infected: 0.0004*26*(1-0.86); Anal, non-PrEP user infected: 0.008*26*(1-0.3); Anal, PrEP user infected: 0.008*26*(1-0.3) *(1-0.86)

Test: 0

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: the same as above

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: 50/365.25 → transmission probability: 26 change to 1

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: 50/365.25 → transmission probability: 1 change to 4

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

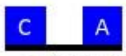
Nothing: 1-Sex-Test-Death

Sex: (50/365.25)*0.8 → transmission probability: 4

Care: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-Care-Death



Sex: (50/365.25)*0.8 → Condom use: 0.3 change to 0.4875; transmission probability: 4

ART: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-ART-Death

Sex: (50/365.25)*0.8 → Condom use: 0.4875; transmission probability: 0.04

Death: $8.19 * 10^{-6}$/day

Nothing: 1-Sex-Death

⑱

Sex: 50/365.25 → Oral: 0.5; Anal: 0.5 → non-PrEP user: 0.75; PrEP user: 0.25 → Oral, non-PrEP user infected: 0.0004*26; Oral, PrEP user infected: 0.0004*26*(1-0.86); Anal, non-PrEP user infected: 0.008*26*(1-0.3); Anal, PrEP user infected: 0.008*26*(1-0.3) *(1-0.86)

Test: 0

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: the same as above

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: 50/365.25 → transmission probability: 26 change to 1

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

T

Sex: 50/365.25 → transmission probability: 1 change to 4

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

T C

Sex: (50/365.25)*0.8 → transmission probability: 4

Care: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-Care-Death

C

Sex: (50/365.25)*0.8 → Condom use: 0.3 change to 0.4875; transmission probability: 4

ART: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-ART-Death

A

Sex: 0

ART: 0.920/day（1/1 day）

Nothing: 1-Sex-ART

A

Sex: (50/365.25)*0.8 → Condom use: 0.4875; transmission probability: 0.04

Death: $4.44 * 10^{-5}$/day

Nothing: 1-Sex-Death

⑲

Sex: 50/365.25 → Oral: 0.5; Anal: 0.5 → non-PrEP user: 0.75; PrEP user: 0.25 → Oral, non-PrEP user infected: 0.0004*26; Oral, PrEP user infected: 0.0004*26*(1-0.86); Anal, non-PrEP user infected: 0.008*26*(1-0.3); Anal, PrEP user infected: 0.008*26*(1-0.3) *(1-0.86)

Test: 0

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: the same as above

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: 50/365.25 → transmission probability: 26 change to 1

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

T

Sex: 50/365.25 → transmission probability: 1 change to 4

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

T

Sex: (50/365.25)*0.8 → transmission probability: 4

Care: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-Care-Death

C

Sex: 0

Care: 0.920/day（1/1 day）

Nothing: 1-Sex-Care

C A

Sex: 0

ART: 0.920/day（1/1 day）

Nothing: 1-Sex-ART

A

Sex: (50/365.25)*0.8 → Condom use: 0.4875; transmission probability: 0.04

Death: $4.44 * 10^{-5}$/day

Nothing: 1-Sex-Death

⑳

Sex: 50/365.25 → Oral: 0.5; Anal: 0.5 → non-PrEP user: 0.75; PrEP user: 0.25 → Oral, non-PrEP user infected: 0.0004*26; Oral, PrEP user infected: 0.0004*26*(1-0.86); Anal, non-PrEP user infected: 0.008*26*(1-0.3); Anal, PrEP user infected: 0.008*26*(1-0.3) *(1-0.86)

Test: 0

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: the same as above

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: 50/365.25 → transmission probability: 26 change to 1

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: 50/365.25 → transmission probability: 1 change to 4

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

T

Sex: 0

Test: 0.0330/day（1/ month）

Nothing: 1-Sex-Test

T C

Sex: 0

Care: 0.920/day（1/1 day）

Nothing: 1-Sex-Care

C A

Sex: 0

ART: 0.920/day（1/1 day）

Nothing: 1-Sex-ART

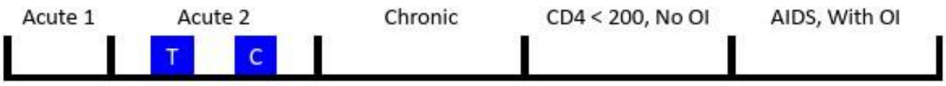
A

Sex: (50/365.25)*0.8 → Condom use: 0.4875; transmission probability: 0.04

Death: $4.44 * 10^{-5}$/day

Nothing: 1-Sex-Death

㉑



Sex: 50/365.25 → Oral: 0.5; Anal: 0.5 → non-PrEP user: 0.75; PrEP user: 0.25 → Oral, non-PrEP user infected: 0.0004*26; Oral, PrEP user infected: 0.0004*26*(1-0.86); Anal, non-PrEP user infected: 0.008*26*(1-0.3); Anal, PrEP user infected: 0.008*26*(1-0.3) *(1-0.86)

Test: 0

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

T

Sex: the same as above

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

T C

Sex: (50/365.25)*0.8 → the same as above

Care: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-Care-Death

C

Sex: (50/365.25)*0.8 → Condom use: 0.3 change to 0.4875

ART: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-ART-Death

Sex: (50/365.25)*0.8 → Condom use: 0.4875; transmission probability: 26 change to 1

ART: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-ART-Death

Sex: (50/365.25)*0.8 → Condom use: 0.4875; transmission probability: 1 change to 4

ART: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

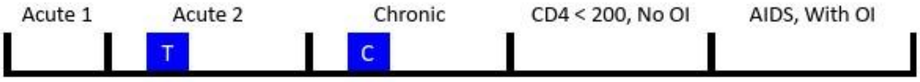
Nothing: 1-Sex-ART-Death

Sex: 0

ART: 0.920/day（1/1 day）

Nothing: 1-Sex-ART

22



Sex: 50/365.25 → Oral: 0.5; Anal: 0.5 → non-PrEP user: 0.75; PrEP user: 0.25 → Oral, non-PrEP user infected: 0.0004*26; Oral, PrEP user infected: 0.0004*26*(1-0.86); Anal, non-PrEP user infected: 0.008*26*(1-0.3); Anal, PrEP user infected: 0.008*26*(1-0.3) *(1-0.86)

Test: 0

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: the same as above

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: (50/365.25)*0.8 → the same as above

Care: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-Care-Death

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Care: 0.920/day（1/1 day）

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ART: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-ART-Death

Sex: (50/365.25)*0.8 → Condom use: 0.4875; transmission probability: 1 change to 4

ART: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

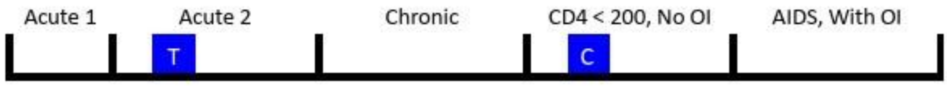
Nothing: 1-Sex-ART-Death

Sex: 0

ART: 0.920/day（1/1 day）

Nothing: 1-Sex-ART

㉓



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Test: 0

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

T

Sex: the same as above

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

T

Sex: (50/365.25)*0.8 → the same as above

Care: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-Care-Death

Sex: (50/365.25)*0.8 → transmission probability: 26 change to 1

Care: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-Care-Death

C

Sex: (50/365.25)*0.8 → transmission probability: 1 change to 4

Care: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-Care-Death

C

Sex: (50/365.25)*0.8 → Condom use: 0.3 change to 0.4875; transmission probability: 4

ART: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

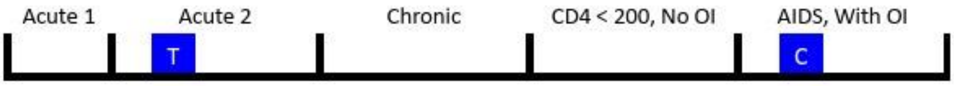
Nothing: 1-Sex-ART-Death

Sex: 0

ART: 0.920/day（1/1 day）

Nothing: 1-Sex-ART

㉔



Sex: 50/365.25 → Oral: 0.5; Anal: 0.5 → non-PrEP user: 0.75; PrEP user: 0.25 →
Oral, non-PrEP user infected: 0.0004*26; Oral, PrEP user infected: 0.0004*26*(1-0.86);
Anal, non-PrEP user infected: 0.008*26*(1-0.3); Anal, PrEP user infected: 0.008*26*(1-0.3) *(1-0.86)

Test: 0

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

T

Sex: the same as above

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

T

Sex: (50/365.25)*0.8 → the same as above

Care: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-Care-Death

Sex: (50/365.25)*0.8 → transmission probability: 26 change to 1

Care: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-Care-Death

Sex: (50/365.25)*0.8 → transmission probability: 1 change to 4

Care: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-Care-Death

C

Sex: 0

Care: 0.920/day（1/1 day）

Nothing: 1-Sex-Care

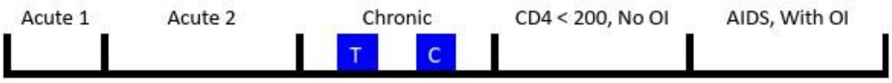
C

Sex: 0

ART: 0.920/day（1/1 day）

Nothing: 1-Sex-ART

25



Sex: 50/365.25 → Oral: 0.5; Anal: 0.5 → non-PrEP user: 0.75; PrEP user: 0.25 → Oral, non-PrEP user infected: 0.0004*26; Oral, PrEP user infected: 0.0004*26*(1-0.86); Anal, non-PrEP user infected: 0.008*26*(1-0.3); Anal, PrEP user infected: 0.008*26*(1-0.3) *(1-0.86)

Test: 0

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: the same as above

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

T

Sex: 50/365.25 → transmission probability: 26 change to 1

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

T C

Sex: (50/365.25)*0.8 → transmission probability: 1

Care: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-Care-Death

C

Sex: (50/365.25)*0.8 → Condom use: 0.3 change to 0.4875; transmission probability: 1

ART: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-ART-Death

Sex: (50/365.25)*0.8 → Condom use: 0.4875; transmission probability: 1 change to 4

ART: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

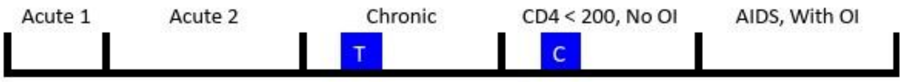
Nothing: 1-Sex-ART-Death

Sex: 0

ART: 0.920/day（1/1 day）

Nothing: 1-Sex-ART

(26)



Sex: 50/365.25 → Oral: 0.5; Anal: 0.5 → non-PrEP user: 0.75; PrEP user: 0.25 → Oral, non-PrEP user infected: 0.0004*26; Oral, PrEP user infected: 0.0004*26*(1-0.86); Anal, non-PrEP user infected: 0.008*26*(1-0.3); Anal, PrEP user infected: 0.008*26*(1-0.3) *(1-0.86)

Test: 0

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: the same as above

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

T

Sex: 50/365.25 → transmission probability: 26 change to 1

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

T

Sex: (50/365.25)*0.8 → transmission probability: 1

Care: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-Care-Death

C

Sex: (50/365.25)*0.8 → transmission probability: 1 change to 4

Care: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-Care-Death

C

Sex: (50/365.25)*0.8 → Condom use: 0.3 change to 0.4875; transmission probability: 4

ART: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

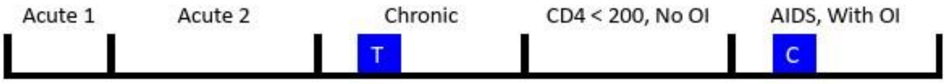
Nothing: 1-Sex-ART-Death

Sex: 0

ART: 0.920/day（1/1 day）

Nothing: 1-Sex-ART

㉗



Sex: 50/365.25 → Oral: 0.5; Anal: 0.5 → non-PrEP user: 0.75; PrEP user: 0.25 → Oral, non-PrEP user infected: 0.0004*26; Oral, PrEP user infected: 0.0004*26*(1-0.86); Anal, non-PrEP user infected: 0.008*26*(1-0.3); Anal, PrEP user infected: 0.008*26*(1-0.3) *(1-0.86)

Test: 0

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: the same as above

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

T

Sex: 50/365.25 → transmission probability: 26 change to 1

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

T

Sex: (50/365.25)*0.8 → transmission probability: 1

Care: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-Care-Death

Sex: (50/365.25)*0.8 → transmission probability: 1 change to 4

Care: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-Care-Death

C

Sex: 0

Care: 0.920/day（1/1 day）

Nothing: 1-Sex-Care

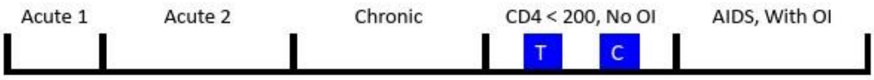
C

Sex: 0

ART: 0.920/day（1/1 day）

Nothing: 1-Sex-ART

㉘



Sex: 50/365.25 → Oral: 0.5; Anal: 0.5 → non-PrEP user: 0.75; PrEP user: 0.25 →
Oral, non-PrEP user infected: 0.0004*26; Oral, PrEP user infected: 0.0004*26*(1-0.86);
Anal, non-PrEP user infected: 0.008*26*(1-0.3); Anal, PrEP user infected: 0.008*26*(1-0.3) *(1-0.86)

Test: 0

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: the same as above

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: 50/365.25 → transmission probability: 26 change to 1

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

T

Sex: 50/365.25 → transmission probability: 1 change to 4

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex- Test-Death

T C

Sex: (50/365.25)*0.8 → transmission probability: 4

Care: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-Care-Death

C

Sex: (50/365.25)*0.8 → Condom use: 0.3 change to 0.4875; transmission probability: 4

ART: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

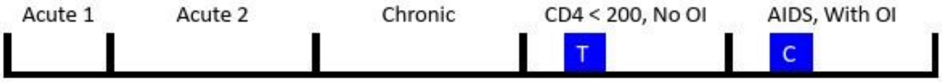
Nothing: 1-Sex-ART-Death

Sex: 0

ART: 0.920/day（1/1 day）

Nothing: 1-Sex-ART

㉙



Sex: 50/365.25 → Oral: 0.5; Anal: 0.5 → non-PrEP user: 0.75; PrEP user: 0.25 →
Oral, non-PrEP user infected: 0.0004*26; Oral, PrEP user infected: 0.0004*26*(1-0.86);
Anal, non-PrEP user infected: 0.008*26*(1-0.3); Anal, PrEP user infected: 0.008*26*(1-0.3) *(1-0.86)

Test: 0

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: the same as above

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: 50/365.25 → transmission probability: 26 change to 1

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

T

Sex: 50/365.25 → transmission probability: 1 change to 4

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex- Test-Death

T

Sex: (50/365.25)*0.8 → transmission probability: 4

Care: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-Care-Death

C

Sex: 0

Care: 0.920/day（1/1 day）

Nothing: 1-Sex-Care

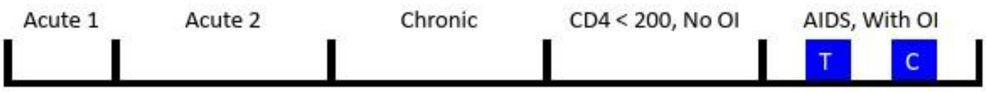
C

Sex: 0

ART: 0.920/day（1/1 day）

Nothing: 1-Sex-ART

㉚



Sex: 50/365.25 → Oral: 0.5; Anal: 0.5 → non-PrEP user: 0.75; PrEP user: 0.25 →
Oral, non-PrEP user infected: 0.0004*26; Oral, PrEP user infected: 0.0004*26*(1-0.86); Anal, non-PrEP user infected: 0.008*26*(1-0.3); Anal, PrEP user infected: 0.008*26*(1-0.3) *(1-0.86)

Test: 0

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: the same as above

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: 50/365.25 → transmission probability: 26 change to 1

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: 50/365.25 → transmission probability: 1 change to 4

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex- Test-Death

T

Sex: 0

Test: 0.0330/day（1/ month）

Nothing: 1-Sex-Test

T C

Sex: 0

Care: 0.920/day（1/1 day）

Nothing: 1-Sex-Care

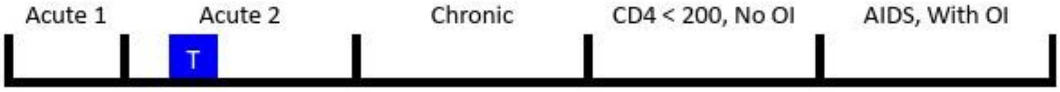
C

Sex: 0

ART: 0.920/day（1/1 day）

Nothing: 1-Sex-ART

(31)



Sex: 50/365.25 → Oral: 0.5; Anal: 0.5 → non-PrEP user: 0.75; PrEP user: 0.25 →
Oral, non-PrEP user infected: 0.0004*26; Oral, PrEP user infected: 0.0004*26*(1-0.86);
Anal, non-PrEP user infected: 0.008*26*(1-0.3); Anal, PrEP user infected: 0.008*26*(1-0.3) *(1-0.86)

Test: 0

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

T

Sex: the same as above

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

T

Sex: (50/365.25)*0.8 → the same as above

Care: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-Care-Death

Sex: (50/365.25)*0.8 → transmission probability: 26 change to 1

Care: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-Care-Death

Sex: (50/365.25)*0.8 → transmission probability: 1 change to 4

Care: 0.920/day（1/1 day）

Death: $9.25 * 10^{-6}$/day

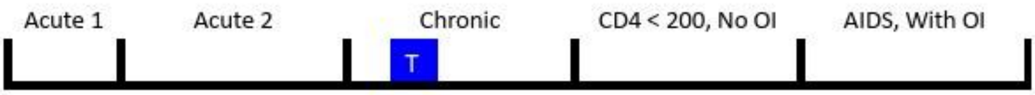
Nothing: 1-Sex-Care-Death

Sex: 0

Care: 0.920/day（1/1 day）

Nothing: 1-Sex-Care

32



Sex: 50/365.25 → Oral: 0.5; Anal: 0.5 → non-PrEP user: 0.75; PrEP user: 0.25 → Oral, non-PrEP user infected: 0.0004*26; Oral, PrEP user infected: 0.0004*26*(1-0.86); Anal, non-PrEP user infected: 0.008*26*(1-0.3); Anal, PrEP user infected: 0.008*26*(1-0.3) *(1-0.86)

Test: 0

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: the same as above

Test: 0.0027/day (1/ year)

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

T

Sex: 50/365.25 → transmission probability: 26 change to 1

Test: 0.0027/day (1/ year)

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

T

Sex: (50/365.25)*0.8 → transmission probability: 1

Care: 0.920/day (1/1 day)

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-Care-Death

Sex: (50/365.25)*0.8 → transmission probability: 1 change to 4

Care: 0.920/day (1/1 day)

Death: $9.25 * 10^{-6}$/day

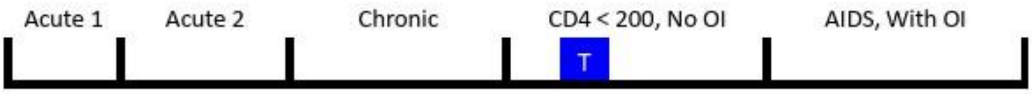
Nothing: 1-Sex-Care-Death

Sex: 0

Care: 0.920/day (1/1 day)

Nothing: 1-Sex-Care

33



Sex: 50/365.25 → Oral: 0.5; Anal: 0.5 → non-PrEP user: 0.75; PrEP user: 0.25 → Oral, non-PrEP user infected: 0.0004*26; Oral, PrEP user infected: 0.0004*26*(1-0.86); Anal, non-PrEP user infected: 0.008*26*(1-0.3); Anal, PrEP user infected: 0.008*26*(1-0.3) *(1-0.86)

Test: 0

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: the same as above

Test: 0.0027/day (1/ year)

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: 50/365.25 → transmission probability: 26 change to 1

Test: 0.0027/day (1/ year)

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

T

Sex: 50/365.25 → transmission probability: 1 change to 4

Test: 0.0027/day (1/ year)

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

T

Sex: (50/365.25)*0.8 → transmission probability: 4

Care: 0.920/day (1/1 day)

Death: $9.25 * 10^{-6}$/day

Nothing: 1-Sex-Care-Death

Sex: 0

Care: 0.920/day (1/1 day)

Nothing: 1-Sex-Care

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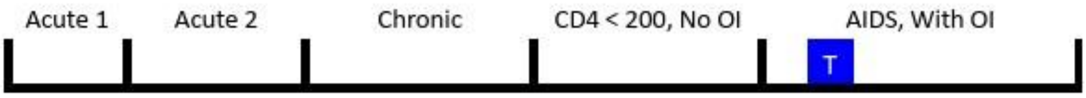


Sex: 50/365.25 → Oral: 0.5; Anal: 0.5 → non-PrEP user: 0.75; PrEP user: 0.25 →
Oral, non-PrEP user infected: 0.0004*26; Oral, PrEP user infected: 0.0004*26*(1-0.86);
Anal, non-PrEP user infected: 0.008*26*(1-0.3); Anal, PrEP user infected: 0.008*26*(1-0.3) *(1-0.86)

Test: 0

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: the same as above

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: 50/365.25 → transmission probability: 26 change to 1

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: 50/365.25 → transmission probability: 1 change to 4

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

T

Sex: 0

Test: 0.0330/day（1/ month）

Nothing: 1-Sex-Test

T

Sex: 0

Care: 0.920/day（1/1 day）

Nothing: 1-Sex-Care

35

Acute 1 | Acute 2 | Chronic | CD4 < 200, No OI | AIDS, With OI

Sex: 50/365.25 → Oral: 0.5; Anal: 0.5 → non-PrEP user: 0.75; PrEP user: 0.25 → Oral, non-PrEP user infected: 0.0004*26; Oral, PrEP user infected: 0.0004*26*(1-0.86); Anal, non-PrEP user infected: 0.008*26*(1-0.3); Anal, PrEP user infected: 0.008*26*(1-0.3) *(1-0.86)

Test: 0

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: the same as above

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: 50/365.25 → transmission probability: 26 change to 1

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

Nothing: 1-Sex-Test-Death

Sex: 50/365.25 → transmission probability: 1 change to 4

Test: 0.0027/day（1/ year）

Death: $7.36 * 10^{-6}$/day

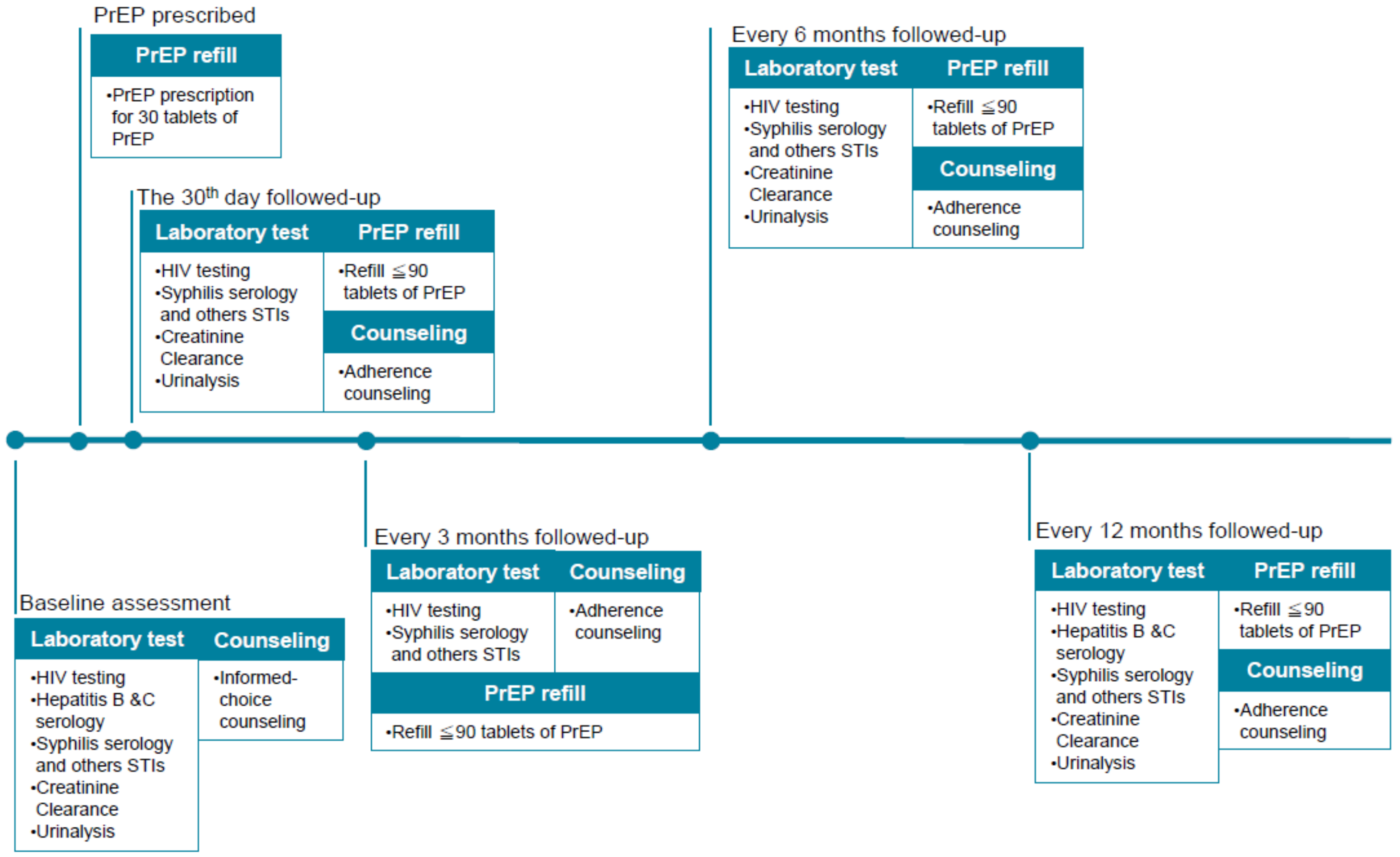
Nothing: 1-Sex-Test-Death

Sex: 0

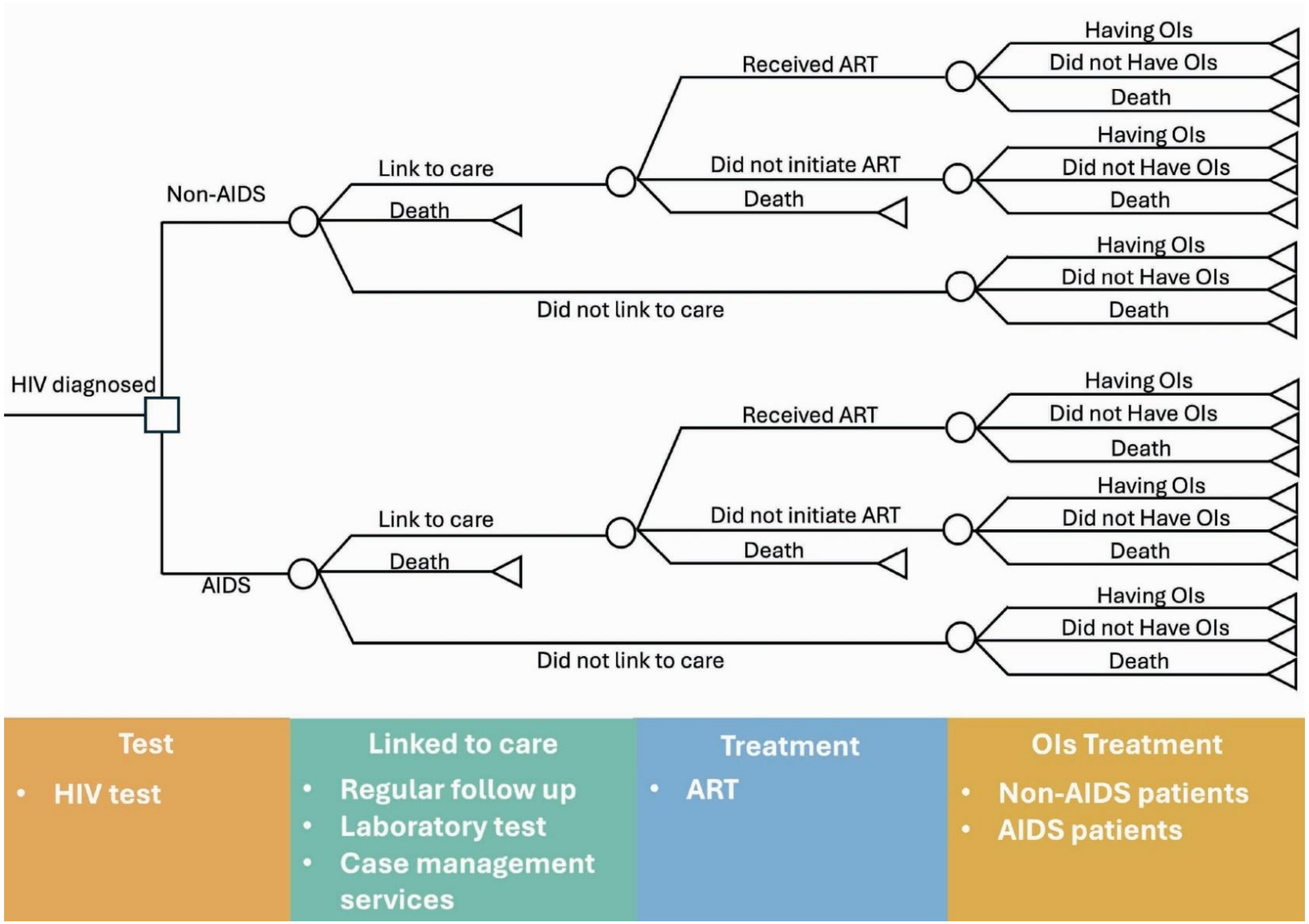
Test: 0.0330/day（1/ month）

Nothing: 1-Sex-Test

Supplementary Figure 8. **Cost structure of pre-exposure prophylaxis (PrEP) program**



Supplementary Figure 9. **Cost structure of HIV-associated medical care**

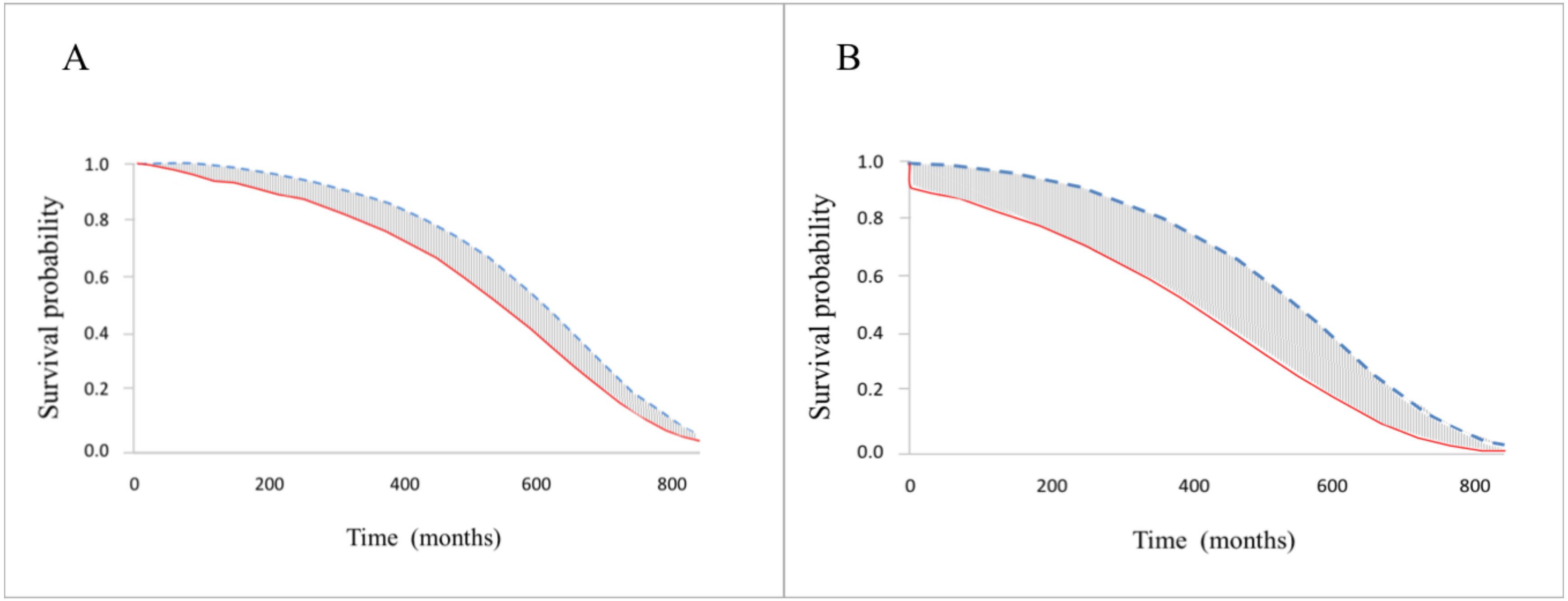


ART, antiretroviral therapy; OI, opportunistic infection

Supplementary Figure 10: **Life time survival curve after HIV diagnosis**. Red curve: survival probability of MSM living with HIV after diagnosis. Blue dash curve: survival probability of age/sex-matched reference population.

(A) Patients without AIDS at diagnosis.

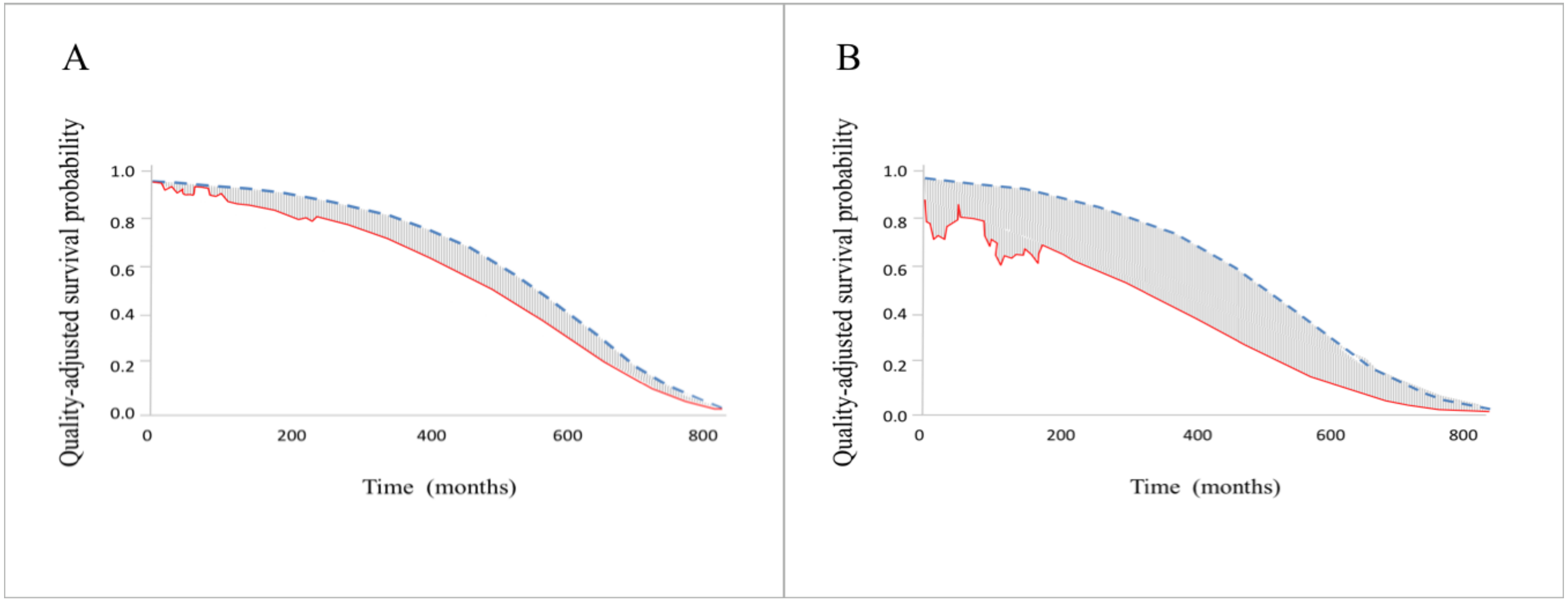
(B) Patient with AIDS at diagnosis



Supplementary Figure 11: **Life time qaulity-adjusted survival curve after HIV diagnosis**. Red curve: Quality-adjusted survival probability of MSM living with HIV after diagnosis; Blue dash curve: Quality-adjusted survival probability of age/sex-matched reference population).

(A) Patients without AIDS at diagnosis.

(B) Patient with AIDS at diagnosis



Supplementary Table 1. **Transmission coefficients, by risk group, between age strata, and across HIV stages in the deterministic model**

Parameter	Description	Value (unit)	Source
$\boldsymbol{\beta}_{\mathbf{HH, j=1}}$	Transmission coefficient within high-risk group in age stratum 15-44 years	1972–1997: 0.0896 ($year^{-1}$) 1997–2001: 0.0896 ($year^{-1}$) 2001–2005: 0.0896–0.0780 ($year^{-1}$) 2005–2009: 0.0780–0.1135 ($year^{-1}$) 2009–2013: 0.1135–0.0980 ($year^{-1}$) 2013–2017: 0.0980–0.1220 ($year^{-1}$) 2017–2019: 0.1220–0.1120 ($year^{-1}$) 2019–2050: 0.1120 ($year^{-1}$)	• Fitting the model to the MSM HIV epidemic curve in Taiwan, 1990 to 2019 by age strata, using the least square method (Supplementary Figure 4). • To account for the trend of changing sexual behaviors over time, the model fitting was separately conducted for each era during which parameters may have increased or decreased linearly: 1990–1997 (before ART), 1997–2001 (introduction of ART), 2001–2005 (impact of the 2003 SARS outbreak in Taiwan), 2005–2009 (rise of internet chat room for sexual partner-seeking), 2009–2013 (rise of mobile apps for sexual partner-seeking), 2013–2017 (chemsex-associated increase in HIV transmisison), and 2017–2019 (status quo), respectively.
$\boldsymbol{\beta}_{\mathbf{HL, j=1}}$ $\boldsymbol{\beta}_{\mathbf{LH, j=1}}$	Transmission coefficients between high-risk group and low-risk group in age stratum 15-44 years	0.5 $\beta_{HH, j=1}$	Ratios between β_{HH}, β_{HL}, β_{LH}, and β_{LL} were set based on data from the EXPLORER Study [4].
$\boldsymbol{\beta}_{\mathbf{LL, j=1}}$	Transmission coefficient within low-risk group in age stratum 15-44 years	0.1 $\beta_{HH, j=1}$	Ratios between β_{HH}, β_{HL}, β_{LH}, and β_{LL} were set based on data from the EXPLORER Study [4].

Parameter	Description	Value (unit)	Source
$\boldsymbol{\beta}_{\mathbf{HH,\ j=2}}$	Transmission coefficient within high-risk group in age stratum 45-64 years	1972–2009: 0.4 $\beta_{\mathrm{HH,\ j=1}}$ 2009–2010: 0.4 $\beta_{\mathrm{HH,\ j=1}}$–$0.4\times10^{-6}$ 2010–2050: 0.4×10^{-6} (year^{-1})	• Fitting the model to the MSM HIV epidemic curve in Taiwan, 1990 to 2019 by age strata, using the least square method (Supplementary Figure 4). • The dissociation of the HIV epidemic between the 15–44 and 45–64 years age strata in 2009-2010 was likely due to the rise of mobile phone platforms for seeking partners, a trend from which older MSM were excluded.
$\boldsymbol{\beta}_{\mathbf{HL,\ j=2}}$ $\boldsymbol{\beta}_{\mathbf{LH,\ j=2}}$	Transmission coefficients between high-risk group and low-risk group in age stratum 45-64 years	0.5 $\beta_{\mathrm{HH,\ j=2}}$	Ratios between β_{HH}, β_{HL}, β_{LH}, and β_{LL} were set based on data from the EXPLORER Study [4].
$\boldsymbol{\beta}_{\mathbf{LL,\ j=2}}$	Transmission coefficient within low-risk group in age stratum 45-64 years	0.1 $\beta_{\mathrm{HH,\ j=2}}$	Ratios between β_{HH}, β_{HL}, β_{LH}, and β_{LL} were set based on data from the EXPLORER Study [4].
$\boldsymbol{\beta}_{\mathbf{HH,\ j=3}}$ $\boldsymbol{\beta}_{\mathbf{HL,\ j=3}}$ $\boldsymbol{\beta}_{\mathbf{LH,\ j=3}}$ $\boldsymbol{\beta}_{\mathbf{LL,\ j=3}}$	Transmission coefficient within and between high-risk group and low-risk group in age stratum ≥65 years We assumed that all MSM in the ≥65 years age stratum had the same low risk. $\beta_{\mathrm{HH\ j=3}} = \beta_{\mathrm{HL\ j=3}} = \beta_{\mathrm{LH\ j=3}} = \beta_{\mathrm{LH\ j=3}}$	1972–2009: 0.01 $\beta_{\mathrm{HH,\ j=1}}$ 2009–2010: 0.01 $\beta_{\mathrm{HH,\ j=1}}$–$0.01\times10^{-6}$ 2010–2050: 0.01×10^{-6} (year^{-1})	• Fitting the model to the MSM HIV epidemic curve in Taiwan, 1990 to 2019 by age strata, using the least square method (Supplementary Figure 4). • The dissociation of the HIV epidemic between the 15–44 and ≥65 years age strata in 2009-2010 was likely due to the rise of mobile phone platforms for seeking partners, a trend from which older MSM were excluded.

Parameter	Description	Value (unit)	Source
κ1,2	Relative risk of cross-age-strata HIV transmission between the 15-44 age stratum and the 45-64 years age stratum	1972–2009: 0.05 2009–2010: 0.05–10^{-6} 2010–2050: 10^{-6}	• Fitting the model to the MSM HIV epidemic curve in Taiwan, 1990 to 2019 by age strata, using the least square method (Supplementary Figure 4). • The decoupling of the HIV epidemic between the 15–44 and 45-64 years age strata in 2009-2010 was likely due to the rise of mobile phone platforms for seeking partners, a trend from which older MSM were excluded.
κ2,3	Relative risk of cross-age-strata HIV transmission between the 45-64 age stratum and the ≥65 years age stratum	0.01	Fitting the model to the MSM HIV epidemic curve in Taiwan, 1990 to 2019 by age strata, using the least square method (Supplementary Figure 4).
κ1,3	Relative risk of cross-age-strata HIV transmission between the 15-44 age stratum and the ≥65 years age stratum	0	We assumed that cross-age-strata HIV transmission between the 15-44 age stratum and the ≥65 years age stratum was negligible.
$\boldsymbol{\lambda_1}$	Relative risk of transmission during acute HIV infection (stage 1 and 2 in Figure 1) in those not receiving ART	26	Hollingsworth et al.[3]
$\boldsymbol{\lambda_2}$	Relative risk of transmission during AIDS stage (CD4 <200/mm^3, without opportunistic infections, stage 6 in Figure 1) in those not receiving ART	4	Hollingsworth et al.[3] Refer to Supplementary Figure 3 for the derivation

Parameter	Description	Value (unit)	Source
$\boldsymbol{\theta}$	Relative risk of HIV transmission during AIDS stage (CD4 <200/mm^3, opportunistic infections have occurred, stage 7 in Figure 1) in those not receiving ART.	0	We assume that no HIV transmissions occur during stage 7 (AIDS, after the onset of opportunistic infections), as the untreated patients became too ill to have sexual behaviors.

Supplementary Table 2. **Mortality rate of MSM living with HIV, by age, period, disease stage, care cascade, and antiretroviral therapy (ART) status in the deterministic model.** We estimated the mortality rate of Taiwanese MSM living with HIV in each compartment through weighting the observed total mortality of MSM HIV patients in the Taiwan HIV registry data [5, 6] by hazard ratios for HIV stage, ART status, age stratum, and time period, as reported by the START study and treatment cohort studies [7, 8, 9, 10, 11, 12], alongside model-estimated proportions of the population in each compartment. We assumed that the mortality rate from 1972 to 1985 was the same as that observed in 1986. We also assumed that mortality from 2016 to 2050 will be the same as that observed in 2015. The data were presented in units of (person-year)$^{-1}$.

1/PY	I1-I3	I4	I5	I6	I7	T1-T3 /C1-C3	T4/C4	T5/C5	T6/C6	T7/C7	A1-A3	A4	A5	A6	A7
Age stratum: 15-44 years															
1972 -1986	0.0087	0.0128	0.0249	0.0464	0.8652	0.0054	0.0079	0.0153	0.0286	0.7312	-	-	-	-	-
1987	0.0087	0.0128	0.0249	0.0464	0.8652	0.0054	0.0079	0.0153	0.0286	0.7312	-	-	-	-	-
1988	0.0087	0.0128	0.0249	0.0464	0.8652	0.0054	0.0079	0.0153	0.0286	0.7312	-	-	-	-	-
1989	0.0087	0.0128	0.0249	0.0464	0.8652	0.0054	0.0079	0.0153	0.0286	0.7312	-	-	-	-	-
1990	0.0087	0.0128	0.0249	0.0464	0.8652	0.0054	0.0079	0.0153	0.0286	0.7312	-	-	-	-	-
1991	0.0087	0.0128	0.0249	0.0464	0.8652	0.0054	0.0079	0.0153	0.0286	0.7312	-	-	-	-	-
1992	0.0087	0.0128	0.0249	0.0464	0.8652	0.0054	0.0079	0.0153	0.0286	0.7312	-	-	-	-	-
1993	0.0087	0.0128	0.0249	0.0464	0.8652	0.0054	0.0079	0.0153	0.0286	0.7312	-	-	-	-	-
1994	0.0087	0.0128	0.0249	0.0464	0.8652	0.0054	0.0079	0.0153	0.0286	0.7312	-	-	-	-	-
1995	0.0087	0.0128	0.0249	0.0464	0.8652	0.0054	0.0079	0.0153	0.0286	0.7312	-	-	-	-	-
1996	0.0087	0.0128	0.0249	0.0464	0.8652	0.0078	0.0114	0.0223	0.0416	0.7759	-	-	-	-	-
1997	0.0078	0.0114	0.0223	0.0416	0.7759	0.0078	0.0114	0.0223	0.0416	0.7759	0.0062	0.0069	0.0089	0.0125	0.1552
1998	0.0078	0.0114	0.0223	0.0416	0.7759	0.0078	0.0114	0.0223	0.0416	0.7759	0.0062	0.0069	0.0089	0.0125	0.1552
1999	0.0078	0.0114	0.0223	0.0416	0.7759	0.0078	0.0114	0.0223	0.0416	0.7759	0.0062	0.0069	0.0089	0.0125	0.1552
2000	0.0078	0.0114	0.0223	0.0416	0.7759	0.0078	0.0114	0.0223	0.0416	0.7759	0.0062	0.0069	0.0089	0.0125	0.1552
2001	0.0078	0.0114	0.0223	0.0416	0.7759	0.0078	0.0114	0.0223	0.0416	0.7759	0.0062	0.0069	0.0089	0.0125	0.1552

1/PY	I1-I3	I4	I5	I6	I7	T1-T3 /C1-C3	T4/C4	T5/C5	T6/C6	T7/C7	A1-A3	A4	A5	A6	A7
2002	0.0072	0.0105	0.0205	0.0383	0.7131	0.0063	0.0092	0.0180	0.0335	0.3629	0.0046	0.0050	0.0065	0.0091	0.0660
2003	0.0072	0.0105	0.0205	0.0383	0.7131	0.0063	0.0092	0.0180	0.0335	0.3629	0.0046	0.0050	0.0065	0.0091	0.0660
2004	0.0072	0.0105	0.0205	0.0383	0.7131	0.0063	0.0092	0.0180	0.0335	0.3629	0.0046	0.0050	0.0065	0.0091	0.0660
2005	0.0072	0.0105	0.0205	0.0383	0.7131	0.0063	0.0092	0.0180	0.0335	0.3629	0.0046	0.0050	0.0065	0.0091	0.0660
2006	0.0072	0.0105	0.0205	0.0383	0.7131	0.0063	0.0092	0.0180	0.0335	0.3629	0.0046	0.0050	0.0065	0.0091	0.0660
2007	0.0062	0.0092	0.0179	0.0333	0.6216	0.0038	0.0056	0.0108	0.0202	0.1831	0.0025	0.0028	0.0036	0.0051	0.0305
2008	0.0062	0.0092	0.0179	0.0333	0.6216	0.0038	0.0056	0.0108	0.0202	0.1831	0.0025	0.0028	0.0036	0.0051	0.0305
2009	0.0062	0.0092	0.0179	0.0333	0.6216	0.0038	0.0056	0.0108	0.0202	0.1831	0.0025	0.0028	0.0036	0.0051	0.0305
2010	0.0062	0.0092	0.0179	0.0333	0.6216	0.0038	0.0056	0.0108	0.0202	0.1831	0.0025	0.0028	0.0036	0.0051	0.0305
2011	0.0062	0.0092	0.0179	0.0333	0.6216	0.0038	0.0056	0.0108	0.0202	0.1831	0.0025	0.0028	0.0036	0.0051	0.0305
2012	0.0053	0.0078	0.0152	0.0283	0.5282	0.0023	0.0034	0.0065	0.0122	0.1203	0.0013	0.0014	0.0019	0.0026	0.0172
2013	0.0053	0.0078	0.0152	0.0283	0.5282	0.0023	0.0034	0.0065	0.0122	0.1203	0.0013	0.0014	0.0019	0.0026	0.0172
2014	0.0053	0.0078	0.0152	0.0283	0.5282	0.0023	0.0034	0.0065	0.0122	0.1203	0.0013	0.0014	0.0019	0.0026	0.0172
2015 -2050	0.0053	0.0078	0.0152	0.0283	0.5282	0.0023	0.0034	0.0065	0.0122	0.1203	0.0013	0.0014	0.0019	0.0026	0.0172
Age stratum: 45-64 years															
1972 -1986	0.0380	0.0557	0.1087	0.2029	1.7498	0.0282	0.0413	0.0805	0.1503	1.5382	-	-	-	-	-
1987	0.0380	0.0557	0.1087	0.2029	1.7498	0.0282	0.0413	0.0805	0.1503	1.5382	-	-	-	-	-
1988	0.0380	0.0557	0.1087	0.2029	1.7498	0.0282	0.0413	0.0805	0.1503	1.5382	-	-	-	-	-
1989	0.0380	0.0557	0.1087	0.2029	1.7498	0.0282	0.0413	0.0805	0.1503	1.5382	-	-	-	-	-
1990	0.0380	0.0557	0.1087	0.2029	1.7498	0.0282	0.0413	0.0805	0.1503	1.5382	-	-	-	-	-
1991	0.0380	0.0557	0.1087	0.2029	1.7498	0.0282	0.0413	0.0805	0.1503	1.5382	-	-	-	-	-
1992	0.0380	0.0557	0.1087	0.2029	1.7498	0.0282	0.0413	0.0805	0.1503	1.5382	-	-	-	-	-
1993	0.0380	0.0557	0.1087	0.2029	1.7498	0.0282	0.0413	0.0805	0.1503	1.5382	-	-	-	-	-
1994	0.0380	0.0557	0.1087	0.2029	1.7498	0.0282	0.0413	0.0805	0.1503	1.5382	-	-	-	-	-
1995	0.0380	0.0557	0.1087	0.2029	1.7498	0.0282	0.0413	0.0805	0.1503	1.5382	-	-	-	-	-

1/PY	I1-I3	I4	I5	I6	I7	T1-T3 /C1-C3	T4/C4	T5/C5	T6/C6	T7/C7	A1-A3	A4	A5	A6	A7
1996	0.0380	0.0557	0.1087	0.2029	1.7498	0.0282	0.0413	0.0805	0.1503	1.5382	-	-	-	-	-
1997	0.0355	0.0521	0.1015	0.1895	1.6344	0.0355	0.0521	0.1015	0.1895	1.6344	0.0237	0.0260	0.0338	0.0474	0.2724
1998	0.0355	0.0521	0.1015	0.1895	1.6344	0.0355	0.0521	0.1015	0.1895	1.6344	0.0237	0.0260	0.0338	0.0474	0.2724
1999	0.0355	0.0521	0.1015	0.1895	1.6344	0.0355	0.0521	0.1015	0.1895	1.6344	0.0237	0.0260	0.0338	0.0474	0.2724
2000	0.0355	0.0521	0.1015	0.1895	1.6344	0.0355	0.0521	0.1015	0.1895	1.6344	0.0237	0.0260	0.0338	0.0474	0.2724
2001	0.0355	0.0521	0.1015	0.1895	1.6344	0.0355	0.0521	0.1015	0.1895	1.6344	0.0237	0.0260	0.0338	0.0474	0.2724
2002	0.0332	0.0486	0.0948	0.1770	1.5264	0.0275	0.0403	0.0786	0.1466	0.6885	0.0166	0.0183	0.0238	0.0333	0.1043
2003	0.0332	0.0486	0.0948	0.1770	1.5264	0.0275	0.0403	0.0786	0.1466	0.6885	0.0166	0.0183	0.0238	0.0333	0.1043
2004	0.0332	0.0486	0.0948	0.1770	1.5264	0.0275	0.0403	0.0786	0.1466	0.6885	0.0166	0.0183	0.0238	0.0333	0.1043
2005	0.0332	0.0486	0.0948	0.1770	1.5264	0.0275	0.0403	0.0786	0.1466	0.6885	0.0166	0.0183	0.0238	0.0333	0.1043
2006	0.0332	0.0486	0.0948	0.1770	1.5264	0.0275	0.0403	0.0786	0.1466	0.6885	0.0166	0.0183	0.0238	0.0333	0.1043
2007	0.0309	0.0454	0.0884	0.1651	1.4240	0.0125	0.0184	0.0358	0.0669	0.4097	0.0070	0.0077	0.0100	0.0139	0.0569
2008	0.0309	0.0454	0.0884	0.1651	1.4240	0.0125	0.0184	0.0358	0.0669	0.4097	0.0070	0.0077	0.0100	0.0139	0.0569
2009	0.0309	0.0454	0.0884	0.1651	1.4240	0.0125	0.0184	0.0358	0.0669	0.4097	0.0070	0.0077	0.0100	0.0139	0.0569
2010	0.0309	0.0454	0.0884	0.1651	1.4240	0.0125	0.0184	0.0358	0.0669	0.4097	0.0070	0.0077	0.0100	0.0139	0.0569
2011	0.0309	0.0454	0.0884	0.1651	1.4240	0.0125	0.0184	0.0358	0.0669	0.4097	0.0070	0.0077	0.0100	0.0139	0.0569
2012	0.0295	0.0433	0.0845	0.1577	1.3604	0.0089	0.0130	0.0254	0.0475	0.2676	0.0042	0.0047	0.0061	0.0085	0.0319
2013	0.0295	0.0433	0.0845	0.1577	1.3604	0.0089	0.0130	0.0254	0.0475	0.2676	0.0042	0.0047	0.0061	0.0085	0.0319
2014	0.0295	0.0433	0.0845	0.1577	1.3604	0.0089	0.0130	0.0254	0.0475	0.2676	0.0042	0.0047	0.0061	0.0085	0.0319
2015 -2050	0.0295	0.0433	0.0845	0.1577	1.3604	0.0089	0.0130	0.0254	0.0475	0.2676	0.0042	0.0047	0.0061	0.0085	0.0319
Age stratum: ≥ 65 years															
1972 -1986	0.1496	0.2194	0.4279	0.7987	4.1765	0.1496	0.2194	0.4279	0.7987	1.2237	-	-	-	-	-
1987	0.1496	0.2194	0.4279	0.7987	4.1765	0.1496	0.2194	0.4279	0.7987	1.2237	-	-	-	-	-
1988	0.1496	0.2194	0.4279	0.7987	4.1765	0.1496	0.2194	0.4279	0.7987	1.2237	-	-	-	-	-
1989	0.1496	0.2194	0.4279	0.7987	4.1765	0.1496	0.2194	0.4279	0.7987	1.2237	-	-	-	-	-

1/PY	I1-I3	I4	I5	I6	I7	T1-T3 /C1-C3	T4/C4	T5/C5	T6/C6	T7/C7	A1-A3	A4	A5	A6	A7
1990	0.1496	0.2194	0.4279	0.7987	4.1765	0.1496	0.2194	0.4279	0.7987	1.2237	-	-	-	-	-
1991	0.1496	0.2194	0.4279	0.7987	4.1765	0.1496	0.2194	0.4279	0.7987	1.2237	-	-	-	-	-
1992	0.1496	0.2194	0.4279	0.7987	4.1765	0.1496	0.2194	0.4279	0.7987	1.2237	-	-	-	-	-
1993	0.1496	0.2194	0.4279	0.7987	4.1765	0.1496	0.2194	0.4279	0.7987	1.2237	-	-	-	-	-
1994	0.1496	0.2194	0.4279	0.7987	4.1765	0.1496	0.2194	0.4279	0.7987	1.2237	-	-	-	-	-
1995	0.1496	0.2194	0.4279	0.7987	4.1765	0.1496	0.2194	0.4279	0.7987	1.2237	-	-	-	-	-
1996	0.1496	0.2194	0.4279	0.7987	4.1765	0.1496	0.2194	0.4279	0.7987	1.2237	-	-	-	-	-
1997	0.1268	0.1860	0.3627	0.6771	3.5404	0.0638	0.0935	0.1824	0.3404	3.5404	0.0364	0.0401	0.0521	0.0729	0.5058
1998	0.1268	0.1860	0.3627	0.6771	3.5404	0.0638	0.0935	0.1824	0.3404	3.5404	0.0364	0.0401	0.0521	0.0729	0.5058
1999	0.1268	0.1860	0.3627	0.6771	3.5404	0.0638	0.0935	0.1824	0.3404	3.5404	0.0364	0.0401	0.0521	0.0729	0.5058
2000	0.1268	0.1860	0.3627	0.6771	3.5404	0.0638	0.0935	0.1824	0.3404	3.5404	0.0364	0.0401	0.0521	0.0729	0.5058
2001	0.1268	0.1860	0.3627	0.6771	3.5404	0.0638	0.0935	0.1824	0.3404	3.5404	0.0364	0.0401	0.0521	0.0729	0.5058
2002	0.1168	0.1713	0.3340	0.6234	3.2600	0.1022	0.1499	0.2923	0.5456	2.6529	0.0531	0.0584	0.0759	0.1063	0.3445
2003	0.1168	0.1713	0.3340	0.6234	3.2600	0.1022	0.1499	0.2923	0.5456	2.6529	0.0531	0.0584	0.0759	0.1063	0.3445
2004	0.1168	0.1713	0.3340	0.6234	3.2600	0.1022	0.1499	0.2923	0.5456	2.6529	0.0531	0.0584	0.0759	0.1063	0.3445
2005	0.1168	0.1713	0.3340	0.6234	3.2600	0.1022	0.1499	0.2923	0.5456	2.6529	0.0531	0.0584	0.0759	0.1063	0.3445
2006	0.1168	0.1713	0.3340	0.6234	3.2600	0.1022	0.1499	0.2923	0.5456	2.6529	0.0531	0.0584	0.0759	0.1063	0.3445
2007	0.1075	0.1577	0.3075	0.5740	3.0015	0.0592	0.0868	0.1693	0.3161	0.9676	0.0282	0.0310	0.0403	0.0564	0.1152
2008	0.1075	0.1577	0.3075	0.5740	3.0015	0.0592	0.0868	0.1693	0.3161	0.9676	0.0282	0.0310	0.0403	0.0564	0.1152
2009	0.1075	0.1577	0.3075	0.5740	3.0015	0.0592	0.0868	0.1693	0.3161	0.9676	0.0282	0.0310	0.0403	0.0564	0.1152
2010	0.1075	0.1577	0.3075	0.5740	3.0015	0.0592	0.0868	0.1693	0.3161	0.9676	0.0282	0.0310	0.0403	0.0564	0.1152
2011	0.1075	0.1577	0.3075	0.5740	3.0015	0.0592	0.0868	0.1693	0.3161	0.9676	0.0282	0.0310	0.0403	0.0564	0.1152
2012	0.0993	0.1456	0.2839	0.5300	2.7714	0.0502	0.0736	0.1436	0.2681	0.7494	0.0205	0.0225	0.0293	0.0410	0.0765
2013	0.0993	0.1456	0.2839	0.5300	2.7714	0.0502	0.0736	0.1436	0.2681	0.7494	0.0205	0.0225	0.0293	0.0410	0.0765
2014	0.0993	0.1456	0.2839	0.5300	2.7714	0.0502	0.0736	0.1436	0.2681	0.7494	0.0205	0.0225	0.0293	0.0410	0.0765
2015 -2050	0.0993	0.1456	0.2839	0.5300	2.7714	0.0502	0.0736	0.1436	0.2681	0.7494	0.0205	0.0225	0.0293	0.0410	0.0765

Supplementary Table 3. **Rate of HIV testing by HIV stage, risk group, age stratum, and PrEP status in the deterministic model**

Parameter	Description	Value (unit)	Source
Testing rate among people not on PrEP			
$\tau_{\kappa=1,j=1,2,3}^{h=1,0}$	Testing rate at stage 1 in the model $\tau_{\kappa,j}^{h}$ is the rate of HIV testing for individuals in risk group h (h=1 for high-risk group, h=0 for low-risk group at HIV stage κ (Figure 1) within age stratum j (j=1 for 15-44 years, j=2 for 45-64 years, and j=3 for ≥65 years)	0	By definition, stage 1 is the window period for HIV testing during acute HIV infection in the model (Figure 1)
$\tau_{\kappa=2,j=1,2,3}^{h=1,0}$	Testing rate at stage 2 in the model (acute HIV infection, detectable by HIV nucleic acid testing or HIV antigen/antibody combo testing)	$\tau_{\kappa=2,j=1,2,3}^{h=1,0} = \tau_{\kappa=3,4,5,j=1,2,3}^{h=1,0} \times \pi$ (coverage rate of nucleic acid testing and Ag/Ab combination testing) The value of π: 1972–2008: 0% 2009: 7.1% 2010: 6.8% 2011: 7.4% 2012: 8.1% 2013: 28.8% 2014: 52.5% 2015: 95% 2016–2019: 95%	• HIV nucleic acid testing and Ag/Ab combo testing began in 2009 in Taiwan [13]. • For stages 2, the HIV testing rate for each risk group/age stratum in the model is equal to the HIV testing rate during chronic HIV infection stages 3, 4, and 5 in the corresponding risk group and age stratum, multiplied by the coverage rate π of nucleic acid testing and combo testing. • The estimated value of π was based on data provided by the Taiwan CDC, the National Cheng Kung University, and the Taiwan Society of Laboratory Medicine.

Parameter	Description	Value (unit)	Source
$\tau^{h=1}_{\kappa=3,4,5,j=1}$	Testing rate at stage 3, 4, 5 (chronic HIV infection) in the model among the high-risk group in age stratum 15-44 years	1972–1988: 0 ($year^{-1}$) 1989–2000: 1/8 ($year^{-1}$) 2000–2001: 1/8–1/4.5 ($year^{-1}$) 2001–2004: 1/4.5–1/3 ($year^{-1}$) 2004–2005: 1/3–1/3.5 ($year^{-1}$) 2005–2006: 1/3.5–1/4.5 ($year^{-1}$) 2006–2009: 1/4.5 ($year^{-1}$) 2009–2010: 1/4.5–1/4 ($year^{-1}$) 2010–2011: 1/4–1/3.5 ($year^{-1}$) 2011–2012: 1/3.5–1/3 ($year^{-1}$) 2012–2013: 1/3 ($year^{-1}$) 2013–2014: 1/3–1/3.25 ($year^{-1}$) 2014–2015: 1/3.25–1/3.25 ($year^{-1}$) 2015–2016: 1/3.25–1/3 ($year^{-1}$) 2016–2017: 1/3–1/2.5 ($year^{-1}$) 2017–2018: 1/2.5-1/2.43 ($year^{-1}$) 2018–2019: 1/2.43 ($year^{-1}$)	• HIV testing began in 1989 in Taiwan [14] • Fitting the model to the percentages of late HIV diagnoses (≤30 days before AIDS diagnosis) [5] among new MSM HIV cases by age strata in the Taiwan HIV registry [5, 6] (Supplementary Figure 5). • To account for the trend of testing changing over time, model fitting was conducted year by year, during which parameters may have increased or decreased linearly: 2000-2004 (the early ART era, emphasizing 'hit early, hit hard'), 2004-2009 (delaying ART until CD4 counts fell to 350/mm³ to avoid unnecessary adverse effects), 2009–2013 (rollout of anonymous HIV testing services), and 2013-2019 (renewed emphasis on early treatment and diagnosis)
$\tau^{h=0}_{\kappa=3,4,5,j=1}$	Testing rate at stage 3, 4, 5 (chronic HIV infection) in the model among the low-risk group in age stratum 15-44 years	1972–1988: 0 ($year^{-1}$) 1989–2000: 1/10 ($year^{-1}$) 2000–2001: 1/10–1/8 ($year^{-1}$) 2001–2004: 1/8 ($year^{-1}$) 2004–2005: 1/8–1/10 ($year^{-1}$) 2005–2019: 1/10 ($year^{-1}$)	• HIV testing began in 1989 in Taiwan [14] • Fitting the model to the percentages of late HIV diagnoses [5] among new MSM HIV cases by age strata in the HIV registry [5, 6] (Supplementary Figure 5).

Parameter	Description	Value (unit)	Source
$\tau_{\kappa=6,j=1}^{h=1,0}$	Testing rate at stage 6 (AIDS, CD4 <200/mm³, without opportunistic infections) in the model among the high-risk group and the low-risk group in age stratum 15-44 years	1972–1988: 0 ($year^{-1}$) 1989–2000: 1/8 ($year^{-1}$) 2000–2001: 1/8–1/4.5 ($year^{-1}$) 2001–2004: 1/4.5–1/3 ($year^{-1}$) 2004–2005: 1/3–1/2 ($year^{-1}$) 2005–2006: 1/2–1/1.6 ($year^{-1}$) 2006–2019: 1/1.6 ($year^{-1}$)	• HIV testing began in 1989 in Taiwan [14] • Fitting the model to the percentages of late HIV diagnoses [5] among new MSM HIV cases by age strata in the HIV registry [5, 6] (Supplementary Figure 5).
$\tau_{\kappa=3,4,5,6,j=2}^{h=1}$	Testing rate at stage 3, 4, and 5 (chronic HIV infection), and 6 (AIDS, CD4 <200/mm³, without opportunistic infections) in the model among the high-risk group in age stratum 45-64 years	1972–1988: 0 ($year^{-1}$) 1989–2000: 1/10 ($year^{-1}$) 2000–2001: 1/10–1/8 ($year^{-1}$) 2001–2004: 1/8 ($year^{-1}$) 2004–2005: 1/8–1/10 ($year^{-1}$) 2005–2015: 1/10 ($year^{-1}$) 2015–2016: 1/10–1/7 ($year^{-1}$) 2016–2019: 1/7 ($year^{-1}$)	• HIV testing began in 1989 in Taiwan [14] • Fitting the model to the percentages of late HIV diagnoses [5] among new MSM HIV cases by age strata in the HIV registry [5, 6] (Supplementary Figure 5).
$\tau_{\kappa=3,4,5,6,j=2}^{h=0}$	Testing rate at stage 3, 4, and 5 (chronic HIV infection), and 6 (AIDS, CD4 <200/mm³, without opportunistic infections) in the model among the low-risk group in age stratum 45-64 years	1972–1988: 0 ($year^{-1}$) 1989–2000: 1/10 ($year^{-1}$) 2000–2001: 1/10–1/9 ($year^{-1}$) 2001–2004: 1/9–1/8 ($year^{-1}$) 2004–2005: 1/8–1/10 ($year^{-1}$) 2005–2015: 1/10 ($year^{-1}$) 2015–2016: 1/10–1/7 ($year^{-1}$) 2016–2019: 1/7 ($year^{-1}$)	• HIV testing began in 1989 in Taiwan [14] • Fitting the model to the percentages of late HIV diagnoses [5] among new MSM HIV cases by age strata in the HIV registry [5, 6] (Supplementary Figure 5)

Parameter	Description	Value (unit)	Source
$\tau^{h=1,0}_{\kappa=3,4,5,6,j=3}$	Testing rate at stage 3, 4, and 5 (chronic HIV infection), and 6 (AIDS, CD4 <200/mm³, without opportunistic infections) in the model among the low-risk group in age stratum ≥65 year	1972–1988: 0 ($year^{-1}$) 1989–2019: 1/10 ($year^{-1}$)	• HIV testing began in 1989 in Taiwan [14] • Fitting the model to the percentages of late HIV diagnoses [5] among new MSM HIV cases by age strata in the HIV registry [5, 6] (Supplementary Figure 5)
$\tau^{h=1,0}_{\kappa=7,j=1,2,3}$	Testing rate at stage 7 (AIDS, CD4 <200/mm³, opportunistic infections have occurred) in the model	12 ($year^{-1}$)	We assumed that ill patients seeking medical care were diagnosed an average of 1 month after the onset of opportunistic infection.
Rate of HIV testing among people in the PrEP program			
$\boldsymbol{\tau_{p,\,\kappa=1}}$	Testing rate at stage 1 among people in the PrEP program	0 ($year^{-1}$)	By definition, stage 1 is the window period for HIV testing during acute HIV infection in the model (Figure 1)
$\boldsymbol{\tau_{p,\,\kappa=2,3,4,5,6}}$	Testing rate at stage 2, 3, 4, 5, and 6 among people in the PrEP program	4 ($year^{-1}$)	Testing every three months, in accordance with the World Health Organization guidelines [15]
$\boldsymbol{\tau_{p,\,\kappa=7}}$	Testing rate at stage 7 among people in the PrEP program	12 ($year^{-1}$)	We assumed that ill patients seeking medical care were diagnosed an average of 1 month after the onset of opportunistic infection.

Supplementary Table 4. **Rate of linkage to care following diagnosis in the deterministic model**

Parameter	Description	Value (unit)	Source
σ_1	Rate of linkage to care at stage 1	0 ($year^{-1}$)	By definition, stage 1 is the testing window period during which no patients are diagnosed.
σ_2	Rate of linkage to care at stage 2	1972–2008: 0 ($year^{-1}$) 2009–2019: $\sigma_2 = \sigma_3 = \sigma_4 = \sigma_5 = \sigma_6$	HIV nucleic acid testing and HIV antigen/antibody combination testing began in 2009 in Taiwan [13].
σ_3 **σ_4** **σ_5** **σ_6**	Rate of linkage to care at stage 3, 4, 5, and 6 We assumed that $\sigma_3 = \sigma_4 = \sigma_5 = \sigma_6$.	1972–1988: 0 ($year^{-1}$) 1989–1996: 2 ($year^{-1}$) 1997–2003: 4 ($year^{-1}$) 2003–2004: 4–0.267 ($year^{-1}$) 2004: 0.267 ($year^{-1}$) 2005: 0.267 ($year^{-1}$) 2006: 0.267 ($year^{-1}$) 2007: 0.278 ($year^{-1}$) 2008: 0.332 ($year^{-1}$) 2009: 0.400 ($year^{-1}$) 2010: 0.439 ($year^{-1}$) 2011: 0.479 ($year^{-1}$) 2012: 0.646 ($year^{-1}$) 2013: 0.767 ($year^{-1}$) 2014: 0.801 ($year^{-1}$) 2015: 0.818 ($year^{-1}$) 2016: 0.927 ($year^{-1}$) 2017: 1.091 ($year^{-1}$) 2018: 1.105 ($year^{-1}$) 2019: 1.346 ($year^{-1}$)	• HIV testing began in 1989 in Taiwan [14] • Values before 2006 are based on the assumption that linkage to care was not delayed in the early ART era, which emphasized 'hit early, hit hard' . This period was followed by a trend of deferring ART until CD4 counts dropped to 350/mm³ to minimize adverse effects, starting in 2002-2004. • Values for 2006-2014 are based on the reciprocal of the mean duration from diagnosis to the first medical visit, according to statistics in the Taiwan CDC national HIV case management system from 2006 to 2014. • To correct the underrepresentation in the case management statistics, which does not include patients not yet linked to care, we applied an adjustment factor. This adjustment ensured that the HIV care cascade predicted by the model aligned with the actual HIV cascade data for MSM HIV patients during 2014–2015, showing a retention/diagnosis ratio of 85% according to the Taiwan CDC. • For the period from 2015 to 2019, we estimated the linkage to care rate by linearly extrapolating the natural logarithm of the mean duration from diagnosis to the first medical visit for 2006-2014, achieving an R-square of 98%. We then took the reciprocal of this extrapolation and multiplied it by the adjustment factor.

Parameter	Description	Value (unit)	Source
σ_7	Rate of linking to care at stage 7	24 ($year^{-1}$)	We assumed that ill patients were linked to HIV care an average of 2 weeks after the diagnosis.

Supplementary Table 5. **Rate of initiating antiretroviral therap (ART) after linkage to care in the deterministic model**

Parameter	Description	Value (unit)	Source
γ_1	Rate of initiating ART at stage 1 (Window Period)	0 ($year^{-1}$)	By definition, stage 1 is the testing window period during which no patients are treated.
γ_2	Rate of initiating ART at stage 2 (Acute HIV infection, detectable by Nucleic acid testing and combo testing)	1972–1996: 0 ($year^{-1}$) 1997–2015: 0 ($year^{-1}$) 2015–2017: 0–0.021 ($year^{-1}$) 2017–2019: 0.021 ($year^{-1}$)	• Acute HIV infection was not treated with ART in Taiwan until 2015, when the World Health Organization issued guidelines recommending the immediate initiation of ART after diagnosis for all people living with HIV [16]. • We assumed that, even after 2015, the percentage of patients who started ART during acute HIV infection remained low (1%) due to the very short duration of stage 2, after taking into account the time from HIV diagnosis to linkage to care. • We initially estimated the rate of initiating ART using the formula in which the percentage of patients starting ART during stage κ is equal to $(\gamma_\kappa/(\gamma_\kappa+\rho_{\kappa,j=1}))$. We assumed that the rate of initiating ART in stage κ is the same for all three age strata. • The value of γ_2 was determined by adjusting the initial estimate by a fine-tuning factor. This adjustment ensured that the HIV cascade predicted by the model aligned with the actual HIV cascade data for 2018, in which 88% of all diagnosed HIV patients were receiving ART, according to the Taiwan CDC.

γ_3	Rate of initiating ART at stage 3 (chronic HIV infection with CD4 count higher than 500/mm^3)	1972–1996: 0 (year^{-1}) 1997–2002: 3.581 (year^{-1}) 2002–2005: 3.581–0.021 (year^{-1}) 2005–2013: 0.021 (year^{-1}) 2014: 0.064 (year^{-1}) 2015–2019: 0.202 (year^{-1})	• Combination ART began in 1997 in Taiwan [14] • Values before 2013 are based on the assumption that ART was initiated in 90% of patients during the early ART era, which emphasized the 'hit early, hit hard' approach. This was followed by a trend, starting in 2002-2004, of deferring ART until CD4 counts dropped to 350/mm^3 to minimize adverse effects; and consequently, the percentage of patients beginning ART linearly decreased to 5% by 2005 and remained stable thereafter until 2013. • Values for 2013–2015 are based on the percentage of patients with a CD4 count >500/mm^3 who started ART in 2013 (5%), 2014 (14%), and 2015 (34%), according to statistics from the Taiwan CDC national HIV case management system. • We initially estimated the rate of initiating ART using the formula in which the percentage of patients starting ART during stage κ is equal to $(\gamma_\kappa/(\gamma_\kappa+\rho_{\kappa,j=1}))$. We assumed that the rate of initiating ART in stage κ is the same for all three age strata. • The value of γ_3 was determined by multiplying the initial estimate by an adjustment factor. This adjustment ensured that the HIV cascade predicted by the model aligned with the actual HIV cascade data for MSM cases in 2014-2015, in which 94% of all retained HIV patients were receiving ART, according to the Taiwan CDC. • For the period from 2015 to 2019, we assumed that the 2015 rate of initiating ART was maintained. This assumption allowed the model's predicted HIV cascade to align with the actual HIV cascade data for the year 2018, in which 88% of all diagnosed HIV patients were receiving ART, according to the Taiwan CDC.

γ_4	Rate of initiating ART at stage 4 (chronic HIV infection with CD4 count 350-500/mm^3)	1972–1996: 0 (year^{-1}) 1997–2002: 7.302 (year^{-1}) 2002–2005: 7.302–0.153 (year^{-1}) 2005–2013: 0.152 (year^{-1}) 2014: 0.448 (year^{-1}) 2015–2019: 0.765 (year^{-1})	• Combination ART began in 1997 in Taiwan [14] • Values before 2013 are based on the assumption that ART was initiated in 90% of patients during the early ART era, which emphasized the 'hit early, hit hard' approach. This was followed by a trend, starting in 2002-2004, of deferring ART until CD4 counts dropped to 350/mm^3 to minimize adverse effects; and consequently, the percentage of patients beginning ART linearly decreased to 16% by 2005 and remained stable thereafter until 2013. • Values for 2013–2015 are based on the percentage of patients with a CD4 count of 350–500/mm^3 who started ART in 2013 (16%), 2014 (36%), and 2015 (49%), according to statistics from the Taiwan CDC national HIV case management system. • We initially estimated the rate of initiating ART using the formula in which the percentage of patients starting ART during stage κ is equal to $(\gamma_\kappa/(\gamma_\kappa+\rho_{\kappa,j=1}))$. We assumed that the rate of initiating ART in stage κ is the same for all three age strata. • The value of γ_4 was determined by multiplying the initial estimate by an adjustment factor. This adjustment ensured that the HIV cascade predicted by the model aligned with the actual HIV cascade data for MSM in 2014-2015, in which 94% of all retained HIV patients were receiving ART, according to the Taiwan CDC. • For the period from 2015 to 2019, we assumed that the 2015 rate of initiating ART was maintained. This assumption allowed the model's predicted HIV cascade to align with the actual HIV cascade data for the year 2018, in which 88% of all diagnosed HIV patients were already receiving ART, according to the Taiwan CDC.

γ_5	Rate of initiating ART at stage 5 (chronic HIV infection with CD4 count 200-350/mm^3)	1972–1996: 0 (year^{-1}) 1997–2002: 7.225 (year^{-1}) 2002–2005: 7.225–1.329 (year^{-1}) 2005–2013: 1.306 (year^{-1}) 2014–2019: 1.708 (year^{-1})	• Combination ART began in 1997 in Taiwan [14] • Values before 2013 are based on the assumption that ART was initiated in 90% of patients during the early ART era, which emphasized the 'hit early, hit hard' approach. This was followed by a trend, starting in 2002-2004, of deferring ART until CD4 counts dropped to 350/mm³ to minimize adverse effects; and consequently, the percentage of patients beginning ART linearly decreased to 63% by 2005 and remained stable thereafter until 2013. • Values for 2013–2015 are based on the percentage of patients with a CD4 count of 200–350/mm³ who started ART in 2013 (63%), 2014 (69%), and 2015 (62%), according to statistics from the Taiwan CDC national HIV case management system. • We initially estimated the rate of initiating ART using the formula in which the percentage of patients starting ART during stage κ is equal to $(\gamma_\kappa/(\gamma_\kappa+\rho_{\kappa,j=1}))$. We assumed that the rate of initiating ART in stage κ is the same for all three age strata. • The value of γ_5 was determined by multiplying the initial estimate by an adjustment factor. This adjustment ensured that the HIV cascade predicted by the model aligned with the actual HIV cascade data for MSM in 2014-2015, in which 94% of all retained HIV patients were receiving ART, according to the Taiwan CDC. • For the period from 2015 to 2019, we assumed that the 2014 rate of initiating ART was maintained. This assumption allowed the model's predicted HIV care cascade to align with the actual HIV cascade data for the year 2018, in which 88% of all diagnosed HIV patients were receiving ART, according to the Taiwan CDC.

Parameter	Description	Value (unit)	Source
γ_6	Rate of initiating ART at stage 6 (AIDS stage, with a CD4 count less than 200/mm³ but did not have any opportunistic infections)	1972–1996: 0 ($year^{-1}$) 1997–2019: 8.5 ($year^{-1}$)	• Combination ART began in 1997 in Taiwan [14] • We assumed that ART was initiated in 95% of patients with a CD4 count less than 200/mm³ but without opportunistic infections, and initially estimated the rate of initiating ART using the formula in which the percentage of living patients starting ART during stage κ is equal to $(\gamma_\kappa/(\gamma_\kappa+\rho_{\kappa,j=1}))$. We assumed that the rate of initiating ART in stage κ is the same for all three age strata. • The value of γ_6 was determined by adjusting the initial estimate by a fine-tuning factor. This adjustment ensured that the HIV cascade predicted by the model aligned with the actual HIV cascade data for the year 2018, in which 88% of all diagnosed HIV patients were receiving ART, according to the Taiwan CDC.
γ_7	Rate of initiating ART at stage 7 (AIDS stage, with opportunistic infections)	1972–1996: 0 ($year^{-1}$) 1997–2019: 48 ($year^{-1}$)	• Combination ART began in 1997 in Taiwan [14] • We assumed that ART was initiated in patients with opportunistic infections on average approximately 1 week after linkage to care.

Supplementary Table 6. **Rate of entry into the model upon reaching age 15 in the deterministic model.** We estimated the rate of entry into the model (by males reaching 15 years of age) using vital statistics back to 1984 [17], with the assumption that approximately 3% of males are men who have sex with men (MSM) in Taiwan [18, 19, 20]. The number of entries was calculated by multiplying the number of males reaching 15 years of age each year in Taiwan by the proportion of MSM. We assume that the number of males reaching 15 years of age in Taiwan remained stable from 1972 to 1984. Due to societal trends becoming more liberal in recent decades, we assume that the proportion of MSM among males reaching 15 years of age slightly increased from 3% in 2006 to 3.9% in 2016 and remained at that level thereafter. We also assume that the number of males reaching 15 years of age in Taiwan during the period 2018-2050 would remain consistent with that observed in 2017.

Year	Number of male reaching 15 years in Taiwan (person/year)	Proportion of MSM among male reaching 15 years in Taiwan (assumed)	Number of entry into the model (*n*) in the year (person/year)
1972-1983	197396	3%	5922
1984	197396	3%	5922
1985	195628	3%	5869
1986	189690	3%	5691
1987	182892	3%	5487
1988	183522	3%	5506
1989	182704	3%	5481
1990	184447	3%	5533
1991	212359	3%	6371
1992	197013	3%	5910
1993	205948	3%	6178
1994	212743	3%	6382
1995	207061	3%	6212

Year	Number of male reaching 15 years in Taiwan (person/year)	Proportion of MSM among male reaching 15 years in Taiwan (assumed)	Number of entry into the model (*n*) in the year (person/year)
1996	209952	3%	6299
1997	203947	3%	6118
1998	193590	3%	5808
1999	187929	3%	5638
2000	174129	3%	5224
2001	155144	3%	4654
2002	160264	3%	4808
2003	176869	3%	5306
2004	161199	3%	4836
2005	175061	3%	5252
2006	166631	3%	4999
2007	167147	3.1%	5182
2008	169058	3.2%	5410
2009	167511	3.3%	5528
2010	167938	3.4%	5710
2011	167562	3.5%	5865
2012	168195	3.6%	6055
2013	138999	3.7%	5143
2014	147581	3.8%	5608
2015	159666	3.9%	6227
2016	133726	3.9%	5215
2017	128699	3.9%	5019
2018-2050	128699	3.9%	5019

Supplementary Table 7. **Mortality rate of MSM without HIV, by age stratum and year in the deterministic model.** We estimated the mortality rate of MSM without HIV in Taiwan using vital statistics back to 1984 [17], assuming that MSM have the same non-HIV mortality rate as the general male population in Taiwan. The mortality rate for an age stratum in a given year was calculated by dividing the number of male deaths in that stratum by the total male population in the same stratum for that year. We assume that the mortality rate of MSM without HIV remained stable from 1972 to 1984. Moreover, we assume that the mortality rate of MSM in Taiwan from 2018 to 2050 would remain consistent with that observed in 2017. The data were presented in units of (person-year)$^{-1}$.

1/PY	Non-HIV Mortality rate for Ages 15-44 ($\boldsymbol{\mu_1}$)	Non-HIV Mortality rate for Ages 45-64 ($\boldsymbol{\mu_2}$)	Non-HIV Mortality rate for Ages ≥65 ($\boldsymbol{\mu_3}$)
1972-1983	0.001938738	0.01097005	0.05101288
1984	0.001938738	0.01097005	0.05101288
1985	0.001874894	0.01063323	0.05150659
1986	0.001918435	0.01065407	0.0515213
1987	0.001994201	0.01055496	0.04976633
1988	0.002108699	0.01055496	0.05067484
1989	0.002144511	0.01070428	0.04966995
1990	0.002074605	0.01089749	0.0486083
1991	0.002060990	0.01062613	0.04646569
1992	0.002062313	0.01065749	0.04711807
1993	0.002134028	0.01039649	0.0455252
1994	0.002143465	0.01032604	0.0455604
1995	0.002125446	0.01022847	0.16378294
1996	0.002108941	0.00999321	0.1608046
1997	0.002072684	0.00942872	0.15911694
1998	0.002039683	0.00907688	0.04619525

1/PY	Non-HIV Mortality rate for Ages 15-44 (μ_1)	Non-HIV Mortality rate for Ages 45-64 (μ_2)	Non-HIV Mortality rate for Ages ≥65 (μ_3)
1999	0.001977729	0.00893930	0.04664643
2000	0.001925421	0.00862907	0.04618095
2001	0.001852354	0.00843934	0.04690281
2002	0.001791909	0.00815512	0.04645823
2003	0.001791730	0.00802815	0.04669879
2004	0.001840289	0.00806691	0.04753594
2005	0.001937626	0.00816129	0.0484946
2006	0.001903519	0.00788222	0.04600809
2007	0.001764490	0.00770592	0.04716316
2008	0.001708854	0.00770122	0.04785871
2009	0.001648724	0.00752319	0.04688773
2010	0.001550279	0.00745422	0.04774293
2011	0.001614778	0.00770264	0.04982529
2012	0.001531432	0.00757985	0.04926864
2013	0.001411582	0.00764722	0.04799649
2014	0.001435673	0.00773982	0.04857466
2015	0.001388703	0.00772575	0.04702602
2016	0.001415654	0.00799526	0.04732274
2017	0.001322814	0.00770957	0.04518246
2018-2050	0.001322814	0.00770957	0.04518246

Supplementary Table 8. **Total MSM population by age stratum in the deterministic model**. We estimated the total number of MSM by age stratum in the model using population statistics back to 1984 [17]. We used the number of the male population by age stratum in 1984 to estimate the initial size of MSM population in the model, assuming that 3% of males are MSM. The changing numbers of the total MSM population by age stratum in the model were calculated year-by-year by adding entries (MSM reaching 15 years of age each year), accounting for aging from the 15-44 years age stratum to the 45-64 years age stratum, and then to the ≥65 years age stratum, and subtracting the numbers exiting the model due to mortality among those living with HIV and among those without HIV.

	Total population aged 15-44 years in the model (N_1) (person)	**Total population aged 45-64 years in the model (N_2) (person)**	**Total population aged ≥65 years in the model (N_3) (person)**
1972	144511	49427	14266
1973	145321	51190	16010
1974	146104	52875	17750
1975	146859	54485	19485
1976	147588	56023	21210
1977	148291	57494	22923
1978	148970	58900	24620
1979	149626	60244	26300
1980	150258	61530	27961
1981	150868	62759	29600
1982	151457	63935	31216
1983	152024	65060	32808
1984	152572	66136	34374
1985	153078	67176	35906
1986	153454	68179	37401
1987	153619	69134	38902

	Total population aged 15-44 years in the model (N_1) (person)	Total population aged 45-64 years in the model (N_2) (person)	Total population aged ≥65 years in the model (N_3) (person)
1988	153670	70039	40390
1989	153703	70885	41850
1990	153748	71670	43320
1991	154228	72415	44826
1992	154875	73145	46331
1993	155390	73854	47824
1994	156104	74553	49319
1995	156799	75239	47962
1996	157416	75914	44260
1997	158002	76604	41237
1998	158324	77300	40879
1999	158394	77975	42812
2000	158172	78621	44688
2001	157471	79229	46503
2002	156603	79792	48255
2003	156099	80316	49957
2004	155617	80796	51577
2005	155118	81223	53101
2006	154719	81619	54614
2007	154299	81987	56108
2008	154101	82328	57500
2009	154080	82652	58852
2010	154198	82957	60156
2011	154483	83244	61323
2012	154937	83524	62397

	Total population aged 15-44 years in the model (N_1) (person)	**Total population aged 45-64 years in the model (N_2) (person)**	**Total population aged ≥65 years in the model (N_3) (person)**
2013	155031	83792	63484
2014	154890	84025	64547
2015	155279	84237	65596
2016	155460	84431	66641
2017	155037	84601	67700
2018	154534	84750	68782
2019	154047	84868	69817
2020	153578	84960	70806
2021	153127	85028	71749
2022	152694	85075	72647
2023	152279	85104	73502
2024	151883	85118	74315
2025	151506	85118	75087
2026	151147	85107	75820
2027	150805	85086	76516
2028	150479	85057	77175
2029	150168	85021	77800
2030	149872	84978	78392
2031	149590	84931	78953
2032	149322	84879	79483
2033	149067	84824	79985
2034	148824	84766	80459
2035	148593	84706	80908
2036	148373	84645	81332
2037	148163	84583	81733

	Total population aged 15-44 years in the model (N_1) (person)	Total population aged 45-64 years in the model (N_2) (person)	Total population aged ≥65 years in the model (N_3) (person)
2038	147964	84519	82112
2039	147774	84456	82470
2040	147594	84392	82809
2041	147422	84329	83129
2042	147258	84266	83432
2043	147102	84204	83719
2044	146953	84142	83990
2045	146812	84082	84247
2046	146677	84022	84489
2047	146548	83964	84719
2048	146425	83907	84937
2049	146308	83851	85144
2050	146196	83796	85339

Supplementary Table 9. **Cost of pre-exposure prophylaxis (PrEP) program** (in USD, using an exchange rate of 30 NTD for 1 USD)

Item	Medical Cost[a]/Visit	The first year		Following year	
		Times/Year	Cost [a]/ person-year	Times/Year	Cost[a]/ person-year
HIV testing	$7.50	6	$45	4	$30.00
Clinic Fee	$24.00	6	$144	4	$96.00
Renal function follow-up and tests for sexually transmitted infections (STIs) Tests					
Creatinine (blood)[b]	$1.33	4	$5.33	2	$2.67
Urinalysis	$2.50	4	$10	2	$5.00
Syphilis Test (RPR) and other STIs test[c]	$21.00	6	$126.00	4	$84.00
Hepatitis B serology	$25.33	2	$50.67	1	$25.33
Hepatitis C serology	$8.33	2	$16.67	1	8.33
Truvada™ (on-demand use)[d]	$191.77	12	$2301.20	12	$2301.20
Case management					
First Interview	$66.67	1	$66.67	0	$0
Drug Adherence	$8.33	5	$41.67	4	$33.33
Total Cost			**$2,807.20 USD**		**$2,585.87 USD**

[a] The items considered in the PrEP program are based on the Taiwan PrEP guidelines and the PrEP demonstration projects in other countries [21, 22, 23, 24, 25, 26]. Costs were based on the reimbursement guidelines for medical services of Taiwan National Health Insurance in 2018.

[b] Serum creatinine test

[c] Other STI testing includes DNA test for chlamydia (qualitative) and gonococcal culture.

[d] 15 tablets/month, based on Molina JM et al.[27]

Supplementary Table 10. **HIV-associated medical cost** (in USD, using an exchange rate of 30 NTD for 1 USD)

	The first year		Following year		Cost/person-lifetime†
	Cost/person	Usage probability	Cost/person	Usage probability	
(a) Patients without AIDS at diagnosis					
Testing	$59.63	100%	$0	0%	$59.63
Laboratory test and clinic fee	$1,122.67	100%	$837.67	100%	$19,420.40
Case management	$100.00	100%	$33.33	100%	$827.90
ART	$6,767.53	100%	$6,767.53	100%	$154,604.07
Outpatient for OI	$7,045.80	1.40%	$7,045.80	1.40%	$2,253.47
Inpatient for OI	-	0%	-	0%	$0
Total cost					**$177,165.50**
(b) Patients with AIDS at diagnosis					
Testing	$59.63	100%	$0	0%	$59.63
Laboratory test and clinic fee	$1,122.67	100%	$837.67	100%	$15,532.40
Case management	$100.00	100%	$33.33	100%	$668.37
ART	$6,767.53	100%	$6,767.53	100%	$123,394.10
Outpatient for OI	$7,218.87	3.10%	$7,218.87	6.20%	$7,957.27
Inpatient for OI	$30,660.17	50%	$30,660.17	0.32%	$15,631.97
Total cost					**$163,243.70**

ART, antiretroviral therapy; OI, opportunistic infection. Costs for ART and OI treatment represent the average cost per patient.

Usage probability and cost are based on real-world data from the Taiwan National Health Insurance database in 2018.

†Lifetime cost = Summation of [(annual cost × usage probability × extrapolated survival probability in the *n*th year) ÷ $(1.03)^n$]

Extrapolated survival probability in the *n*th year is shown in Supplementary Figure 10.

Supplementary Note 1. **TRACE checklist [28] for the deterministic model**

1. Problem formation	To assess the impact of a high-coverage pre-exposure prophylaxis (PrEP) program in Taiwan from an HIV elimination perspective, we developed a deterministic model to simulate the HIV epidemic among men who have sex with men (MSM) in Taiwan. This model examines the trajectory of the epidemic under various scenarios over the next 20 years. The justification for using a deterministic model in this context lies in the observation that, in Taiwan, sexually transmitted HIV infection and hepatitis A among MSM occur as a single, synchronous epidemic rather than as multiple micro-epidemics across cities. This phenomenon can likely be attributed to the intense mixing between MSM communities from different cities, facilitated by high-speed transportation networks that interconnect metropolitan areas into a unified megalopolis.
2. Model description	The compartmental model is risk-structured (high-risk and low-risk group), and age-structured (15-44 years, 45-64 years, and ≥65 years) with assortative mixing (Supplementary Figure 1). The high-risk groups consist of MSM at risk of acquiring HIV from unsafe sexual practices with multiple, random sexual partners. Each risk/age stratum was subdivided to 37 mutually exclusive compartments, based on the stage of natural history, HIV test-and-treat status, and PrEP status (Figure 1). The model considers the natural history of HIV infection across age strata (Supplementary Figure 2) and the substantially higher infectiousness observed during the acute HIV infection and the AIDS stage (Supplementary Figure 3). It also considers the impact of antiretroviral therapy (ART) in reducing HIV transmission and HIV-related mortality. Furthermore, we assume that behavioral changes following HIV diagnosis and linkage to care are associated with a reduction in HIV transmissions. We have provided a comprehensive model description in this manuscript and the supplementary information, including schematic diagrams of the risk/age structure (Supplementary Figure 1) and 37 compartments for each risk/age stratum (Figure 1), as well as the differential equations for the model (Supplementary Note 4). The model parameters, values, data references, and initial conditions

	are detailed in Supplementary Data 1 as well as Supplementary Tables 1 to 8. The code for the model is available at https://github.com/ninowwss/SPITCA-model/tree/main.
3. Data evaluation	This model was built using Taiwan's national HIV registry data from 1990 to 2019 (Figure 2), and HIV cascade data provided by the Taiwan Centers for Disease Control (CDC) (Supplementary Tables 4 and 5). The size of the at-risk population is based on Taiwan population statistics, assuming that 3% of the male population are MSM (Supplementary Tables 6 and 8). We estimated the effective population size of the high-risk group, transmission coefficients, and the theoretical initial year when the first HIV infection occurred in Taiwan (Supplementary Data 1), by fitting the model to the actual Taiwan HIV epidemic curve from 1990 to 2019 (Figure 2 and Supplementary Figure 4) using the least squares method. Mortality rates for people with or without HIV are based on the Taiwan HIV registry, weighted by hazard ratios for HIV stage, antiretroviral treatment status, age strata, and time period as reported by large treatment cohort studies (Supplementary Table 2), as well as Taiwan's vital statistics (Supplementary Table 7), respectively. We estimated the rates of linkage to care and initiation of ART based on the reciprocal of the mean duration from diagnosis to the first medical visit, and on the HIV treatment data provided by the Taiwan CDC, respectively. (Supplementary Tables 4 and 5)
4. Conceptual model evaluation	The conceptual model is based on the well-established natural history of HIV (Supplementary Figure 2) and the concept of the HIV care continuum, from testing and linkage to care, to the initiation of ART (Figure 1). This model was constructed to simulate the well-documented effects of ART in reducing HIV transmission and mortality, as well as the well-documented effects of PrEP in preventing HIV acquisition.
5. Implementation verification	The model is implemented in STELLA (ISEE Systems, Lebanon, NH 03766, USA), a software with a graphical user interface that allows for intuitive visual inspection and validation of the computer coding. The model coding underwent extensive testing

	and verification during the model fitting and parameterization process.
6. Model output verification	The model output was fitted to Taiwan's national HIV registry data from 1990 to 2019, by age strata (Figure 2 and Supplementary Figure 4) and by timing of diagnosis (Supplementary Figure 5).
7. Model analysis	We conducted one-way sensitivity analyses (Table 3) to examine the impact of uncertainties in key variables on HIV elimination. The coverage rate of PrEP among young high-risk MSM emerges as the single most critical factor. Should the coverage rate decrease to 25%, HIV elimination becomes unattainable. Conversely, frequently voiced concerns—including a reduction in condom use among PrEP users (from the current 30% to 0%), suboptimal (75%) adherence to PrEP, an increase in the rate (to 10%) of PrEP drug resistance, an escalation (to 25%) in the proportion of MSM engaging in high-risk behaviors, or the lack of initial HIV testing upon entry during the PrEP scale-up—may delay the timing to reach the World Health Organization (WHO)'s HIV elimination threshold but will not alter the ultimate feasibility of HIV elimination via scaling up PrEP program.
8. Model output corroboration	The main model output suggests that implementing a PrEP program with 50% coverage will reduce the trajectory of the HIV epidemic in Taiwan to below the WHO HIV elimination threshold (1/1,000 person-years) by 2030 (Figure 4). This finding is corroborated by external observations that a rapid, targeted, high-coverage rollout of PrEP was associated with a rapid decline in new HIV diagnoses in New South Wales, Australia. Another significant output regarding the limitations of the HIV test-and-treat strategy in eliminating HIV among MSM echoes the conclusions drawn by two external modeling studies, Powers et al. (2011) and Akullian et al. (2020), regarding the strategy's inadequacy for eliminating HIV among heterosexual populations in Africa. The third significant output of our model, the synergism between PrEP and HIV test-and-treat strategies, corroborates an external modeling study by Lima et al. (2021). This study shows that the HIV epidemic among MSM in British Columbia, which

	was less responsive to the HIV test-and-treat strategy than the HIV epidemic among other key populations, might be eliminated with the provision of PrEP.

Supplementary Note 2. **TRACE checklist [28] for the stochastic model**

1. Problem formation	To assess the impact of a high-coverage pre-exposure prophylaxis (PrEP) program in Taiwan from an HIV elimination perspective, we developed a stochastic model. This model examines the basic reproduction number (R_0) of HIV among high-risk men who have sex with men (MSM) under various scenarios. The World Health Organization stated that "reduction in HIV incidence, with the goal of eventual elimination, would require that the R_0 —the number of secondary infections resulting from one primary infection in an otherwise susceptible population—is reduced to and kept below 1" [29]. The necessity to simulate whether HIV elimination can be achieved with an R_0 less than 1 justified the use of a stochastic model in this context.
2. Model description	The model simulates the life course of a young MSM with high-risk sexual behavior, who acquires HIV on his 20th birthday, up to the age of 45. The natural history of HIV, the substantially higher infectiousness during the acute HIV infection and AIDS stages, the HIV test-and-treat process, the effect of antiretroviral therapy (ART) on transmission and mortality, and the effect of PrEP in preventing HIV infection mirror those aspects in the deterministic model. Each day, the index patient may engage in oral or anal sex with other high-risk, HIV-negative MSM (on PrEP or not), undergo HIV testing (which is followed by linkage to care and the subsequent initiation of ART), or die. We have provided a comprehensive model description in this manuscript and the supplementary information. This includes schematic diagrams of the natural history of HIV infection (Supplementary Figures 2 and 3), the stochastic model (Supplementary Figure 6), and 35 scenarios in which HIV testing, linkage to care, and initiation of ART either occur or do not occur at various stages of HIV (Supplementary Figure 7), as well as the R code script of the model (Supplementary Note 5). The model parameters, values, data references, and initial conditions are detailed in Supplementary Data 2. The code for the model is available at https://github.com/ninowwss/SPITCA-model/tree/main.

3. Data evaluation	This model was constructed using data on the natural history of HIV and the relative infectiousness during the acute stage compared to the chronic stage, as reported by Longini et al.[1] and Hollingsworth et al.[3]. The per-act probability of HIV transmission is based on a systematic review of empirical studies. The condom use rate is based on published behavioral data in Taiwan. The level of sexual mixing among high-risk MSM aged 15-44 years and the status quo HIV testing rate are derived from the fitting results of the deterministic model. Mortality rates are likewise based on estimates utilized in the deterministic model.
4. Conceptual model evaluation	The conceptual model is based on the well-established natural history of HIV (Supplementary Figure 2) and the concept of the HIV care continuum, from testing and linkage to care, to the initiation of ART (Figure 1). This model was constructed to simulate the well-documented effects of ART in reducing HIV transmission and mortality, as well as the well-documented effects of PrEP in preventing HIV acquisition.
5. Implementation verification	The model is implemented in R (R Foundation for Statistical Computing, Vienna, Austria). The model's coding underwent extensive testing and verification during the parameterization process.
6. Model output verification	No model output verification was performed in the sense of optimizing parameters to a dataset. How well the model simulation matches observation is presented in Model Output Corroboration.
7. Model analysis	We conducted one-way sensitivity analyses to examine the impact of uncertainties in key variables on HIV elimination (Table 2, Supplementary Data 3E, and Supplementary Data 3F). The results indicate that, in the absence of PrEP, annual HIV testing and immediate initiation of ART could eliminate HIV only in favorable scenarios with a mixing level as low as 25 sexual partners per year or acute stage infectiousness of only 3 to 10-fold higher than the chronic stage. In contrast, under the status quo of HIV test-and-treat, a 50% PrEP coverage targeting high-risk MSM aged 15 to 44 years will reduce the R_0 of HIV to below 1, even under

	unfavorable scenarios with a mixing level as high as 75 sexual partners per year, acute stage infectiousness of up to 30-fold over the chronic stage, or PrEP drug resistance up to 10%.
8. Model output corroboration	The main model output suggests that implementing a PrEP program with 50% coverage will reduce the R_0 of the HIV to below 1. This finding is corroborated by external observations that a rapid, targeted, high-coverage rollout of PrEP was associated with a rapid decline in new HIV diagnoses in New South Wales, Australia. Another significant output regarding the limitations of the HIV test-and-treat strategy in eliminating HIV among MSM echoes the conclusions drawn by two external modeling studies, Powers et al. (2011) and Akullian et al. (2020), regarding the strategy's inadequacy for eliminating HIV among heterosexual populations in Africa. The third significant output of our model is the proportion of HIV transmissions that occur during the acute stage. Powers et al. (2011) estimated that, in Malawi, 38% of HIV transmissions occur in the acute stage. Our results also showed that, in Taiwan, approximately one-third of all HIV transmissions occur in the acute stage (Table 1). The fourth significant output of our model, the synergism between PrEP and HIV test-and-treat strategies, corroborates an external modeling study by Lima et al. (2021). This study shows that the HIV epidemic among MSM in British Columbia, which was less responsive to the HIV test-and-treat strategy than the HIV epidemic among other key populations, might be eliminated with the provision of PrEP.

Supplementary Note 3. **TRACE checklist [28] for the economic analysis**

1. Problem formation	To assess the cost-effectiveness of a high-coverage pre-exposure prophylaxis (PrEP) program in Taiwan from an HIV elimination perspective, the economic analysis compares scenarios with or without a PrEP program, projected into the future using the deterministic model. This model examines the trajectory of the epidemic under various scenarios over the next 20 years. The justification for using a deterministic model in this context lies in the observation that, in Taiwan, sexually transmitted HIV infection and hepatitis A among MSM occur as a single, synchronous epidemic rather than as multiple micro-epidemics across cities. This phenomenon can likely be attributed to the intense mixing between MSM communities from different cities, facilitated by high-speed transportation networks that interconnect metropolitan areas into a unified megalopolis.
2. Model description	The compartmental model is risk-structured (high-risk and low-risk group), and age-structured (15-44 years, 45-64 years, and ≥65 years) with assortative mixing (Supplementary Figure 1). The high-risk groups consist of MSM at risk of acquiring HIV from unsafe sexual practices with multiple, random sexual partners. Each risk/age stratum was subdivided to 37 mutually exclusive compartments, based on the stage of natural history, HIV test-and-treat status, and PrEP status (Figure 1). The model considers the natural history of HIV infection across age strata (Supplementary Figure 2) and the substantially higher infectiousness observed during the acute HIV infection and the AIDS stage (Supplementary Figure 3). It also considers the impact of antiretroviral therapy (ART) in reducing HIV transmission and HIV-related mortality. Furthermore, we assume that behavioral changes following HIV diagnosis and linkage to care are associated with a reduction in HIV transmissions. We adopt a societal perspective over a 20-year time horizon. All future costs, including those related to PrEP and HIV treatnent, are adjusted by a 3% annual discount rate to their 2021 value. We have provided a comprehensive model description in this manuscript and the supplementary information, including schematic diagrams of the

	risk/age structure (Supplementary Figure 1) and 37 compartments for each risk/age stratum (Figure 1), the differential equations for the model (Supplementary Note 4), as well as the cost structure of PrEP and HIV treatment (Supplementary Figures 8 and 9). The model parameters, values, data references, and initial conditions are detailed in Supplementary Data 1, as well as in Supplementary Tables 1 to 10. The code for the model is available at https://github.com/ninowwss/SPITCA-model/tree/main.
3. Data evaluation	This model was built using Taiwan's national HIV registry data (Figure 2) and HIV cascade data provided by the Taiwan Centers for Disease Control (Supplementary Tables 4 and 5), and cost data for PrEP and HIV-associated medical care from Taiwan National Health Insurance (Supplementary Tables 9 and 10). The size of the at-risk population is based on Taiwan population statistics, assuming that 3% of the male population are MSM (Supplementary Tables 6 and 8). We estimated the effective population size of the high-risk group, transmission coefficients, and the theoretical initial year when the first HIV infection occurred in Taiwan (Supplementary Data 1), by fitting the model to the actual Taiwan HIV epidemic curve from 1990 to 2019 (Figure 2 and Supplementary Figure 4) using the least squares method. Mortality rates for people with or without HIV are based on the Taiwan HIV registry, weighted by hazard ratios for HIV stage, antiretroviral treatment status, age strata, and time period as reported by large treatment cohort studies (Supplementary Table 2), as well as Taiwan's vital statistics (Supplementary Table 7), respectively. We estimated the rates of linkage to care and initiation of ART based on the reciprocal of the mean duration from diagnosis to the first medical visit, and on the HIV treatment data provided by the Taiwan CDC, respectively (Supplementary Tables 4 and 5). The cost structure of the PrEP program includes costs for PrEP drugs, counseling, regular testing for HIV, syphilis, and other sexually transmitted infections, as well as biochemical monitoring for adverse effects (Supplementary Figure 8 and Supplementary Table 9). The cost for each item was based on the reimbursement guidelines for medical services of the Taiwan National Health Insurance. The cost structure of HIV treatment

	encompasses cost for ART, regular testing for CD4 count and HIV viral load, biochemical follow-ups, case management, and treatment for opportunistic infections, stratified by the presence of AIDS at diagnosis (Supplementary Figure 9 and Supplementary Table 10). The cost for each item was based on real-world data from the Taiwan National Health Insurance database. We estimated the lifetime HIV-associated medical costs under Taiwan's National Health Insurance by integrating projected lifetime survival curves (Supplementary Figure 10) with the mean HIV treatment cost per patient. The projected lifetime survival curves were based on the work of Lo et al. (2024). Additionally, the loss of quality-adjusted life expectancy (QALE) for each Taiwanese MSM with a new HIV diagnosis are also based on the work of Lo et al. (2024) who empirically measured the quality of life among HIV-infected patients using the EuroQol-5D health utility instrument, and integrated this with projected lifetime survival to estimate QALE after HIV diagnosis and loss-of-QALE relative to the general population (Supplementary Figure 11). We calculate the societal human capital saved by averting new HIV diagnoses by multiplying the total number of QALYs gained (Table 4), under the intervention scenario, by Taiwan's per capita gross domestic product (GDP), in line with the World Health Organization's recommended threshold for cost-effectiveness of interventions[30].
4. Conceptual model evaluation	The conceptual model is based on the well-established natural history of HIV (Supplementary Figure 2) and the concept of the HIV care continuum, from testing and linkage to care, to the initiation of ART (Figure 1). This model was constructed to simulate the well-documented effects of ART in reducing HIV transmission and mortality, as well as the well-documented effects of PrEP in preventing HIV acquisition.
5. Implementation verification	The model is implemented in STELLA (ISEE Systems, Lebanon, NH 03766, USA), a software with a graphical user interface that allows for intuitive visual inspection and validation of the computer coding. The model coding underwent extensive testing and verification during the model fitting and parameterization.

6. Model output verification	The model output was fitted to the actual HIV epidemic curve in Taiwan from 1990 to 2019 by age strata (Figure 2 and Supplementary Figure 4) and the percentage of late HIV diagnosis among new HIV cases by age strata (Supplementary Figure 5).
7. Model analysis	We conducted one-way sensitivity analyses (Figure 5) to examine the impact of uncertainties in key variables on economic analysis. These parameters include the cost of PrEP (generic versus brand-name drugs), the timing of PrEP rollout (2019 versus 2023), the mode of PrEP use (on-demand versus daily use), the time horizon (10 years versus 30 years), the cost of ART (cheapest first-line ART versus the most expensive second-line ART), the coverage rate of PrEP (25% versus 75%), adherence to PrEP (75% versus 100%), resistance to PrEP drugs (0% versus 10%), and condom use (0% versus 30%). The adoption of a generic drug, costing one-third the price of brand-name drugs, and switching from an on-demand mode of PrEP use (the base scenario) to daily use (associated with a two-fold increase in drug consumption and cost) exert the most significant impacts on the benefit-cost ratio estimate. Nonetheless, even under the scenario of daily use of brand-name Truvada^{TM}, a high-coverage PrEP program remains cost-effective, exhibiting a benefit-cost ratio of 3.80. The influence of other parameters on the benefit-cost ratio of a PrEP program is even more marginal.
8. Model output corroboration	Previous studies on the cost-effectiveness of PrEP generally show that, under a persistent HIV epidemic, PrEP is cost-effective but not cost-saving unless over a very long (80 years) time horizon or with massive price reduction. In contrast, we found that PrEP using brand name Truvada^{TM} is highly cost-saving over a 20-year time horizon when implemented to eliminate the HIV epidemic by averting a substantial amount of HIV-associated lifetime medical costs and HIV-associated losses in human capital. As this model is the first to evaluate the cost-effectiveness of implementing a high-coverage PrEP program for HIV elimination, we are unable to find external data sources to corroborate our findings in terms of similar model output results.

Supplementary Note 4. **Differential equations of the deterministic model**

<u>Force of infection (V)</u>

By Age strata and PrEP status

Non-PrEP users, 15-44 years

$$\mathrm{V}_1 = \left[(\beta_{HH,j=1} \cdot \frac{S^{h=1}_{\mathrm{j=1}}}{N^{h=1}_{\mathrm{j=1}}}) + (\beta_{HL,j=1} \cdot \frac{S^{h=0}_{\mathrm{j=1}}}{N^{h=0}_{\mathrm{j=1}}}) \right] \cdot$$

$$\left\{ \begin{array}{c} \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(I^{h=1}_{k,\mathrm{j=1}}\right) + \sum_{k=3}^{5}\left(I^{h=1}_{k,\mathrm{j=1}}\right) + \lambda_2 \cdot I^{h=1}_{k=6,\mathrm{j=1}} + \theta \cdot I^{h=1}_{k=7,\mathrm{j=1}}\right] + \\ \varepsilon_T \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(T^{h=1}_{k,\mathrm{j=1}}\right) + \sum_{k=3}^{5}\left(T^{h=1}_{k,\mathrm{j=1}}\right) + \lambda_2 \cdot T^{h=1}_{k=6,\mathrm{j=1}} + \theta \cdot T^{h=1}_{k=7,\mathrm{j=1}}\right] + \\ \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(C^{h=1}_{k,\mathrm{j=1}}\right) + \sum_{k=3}^{5}\left(C^{h=1}_{k,\mathrm{j=1}}\right) + \lambda_2 \cdot C^{h=1}_{k=6,\mathrm{j=1}} + \theta \cdot C^{h=1}_{k=7,\mathrm{j=1}}\right] + \\ \varepsilon_A \cdot \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(A^{h=1}_{k,\mathrm{j=1}}\right) + \sum_{k=3}^{5}\left(A^{h=1}_{k,\mathrm{j=1}}\right) + \lambda_2 \cdot \sum_{k=6}^{7}\left(A^{h=1}_{k,\mathrm{j=1}}\right)\right] + \\ \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(P^{h=1}_{k,\mathrm{j=1}}\right) + \sum_{k=3}^{5}\left(P^{h=1}_{k,\mathrm{j=1}}\right) + \lambda_2 \cdot P^{h=1}_{k=6,\mathrm{j=1}} + \theta \cdot P^{h=1}_{k=7,\mathrm{j=1}}\right] \end{array} \right\} +$$

$$\left\{ \left[\beta_{HL,j=1} \cdot \frac{S^{h=1}_{\mathrm{j=1}}}{N^{h=1}_{\mathrm{j=1}}}\right] + \left[\beta_{LL,j=1} \cdot \frac{S^{h=0}_{\mathrm{j=1}}}{N^{h=0}_{\mathrm{j=1}}}\right] \right\} \cdot$$

$$\left\{ \begin{array}{c} \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(I^{h=0}_{k,\mathrm{j=1}}\right) + \sum_{k=3}^{5}\left(I^{h=0}_{k,\mathrm{j=1}}\right) + \lambda_2 \cdot I^{h=0}_{k=6,\mathrm{j=1}} + \theta \cdot I^{h=0}_{k=7,\mathrm{j=1}}\right] + \\ \varepsilon_T \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(T^{h=0}_{k,\mathrm{j=1}}\right) + \sum_{k=3}^{5}\left(T^{h=0}_{k,\mathrm{j=1}}\right) + \lambda_2 \cdot T^{h=0}_{k=6,\mathrm{j=1}} + \theta \cdot T^{h=0}_{k=7,\mathrm{j=1}}\right] + \\ \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(C^{h=0}_{k,\mathrm{j=1}}\right) + \sum_{k=3}^{5}\left(C^{h=0}_{k,\mathrm{j=1}}\right) + \lambda_2 \cdot C^{h=0}_{k=6,\mathrm{j=1}} + \theta \cdot C^{h=0}_{k=7,\mathrm{j=1}}\right] + \\ \varepsilon_A \cdot \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(A^{h=0}_{k,\mathrm{j=1}}\right) + \sum_{k=3}^{5}\left(A^{h=0}_{k,\mathrm{j=1}}\right) + \lambda_2 \cdot \sum_{k=6}^{7}\left(A^{h=0}_{k,\mathrm{j=1}}\right)\right] \end{array} \right\} + \kappa 1,2 \cdot$$

$$\left\{ \begin{array}{c} \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(I^{h=1}_{k,\mathrm{j=2}}\right) + \sum_{k=3}^{5}\left(I^{h=1}_{k,\mathrm{j=2}}\right) + \lambda_2 \cdot I^{h=1}_{k=6,\mathrm{j=2}} + \theta \cdot I^{h=1}_{k=7,\mathrm{j=2}}\right] + \\ \varepsilon_T \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(T^{h=1}_{k,\mathrm{j=2}}\right) + \sum_{k=3}^{5}\left(T^{h=1}_{k,\mathrm{j=2}}\right) + \lambda_2 \cdot T^{h=1}_{k=6,\mathrm{j=2}} + \theta \cdot T^{h=1}_{k=7,\mathrm{j=2}}\right] + \\ \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(C^{h=1}_{k,\mathrm{j=2}}\right) + \sum_{k=3}^{5}\left(C^{h=1}_{k,\mathrm{j=2}}\right) + \lambda_2 \cdot C^{h=1}_{k=6,\mathrm{j=2}} + \theta \cdot C^{h=1}_{k=7,\mathrm{j=2}}\right] + \\ \varepsilon_A \cdot \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(A^{h=1}_{k,\mathrm{j=2}}\right) + \sum_{k=3}^{5}\left(A^{h=1}_{k,\mathrm{j=2}}\right) + \lambda_2 \cdot \sum_{k=6}^{7}\left(A^{h=1}_{k,\mathrm{j=2}}\right)\right] \end{array} \right\} \cdot$$

$$\left\{ \left[\beta_{HH,j=2} \cdot \frac{S^{h=1}_{\mathrm{j=1}}}{N^{h=1}_{\mathrm{j=1}}}\right] + \left[\beta_{HL,j=2} \cdot \frac{S^{h=0}_{\mathrm{j=1}}}{N^{h=0}_{\mathrm{j=1}}}\right] \right\} + \kappa 1,2 \cdot$$

$$\left\{\begin{array}{c} \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(I_{k,\mathrm{j}=2}^{h=0}\right) + \sum_{k=3}^{5}\left(I_{k,\mathrm{j}=2}^{h=0}\right) + \lambda_2 \cdot I_{k=6,\mathrm{j}=2}^{h=0} + \theta \cdot I_{k=7,\mathrm{j}=2}^{h=0}\right] + \\ \varepsilon_T \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(T_{k,\mathrm{j}=2}^{h=0}\right) + \sum_{k=3}^{5}\left(T_{k,\mathrm{j}=2}^{h=0}\right) + \lambda_2 \cdot T_{k=6,\mathrm{j}=2}^{h=0} + \theta \cdot T_{k=7,\mathrm{j}=2}^{h=0}\right] + \\ \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(C_{k,\mathrm{j}=2}^{h=0}\right) + \sum_{k=3}^{5}\left(C_{k,\mathrm{j}=2}^{h=0}\right) + \lambda_2 \cdot C_{k=6,\mathrm{j}=2}^{h=0} + \theta \cdot C_{k=7,\mathrm{j}=2}^{h=0}\right] + \\ \varepsilon_A \cdot \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(A_{k,\mathrm{j}=2}^{h=0}\right) + \sum_{k=3}^{5}\left(A_{k,\mathrm{j}=2}^{h=0}\right) + \lambda_2 \cdot \sum_{k=6}^{7}\left(A_{k,\mathrm{j}=2}^{h=0}\right)\right] \end{array}\right\} \cdot$$

$$\left\{\left[\beta_{HL,j=2} \cdot \frac{S_{\mathrm{j}=1}^{h=1}}{N_{\mathrm{j}=1}^{h=1}}\right] + \left[\beta_{LL,j=2} \cdot \frac{S_{\mathrm{j}=1}^{h=0}}{N_{\mathrm{j}=1}^{h=0}}\right]\right\} + \kappa 1{,}3 \cdot$$

$$\left\{\begin{array}{c} \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(I_{k,\mathrm{j}=3}^{h=1}\right) + \sum_{k=3}^{5}\left(I_{k,\mathrm{j}=3}^{h=1}\right) + \lambda_2 \cdot I_{k=6,\mathrm{j}=3}^{h=1} + \theta \cdot I_{k=7,\mathrm{j}=3}^{h=1}\right] + \\ \varepsilon_T \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(T_{k,\mathrm{j}=3}^{h=1}\right) + \sum_{k=3}^{5}\left(T_{k,\mathrm{j}=3}^{h=1}\right) + \lambda_2 \cdot T_{k=6,\mathrm{j}=3}^{h=1} + \theta \cdot T_{k=7,\mathrm{j}=3}^{h=1}\right] + \\ \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(C_{k,\mathrm{j}=3}^{h=1}\right) + \sum_{k=3}^{5}\left(C_{k,\mathrm{j}=3}^{h=1}\right) + \lambda_2 \cdot C_{k=6,\mathrm{j}=3}^{h=1} + \theta \cdot C_{k=7,\mathrm{j}=3}^{h=1}\right] + \\ \varepsilon_A \cdot \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(A_{k,\mathrm{j}=3}^{h=1}\right) + \sum_{k=3}^{5}\left(A_{k,\mathrm{j}=3}^{h=1}\right) + \lambda_2 \cdot \sum_{k=6}^{7}\left(A_{k,\mathrm{j}=3}^{h=1}\right)\right] \end{array}\right\} \cdot$$

$$\left\{\left[\beta_{HH,j=3} \cdot \frac{S_{\mathrm{j}=1}^{h=1}}{N_{\mathrm{j}=1}^{h=1}}\right] + \left[\beta_{HL,j=3} \cdot \frac{S_{\mathrm{j}=1}^{h=0}}{N_{\mathrm{j}=1}^{h=0}}\right]\right\} + \kappa 1{,}3 \cdot$$

$$\left\{\begin{array}{c} \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(I_{k,\mathrm{j}=3}^{h=0}\right) + \sum_{k=3}^{5}\left(I_{k,\mathrm{j}=3}^{h=0}\right) + \lambda_2 \cdot I_{k=6,\mathrm{j}=3}^{h=0} + \theta \cdot I_{k=7,\mathrm{j}=3}^{h=0}\right] + \\ \varepsilon_T \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(T_{k,\mathrm{j}=3}^{h=0}\right) + \sum_{k=3}^{5}\left(T_{k,\mathrm{j}=3}^{h=0}\right) + \lambda_2 \cdot T_{k=6,\mathrm{j}=3}^{h=0} + \theta \cdot T_{k=7,\mathrm{j}=3}^{h=0}\right] + \\ \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(C_{k,\mathrm{j}=3}^{h=0}\right) + \sum_{k=3}^{5}\left(C_{k,\mathrm{j}=3}^{h=0}\right) + \lambda_2 \cdot C_{k=6,\mathrm{j}=3}^{h=0} + \theta \cdot C_{k=7,\mathrm{j}=3}^{h=0}\right] + \\ \varepsilon_A \cdot \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(A_{k,\mathrm{j}=3}^{h=0}\right) + \sum_{k=3}^{5}\left(A_{k,\mathrm{j}=3}^{h=0}\right) + \lambda_2 \cdot \sum_{k=6}^{7}\left(A_{k,\mathrm{j}=3}^{h=0}\right)\right] \end{array}\right\} \cdot$$

$$\left\{\left[\beta_{HL,j=3} \cdot \frac{S_{\mathrm{j}=1}^{h=1}}{N_{\mathrm{j}=1}^{h=1}}\right] + \left[\beta_{LL,j=3} \cdot \frac{S_{\mathrm{j}=1}^{h=0}}{N_{\mathrm{j}=1}^{h=0}}\right]\right\}$$

Non-PrEP users, 45-64 years

$$V_2 = \kappa 1{,}2 \cdot \left(\beta_{HL,j=2} \cdot \frac{S_{\mathrm{j}=2}^{h=0}}{N_{\mathrm{j}=2}^{h=0}} + \beta_{HH,j=2} \cdot \frac{S_{\mathrm{j}=2}^{h=1}}{N_{\mathrm{j}=2}^{h=1}}\right) \cdot$$

$$\left\{\begin{array}{c} \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(I_{k,\mathrm{j}=1}^{h=1}\right) + \sum_{k=3}^{5}\left(I_{k,\mathrm{j}=1}^{h=1}\right) + \lambda_2 \cdot I_{k=6,\mathrm{j}=1}^{h=1} + \theta \cdot I_{k=7,\mathrm{j}=1}^{h=1}\right] + \\ \varepsilon_T \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(T_{k,\mathrm{j}=1}^{h=1}\right) + \sum_{k=3}^{5}\left(T_{k,\mathrm{j}=1}^{h=1}\right) + \lambda_2 \cdot T_{k=6,\mathrm{j}=1}^{h=1} + \theta \cdot T_{k=7,\mathrm{j}=1}^{h=1}\right] + \\ \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(C_{k,\mathrm{j}=1}^{h=1}\right) + \sum_{k=3}^{5}\left(C_{k,\mathrm{j}=1}^{h=1}\right) + \lambda_2 \cdot C_{k=6,\mathrm{j}=1}^{h=1} + \theta \cdot C_{k=7,\mathrm{j}=1}^{h=1}\right] + \\ \varepsilon_A \cdot \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(A_{k,\mathrm{j}=1}^{h=1}\right) + \sum_{k=3}^{5}\left(A_{k,\mathrm{j}=1}^{h=1}\right) + \lambda_2 \cdot \sum_{k=6}^{7}\left(A_{k,\mathrm{j}=1}^{h=1}\right)\right] + \\ \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(P_{k,\mathrm{j}=1}^{h=1}\right) + \sum_{k=3}^{5}\left(P_{k,\mathrm{j}=1}^{h=1}\right) + \lambda_2 \cdot P_{k=6,\mathrm{j}=1}^{h=1} + \theta \cdot P_{k=7,\mathrm{j}=1}^{h=1}\right] \end{array}\right\}$$

$$+\kappa 1{,}2 \cdot \left(\beta_{LL,j=2} \cdot \frac{S_{\mathrm{j}=2}^{h=0}}{N_{\mathrm{j}=2}^{h=0}} + \beta_{HL,j=2} \cdot \frac{S_{\mathrm{j}=2}^{h=1}}{N_{\mathrm{j}=2}^{h=1}}\right) \cdot$$

$$\left\{\begin{array}{c} \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(I_{k,\mathrm{j}=1}^{h=0}\right) + \sum_{k=3}^{5}\left(I_{k,\mathrm{j}=1}^{h=0}\right) + \lambda_2 \cdot I_{k=6,\mathrm{j}=1}^{h=0} + \theta \cdot I_{k=7,\mathrm{j}=1}^{h=0}\right] + \\ \varepsilon_T \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(T_{k,\mathrm{j}=1}^{h=0}\right) + \sum_{k=3}^{5}\left(T_{k,\mathrm{j}=1}^{h=0}\right) + \lambda_2 \cdot T_{k=6,\mathrm{j}=1}^{h=0} + \theta \cdot T_{k=7,\mathrm{j}=1}^{h=0}\right] + \\ \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(C_{k,\mathrm{j}=1}^{h=0}\right) + \sum_{k=3}^{5}\left(C_{k,\mathrm{j}=1}^{h=0}\right) + \lambda_2 \cdot C_{k=6,\mathrm{j}=1}^{h=0} + \theta \cdot C_{k=7,\mathrm{j}=1}^{h=0}\right] + \\ \varepsilon_A \cdot \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(A_{k,\mathrm{j}=1}^{h=0}\right) + \sum_{k=3}^{5}\left(A_{k,\mathrm{j}=1}^{h=0}\right) + \lambda_2 \cdot \sum_{k=6}^{7}\left(A_{k,\mathrm{j}=1}^{h=0}\right)\right] \end{array}\right\}$$

$$+\left(\beta_{HL,j=2} \cdot \frac{S_{\mathrm{j}=2}^{h=0}}{N_{\mathrm{j}=2}^{h=0}} + \beta_{HH,j=2} \cdot \frac{S_{\mathrm{j}=2}^{h=1}}{N_{\mathrm{j}=2}^{h=1}}\right) \cdot$$

$$\left\{\begin{array}{c} \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(I_{k,\mathrm{j}=2}^{h=1}\right) + \sum_{k=3}^{5}\left(I_{k,\mathrm{j}=2}^{h=1}\right) + \lambda_2 \cdot I_{k=6,\mathrm{j}=2}^{h=1} + \theta \cdot I_{k=7,\mathrm{j}=2}^{h=1}\right] + \\ \varepsilon_T \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(T_{k,\mathrm{j}=2}^{h=1}\right) + \sum_{k=3}^{5}\left(T_{k,\mathrm{j}=2}^{h=1}\right) + \lambda_2 \cdot T_{k=6,\mathrm{j}=2}^{h=1} + \theta \cdot T_{k=7,\mathrm{j}=2}^{h=1}\right] + \\ \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(C_{k,\mathrm{j}=2}^{h=1}\right) + \sum_{k=3}^{5}\left(C_{k,\mathrm{j}=2}^{h=1}\right) + \lambda_2 \cdot C_{k=6,\mathrm{j}=2}^{h=1} + \theta \cdot C_{k=7,\mathrm{j}=2}^{h=1}\right] + \\ \varepsilon_A \cdot \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(A_{k,\mathrm{j}=2}^{h=1}\right) + \sum_{k=3}^{5}\left(A_{k,\mathrm{j}=2}^{h=1}\right) + \lambda_2 \cdot \sum_{k=6}^{7}\left(A_{k,\mathrm{j}=2}^{h=1}\right)\right] \end{array}\right\}$$

$$+\left(\beta_{LL,j=2} \cdot \frac{S_{\mathrm{j}=2}^{h=0}}{N_{\mathrm{j}=2}^{h=0}} + \beta_{HL,j=2} \cdot \frac{S_{\mathrm{j}=2}^{h=1}}{N_{\mathrm{j}=2}^{h=1}}\right) \cdot$$

$$\left\{\begin{array}{c} \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(I_{k,\mathrm{j}=2}^{h=0}\right) + \sum_{k=3}^{5}\left(I_{k,\mathrm{j}=2}^{h=0}\right) + \lambda_2 \cdot I_{k=6,\mathrm{j}=2}^{h=0} + \theta \cdot I_{k=7,\mathrm{j}=2}^{h=0}\right] + \\ \varepsilon_T \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(T_{k,\mathrm{j}=2}^{h=0}\right) + \sum_{k=3}^{5}\left(T_{k,\mathrm{j}=2}^{h=0}\right) + \lambda_2 \cdot T_{k=6,\mathrm{j}=2}^{h=0} + \theta \cdot T_{k=7,\mathrm{j}=2}^{h=0}\right] + \\ \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(C_{k,\mathrm{j}=2}^{h=0}\right) + \sum_{k=3}^{5}\left(C_{k,\mathrm{j}=2}^{h=0}\right) + \lambda_2 \cdot C_{k=6,\mathrm{j}=2}^{h=0} + \theta \cdot C_{k=7,\mathrm{j}=2}^{h=0}\right] + \\ \varepsilon_A \cdot \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(A_{k,\mathrm{j}=2}^{h=0}\right) + \sum_{k=3}^{5}\left(A_{k,\mathrm{j}=2}^{h=0}\right) + \lambda_2 \cdot \sum_{k=6}^{7}\left(A_{k,\mathrm{j}=2}^{h=0}\right)\right] \end{array}\right\}$$

$$+\kappa 2{,}3 \cdot \left(\beta_{HL,j=3} \cdot \frac{S_{\mathrm{j}=2}^{h=0}}{N_{\mathrm{j}=2}^{h=0}} + \beta_{HH,j=3} \cdot \frac{S_{\mathrm{j}=2}^{h=1}}{N_{\mathrm{j}=2}^{h=1}}\right) \cdot$$

$$\left\{\begin{array}{c} \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(I_{k,\mathrm{j}=3}^{h=1}\right) + \sum_{k=3}^{5}\left(I_{k,\mathrm{j}=3}^{h=1}\right) + \lambda_2 \cdot I_{k=6,\mathrm{j}=3}^{h=1} + \theta \cdot I_{k=7,\mathrm{j}=3}^{h=1}\right] + \\ \varepsilon_T \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(T_{k,\mathrm{j}=3}^{h=1}\right) + \sum_{k=3}^{5}\left(T_{k,\mathrm{j}=3}^{h=1}\right) + \lambda_2 \cdot T_{k=6,\mathrm{j}=3}^{h=1} + \theta \cdot T_{k=7,\mathrm{j}=3}^{h=1}\right] + \\ \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(C_{k,\mathrm{j}=3}^{h=1}\right) + \sum_{k=3}^{5}\left(C_{k,\mathrm{j}=3}^{h=1}\right) + \lambda_2 \cdot C_{k=6,\mathrm{j}=3}^{h=1} + \theta \cdot C_{k=7,\mathrm{j}=3}^{h=1}\right] + \\ \varepsilon_A \cdot \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(A_{k,\mathrm{j}=3}^{h=1}\right) + \sum_{k=3}^{5}\left(A_{k,\mathrm{j}=3}^{h=1}\right) + \lambda_2 \cdot \sum_{k=6}^{7}\left(A_{k,\mathrm{j}=3}^{h=1}\right)\right] \end{array}\right\}$$

$$+\kappa 2{,}3 \cdot \left(\beta_{LL,j=3} \cdot \frac{S_{\mathrm{j}=2}^{h=0}}{N_{\mathrm{j}=2}^{h=0}} + \beta_{HL,j=3} \cdot \frac{S_{\mathrm{j}=2}^{h=1}}{N_{\mathrm{j}=2}^{h=1}}\right) \cdot$$

$$\left\{\begin{array}{c}\left[\lambda_1 \cdot \sum_{k=1}^{2}\left(I_{k,\mathrm{j}=3}^{h=0}\right) + \sum_{k=3}^{5}\left(I_{k,\mathrm{j}=3}^{h=0}\right) + \lambda_2 \cdot I_{k=6,\mathrm{j}=3}^{h=0} + \theta \cdot I_{k=7,\mathrm{j}=3}^{h=0}\right] + \\ \varepsilon_T \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(T_{k,\mathrm{j}=3}^{h=0}\right) + \sum_{k=3}^{5}\left(T_{k,\mathrm{j}=3}^{h=0}\right) + \lambda_2 \cdot T_{k=6,\mathrm{j}=3}^{h=0} + \theta \cdot T_{k=7,\mathrm{j}=3}^{h=0}\right] + \\ \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(C_{k,\mathrm{j}=3}^{h=0}\right) + \sum_{k=3}^{5}\left(C_{k,\mathrm{j}=3}^{h=0}\right) + \lambda_2 \cdot C_{k=6,\mathrm{j}=3}^{h=0} + \theta \cdot C_{k=7,\mathrm{j}=3}^{h=0}\right] + \\ \varepsilon_A \cdot \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(A_{k,\mathrm{j}=3}^{h=0}\right) + \sum_{k=3}^{5}\left(A_{k,\mathrm{j}=3}^{h=0}\right) + \lambda_2 \cdot \sum_{k=6}^{7}\left(A_{k,\mathrm{j}=3}^{h=0}\right)\right]\end{array}\right\}$$

Non-PrEP users, ≥65 years

$$V_3 = \kappa 1{,}3 \cdot \left(\beta_{HL,j=3} \cdot \frac{S_{\mathrm{j}=3}^{h=0}}{N_{\mathrm{j}=3}^{h=0}} + \beta_{HH,j=3} \cdot \frac{S_{\mathrm{j}=3}^{h=1}}{N_{\mathrm{j}=3}^{h=1}}\right) \cdot$$

$$\left\{\begin{array}{c}\left[\lambda_1 \cdot \sum_{k=1}^{2}\left(I_{k,\mathrm{j}=1}^{h=1}\right) + \sum_{k=3}^{5}\left(I_{k,\mathrm{j}=1}^{h=1}\right) + \lambda_2 \cdot I_{k=6,\mathrm{j}=1}^{h=1} + \theta \cdot I_{k=7,\mathrm{j}=1}^{h=1}\right] + \\ \varepsilon_T \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(T_{k,\mathrm{j}=1}^{h=1}\right) + \sum_{k=3}^{5}\left(T_{k,\mathrm{j}=1}^{h=1}\right) + \lambda_2 \cdot T_{k=6,\mathrm{j}=1}^{h=1} + \theta \cdot T_{k=7,\mathrm{j}=1}^{h=1}\right] + \\ \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(C_{k,\mathrm{j}=1}^{h=1}\right) + \sum_{k=3}^{5}\left(C_{k,\mathrm{j}=1}^{h=1}\right) + \lambda_2 \cdot C_{k=6,\mathrm{j}=1}^{h=1} + \theta \cdot C_{k=7,\mathrm{j}=1}^{h=1}\right] + \\ \varepsilon_A \cdot \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(A_{k,\mathrm{j}=1}^{h=1}\right) + \sum_{k=3}^{5}\left(A_{k,\mathrm{j}=1}^{h=1}\right) + \lambda_2 \cdot \sum_{k=6}^{7}\left(A_{k,\mathrm{j}=1}^{h=1}\right)\right] + \\ \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(P_{k,\mathrm{j}=1}^{h=1}\right) + \sum_{k=3}^{5}\left(P_{k,\mathrm{j}=1}^{h=1}\right) + \lambda_2 \cdot P_{k=6,\mathrm{j}=1}^{h=1} + \theta \cdot P_{k=7,\mathrm{j}=1}^{h=1}\right]\end{array}\right\}$$

$$+\kappa 1{,}3 \cdot \left(\beta_{LL,j=3} \cdot \frac{S_{\mathrm{j}=3}^{h=0}}{N_{\mathrm{j}=3}^{h=0}} + \beta_{HL,j=2} \cdot \frac{S_{\mathrm{j}=3}^{h=1}}{N_{\mathrm{j}=3}^{h=1}}\right) \cdot$$

$$\left\{\begin{array}{c}\left[\lambda_1 \cdot \sum_{k=1}^{2}\left(I_{k,\mathrm{j}=1}^{h=0}\right) + \sum_{k=3}^{5}\left(I_{k,\mathrm{j}=1}^{h=0}\right) + \lambda_2 \cdot I_{k=6,\mathrm{j}=1}^{h=0} + \theta \cdot I_{k=7,\mathrm{j}=1}^{h=0}\right] + \\ \varepsilon_T \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(T_{k,\mathrm{j}=1}^{h=0}\right) + \sum_{k=3}^{5}\left(T_{k,\mathrm{j}=1}^{h=0}\right) + \lambda_2 \cdot T_{k=6,\mathrm{j}=1}^{h=0} + \theta \cdot T_{k=7,\mathrm{j}=1}^{h=0}\right] + \\ \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(C_{k,\mathrm{j}=1}^{h=0}\right) + \sum_{k=3}^{5}\left(C_{k,\mathrm{j}=1}^{h=0}\right) + \lambda_2 \cdot C_{k=6,\mathrm{j}=1}^{h=0} + \theta \cdot C_{k=7,\mathrm{j}=1}^{h=0}\right] + \\ \varepsilon_A \cdot \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(A_{k,\mathrm{j}=1}^{h=0}\right) + \sum_{k=3}^{5}\left(A_{k,\mathrm{j}=1}^{h=0}\right) + \lambda_2 \cdot \sum_{k=6}^{7}\left(A_{k,\mathrm{j}=1}^{h=0}\right)\right]\end{array}\right\}$$

$$+\kappa 2{,}3 \cdot \left(\beta_{HL,j=3} \cdot \frac{S_{\mathrm{j}=3}^{h=0}}{N_{\mathrm{j}=3}^{h=0}} + \beta_{HH,j=3} \cdot \frac{S_{\mathrm{j}=3}^{h=1}}{N_{\mathrm{j}=3}^{h=1}}\right) \cdot$$

$$\left\{\begin{array}{c}\left[\lambda_1 \cdot \sum_{k=1}^{2}\left(I_{k,\mathrm{j}=2}^{h=1}\right) + \sum_{k=3}^{5}\left(I_{k,\mathrm{j}=2}^{h=1}\right) + \lambda_2 \cdot I_{k=6,\mathrm{j}=2}^{h=1} + \theta \cdot I_{k=7,\mathrm{j}=2}^{h=1}\right] + \\ \varepsilon_T \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(T_{k,\mathrm{j}=2}^{h=1}\right) + \sum_{k=3}^{5}\left(T_{k,\mathrm{j}=2}^{h=1}\right) + \lambda_2 \cdot T_{k=6,\mathrm{j}=2}^{h=1} + \theta \cdot T_{k=7,\mathrm{j}=2}^{h=1}\right] + \\ \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(C_{k,\mathrm{j}=2}^{h=1}\right) + \sum_{k=3}^{5}\left(C_{k,\mathrm{j}=2}^{h=1}\right) + \lambda_2 \cdot C_{k=6,\mathrm{j}=2}^{h=1} + \theta \cdot C_{k=7,\mathrm{j}=2}^{h=1}\right] + \\ \varepsilon_A \cdot \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(A_{k,\mathrm{j}=2}^{h=1}\right) + \sum_{k=3}^{5}\left(A_{k,\mathrm{j}=2}^{h=1}\right) + \lambda_2 \cdot \sum_{k=6}^{7}\left(A_{k,\mathrm{j}=2}^{h=1}\right)\right]\end{array}\right\}$$

$$+\kappa 2{,}3 \cdot \left(\beta_{LL,j=3} \cdot \frac{S_{\mathrm{j}=3}^{h=0}}{N_{\mathrm{j}=3}^{h=0}} + \beta_{HL,j=3} \cdot \frac{S_{\mathrm{j}=3}^{h=1}}{N_{\mathrm{j}=3}^{h=1}}\right) \cdot$$

$$\left\{\begin{array}{c}\left[\lambda_1\cdot\sum_{k=1}^{2}\left(I_{k,\mathrm{j}=2}^{h=0}\right)+\sum_{k=3}^{5}\left(I_{k,\mathrm{j}=2}^{h=0}\right)+\lambda_2\cdot I_{k=6,\mathrm{j}=2}^{h=0}+\theta\cdot I_{k=7,\mathrm{j}=2}^{h=0}\right]+\\ \varepsilon_T\cdot\left[\lambda_1\cdot\sum_{k=1}^{2}\left(T_{k,\mathrm{j}=2}^{h=0}\right)+\sum_{k=3}^{5}\left(T_{k,\mathrm{j}=2}^{h=0}\right)+\lambda_2\cdot T_{k=6,\mathrm{j}=2}^{h=0}+\theta\cdot T_{k=7,\mathrm{j}=2}^{h=0}\right]+\\ \varepsilon_C\cdot\left[\lambda_1\cdot\sum_{k=1}^{2}\left(C_{k,\mathrm{j}=2}^{h=0}\right)+\sum_{k=3}^{5}\left(C_{k,\mathrm{j}=2}^{h=0}\right)+\lambda_2\cdot C_{k=6,\mathrm{j}=2}^{h=0}+\theta\cdot C_{k=7,\mathrm{j}=2}^{h=0}\right]+\\ \varepsilon_A\cdot\varepsilon_C\cdot\left[\lambda_1\cdot\sum_{k=1}^{2}\left(A_{k,\mathrm{j}=2}^{h=0}\right)+\sum_{k=3}^{5}\left(A_{k,\mathrm{j}=2}^{h=0}\right)+\lambda_2\cdot\sum_{k=6}^{7}\left(A_{k,\mathrm{j}=2}^{h=0}\right)\right]\end{array}\right\}+$$

$$\left(\beta_{HL,j=3}\cdot\frac{S_{\mathrm{j}=3}^{h=0}}{N_{\mathrm{j}=3}^{h=0}}+\beta_{HH,j=3}\cdot\frac{S_{\mathrm{j}=3}^{h=1}}{N_{\mathrm{j}=3}^{h=1}}\right)\cdot$$

$$\left\{\begin{array}{c}\left[\lambda_1\cdot\sum_{k=1}^{2}\left(I_{k,\mathrm{j}=3}^{h=1}\right)+\sum_{k=3}^{5}\left(I_{k,\mathrm{j}=3}^{h=1}\right)+\lambda_2\cdot I_{k=6,\mathrm{j}=3}^{h=1}+\theta\cdot I_{k=7,\mathrm{j}=3}^{h=1}\right]+\\ \varepsilon_T\cdot\left[\lambda_1\cdot\sum_{k=1}^{2}\left(T_{k,\mathrm{j}=3}^{h=1}\right)+\sum_{k=3}^{5}\left(T_{k,\mathrm{j}=3}^{h=1}\right)+\lambda_2\cdot T_{k=6,\mathrm{j}=3}^{h=1}+\theta\cdot T_{k=7,\mathrm{j}=3}^{h=1}\right]+\\ \varepsilon_C\cdot\left[\lambda_1\cdot\sum_{k=1}^{2}\left(C_{k,\mathrm{j}=3}^{h=1}\right)+\sum_{k=3}^{5}\left(C_{k,\mathrm{j}=3}^{h=1}\right)+\lambda_2\cdot C_{k=6,\mathrm{j}=3}^{h=1}+\theta\cdot C_{k=7,\mathrm{j}=3}^{h=1}\right]+\\ \varepsilon_A\cdot\varepsilon_C\cdot\left[\lambda_1\cdot\sum_{k=1}^{2}\left(A_{k,\mathrm{j}=3}^{h=1}\right)+\sum_{k=3}^{5}\left(A_{k,\mathrm{j}=3}^{h=1}\right)+\lambda_2\cdot\sum_{k=6}^{7}\left(A_{k,\mathrm{j}=3}^{h=1}\right)\right]\end{array}\right\}-$$

$$+\left(\beta_{HL,j=3}\cdot\frac{S_{\mathrm{j}=3}^{h=1}}{N_{\mathrm{j}=3}^{h=1}}+\beta_{LL,j=3}\cdot\frac{S_{\mathrm{j}=3}^{h=0}}{N_{\mathrm{j}=3}^{h=0}}\right)\cdot$$

$$\left\{\begin{array}{c}\left[\lambda_1\cdot\sum_{k=1}^{2}\left(I_{k,\mathrm{j}=3}^{h=0}\right)+\sum_{k=3}^{5}\left(I_{k,\mathrm{j}=3}^{h=0}\right)+\lambda_2\cdot I_{k=6,\mathrm{j}=3}^{h=0}+\theta\cdot I_{k=7,\mathrm{j}=3}^{h=0}\right]+\\ \varepsilon_T\cdot\left[\lambda_1\cdot\sum_{k=1}^{2}\left(T_{k,\mathrm{j}=3}^{h=0}\right)+\sum_{k=3}^{5}\left(T_{k,\mathrm{j}=3}^{h=0}\right)+\lambda_2\cdot T_{k=6,\mathrm{j}=3}^{h=0}+\theta\cdot T_{k=7,\mathrm{j}=3}^{h=0}\right]+\\ \varepsilon_C\cdot\left[\lambda_1\cdot\sum_{k=1}^{2}\left(C_{k,\mathrm{j}=3}^{h=0}\right)+\sum_{k=3}^{5}\left(C_{k,\mathrm{j}=3}^{h=0}\right)+\lambda_2\cdot C_{k=6,\mathrm{j}=3}^{h=0}+\theta\cdot C_{k=7,\mathrm{j}=3}^{h=0}\right]+\\ \varepsilon_A\cdot\varepsilon_C\cdot\left[\lambda_1\cdot\sum_{k=1}^{2}\left(A_{k,\mathrm{j}=3}^{h=0}\right)+\sum_{k=3}^{5}\left(A_{k,\mathrm{j}=3}^{h=0}\right)+\lambda_2\cdot\sum_{k=6}^{7}\left(A_{k,\mathrm{j}=3}^{h=0}\right)\right]\end{array}\right\}$$

PrEP users

$$V_4=\omega\cdot\beta_{HH,j=1}\cdot$$

$$\frac{P_{0,\mathrm{j}=1}^{h=1}}{N_{\mathrm{j}=1}^{h=1}}\cdot\left\{\begin{array}{c}\left[\lambda_1\cdot\sum_{k=1}^{2}\left(I_{k,\mathrm{j}=1}^{h=1}\right)+\sum_{k=3}^{5}\left(I_{k,\mathrm{j}=1}^{h=1}\right)+\lambda_2\cdot I_{k=6,\mathrm{j}=1}^{h=1}+\theta\cdot I_{k=7,\mathrm{j}=1}^{h=1}\right]+\\ \varepsilon_T\cdot\left[\lambda_1\cdot\sum_{k=1}^{2}\left(T_{k,\mathrm{j}=1}^{h=1}\right)+\sum_{k=3}^{5}\left(T_{k,\mathrm{j}=1}^{h=1}\right)+\lambda_2\cdot T_{k=6,\mathrm{j}=1}^{h=1}+\theta\cdot T_{k=7,\mathrm{j}=1}^{h=1}\right]+\\ \varepsilon_C\cdot\left[\lambda_1\cdot\sum_{k=1}^{2}\left(C_{k,\mathrm{j}=1}^{h=1}\right)+\sum_{k=3}^{5}\left(C_{k,\mathrm{j}=1}^{h=1}\right)+\lambda_2\cdot C_{k=6,\mathrm{j}=1}^{h=1}+\theta\cdot C_{k=7,\mathrm{j}=1}^{h=1}\right]+\\ \varepsilon_A\cdot\varepsilon_C\cdot\left[\lambda_1\cdot\sum_{k=1}^{2}\left(A_{k,\mathrm{j}=1}^{h=1}\right)+\sum_{k=3}^{5}\left(A_{k,\mathrm{j}=1}^{h=1}\right)+\lambda_2\cdot\sum_{k=6}^{7}\left(A_{k,\mathrm{j}=1}^{h=1}\right)\right]+\\ \left[\lambda_1\cdot\sum_{k=1}^{2}\left(P_{k,\mathrm{j}=1}^{h=1}\right)+\sum_{k=3}^{5}\left(P_{k,\mathrm{j}=1}^{h=1}\right)+\lambda_2\cdot P_{k=6,\mathrm{j}=1}^{h=1}+\theta\cdot P_{k=7,\mathrm{j}=1}^{h=1}\right]\end{array}\right\}+\omega\cdot$$

$$\beta_{HL,j=1}\cdot\frac{P_{0,\mathrm{j}=1}^{h=1}}{N_{\mathrm{j}=1}^{h=1}}\cdot$$

$$\left\{\begin{array}{c}\left[\lambda_1\cdot\sum_{k=1}^{2}\left(I_{k,\mathrm{j}=1}^{h=0}\right)+\sum_{k=3}^{5}\left(I_{k,\mathrm{j}=1}^{h=0}\right)+\lambda_2\cdot I_{k=6,\mathrm{j}=1}^{h=0}+\theta\cdot I_{k=7,\mathrm{j}=1}^{h=0}\right]+\\ \varepsilon_T\cdot\left[\lambda_1\cdot\sum_{k=1}^{2}\left(T_{k,\mathrm{j}=1}^{h=0}\right)+\sum_{k=3}^{5}\left(T_{k,\mathrm{j}=1}^{h=0}\right)+\lambda_2\cdot T_{k=6,\mathrm{j}=1}^{h=0}+\theta\cdot T_{k=7,\mathrm{j}=1}^{h=0}\right]+\\ \varepsilon_C\cdot\left[\lambda_1\cdot\sum_{k=1}^{2}\left(C_{k,\mathrm{j}=1}^{h=0}\right)+\sum_{k=3}^{5}\left(C_{k,\mathrm{j}=1}^{h=0}\right)+\lambda_2\cdot C_{k=6,\mathrm{j}=1}^{h=0}+\theta\cdot C_{k=7,\mathrm{j}=1}^{h=0}\right]+\\ \varepsilon_A\cdot\varepsilon_C\cdot\left[\lambda_1\cdot\sum_{k=1}^{2}\left(A_{k,\mathrm{j}=1}^{h=0}\right)+\sum_{k=3}^{5}\left(A_{k,\mathrm{j}=1}^{h=0}\right)+\lambda_2\cdot\sum_{k=6}^{7}\left(A_{k,\mathrm{j}=1}^{h=0}\right)\right]\end{array}\right\}+\omega\cdot\kappa 1{,}2\cdot$$

$$\beta_{HH,j=2}\cdot\frac{P_{0,\mathrm{j}=1}^{h=1}}{N_{\mathrm{j}=1}^{h=1}}\cdot\left\{\begin{array}{c}\left[\lambda_1\cdot\sum_{k=1}^{2}\left(I_{k,\mathrm{j}=2}^{h=1}\right)+\sum_{k=3}^{5}\left(I_{k,\mathrm{j}=2}^{h=1}\right)+\lambda_2\cdot I_{k=6,\mathrm{j}=2}^{h=1}+\theta\cdot I_{k=7,\mathrm{j}=2}^{h=1}\right]+\\ \varepsilon_T\cdot\left[\lambda_1\cdot\sum_{k=1}^{2}\left(T_{k,\mathrm{j}=2}^{h=1}\right)+\sum_{k=3}^{5}\left(T_{k,\mathrm{j}=2}^{h=1}\right)+\lambda_2\cdot T_{k=6,\mathrm{j}=2}^{h=1}+\theta\cdot T_{k=7,\mathrm{j}=2}^{h=1}\right]+\\ \varepsilon_C\cdot\left[\lambda_1\cdot\sum_{k=1}^{2}\left(C_{k,\mathrm{j}=2}^{h=1}\right)+\sum_{k=3}^{5}\left(C_{k,\mathrm{j}=2}^{h=1}\right)+\lambda_2\cdot C_{k=6,\mathrm{j}=2}^{h=1}+\theta\cdot C_{k=7,\mathrm{j}=2}^{h=1}\right]+\\ \varepsilon_A\cdot\varepsilon_C\cdot\left[\lambda_1\cdot\sum_{k=1}^{2}\left(A_{k,\mathrm{j}=2}^{h=1}\right)+\sum_{k=3}^{5}\left(A_{k,\mathrm{j}=2}^{h=1}\right)+\lambda_2\cdot\sum_{k=6}^{7}\left(A_{k,\mathrm{j}=2}^{h=1}\right)\right]\end{array}\right\}$$

$$+\omega\cdot\kappa 1{,}2\cdot\beta_{HL,j=2}\cdot\frac{P_{0,\mathrm{j}=1}^{h=1}}{N_{\mathrm{j}=1}^{h=1}}\cdot$$

$$\left\{\begin{array}{c}\left[\lambda_1\cdot\sum_{k=1}^{2}\left(I_{k,\mathrm{j}=2}^{h=0}\right)+\sum_{k=3}^{5}\left(I_{k,\mathrm{j}=2}^{h=0}\right)+\lambda_2\cdot I_{k=6,\mathrm{j}=2}^{h=0}+\theta\cdot I_{k=7,\mathrm{j}=2}^{h=0}\right]+\\ \varepsilon_T\cdot\left[\lambda_1\cdot\sum_{k=1}^{2}\left(T_{k,\mathrm{j}=2}^{h=0}\right)+\sum_{k=3}^{5}\left(T_{k,\mathrm{j}=2}^{h=0}\right)+\lambda_2\cdot T_{k=6,\mathrm{j}=2}^{h=0}+\theta\cdot T_{k=7,\mathrm{j}=2}^{h=0}\right]+\\ \varepsilon_C\cdot\left[\lambda_1\cdot\sum_{k=1}^{2}\left(C_{k,\mathrm{j}=2}^{h=0}\right)+\sum_{k=3}^{5}\left(C_{k,\mathrm{j}=2}^{h=0}\right)+\lambda_2\cdot C_{k=6,\mathrm{j}=2}^{h=0}+\theta\cdot C_{k=7,\mathrm{j}=2}^{h=0}\right]+\\ \varepsilon_A\cdot\varepsilon_C\cdot\left[\lambda_1\cdot\sum_{k=1}^{2}\left(A_{k,\mathrm{j}=2}^{h=0}\right)+\sum_{k=3}^{5}\left(A_{k,\mathrm{j}=2}^{h=0}\right)+\lambda_2\cdot\sum_{k=6}^{7}\left(A_{k,\mathrm{j}=2}^{h=0}\right)\right]\end{array}\right\}$$

$$+\omega\cdot\kappa 1{,}3\cdot\beta_{HH,j=3}\cdot\frac{P_{0,\mathrm{j}=1}^{h=1}}{N_{\mathrm{j}=1}^{h=1}}\cdot$$

$$\left\{\begin{array}{c}\left[\lambda_1\cdot\sum_{k=1}^{2}\left(I_{k,\mathrm{j}=3}^{h=1}\right)+\sum_{k=3}^{5}\left(I_{k,\mathrm{j}=3}^{h=1}\right)+\lambda_2\cdot I_{k=6,\mathrm{j}=3}^{h=1}+\theta\cdot I_{k=7,\mathrm{j}=3}^{h=1}\right]+\\ \varepsilon_T\cdot\left[\lambda_1\cdot\sum_{k=1}^{2}\left(T_{k,\mathrm{j}=3}^{h=1}\right)+\sum_{k=3}^{5}\left(T_{k,\mathrm{j}=3}^{h=1}\right)+\lambda_2\cdot T_{k=6,\mathrm{j}=3}^{h=1}+\theta\cdot T_{k=7,\mathrm{j}=3}^{h=1}\right]+\\ \varepsilon_C\cdot\left[\lambda_1\cdot\sum_{k=1}^{2}\left(C_{k,\mathrm{j}=3}^{h=1}\right)+\sum_{k=3}^{5}\left(C_{k,\mathrm{j}=3}^{h=1}\right)+\lambda_2\cdot C_{k=6,\mathrm{j}=3}^{h=1}+\theta\cdot C_{k=7,\mathrm{j}=3}^{h=1}\right]+\\ \varepsilon_A\cdot\varepsilon_C\cdot\left[\lambda_1\cdot\sum_{k=1}^{2}\left(A_{k,\mathrm{j}=3}^{h=1}\right)+\sum_{k=3}^{5}\left(A_{k,\mathrm{j}=3}^{h=1}\right)+\lambda_2\cdot\sum_{k=6}^{7}\left(A_{k,\mathrm{j}=3}^{h=1}\right)\right]\end{array}\right\}$$

$$+\omega\cdot\kappa 1{,}3\cdot\beta_{HL,j=3}\cdot\frac{P_{0,\mathrm{j}=1}^{h=1}}{N_{\mathrm{j}=1}^{h=1}}\cdot$$

$$\left\{\begin{array}{c}\left[\lambda_1\cdot\sum_{k=1}^{2}\left(I_{k,\mathrm{j}=3}^{h=0}\right)+\sum_{k=3}^{5}\left(I_{k,\mathrm{j}=3}^{h=0}\right)+\lambda_2\cdot I_{k=6,\mathrm{j}=3}^{h=0}+\theta\cdot I_{k=7,\mathrm{j}=3}^{h=0}\right]+\\ \varepsilon_T\cdot\left[\lambda_1\cdot\sum_{k=1}^{2}\left(T_{k,\mathrm{j}=3}^{h=0}\right)+\sum_{k=3}^{5}\left(T_{k,\mathrm{j}=3}^{h=0}\right)+\lambda_2\cdot T_{k=6,\mathrm{j}=3}^{h=0}+\theta\cdot T_{k=7,\mathrm{j}=3}^{h=0}\right]+\\ \varepsilon_C\cdot\left[\lambda_1\cdot\sum_{k=1}^{2}\left(C_{k,\mathrm{j}=3}^{h=0}\right)+\sum_{k=3}^{5}\left(C_{k,\mathrm{j}=3}^{h=0}\right)+\lambda_2\cdot C_{k=6,\mathrm{j}=3}^{h=0}+\theta\cdot C_{k=7,\mathrm{j}=3}^{h=0}\right]+\\ \varepsilon_A\cdot\varepsilon_C\cdot\left[\lambda_1\cdot\sum_{k=1}^{2}\left(A_{k,\mathrm{j}=3}^{h=0}\right)+\sum_{k=3}^{5}\left(A_{k,\mathrm{j}=3}^{h=0}\right)+\lambda_2\cdot\sum_{k=6}^{7}\left(A_{k,\mathrm{j}=3}^{h=0}\right)\right]\end{array}\right\}$$

Total

$$V_1 + V_2 + V_3 + V_4 = \Bigg[\beta_{HH,j=1} \cdot (\frac{S_{\mathrm{j=1}}^{h=1}}{N_{\mathrm{j=1}}^{h=1}} + \omega \cdot \frac{P_{0,\mathrm{j=1}}^{h=1}}{N_{\mathrm{j=1}}^{h=1}}) + \beta_{HL,j=1} \cdot \frac{S_{\mathrm{j=1}}^{h=0}}{N_{\mathrm{j=1}}^{h=0}} + \kappa 1{,}2 \cdot$$

$$\left(\beta_{HH,j=2} \cdot \frac{S_{\mathrm{j=2}}^{h=1}}{N_{\mathrm{j=2}}^{h=1}} + \beta_{HL,j=2} \cdot \frac{S_{\mathrm{j=2}}^{h=0}}{N_{\mathrm{j=2}}^{h=0}}\right) + \kappa 1{,}3 \cdot (\beta_{HH,j=3} \cdot \frac{S_{\mathrm{j=3}}^{h=1}}{N_{\mathrm{j=3}}^{h=1}} + \beta_{HL,j=3} \cdot \frac{S_{\mathrm{j=3}}^{h=0}}{N_{\mathrm{j=3}}^{h=0}})\Bigg] \cdot$$

$$\left\{\begin{matrix} \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(I_{k,\mathrm{j=1}}^{h=1}\right) + \sum_{k=3}^{5}\left(I_{k,\mathrm{j=1}}^{h=1}\right) + \lambda_2 \cdot I_{k=6,\mathrm{j=1}}^{h=1} + \theta \cdot I_{k=7,\mathrm{j=1}}^{h=1}\right] + \\ \varepsilon_T \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(T_{k,\mathrm{j=1}}^{h=1}\right) + \sum_{k=3}^{5}\left(T_{k,\mathrm{j=1}}^{h=1}\right) + \lambda_2 \cdot T_{k=6,\mathrm{j=1}}^{h=1} + \theta \cdot T_{k=7,\mathrm{j=1}}^{h=1}\right] + \\ \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(C_{k,\mathrm{j=1}}^{h=1}\right) + \sum_{k=3}^{5}\left(C_{k,\mathrm{j=1}}^{h=1}\right) + \lambda_2 \cdot C_{k=6,\mathrm{j=1}}^{h=1} + \theta \cdot C_{k=7,\mathrm{j=1}}^{h=1}\right] + \\ \varepsilon_A \cdot \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(A_{k,\mathrm{j=1}}^{h=1}\right) + \sum_{k=3}^{5}\left(A_{k,\mathrm{j=1}}^{h=1}\right) + \lambda_2 \cdot \sum_{k=6}^{7}\left(A_{k,\mathrm{j=1}}^{h=1}\right)\right] + \\ \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(P_{k,\mathrm{j=1}}^{h=1}\right) + \sum_{k=3}^{5}\left(P_{k,\mathrm{j=1}}^{h=1}\right) + \lambda_2 \cdot P_{k=6,\mathrm{j=1}}^{h=1} + \theta \cdot P_{k=7,\mathrm{j=1}}^{h=1}\right] \end{matrix}\right\} +$$

$$\left[\beta_{HL,j=1} \cdot \frac{S_{\mathrm{j=1}}^{h=1}}{N_{\mathrm{j=1}}^{h=1}} + \beta_{LL,j=1} \cdot \frac{S_{\mathrm{j=1}}^{h=0}}{N_{\mathrm{j=1}}^{h=0}} + \kappa 1{,}2 \cdot \left(\beta_{HL,j=2} \cdot \frac{S_{\mathrm{j=2}}^{h=1}}{N_{\mathrm{j=2}}^{h=1}} + \beta_{LL,j=2} \cdot \frac{S_{\mathrm{j=2}}^{h=0}}{N_{\mathrm{j=2}}^{h=0}}\right) + \kappa 1{,}3 \cdot\right.$$

$$\left.\left(\beta_{HL,j=3} \cdot \frac{S_{\mathrm{j=3}}^{h=1}}{N_{\mathrm{j=3}}^{h=1}} + \beta_{LL,j=3} \cdot \frac{S_{\mathrm{j=3}}^{h=0}}{N_{\mathrm{j=3}}^{h=0}}\right)\right] \cdot$$

$$\left\{\begin{matrix} \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(I_{k,\mathrm{j=1}}^{h=0}\right) + \sum_{k=3}^{5}\left(I_{k,\mathrm{j=1}}^{h=0}\right) + \lambda_2 \cdot I_{k=6,\mathrm{j=1}}^{h=0} + \theta \cdot I_{k=7,\mathrm{j=1}}^{h=0}\right] + \\ \varepsilon_T \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(T_{k,\mathrm{j=1}}^{h=0}\right) + \sum_{k=3}^{5}\left(T_{k,\mathrm{j=1}}^{h=0}\right) + \lambda_2 \cdot T_{k=6,\mathrm{j=1}}^{h=0} + \theta \cdot T_{k=7,\mathrm{j=1}}^{h=0}\right] + \\ \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(C_{k,\mathrm{j=1}}^{h=0}\right) + \sum_{k=3}^{5}\left(C_{k,\mathrm{j=1}}^{h=0}\right) + \lambda_2 \cdot C_{k=6,\mathrm{j=1}}^{h=0} + \theta \cdot C_{k=7,\mathrm{j=1}}^{h=0}\right] + \\ \varepsilon_A \cdot \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(A_{k,\mathrm{j=1}}^{h=0}\right) + \sum_{k=3}^{5}\left(A_{k,\mathrm{j=1}}^{h=0}\right) + \lambda_2 \cdot \sum_{k=6}^{7}\left(A_{k,\mathrm{j=1}}^{h=0}\right)\right] \end{matrix}\right\} +$$

$$\left[\beta_{HH,j=2} \cdot (\kappa 1{,}2 \cdot \frac{S_{\mathrm{j=1}}^{h=1}}{N_{\mathrm{j=1}}^{h=1}} + \frac{S_{\mathrm{j=2}}^{h=1}}{N_{\mathrm{j=2}}^{h=1}}) + \beta_{HL,j=2} \cdot (\kappa 1{,}2 \cdot \frac{S_{\mathrm{j=1}}^{h=0}}{N_{\mathrm{j=1}}^{h=0}} + \frac{S_{\mathrm{j=2}}^{h=0}}{N_{\mathrm{j=2}}^{h=0}}) + \kappa 2{,}3 \cdot \left(\beta_{HH,j=3} \cdot \frac{S_{\mathrm{j=3}}^{h=1}}{N_{\mathrm{j=3}}^{h=1}} +\right.\right.$$

$$\left.\left.\beta_{HL,j=3} \cdot \frac{S_{\mathrm{j=3}}^{h=0}}{N_{\mathrm{j=3}}^{h=0}}\right)\right] \cdot$$

$$\left\{\begin{matrix} \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(I_{k,\mathrm{j=2}}^{h=1}\right) + \sum_{k=3}^{5}\left(I_{k,\mathrm{j=2}}^{h=1}\right) + \lambda_2 \cdot I_{k=6,\mathrm{j=2}}^{h=1} + \theta \cdot I_{k=7,\mathrm{j=2}}^{h=1}\right] + \\ \varepsilon_T \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(T_{k,\mathrm{j=2}}^{h=1}\right) + \sum_{k=3}^{5}\left(T_{k,\mathrm{j=2}}^{h=1}\right) + \lambda_2 \cdot T_{k=6,\mathrm{j=2}}^{h=1} + \theta \cdot T_{k=7,\mathrm{j=2}}^{h=1}\right] + \\ \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(C_{k,\mathrm{j=2}}^{h=1}\right) + \sum_{k=3}^{5}\left(C_{k,\mathrm{j=2}}^{h=1}\right) + \lambda_2 \cdot C_{k=6,\mathrm{j=2}}^{h=1} + \theta \cdot C_{k=7,\mathrm{j=2}}^{h=1}\right] + \\ \varepsilon_A \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(A_{k,\mathrm{j=2}}^{h=1}\right) + \sum_{k=3}^{5}\left(A_{k,\mathrm{j=2}}^{h=1}\right) + \lambda_2 \cdot \sum_{k=6}^{7}\left(A_{k,\mathrm{j=2}}^{h=1}\right)\right] \end{matrix}\right\} +$$

$$\left[\beta_{HL,j=2} \cdot (\kappa 1{,}2 \cdot \frac{S_{\mathrm{j=1}}^{h=1}}{N_{\mathrm{j=1}}^{h=1}} + \frac{S_{\mathrm{j=2}}^{h=1}}{N_{\mathrm{j=2}}^{h=1}}) + \beta_{LL,j=2} \cdot (\kappa 1{,}2 \cdot \frac{S_{\mathrm{j=1}}^{h=0}}{N_{\mathrm{j=1}}^{h=0}} + \frac{S_{\mathrm{j=2}}^{h=0}}{N_{\mathrm{j=2}}^{h=0}}) + \kappa 2{,}3 \cdot \left(\beta_{HL,j=3} \cdot \frac{S_{\mathrm{j=3}}^{h=1}}{N_{\mathrm{j=3}}^{h=1}} +\right.\right.$$

$$\beta_{LL,j=3} \cdot \frac{S_{\mathrm{j}=3}^{h=0}}{N_{\mathrm{j}=3}^{h=0}}\Big)\Big] \cdot$$

$$\left\{\begin{matrix} \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(I_{k,\mathrm{j}=2}^{h=0}\right) + \sum_{k=3}^{5}\left(I_{k,\mathrm{j}=2}^{h=0}\right) + \lambda_2 \cdot I_{k=6,\mathrm{j}=2}^{h=0} + \theta \cdot I_{k=7,\mathrm{j}=2}^{h=0}\right] + \\ \varepsilon_T \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(T_{k,\mathrm{j}=2}^{h=0}\right) + \sum_{k=3}^{5}\left(T_{k,\mathrm{j}=2}^{h=0}\right) + \lambda_2 \cdot T_{k=6,\mathrm{j}=2}^{h=0} + \theta \cdot T_{k=7,\mathrm{j}=2}^{h=0}\right] + \\ \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(C_{k,\mathrm{j}=2}^{h=0}\right) + \sum_{k=3}^{5}\left(C_{k,\mathrm{j}=2}^{h=0}\right) + \lambda_2 \cdot C_{k=6,\mathrm{j}=2}^{h=0} + \theta \cdot C_{k=7,\mathrm{j}=2}^{h=0}\right] + \\ \varepsilon_A \cdot \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(A_{k,\mathrm{j}=2}^{h=0}\right) + \sum_{k=3}^{5}\left(A_{k,\mathrm{j}=2}^{h=0}\right) + \lambda_2 \cdot \sum_{k=6}^{7}\left(A_{k,\mathrm{j}=2}^{h=0}\right)\right] \end{matrix}\right\} +$$

$$\left[\beta_{HH,j=3} \cdot (\kappa 1{,}3 \cdot \frac{S_{\mathrm{j}=1}^{h=1}}{N_{\mathrm{j}=1}^{h=1}} + \kappa 2{,}3 \cdot \frac{S_{\mathrm{j}=2}^{h=1}}{N_{\mathrm{j}=2}^{h=1}} + \frac{S_{\mathrm{j}=3}^{h=1}}{N_{\mathrm{j}=3}^{h=1}}) + \beta_{HL,j=3} \cdot (\kappa 1{,}3 \cdot \frac{S_{\mathrm{j}=1}^{h=0}}{N_{\mathrm{j}=1}^{h=0}} + \kappa 2{,}3 \cdot \frac{S_{\mathrm{j}=2}^{h=0}}{N_{\mathrm{j}=2}^{h=0}} + \frac{S_{\mathrm{j}=3}^{h=0}}{N_{\mathrm{j}=3}^{h=0}})\right] \cdot$$

$$\left\{\begin{matrix} \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(I_{k,\mathrm{j}=3}^{h=1}\right) + \sum_{k=3}^{5}\left(I_{k,\mathrm{j}=3}^{h=1}\right) + \lambda_2 \cdot I_{k=6,\mathrm{j}=3}^{h=1} + \theta \cdot I_{k=7,\mathrm{j}=3}^{h=1}\right] + \\ \varepsilon_T \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(T_{k,\mathrm{j}=3}^{h=1}\right) + \sum_{k=3}^{5}\left(T_{k,\mathrm{j}=3}^{h=1}\right) + \lambda_2 \cdot T_{k=6,\mathrm{j}=3}^{h=1} + \theta \cdot T_{k=7,\mathrm{j}=3}^{h=1}\right] + \\ \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(C_{k,\mathrm{j}=3}^{h=1}\right) + \sum_{k=3}^{5}\left(C_{k,\mathrm{j}=3}^{h=1}\right) + \lambda_2 \cdot C_{k=6,\mathrm{j}=3}^{h=1} + \theta \cdot C_{k=7,\mathrm{j}=3}^{h=1}\right] + \\ \varepsilon_A \cdot \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(A_{k,\mathrm{j}=3}^{h=1}\right) + \sum_{k=3}^{5}\left(A_{k,\mathrm{j}=3}^{h=1}\right) + \lambda_2 \cdot \sum_{k=6}^{7}\left(A_{k,\mathrm{j}=3}^{h=1}\right)\right] \end{matrix}\right\} +$$

$$\left[\beta_{HL,j=3} \cdot (\kappa 1{,}3 \cdot \frac{S_{\mathrm{j}=1}^{h=1}}{N_{\mathrm{j}=1}^{h=1}} + \kappa 2{,}3 \cdot \frac{S_{\mathrm{j}=2}^{h=1}}{N_{\mathrm{j}=2}^{h=1}} + \frac{S_{\mathrm{j}=3}^{h=1}}{N_{\mathrm{j}=3}^{h=1}}) + \beta_{LL,j=3} \cdot (\kappa 1{,}3 \cdot \frac{S_{\mathrm{j}=1}^{h=0}}{N_{\mathrm{j}=1}^{h=0}} + \kappa 2{,}3 \cdot \frac{S_{\mathrm{j}=2}^{h=0}}{N_{\mathrm{j}=2}^{h=0}} + \frac{S_{\mathrm{j}=3}^{h=0}}{N_{\mathrm{j}=3}^{h=0}})\right] \cdot$$

$$\left\{\begin{matrix} \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(I_{k,\mathrm{j}=3}^{h=0}\right) + \sum_{k=3}^{5}\left(I_{k,\mathrm{j}=3}^{h=0}\right) + \lambda_2 \cdot I_{k=6,\mathrm{j}=3}^{h=0} + \theta \cdot I_{k=7,\mathrm{j}=3}^{h=0}\right] + \\ \varepsilon_T \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(T_{k,\mathrm{j}=3}^{h=0}\right) + \sum_{k=3}^{5}\left(T_{k,\mathrm{j}=3}^{h=0}\right) + \lambda_2 \cdot T_{k=6,\mathrm{j}=3}^{h=0} + \theta \cdot T_{k=7,\mathrm{j}=3}^{h=0}\right] + \\ \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(C_{k,\mathrm{j}=3}^{h=0}\right) + \sum_{k=3}^{5}\left(C_{k,\mathrm{j}=3}^{h=0}\right) + \lambda_2 \cdot C_{k=6,\mathrm{j}=3}^{h=0} + \theta \cdot C_{k=7,\mathrm{j}=3}^{h=0}\right] + \\ \varepsilon_A \cdot \varepsilon_C \cdot \left[\lambda_1 \cdot \sum_{k=1}^{2}\left(A_{k,\mathrm{j}=3}^{h=0}\right) + \sum_{k=3}^{5}\left(A_{k,\mathrm{j}=3}^{h=0}\right) + \lambda_2 \cdot \sum_{k=6}^{7}\left(A_{k,\mathrm{j}=3}^{h=0}\right)\right] \end{matrix}\right\}$$

<u>Susceptible</u>

Non-PrEP users, 15-44 years ($S_{j=1}$)

$$\frac{\mathrm{d}S_{\mathrm{j}=1}^{h=0,1}}{\mathrm{dt}} = nE - \alpha_1 S_{\mathrm{j}=1}^{h=0,1} - \mu_{\mathrm{j}=1} S_{\mathrm{j}=1}^{h=0,1} - \varphi S_{\mathrm{j}=1}^{h=1} - V_1$$

Non-PrEP users, 45-64 years ($S_{j=2}$)

$$\frac{\mathrm{d}S_{\mathrm{j}=2}^{h=0,1}}{\mathrm{dt}} = \alpha_1 \cdot (S_{\mathrm{j}=1}^{h=0,1} + P_{0,\mathrm{j}=1}^{h=1}) - \mu_{\mathrm{j}=2} S_{\mathrm{j}=2}^{h=0,1} - V_2$$

Non-PrEP users, ≥65 years ($S_{j=3}$)

$$\frac{\mathrm{d}S_{\mathrm{j}=3}^{h=0,1}}{\mathrm{dt}} = \alpha_2 S_{\mathrm{j}=2}^{h=0,1} - \mu_{\mathrm{j}=3} S_{\mathrm{j}=3}^{h=0,1} - V_3$$

PrEP users (P^0)

$$\frac{\mathrm{d}P_{0,\mathrm{j}=1}^{h=1}}{\mathrm{dt}} = \varphi S_{\mathrm{j}=1}^{h=1} - \alpha_1 P_{0,\mathrm{j}=1}^{h=1} - \mu_{\mathrm{j}=1} P_{0,\mathrm{j}=1}^{h=1} - V_4$$

<u>Infectious, Undiagnosed (I, $P_{1\text{-}7}$)</u>

Age strata

15-44 years

$$\frac{\mathrm{d}I_{k,j=1}^{h}}{\mathrm{dt}} = V_1 - \sum_{h=0}^{1}\sum_{k=1}^{7}\left[(\tau_{k,\mathrm{j}=1}^{h} + \eta I_{k,j=1}) \cdot I_{k,j=1}^{h}\right] - \sum_{h=0}^{1}\sum_{k=1}^{7} I_{k,j=1}^{h} \cdot \alpha_1$$

45-64 years

$$\frac{\mathrm{d}I_{k,j=2}^{h}}{\mathrm{dt}} = V_2 + \sum_{h=0}^{1}\sum_{k=1}^{7} I_{k,j=1}^{h} \cdot \alpha_1 - \sum_{h=0}^{1}\sum_{k=1}^{7}\left[\left(\tau_{k,\mathrm{j}=2}^{h} + \eta I_{k,j=2}\right) \cdot I_{k,j=2}^{h}\right] - \sum_{h=0}^{1}\sum_{k=1}^{7} I_{k,j=2}^{h} \cdot \alpha_2$$

≥65 years

$$\frac{\mathrm{d}I_{k,j=3}^{h}}{\mathrm{dt}} = V_3 + \sum_{h=0}^{1}\sum_{k=1}^{7} I_{k,j=2}^{h} \cdot \alpha_2 - \sum_{h=0}^{1}\sum_{k=1}^{7}\left[\left(\tau_{k,\mathrm{j}=3}^{h} + \eta I_{k,j=3}\right) \cdot I_{k,j=3}^{h}\right]$$

PrEP users

$$\frac{\mathrm{d}P_{k,j=1}^{h=1}}{\mathrm{dt}} = V_4 - \sum_{k=1}^{7}\left[(\tau_{p}{}_{k,\mathrm{j}=1}^{h=1} + \eta I_{k,j=1}) \cdot P_{k,j=1}^{h=1}\right] - \sum_{k=1}^{7} P_{k,j=1}^{h=1} \cdot \alpha_1$$

Total

$$\frac{\mathrm{d}(I_{k,j}^{h} + P_{k,j=1}^{h=1})}{\mathrm{dt}} = V_1 + V_2 + V_3 + V_4$$
$$- \sum_{j=1}^{3}\sum_{h=0}^{1}\sum_{k=1}^{7}\left[\left(\tau_{k,\mathrm{j}}^{h} + \eta I_{k,j}\right) \cdot I_{k,j}^{h}\right] - \sum_{k=1}^{7}\left[\left(\tau_{p}{}_{k,\mathrm{j}=1}^{h=1} + \eta I_{k,j=1}\right) \cdot P_{k,j=1}^{h=1}\right] - \sum_{k=1}^{7} P_{k,j=1}^{h=1} \cdot \alpha_1$$

<u>Tested and Diagnosed (T)</u>

Age strata

15-44 years

$$\frac{\mathrm{d}T_{k,j=1}}{\mathrm{dt}} = \sum_{h=0}^{1}\sum_{k=1}^{7}\left(\tau_{k,\mathrm{j}=1}^{h} \cdot I_{k,j=1}^{h}\right) + \sum_{k=3}^{6}\left(\tau_{pa} \cdot I_{k,j=1}^{h=1}\right) + \pi \cdot \tau_{pa} \cdot I_{k=2,j=1}^{h=1}$$
$$+ \sum_{k=1}^{7}\left(\tau_{p}{}_{k,j=1}^{h=1} \cdot P_{k,j=1}^{h=1}\right) -$$

$$\sum_{h=0}^{1}\sum_{k=1}^{7}\left[\left(\sigma_k + \eta T_{k,j=1}\right) \cdot T_{k,j=1}^{h}\right] - \sum_{h=0}^{1}\sum_{k=1}^{7} T_{k,j=1}^{h} \cdot \alpha_1$$

45-64 years

$$\frac{\mathrm{d}T_{k,j=2}}{\mathrm{dt}} = \sum_{h=0}^{1}\sum_{k=1}^{7}\left(\tau_{k,\mathrm{j}=2}^{h} \cdot I_{k,j=2}^{h}\right) + \sum_{h=0}^{1}\sum_{k=1}^{7} T_{k,j=1}^{h} \cdot \alpha_1 -$$

$$\sum_{h=0}^{1}\sum_{k=1}^{7}\left[\left(\sigma_k + \eta T_{k,j=2}\right) \cdot T_{k,j=2}^{h}\right] - \sum_{h=0}^{1}\sum_{k=1}^{7} T_{k,j=2}^{h} \cdot \alpha_2$$

≥65 years

$$\frac{\mathrm{d}T_{k,j=3}}{\mathrm{dt}} = \sum_{h=0}^{1}\sum_{k=1}^{7}\left(\tau_{k,\mathrm{j}=3}^{h} \cdot I_{k,j=3}^{h}\right) + \sum_{h=0}^{1}\sum_{k=1}^{7} T_{k,j=2}^{h} \cdot \alpha_2 -$$

$$\sum_{h=0}^{1}\sum_{k=1}^{7}\left[(\sigma_k+\eta T_{k,j=3})\cdot T_{k,j=3}^{h}\right]$$

Total

$$\frac{\mathrm{d}T_{k,j}}{\mathrm{dt}}=\sum_{j=1}^{3}\sum_{h=0}^{1}\sum_{k=1}^{7}\left(\tau_{k,\mathrm{j}}^{h}\cdot I_{k,j}^{h}\right)+\sum_{k=1}^{7}\left(\tau_{p}{}_{k,j=1}^{h=1}\cdot P_{k,j=1}^{h=1}\right)+$$

$$\sum_{k=3}^{6}\left(\tau_{pa}\cdot I_{k,j=1}^{h=1}\right)+\text{ב}\cdot\tau_{pa}\cdot I_{k=2,j=1}^{h=1}-\sum_{j=1}^{3}\sum_{h=0}^{1}\sum_{k=1}^{7}\left[(\sigma_k+\eta T_{k,j})\cdot T_{k,j}^{h}\right]$$

<u>Linked to Care (C)</u>

Age strata

15-44 years

$$\frac{\mathrm{d}C_{k,j=1}}{\mathrm{dt}}=\sum_{h=0}^{1}\sum_{k=1}^{7}\left(\sigma_k\cdot T_{k,j=1}^{h}\right)-$$

$$\sum_{h=0}^{1}\sum_{k=1}^{7}\left[(\gamma_k+\eta C_{k,j=1})\cdot C_{k,j=1}^{h}\right]-\sum_{h=0}^{1}\sum_{k=1}^{7}C_{k,j=1}^{h}\cdot\alpha_1$$

45-64 years

$$\frac{\mathrm{d}C_{k,j=2}}{\mathrm{dt}}=\sum_{h=0}^{1}\sum_{k=1}^{7}\left(\sigma_k\cdot T_{k,j=2}^{h}\right)+\sum_{h=0}^{1}\sum_{k=1}^{7}C_{k,j=1}^{h}\cdot\alpha_1-$$

$$\sum_{h=0}^{1}\sum_{k=1}^{7}\left[(\gamma_k+\eta C_{k,j=2})\cdot C_{k,j=2}^{h}\right]-\sum_{h=0}^{1}\sum_{k=1}^{7}C_{k,j=2}^{h}\cdot\alpha_2$$

≥65 years

$$\frac{\mathrm{d}C_{k,j=3}}{\mathrm{dt}}=\sum_{h=0}^{1}\sum_{k=1}^{7}\left(\sigma_{k,\mathrm{j}=3}\cdot T_{k,j=3}^{h}\right)+\sum_{h=0}^{1}\sum_{k=1}^{7}C_{k,j=2}^{h}\cdot\alpha_2-$$

$$\sum_{h=0}^{1}\sum_{k=1}^{7}\left[(\gamma_k + \eta C_{k,j=3}) \cdot C_{k,j=3}^{h}\right]$$

Total

$$\frac{\mathrm{d}C_{k,j}}{\mathrm{dt}} = \sum_{j=1}^{3}\sum_{h=0}^{1}\sum_{k=1}^{7}\left(\sigma_k \cdot T_{k,j}^{h}\right) - \sum_{j=1}^{3}\sum_{h=0}^{1}\sum_{k=1}^{7}\left[(\gamma_k + \eta C_{k,j}) \cdot C_{k,j}^{h}\right]$$

<u>Receiving Antiretroviral therapy (A)</u>

Age strata

15-44 years

$$\frac{\mathrm{d}A_{k,j=1}}{\mathrm{dt}} = \sum_{h=0}^{1}\sum_{k=1}^{7}\left(\gamma_k \cdot C_{k,j=1}^{h}\right) - \sum_{h=0}^{1}\sum_{k=1}^{7}\left[(\alpha_1 + \eta A_{k,j=1}) \cdot A_{k,j=1}^{h}\right]$$

45-64 years

$$\frac{\mathrm{d}A_{k,j=2}}{\mathrm{dt}} = \sum_{h=0}^{1}\sum_{k=1}^{7}\left(\gamma_k \cdot C_{k,j=2}^{h}\right) + \sum_{h=0}^{1}\sum_{k=1}^{7}\left(\alpha_1 \cdot A_{k,j=1}^{h}\right)$$

$$-\sum_{h=0}^{1}\sum_{k=1}^{7}\left[\left(\alpha_2 + \eta A_{k,j=2}\right) \cdot A_{k,j=2}^{h}\right]$$

≥65 years

$$\frac{\mathrm{d}A_{k,j=3}}{\mathrm{dt}} = \sum_{h=0}^{1}\sum_{k=1}^{7}\left(\gamma_k \cdot C_{k,j=3}^{h}\right) + \sum_{h=0}^{1}\sum_{k=1}^{7}(\alpha_2 \cdot A_{k,j=1}^{h}) - \sum_{h=0}^{1}\sum_{k=1}^{7}(\eta A_{k,j=3} \cdot A_{k,j=3}^{h})$$

Total

$$\frac{\mathrm{d}A_{k,j}}{\mathrm{dt}} = \sum_{j=1}^{3}\sum_{h=0}^{1}\sum_{k=1}^{7}\left(\gamma_k \cdot C_{k,j}^{h}\right) - \sum_{j=1}^{3}\sum_{h=0}^{1}\sum_{k=1}^{7}\left(\eta A_{k,j} \cdot A_{k,j}^{h}\right)$$

Supplementary Note 5. **Scripts for R code of the stochastic model**

Setting:

- Test-and-Treat strategy: Annual HIV testing followed by immediate ART
- PrEP strategy: PrEP coverage rate 25%
- Number of sexual partners = 50/year
- Relative Infectiousness (Acute stage/Chronic stage) = 26-fold

Scripts for R code：

```
sum_infected <- 0
sum_contact <- 0
acute_infected <- 0
for (number in 1:1000) {

CD4 <- rnorm(1,1000,20)
Z <- (CD4-1000)/20
Z_new <- function(Z){
if(Z<0)
dice <- -Z
if(Z>=0)
dice <- -Z
return(dice)
}
Z_final <- Z_new(Z)
#time to AIDS
month_AIDS <- 0
while (CD4>200) {
if (CD4<=199)
CD4 <- CD4-((Z_final*0.5)+6.9)
else if (CD4<=349)
CD4 <- CD4-((Z_final*0.3)+6.1)
else if (CD4<=499)
CD4 <- CD4-((Z_final*0.3)+6.4)
```

```
else if (CD4<=699)
CD4 <- CD4-((Z_final*0.4)+10.0)
else if (CD4<=899)
CD4 <- CD4-((Z_final*0.7)+13.3)
else
CD4 <- CD4-((Z_final*1.5)+22.9)
end
month_AIDS <- month_AIDS+1
}
day_AIDS <- month_AIDS*30.4375

#Parameter Setting
contact_rate <- (50/365.25)
prep_efficacy <- 0.86
compliance <- 1
prep <- 0.25
no_prep <- (1-prep)
testing_rate <- 0.0027378507871321
T_C_rate <- 0.919963201471941
C_A_rate <- 0.919963201471941
I6_testing_rate <- 0.0328542094455852
I6_T_C_rate <- 0.919963201471941
I6_C_A_rate <- 0.919963201471941
acute_chronic <- 26
death_withoutT <- 0.00000736
death_T_to_C_to_A <- 0.00000925
death_after_A <- 0.00000819
death_I6_after_A <- 0.00004435

#Simulation
#acute stage 0-30 day (acute1)
count_acute1 <- 1
contact_acute1 <- 0
```

```
testing_acute1 <- 0
death_acute1 <- 0
nothing_acute1 <- 0
infected_acute1 <- 0
probability <- runif(30,0,1)
P_Have_Sex <- contact_rate
P_Test <- 0
P_death <- death_withoutT
P_Nothing <- (1-P_Have_Sex-P_Test-P_death)
P_Oral_Sex <- (1/2)
P_Anal_Sex <- (1/2)
P_Oral_noprep_infected <- (0.0004*acute_chronic)
P_Oral_noprep_uninfected <- (1-P_Oral_noprep_infected)
P_Oral_prep_infected <- (0.0004*acute_chronic*(1-prep_efficacy*compliance))
P_Oral_prep_uninfected <- (1-P_Oral_prep_infected)
P_Anal_noprep_infected <- (0.008*(1-0.3)*acute_chronic)
P_Anal_noprep_uninfected <- (1-P_Anal_noprep_infected)
P_Anal_prep_infected <- (0.008*(1-0.3)*acute_chronic*(1-prep_efficacy*compliance))
P_Anal_prep_uninfected <- (1-P_Anal_prep_infected)
while (count_acute1<=30) {
if (probability[count_acute1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected)
{contact_acute1 <- contact_acute1+1
infected_acute1 <- infected_acute1+1}
else if (probability[count_acute1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected)
contact_acute1 <- contact_acute1+1
else if (probability[count_acute1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected)
{contact_acute1 <- contact_acute1+1
infected_acute1 <- infected_acute1+1}
```

```
else if (probability[count_acute1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected)
contact_acute1 <- contact_acute1+1
else if (probability[count_acute1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected)
{contact_acute1 <- contact_acute1+1
infected_acute1 <- infected_acute1+1}
else if (probability[count_acute1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected)
contact_acute1 <- contact_acute1+1
else if (probability[count_acute1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected)
{contact_acute1 <- contact_acute1+1
infected_acute1 <- infected_acute1+1}
else if (probability[count_acute1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected)
contact_acute1 <- contact_acute1+1
else if (probability[count_acute1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
```

```
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected+P_Test)
testing_acute1 <- testing_acute1+1
else if (probability[count_acute1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected+P_Test+P_death)
{death_acute1 <- death_acute1+1
count_acute1 <-30}
else
nothing_acute1 <- nothing_acute1+1
end
count_acute1 <- count_acute1+1
}

#acute stage 31-90 day (acute2)
count_acute2_1 <- 1
contact_acute2_1 <- 0
testing_acute2_1 <- 0
death_acute2_1 <- 0
nothing_acute2_1 <- 0
infected_acute2_1 <- 0
probability_acute2_1 <- runif(60,0,1)
P_Have_Sex <- ifelse(death_acute1==0, contact_rate, 0)
P_Test <- ifelse(death_acute1==0, testing_rate, 0)
P_death <- ifelse(death_acute1==0, death_withoutT, 0)
P_Nothing <- ifelse(death_acute1==0, (1-P_Have_Sex-P_Test-P_death),0)
P_Oral_Sex <- (1/2)
P_Anal_Sex <- (1/2)
P_Oral_noprep_infected <- (0.0004*acute_chronic)
```

```
P_Oral_noprep_uninfected <- (1-P_Oral_noprep_infected)

P_Oral_prep_infected <- (0.0004*acute_chronic*(1-prep_efficacy*compliance))

P_Oral_prep_uninfected <- (1-P_Oral_prep_infected)

P_Anal_noprep_infected <- (0.008*(1-0.3)*acute_chronic)

P_Anal_noprep_uninfected <- (1-P_Anal_noprep_infected)

P_Anal_prep_infected <- (0.008*(1-0.3)*acute_chronic*(1-prep_efficacy*compliance))

P_Anal_prep_uninfected <- (1-P_Anal_prep_infected)

while (count_acute2_1<=60) {

if (probability_acute2_1[count_acute2_1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected)

{contact_acute2_1 <- contact_acute2_1+1

infected_acute2_1 <- infected_acute2_1+1}

else if (probability_acute2_1[count_acute2_1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+

P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected)

contact_acute2_1 <- contact_acute2_1+1

else if (probability_acute2_1[count_acute2_1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+

P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*

P_Oral_prep_infected)

{contact_acute2_1 <- contact_acute2_1+1

infected_acute2_1 <- infected_acute2_1+1}

else if (probability_acute2_1[count_acute2_1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+

P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*

P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected)

contact_acute2_1 <- contact_acute2_1+1

else if (probability_acute2_1[count_acute2_1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+

P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*

P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+

P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected)

{contact_acute2_1 <- contact_acute2_1+1

infected_acute2_1 <- infected_acute2_1+1}

else if (probability_acute2_1[count_acute2_1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+

P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*

P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
```

```
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected)
contact_acute2_1 <- contact_acute2_1+1
else if (probability_acute2_1[count_acute2_1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected)
{contact_acute2_1 <- contact_acute2_1+1
infected_acute2_1 <- infected_acute2_1+1}
else if (probability_acute2_1[count_acute2_1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected)
contact_acute2_1 <- contact_acute2_1+1
else if (probability_acute2_1[count_acute2_1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected+P_Test)
{testing_acute2_1 <- testing_acute2_1+1
count_acute2_1 <- 60}
else if (probability_acute2_1[count_acute2_1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected+P_Test+P_death)
{death_acute2_1 <- death_acute2_1+1
count_acute2_1 <-60}
```

```
else
nothing_acute2_1 <- nothing_acute2_1+1
end
count_acute2_1 <- count_acute2_1+1
}

a <- (contact_acute2_1+testing_acute2_1+death_acute2_1+nothing_acute2_1)

acute2_test_day <- function(testing_acute2_1){
if(testing_acute2_1>0)
dice <- a
if(testing_acute2_1<=0)
dice <- NA
return(dice)
}
acute2_test_day <- acute2_test_day(testing_acute2_1)

count_acute2_2 <- 1
contact_acute2_2 <- 0
care_acute2_2 <- 0
death_acute2_2 <- 0
nothing_acute2_2 <- 0
infected_acute2_2 <- 0
probability_acute2_2 <- runif((60-a),0,1)
P_Have_Sex <- ifelse((death_acute1+death_acute2_1)==0, (contact_rate*0.8),0)
P_Care <- ifelse((death_acute1+death_acute2_1)==0, T_C_rate,0)
P_death <- ifelse((death_acute1+death_acute2_1)==0, death_T_to_C_to_A,0)
P_Nothing <- ifelse((death_acute1+death_acute2_1)==0, (1-P_Have_Sex-P_Care-P_death),0)
P_Oral_Sex <- (1/2)
P_Anal_Sex <- (1/2)
P_Oral_noprep_infected <- (0.0004*acute_chronic)
P_Oral_noprep_uninfected <- (1-P_Oral_noprep_infected)
P_Oral_prep_infected <- (0.0004*acute_chronic*(1-prep_efficacy*compliance))
```

```
P_Oral_prep_uninfected <- (1-P_Oral_prep_infected)

P_Anal_noprep_infected <- (0.008*(1-0.3)*acute_chronic)

P_Anal_noprep_uninfected <- (1-P_Anal_noprep_infected)

P_Anal_prep_infected <- (0.008*(1-0.3)*acute_chronic*(1-prep_efficacy*compliance))

P_Anal_prep_uninfected <- (1-P_Anal_prep_infected)

while (count_acute2_2<=(60-a)) {

if (probability_acute2_2[count_acute2_2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected)

{contact_acute2_2 <- contact_acute2_2+1

infected_acute2_2 <- infected_acute2_2+1}

else if (probability_acute2_2[count_acute2_2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+

P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected)

contact_acute2_2 <- contact_acute2_2+1

else if (probability_acute2_2[count_acute2_2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+

P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*

P_Oral_prep_infected)

{contact_acute2_2 <- contact_acute2_2+1

infected_acute2_2 <- infected_acute2_2+1}

else if (probability_acute2_2[count_acute2_2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+

P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*

P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected)

contact_acute2_2 <- contact_acute2_2+1

else if (probability_acute2_2[count_acute2_2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+

P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*

P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+

P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected)

{contact_acute2_2 <- contact_acute2_2+1

infected_acute2_2 <- infected_acute2_2+1}

else if (probability_acute2_2[count_acute2_2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+

P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*

P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+

P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*

P_Anal_noprep_uninfected)

contact_acute2_2 <- contact_acute2_2+1
```

```
else if (probability_acute2_2[count_acute2_2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected)
{contact_acute2_2 <- contact_acute2_2+1
infected_acute2_2 <- infected_acute2_2+1}
else if (probability_acute2_2[count_acute2_2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected)
contact_acute2_2 <- contact_acute2_2+1
else if (probability_acute2_2[count_acute2_2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected+P_Care)
{care_acute2_2 <- care_acute2_2+1
count_acute2_2 <- (60-a)}
else if (probability_acute2_2[count_acute2_2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected+P_Care+P_death)
{death_acute2_2 <- death_acute2_2+1
count_acute2_2 <- (60-a)}
else
nothing_acute2_2 <- nothing_acute2_2+1
end
```

```
count_acute2_2 <- count_acute2_2+1
}

b <- (a+contact_acute2_2+care_acute2_2+death_acute2_2+nothing_acute2_2)
acute2_care_day <- function(care_acute2_2){
if(care_acute2_2>0)
dice <- b
if(care_acute2_2<=0)
dice <- NA
return(dice)
}
acute2_care_day <- acute2_care_day(care_acute2_2)

count_acute2_3 <- 1
contact_acute2_3 <- 0
ART_acute2_3 <- 0
death_acute2_3 <- 0
nothing_acute2_3 <- 0
infected_acute2_3 <- 0
probability_acute2_3 <- runif((60-b),0,1)
P_Have_Sex <- ifelse((death_acute1+death_acute2_1+death_acute2_2)==0,(contact_rate*0.8),0)
P_ART <- ifelse((death_acute1+death_acute2_1+death_acute2_2)==0,C_A_rate,0)
P_death <- ifelse((death_acute1+death_acute2_1+death_acute2_2)==0, death_T_to_C_to_A,0)
P_Nothing <- ifelse((death_acute1+death_acute2_1+death_acute2_2)==0,(1-P_Have_Sex-P_ART-P_death),0)
P_Oral_Sex <- (1/2)
P_Anal_Sex <- (1/2)
P_Oral_noprep_infected <- (0.0004*acute_chronic)
P_Oral_noprep_uninfected <- (1-P_Oral_noprep_infected)
P_Oral_prep_infected <- (0.0004*acute_chronic*(1-prep_efficacy*compliance))
P_Oral_prep_uninfected <- (1-P_Oral_prep_infected)
P_Anal_noprep_infected <- (0.008*(1-0.4875)*acute_chronic)
P_Anal_noprep_uninfected <- (1-P_Anal_noprep_infected)
P_Anal_prep_infected <- (0.008*(1-0.4875)*acute_chronic*(1-prep_efficacy*compliance))
```

```
P_Anal_prep_uninfected <- (1-P_Anal_prep_infected)
while (count_acute2_3<=(60-b)) {
if (probability_acute2_3[count_acute2_3]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected)
{contact_acute2_3 <- contact_acute2_3+1
infected_acute2_3 <- infected_acute2_3+1}
else if (probability_acute2_3[count_acute2_3]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected)
contact_acute2_3 <- contact_acute2_3+1
else if (probability_acute2_3[count_acute2_3]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected)
{contact_acute2_3 <- contact_acute2_3+1
infected_acute2_3 <- infected_acute2_3+1}
else if (probability_acute2_3[count_acute2_3]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected)
contact_acute2_3 <- contact_acute2_3+1
else if (probability_acute2_3[count_acute2_3]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected)
{contact_acute2_3 <- contact_acute2_3+1
infected_acute2_3 <- infected_acute2_3+1}
else if (probability_acute2_3[count_acute2_3]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected)
contact_acute2_3 <- contact_acute2_3+1
else if (probability_acute2_3[count_acute2_3]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
```

```
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected)
{contact_acute2_3 <- contact_acute2_3+1
infected_acute2_3 <- infected_acute2_3+1}
else if (probability_acute2_3[count_acute2_3]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected)
contact_acute2_3 <- contact_acute2_3+1
else if (probability_acute2_3[count_acute2_3]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected+P_ART)
{ART_acute2_3 <- ART_acute2_3+1
count_acute2_3 <- (60-b)}
else if (probability_acute2_3[count_acute2_3]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected+P_ART+P_death)
{death_acute2_3 <- death_acute2_3+1
count_acute2_3 <- (60-b)}
else
nothing_acute2_3 <- nothing_acute2_3+1
end
count_acute2_3 <- count_acute2_3+1
}
```

```
c <- (b+contact_acute2_3+ART_acute2_3+death_acute2_3+nothing_acute2_3)
acute2_ART_day <- function(ART_acute2_3){
if(ART_acute2_3>0)
dice <- c
if(ART_acute2_3<=0)
dice <- NA
return(dice)
}
acute2_ART_day <- acute2_ART_day(ART_acute2_3)

contact_acute2 <- (contact_acute2_1+contact_acute2_2+contact_acute2_3)
infected_acute2 <- (infected_acute2_1+infected_acute2_2+infected_acute2_3)

d <- (testing_acute2_1+care_acute2_2+ART_acute2_3)
ab <- (death_acute1+death_acute2_1+death_acute2_2+death_acute2_3)

#chronic stage---acute2; without Test, without Care, without ART(d==0)
count_chronic_1 <- 1
contact_chronic_1 <- 0
testing_chronic_1 <- 0
death_chronic_1 <- 0
nothing_chronic_1 <- 0
infected_chronic_1 <- 0
probability_chronic_1 <- runif((day_AIDS-90),0,1)
P_Have_Sex <- ifelse(d==0 & ab==0, contact_rate, 0)
P_Test <- ifelse(d==0 & ab==0, testing_rate, 0)
P_death <- ifelse(d==0 & ab==0, death_withoutT,0)
P_Nothing <- ifelse(d==0 & ab==0,(1-P_Have_Sex-P_Test-P_death),0)
P_Oral_Sex <- (1/2)
P_Anal_Sex <- (1/2)
P_Oral_noprep_infected <- ifelse(d==0, (0.0004*1), 0)
P_Oral_noprep_uninfected <- (1-P_Oral_noprep_infected)
P_Oral_prep_infected <- ifelse(d==0, (0.0004*1*(1-prep_efficacy*compliance)), 0)
```

```
P_Oral_prep_uninfected <- (1-P_Oral_prep_infected)

P_Anal_noprep_infected <- ifelse(d==0, (0.008*(1-0.3)*1), 0)

P_Anal_noprep_uninfected <- (1-P_Anal_noprep_infected)

P_Anal_prep_infected <- ifelse(d==0, (0.008*(1-0.3)*1*(1-prep_efficacy*compliance)), 0)

P_Anal_prep_uninfected <- (1-P_Anal_prep_infected)

while (count_chronic_1<=(day_AIDS-90)) {

if (probability_chronic_1[count_chronic_1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected)

{contact_chronic_1 <- contact_chronic_1+1

infected_chronic_1 <- infected_chronic_1+1}

else if (probability_chronic_1[count_chronic_1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+

P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected)

contact_chronic_1 <- contact_chronic_1+1

else if (probability_chronic_1[count_chronic_1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+

P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*

P_Oral_prep_infected)

{contact_chronic_1 <- contact_chronic_1+1

infected_chronic_1 <- infected_chronic_1+1}

else if (probability_chronic_1[count_chronic_1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+

P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*

P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected)

contact_chronic_1 <- contact_chronic_1+1

else if (probability_chronic_1[count_chronic_1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+

P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*

P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+

P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected)

{contact_chronic_1 <- contact_chronic_1+1

infected_chronic_1 <- infected_chronic_1+1}

else if (probability_chronic_1[count_chronic_1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+

P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*

P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+

P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*

P_Anal_noprep_uninfected)

contact_chronic_1 <- contact_chronic_1+1
```

```
else if (probability_chronic_1[count_chronic_1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected)
{contact_chronic_1 <- contact_chronic_1+1
infected_chronic_1 <- infected_chronic_1+1}
else if (probability_chronic_1[count_chronic_1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected)
contact_chronic_1 <- contact_chronic_1+1
else if (probability_chronic_1[count_chronic_1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected+P_Test)
{testing_chronic_1 <- testing_chronic_1+1
count_chronic_1 <- (day_AIDS-90)}
else if (probability_chronic_1[count_chronic_1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected+P_Test+P_death)
{death_chronic_1 <- death_chronic_1+1
count_chronic_1 <- (day_AIDS-90)}
else
nothing_chronic_1 <- nothing_chronic_1+1
end
```

```
count_chronic_1 <- count_chronic_1+1
}

e <- (contact_chronic_1+testing_chronic_1+death_chronic_1+nothing_chronic_1)
chronic_test_day_NO_TCA <- ifelse(testing_chronic_1==1, e, NA)

count_chronic_2 <- 1
contact_chronic_2 <- 0
care_chronic_2 <- 0
death_chronic_2 <- 0
nothing_chronic_2 <- 0
infected_chronic_2 <- 0
probability_chronic_2 <- runif((day_AIDS-90-e),0,1)
P_Have_Sex <- ifelse(d==0 & (ab+death_chronic_1)==0, (contact_rate*0.8), 0)
P_Care <- ifelse(d==0 & (ab+death_chronic_1)==0, T_C_rate, 0)
P_death <- ifelse(d==0 & (ab+death_chronic_1)==0, death_T_to_C_to_A, 0)
P_Nothing <- ifelse(d==0 & (ab+death_chronic_1)==0, (1-P_Have_Sex-P_Care-P_death),0)
P_Oral_Sex <- (1/2)
P_Anal_Sex <- (1/2)
P_Oral_noprep_infected <- ifelse(d==0, (0.0004*1), 0)
P_Oral_noprep_uninfected <- (1-P_Oral_noprep_infected)
P_Oral_prep_infected <- ifelse(d==0, (0.0004*1*(1-prep_efficacy*compliance)), 0)
P_Oral_prep_uninfected <- (1-P_Oral_prep_infected)
P_Anal_noprep_infected <- ifelse(d==0, (0.008*(1-0.3)*1), 0)
P_Anal_noprep_uninfected <- (1-P_Anal_noprep_infected)
P_Anal_prep_infected <- ifelse(d==0, (0.008*(1-0.3)*1*(1-prep_efficacy*compliance)), 0)
P_Anal_prep_uninfected <- (1-P_Anal_prep_infected)
while (count_chronic_2<=(day_AIDS-90-e)) {
if (probability_chronic_2[count_chronic_2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected)
{contact_chronic_2 <- contact_chronic_2+1
infected_chronic_2 <- infected_chronic_2+1}
else if (probability_chronic_2[count_chronic_2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected)
```

```
contact_chronic_2 <- contact_chronic_2+1
else if (probability_chronic_2[count_chronic_2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected)
{contact_chronic_2 <- contact_chronic_2+1
infected_chronic_2 <- infected_chronic_2+1}
else if (probability_chronic_2[count_chronic_2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected)
contact_chronic_2 <- contact_chronic_2+1
else if (probability_chronic_2[count_chronic_2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected)
{contact_chronic_2 <- contact_chronic_2+1
infected_chronic_2 <- infected_chronic_2+1}
else if (probability_chronic_2[count_chronic_2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected)
contact_chronic_2 <- contact_chronic_2+1
else if (probability_chronic_2[count_chronic_2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected)
{contact_chronic_2 <- contact_chronic_2+1
infected_chronic_2 <- infected_chronic_2+1}
else if (probability_chronic_2[count_chronic_2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
```

```
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected)
contact_chronic_2 <- contact_chronic_2+1
else if (probability_chronic_2[count_chronic_2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected+P_Care)
{care_chronic_2 <- care_chronic_2+1
count_chronic_2 <- (day_AIDS-90-e)}
else if (probability_chronic_2[count_chronic_2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected+P_Care+P_death)
{death_chronic_2 <- death_chronic_2+1
count_chronic_2 <- (day_AIDS-90-e)}
else
nothing_chronic_2 <- nothing_chronic_2+1
end
count_chronic_2 <- count_chronic_2+1
}

f <- (e+contact_chronic_2+care_chronic_2+death_chronic_2+nothing_chronic_2)
chronic_care_day_NO_TCA <- ifelse(care_chronic_2==1, f, NA)

count_chronic_3 <- 1
contact_chronic_3 <- 0
ART_chronic_3 <- 0
death_chronic_3 <- 0
nothing_chronic_3 <- 0
```

```
infected_chronic_3 <- 0
probability_chronic_3 <- runif((day_AIDS-90-f),0,1)
P_Have_Sex <- ifelse(d==0 & (ab+death_chronic_1+death_chronic_2)==0, (contact_rate*0.8), 0)
P_ART <- ifelse(d==0 & (ab+death_chronic_1+death_chronic_2)==0, C_A_rate, 0)
P_death <- ifelse(d==0 & (ab+death_chronic_1+death_chronic_2)==0, death_T_to_C_to_A, 0)
P_Nothing <- ifelse(d==0 & (ab+death_chronic_1+death_chronic_2)==0,(1-P_Have_Sex-P_ART-P_death),0)
P_Oral_Sex <- (1/2)
P_Anal_Sex <- (1/2)
P_Oral_noprep_infected <- ifelse(d==0, (0.0004*1), 0)
P_Oral_noprep_uninfected <- (1-P_Oral_noprep_infected)
P_Oral_prep_infected <- ifelse(d==0, (0.0004*1*(1-prep_efficacy*compliance)), 0)
P_Oral_prep_uninfected <- (1-P_Oral_prep_infected)
P_Anal_noprep_infected <- ifelse(d==0, (0.008*(1-0.4875)*1), 0)
P_Anal_noprep_uninfected <- (1-P_Anal_noprep_infected)
P_Anal_prep_infected <- ifelse(d==0, (0.008*(1-0.4875)*1*(1-prep_efficacy*compliance)), 0)
P_Anal_prep_uninfected <- (1-P_Anal_prep_infected)
while (count_chronic_3<=(day_AIDS-90-f)) {
if (probability_chronic_3[count_chronic_3]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected)
{contact_chronic_3 <- contact_chronic_3+1
infected_chronic_3 <- infected_chronic_3+1}
else if (probability_chronic_3[count_chronic_3]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected)
contact_chronic_3 <- contact_chronic_3+1
else if (probability_chronic_3[count_chronic_3]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected)
{contact_chronic_3 <- contact_chronic_3+1
infected_chronic_3 <- infected_chronic_3+1}
else if (probability_chronic_3[count_chronic_3]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected)
contact_chronic_3 <- contact_chronic_3+1
```

```
else if (probability_chronic_3[count_chronic_3]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected)
{contact_chronic_3 <- contact_chronic_3+1
infected_chronic_3 <- infected_chronic_3+1}
else if (probability_chronic_3[count_chronic_3]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected)
contact_chronic_3 <- contact_chronic_3+1
else if (probability_chronic_3[count_chronic_3]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected)
{contact_chronic_3 <- contact_chronic_3+1
infected_chronic_3 <- infected_chronic_3+1}
else if (probability_chronic_3[count_chronic_3]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected)
contact_chronic_3 <- contact_chronic_3+1
else if (probability_chronic_3[count_chronic_3]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected+P_ART)
{ART_chronic_3 <- ART_chronic_3+1
```

```
count_chronic_3 <- (day_AIDS-90-f)}
else if (probability_chronic_3[count_chronic_3]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected+P_ART+P_death)
{death_chronic_3 <- death_chronic_3+1
count_chronic_3 <- (day_AIDS-90-f)}
else
nothing_chronic_3 <- nothing_chronic_3+1
end
count_chronic_3 <- count_chronic_3+1
}

g <- (f+contact_chronic_3+ART_chronic_3+death_chronic_3+nothing_chronic_3)
chronic_ART_day_NO_TCA <- ifelse(ART_chronic_3==1, g, NA)

#chronic stage---acute2; Test, without Care, without ART(d==1)
count_chronic_4 <- 1
contact_chronic_4 <- 0
care_chronic_4 <- 0
death_chronic_4 <- 0
nothing_chronic_4 <- 0
infected_chronic_4 <- 0
probability_chronic_4 <- runif((day_AIDS-90),0,1)
P_Have_Sex <- ifelse(d==1 & ab==0, (contact_rate*0.8), 0)
P_Care <- ifelse(d==1 & ab==0, T_C_rate, 0)
P_death <- ifelse(d==1 & ab==0, death_T_to_C_to_A, 0)
P_Nothing <- ifelse(d==1 & ab==0, (1-P_Have_Sex-P_Care-P_death),0)
P_Oral_Sex <- (1/2)
P_Anal_Sex <- (1/2)
P_Oral_noprep_infected <- ifelse(d==1, (0.0004*1), 0)
```

```
P_Oral_noprep_uninfected <- (1-P_Oral_noprep_infected)

P_Oral_prep_infected <- ifelse(d==1, (0.0004*1*(1-prep_efficacy*compliance)), 0)

P_Oral_prep_uninfected <- (1-P_Oral_prep_infected)

P_Anal_noprep_infected <- ifelse(d==1, (0.008*(1-0.3)*1), 0)

P_Anal_noprep_uninfected <- (1-P_Anal_noprep_infected)

P_Anal_prep_infected <- ifelse(d==1, (0.008*(1-0.3)*1*(1-prep_efficacy*compliance)), 0)

P_Anal_prep_uninfected <- (1-P_Anal_prep_infected)

while (count_chronic_4<=(day_AIDS-90)) {

if (probability_chronic_4[count_chronic_4]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected)

{contact_chronic_4 <- contact_chronic_4+1

infected_chronic_4 <- infected_chronic_4+1}

else if (probability_chronic_4[count_chronic_4]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+

P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected)

contact_chronic_4 <- contact_chronic_4+1

else if (probability_chronic_4[count_chronic_4]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+

P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*

P_Oral_prep_infected)

{contact_chronic_4 <- contact_chronic_4+1

infected_chronic_4 <- infected_chronic_4+1}

else if (probability_chronic_4[count_chronic_4]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+

P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*

P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected)

contact_chronic_4 <- contact_chronic_4+1

else if (probability_chronic_4[count_chronic_4]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+

P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*

P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+

P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected)

{contact_chronic_4 <- contact_chronic_4+1

infected_chronic_4 <- infected_chronic_4+1}

else if (probability_chronic_4[count_chronic_4]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+

P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*

P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
```

```
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected)
contact_chronic_4 <- contact_chronic_4+1
else if (probability_chronic_4[count_chronic_4]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected)
{contact_chronic_4 <- contact_chronic_4+1
infected_chronic_4 <- infected_chronic_4+1}
else if (probability_chronic_4[count_chronic_4]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected)
contact_chronic_4 <- contact_chronic_4+1
else if (probability_chronic_4[count_chronic_4]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected+P_Care)
{care_chronic_4 <- care_chronic_4+1
count_chronic_4 <- (day_AIDS-90)}
else if (probability_chronic_4[count_chronic_4]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected+P_Care+P_death)
{death_chronic_4 <- death_chronic_4+1
count_chronic_4 <- (day_AIDS-90)}
```

```
else
nothing_chronic_4 <- nothing_chronic_4+1
end
count_chronic_4 <- count_chronic_4+1
}

h <- (contact_chronic_4+care_chronic_4+death_chronic_4+nothing_chronic_4)
chronic_care_day_NO_CA <- ifelse(care_chronic_4==1, h, NA)

count_chronic_5 <- 1
contact_chronic_5 <- 0
ART_chronic_5 <- 0
death_chronic_5 <- 0
nothing_chronic_5 <- 0
infected_chronic_5 <- 0
probability_chronic_5 <- runif((day_AIDS-90-h),0,1)
P_Have_Sex <- ifelse(d==1 & (ab+death_chronic_4)==0, (contact_rate*0.8), 0)
P_ART <- ifelse(d==1 & (ab+death_chronic_4)==0, C_A_rate, 0)
P_death <- ifelse(d==1 & (ab+death_chronic_4)==0, death_T_to_C_to_A, 0)
P_Nothing <- ifelse(d==1 & (ab+death_chronic_4)==0,(1-P_Have_Sex-P_ART-P_death),0)
P_Oral_Sex <- (1/2)
P_Anal_Sex <- (1/2)
P_Oral_noprep_infected <- ifelse(d==1, (0.0004*1), 0)
P_Oral_noprep_uninfected <- (1-P_Oral_noprep_infected)
P_Oral_prep_infected <- ifelse(d==1, (0.0004*1*(1-prep_efficacy*compliance)), 0)
P_Oral_prep_uninfected <- (1-P_Oral_prep_infected)
P_Anal_noprep_infected <- ifelse(d==1, (0.008*(1-0.4875)*1), 0)
P_Anal_noprep_uninfected <- (1-P_Anal_noprep_infected)
P_Anal_prep_infected <- ifelse(d==1, (0.008*(1-0.4875)*1*(1-prep_efficacy*compliance)), 0)
P_Anal_prep_uninfected <- (1-P_Anal_prep_infected)
while (count_chronic_5<=(day_AIDS-90-h)) {
if (probability_chronic_5[count_chronic_5]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected)
{contact_chronic_5 <- contact_chronic_5+1
```

```
infected_chronic_5 <- infected_chronic_5+1}
else if (probability_chronic_5[count_chronic_5]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected)
contact_chronic_5 <- contact_chronic_5+1
else if (probability_chronic_5[count_chronic_5]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected)
{contact_chronic_5 <- contact_chronic_5+1
infected_chronic_5 <- infected_chronic_5+1}
else if (probability_chronic_5[count_chronic_5]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected)
contact_chronic_5 <- contact_chronic_5+1
else if (probability_chronic_5[count_chronic_5]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected)
{contact_chronic_5 <- contact_chronic_5+1
infected_chronic_5 <- infected_chronic_5+1}
else if (probability_chronic_5[count_chronic_5]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected)
contact_chronic_5 <- contact_chronic_5+1
else if (probability_chronic_5[count_chronic_5]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected)
{contact_chronic_5 <- contact_chronic_5+1
infected_chronic_5 <- infected_chronic_5+1}
```

```
else if (probability_chronic_5[count_chronic_5]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected)
contact_chronic_5 <- contact_chronic_5+1
else if (probability_chronic_5[count_chronic_5]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected+P_ART)
{ART_chronic_5 <- ART_chronic_5+1
count_chronic_5 <- (day_AIDS-90-h)}
else if (probability_chronic_5[count_chronic_5]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected+P_ART+P_death)
{death_chronic_5 <- death_chronic_5+1
count_chronic_5 <- (day_AIDS-90-h)}
else
nothing_chronic_5 <- nothing_chronic_5+1
end
count_chronic_5 <- count_chronic_5+1
}

i <- (h+contact_chronic_5+ART_chronic_5+death_chronic_5+nothing_chronic_5)
chronic_ART_day_NO_CA <- ifelse(ART_chronic_5==1, i, NA)

#chronic stage---acute2; Test, Care, without ART(d==2)
```

```
count_chronic_6 <- 1
contact_chronic_6 <- 0
ART_chronic_6 <- 0
death_chronic_6 <- 0
nothing_chronic_6 <- 0
infected_chronic_6 <- 0
probability_chronic_6 <- runif((day_AIDS-90),0,1)
P_Have_Sex <- ifelse(d==2 & ab==0, (contact_rate*0.8), 0)
P_ART <- ifelse(d==2 & ab==0, C_A_rate, 0)
P_death <- ifelse(d==2 & ab==0, death_T_to_C_to_A, 0)
P_Nothing <- ifelse(d==2 & ab==0, (1-P_Have_Sex-P_ART-P_death),0)
P_Oral_Sex <- (1/2)
P_Anal_Sex <- (1/2)
P_Oral_noprep_infected <- ifelse(d==2, (0.0004*1), 0)
P_Oral_noprep_uninfected <- (1-P_Oral_noprep_infected)
P_Oral_prep_infected <- ifelse(d==2, (0.0004*1*(1-prep_efficacy*compliance)), 0)
P_Oral_prep_uninfected <- (1-P_Oral_prep_infected)
P_Anal_noprep_infected <- ifelse(d==2, (0.008*(1-0.4875)*1), 0)
P_Anal_noprep_uninfected <- (1-P_Anal_noprep_infected)
P_Anal_prep_infected <- ifelse(d==2, (0.008*(1-0.4875)*1*(1-prep_efficacy*compliance)), 0)
P_Anal_prep_uninfected <- (1-P_Anal_prep_infected)
while (count_chronic_6<=(day_AIDS-90)) {
if (probability_chronic_6[count_chronic_6]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected)
{contact_chronic_6 <- contact_chronic_6+1
infected_chronic_6 <- infected_chronic_6+1}
else if (probability_chronic_6[count_chronic_6]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected)
contact_chronic_6 <- contact_chronic_6+1
else if (probability_chronic_6[count_chronic_6]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected)
{contact_chronic_6 <- contact_chronic_6+1
infected_chronic_6 <- infected_chronic_6+1}
```

```
else if (probability_chronic_6[count_chronic_6]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected)
contact_chronic_6 <- contact_chronic_6+1
else if (probability_chronic_6[count_chronic_6]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected)
{contact_chronic_6 <- contact_chronic_6+1
infected_chronic_6 <- infected_chronic_6+1}
else if (probability_chronic_6[count_chronic_6]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected)
contact_chronic_6 <- contact_chronic_6+1
else if (probability_chronic_6[count_chronic_6]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected)
{contact_chronic_6 <- contact_chronic_6+1
infected_chronic_6 <- infected_chronic_6+1}
else if (probability_chronic_6[count_chronic_6]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected)
contact_chronic_6 <- contact_chronic_6+1
else if (probability_chronic_6[count_chronic_6]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
```

```
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected+P_ART)
{ART_chronic_6 <- ART_chronic_6+1
count_chronic_6 <- (day_AIDS-90)}
else if (probability_chronic_6[count_chronic_6]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected+P_ART+P_death)
{death_chronic_6 <- death_chronic_6+1
count_chronic_6 <- (day_AIDS-90)}
else
nothing_chronic_6 <- nothing_chronic_6+1
end
count_chronic_6 <- count_chronic_6+1
}

j <- (contact_chronic_6+ART_chronic_6+death_chronic_6+nothing_chronic_6)
chronic_ART_day_NO_A <- ifelse(ART_chronic_6==1, j, NA)

contact_chronic <-
(contact_chronic_1+contact_chronic_2+contact_chronic_3+contact_chronic_4+contact_chronic_5+contact_chr
onic_6)
infected_chronic <-
(infected_chronic_1+infected_chronic_2+infected_chronic_3+infected_chronic_4+infected_chronic_5+infected
_chronic_6)

chronic_test_day <-
if(d==0){
chronic_test_day <- chronic_test_day_NO_TCA
}else{
```

```
chronic_test_day <- NA
}

chronic_care_day <-
if(d==0){
chronic_care_day <- chronic_care_day_NO_TCA
}else if(d==1){
chronic_care_day <- chronic_care_day_NO_CA
}else{
chronic_care_day <- NA
}

chronic_ART_day <-
if(d==0){
chronic_ART_day <- chronic_ART_day_NO_TCA
}else if(d==1){
chronic_ART_day <- chronic_ART_day_NO_CA
}else if(d==2){
chronic_ART_day <- chronic_ART_day_NO_A
}else{
chronic_ART_day <- NA
}

k <-
(d+testing_chronic_1+care_chronic_2+ART_chronic_3+care_chronic_4+ART_chronic_5+ART_chronic_6)
ac <-
(ab+death_chronic_1+death_chronic_2+death_chronic_3+death_chronic_4+death_chronic_5+death_chronic_6)

#I5 stage---acute2+chronic; without Test, without Care, without ART(k==0)
count_I5_1 <- 1
contact_I5_1 <- 0
testing_I5_1 <- 0
death_I5_1 <- 0
```

```
nothing_I5_1 <- 0
infected_I5_1 <- 0
probability_4 <- runif((1.6*365.25),0,1)
P_Have_Sex <- ifelse(k==0 & ac==0, contact_rate, 0)
P_Test <- ifelse(k==0 & ac==0, testing_rate, 0)
P_death <- ifelse(k==0 & ac==0,death_withoutT ,0)
P_Nothing <- ifelse(k==0 & ac==0,(1-P_Have_Sex-P_Test-P_death),0)
P_Oral_Sex <- (1/2)
P_Anal_Sex <- (1/2)
P_Oral_noprep_infected <- ifelse(k==0, (0.0004*4), 0)
P_Oral_noprep_uninfected <- (1-P_Oral_noprep_infected)
P_Oral_prep_infected <- ifelse(k==0, (0.0004*4*(1-prep_efficacy*compliance)), 0)
P_Oral_prep_uninfected <- (1-P_Oral_prep_infected)
P_Anal_noprep_infected <- ifelse(k==0, (0.008*(1-0.3)*4), 0)
P_Anal_noprep_uninfected <- (1-P_Anal_noprep_infected)
P_Anal_prep_infected <- ifelse(k==0, (0.008*(1-0.3)*4*(1-prep_efficacy*compliance)), 0)
P_Anal_prep_uninfected <- (1-P_Anal_prep_infected)
while (count_I5_1<=(1.6*365.25)) {
if (probability_4[count_I5_1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected)
{contact_I5_1 <- contact_I5_1+1
infected_I5_1 <- infected_I5_1+1}
else if (probability_4[count_I5_1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected)
contact_I5_1 <- contact_I5_1+1
else if (probability_4[count_I5_1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected)
{contact_I5_1 <- contact_I5_1+1
infected_I5_1 <- infected_I5_1+1}
else if (probability_4[count_I5_1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected)
contact_I5_1 <- contact_I5_1+1
```

```
else if (probability_4[count_I5_1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected)
{contact_I5_1 <- contact_I5_1+1
infected_I5_1 <- infected_I5_1+1}
else if (probability_4[count_I5_1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected)
contact_I5_1 <- contact_I5_1+1
else if (probability_4[count_I5_1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected)
{contact_I5_1 <- contact_I5_1+1
infected_I5_1 <- infected_I5_1+1}
else if (probability_4[count_I5_1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected)
contact_I5_1 <- contact_I5_1+1
else if (probability_4[count_I5_1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected+P_Test)
{testing_I5_1 <- testing_I5_1+1
```

```
count_I5_1 <- (1.6*365.25)}
else if (probability_4[count_I5_1]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected+P_Test+P_death)
{death_I5_1 <- death_I5_1+1
count_I5_1 <- (1.6*365.25)}
else
nothing_I5_1 <- nothing_I5_1+1
end
count_I5_1 <- count_I5_1+1
}

l <- (contact_I5_1+testing_I5_1+death_I5_1+nothing_I5_1)
I5_test_day_NO_TCA <- ifelse(testing_I5_1==1, l, NA)

count_I5_2 <- 1
contact_I5_2 <- 0
care_I5_2 <- 0
death_I5_2 <- 0
nothing_I5_2 <- 0
infected_I5_2 <- 0
probability_5 <- runif((1.6*365.25-l),0,1)
P_Have_Sex <- ifelse(k==0 & (ac+death_I5_1)==0, (contact_rate*0.8), 0)
P_Care <- ifelse(k==0 & (ac+death_I5_1)==0, T_C_rate, 0)
P_death <- ifelse(k==0 & (ac+death_I5_1)==0, death_T_to_C_to_A, 0)
P_Nothing <- ifelse(k==0 & (ac+death_I5_1)==0, (1-P_Have_Sex-P_Care-P_death),0)
P_Oral_Sex <- (1/2)
P_Anal_Sex <- (1/2)
P_Oral_noprep_infected <- ifelse(k==0, (0.0004*4), 0)
P_Oral_noprep_uninfected <- (1-P_Oral_noprep_infected)
```

```
P_Oral_prep_infected <- ifelse(k==0, (0.0004*4*(1-prep_efficacy*compliance)), 0)

P_Oral_prep_uninfected <- (1-P_Oral_prep_infected)

P_Anal_noprep_infected <- ifelse(k==0, (0.008*(1-0.3)*4), 0)

P_Anal_noprep_uninfected <- (1-P_Anal_noprep_infected)

P_Anal_prep_infected <- ifelse(k==0, (0.008*(1-0.3)*4*(1-prep_efficacy*compliance)), 0)

P_Anal_prep_uninfected <- (1-P_Anal_prep_infected)

while (count_I5_2<=(1.6*365.25-l)) {

if (probability_5[count_I5_2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected)

{contact_I5_2 <- contact_I5_2+1

infected_I5_2 <- infected_I5_2+1}

else if (probability_5[count_I5_2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+

P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected)

contact_I5_2 <- contact_I5_2+1

else if (probability_5[count_I5_2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+

P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*

P_Oral_prep_infected)

{contact_I5_2 <- contact_I5_2+1

infected_I5_2 <- infected_I5_2+1}

else if (probability_5[count_I5_2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+

P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*

P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected)

contact_I5_2 <- contact_I5_2+1

else if (probability_5[count_I5_2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+

P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*

P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+

P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected)

{contact_I5_2 <- contact_I5_2+1

infected_I5_2 <- infected_I5_2+1}

else if (probability_5[count_I5_2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+

P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*

P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+

P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*

P_Anal_noprep_uninfected)
```

```
contact_I5_2 <- contact_I5_2+1
else if (probability_5[count_I5_2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected)
{contact_I5_2 <- contact_I5_2+1
infected_I5_2 <- infected_I5_2+1}
else if (probability_5[count_I5_2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected)
contact_I5_2 <- contact_I5_2+1
else if (probability_5[count_I5_2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected+P_Care)
{care_I5_2 <- care_I5_2+1
count_I5_2 <- (1.6*365.25-l)}
else if (probability_5[count_I5_2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected+P_Care+P_death)
{death_I5_2 <- death_I5_2+1
count_I5_2 <- (1.6*365.25-l)}
else
nothing_I5_2 <- nothing_I5_2+1
```

```
end
count_I5_2 <- count_I5_2+1
}

m <- (l+contact_I5_2+care_I5_2+death_I5_2+nothing_I5_2)
I5_care_day_NO_TCA <- ifelse(care_I5_2==1, m, NA)

count_I5_3 <- 1
contact_I5_3 <- 0
ART_I5_3 <- 0
death_I5_3 <- 0
nothing_I5_3 <- 0
infected_I5_3 <- 0
probability_6 <- runif((1.6*365.25-m),0,1)
P_Have_Sex <- ifelse(k==0 & (ac+death_I5_1+death_I5_2)==0, (contact_rate*0.8), 0)
P_ART <- ifelse(k==0 & (ac+death_I5_1+death_I5_2)==0, C_A_rate, 0)
P_death <- ifelse(k==0 & (ac+death_I5_1+death_I5_2)==0, death_T_to_C_to_A, 0)
P_Nothing <- ifelse(k==0 & (ac+death_I5_1+death_I5_2)==0,(1-P_Have_Sex-P_ART-P_death),0)
P_Oral_Sex <- (1/2)
P_Anal_Sex <- (1/2)
P_Oral_noprep_infected <- ifelse(k==0, (0.0004*4), 0)
P_Oral_noprep_uninfected <- (1-P_Oral_noprep_infected)
P_Oral_prep_infected <- ifelse(k==0, (0.0004*4*(1-prep_efficacy*compliance)), 0)
P_Oral_prep_uninfected <- (1-P_Oral_prep_infected)
P_Anal_noprep_infected <- ifelse(k==0, (0.008*(1-0.4875)*4), 0)
P_Anal_noprep_uninfected <- (1-P_Anal_noprep_infected)
P_Anal_prep_infected <- ifelse(k==0, (0.008*(1-0.4875)*4*(1-prep_efficacy*compliance)), 0)
P_Anal_prep_uninfected <- (1-P_Anal_prep_infected)
while (count_I5_3<=(1.6*365.25-m)) {
if (probability_6[count_I5_3]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected)
{contact_I5_3 <- contact_I5_3+1
infected_I5_3 <- infected_I5_3+1}
```

```
else if (probability_6[count_I5_3]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected)
contact_I5_3 <- contact_I5_3+1
else if (probability_6[count_I5_3]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected)
{contact_I5_3 <- contact_I5_3+1
infected_I5_3 <- infected_I5_3+1}
else if (probability_6[count_I5_3]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected)
contact_I5_3 <- contact_I5_3+1
else if (probability_6[count_I5_3]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected)
{contact_I5_3 <- contact_I5_3+1
infected_I5_3 <- infected_I5_3+1}
else if (probability_6[count_I5_3]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected)
contact_I5_3 <- contact_I5_3+1
else if (probability_6[count_I5_3]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected)
{contact_I5_3 <- contact_I5_3+1
infected_I5_3 <- infected_I5_3+1}
else if (probability_6[count_I5_3]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
```

```
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected)
contact_I5_3 <- contact_I5_3+1
else if (probability_6[count_I5_3]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected+P_ART)
{ART_I5_3 <- ART_I5_3+1
count_I5_3 <- (1.6*365.25-m)}
else if (probability_6[count_I5_3]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected+P_ART+P_death)
{death_I5_3 <- death_I5_3+1
count_I5_3 <- (1.6*365.25-m)}
else
nothing_I5_3 <- nothing_I5_3+1
end
count_I5_3 <- count_I5_3+1
}

n <- (m+contact_I5_3+ART_I5_3+death_I5_3+nothing_I5_3)
I5_ART_day_NO_TCA <- ifelse(ART_I5_3==1, n, NA)

#I5 stage---acute2+chronic; Test, without Care, without ART(k==1)
count_I5_4 <- 1
contact_I5_4 <- 0
```

```
care_I5_4 <- 0
death_I5_4 <- 0
nothing_I5_4 <- 0
infected_I5_4 <- 0
probability_7 <- runif((1.6*365.25),0,1)
P_Have_Sex <- ifelse(k==1 & ac==0, (contact_rate*0.8), 0)
P_Care <- ifelse(k==1 & ac==0, T_C_rate, 0)
P_death <- ifelse(k==1 & ac==0, death_T_to_C_to_A, 0)
P_Nothing <- ifelse(k==1 & ac==0, (1-P_Have_Sex-P_Care-P_death),0)
P_Oral_Sex <- (1/2)
P_Anal_Sex <- (1/2)
P_Oral_noprep_infected <- ifelse(k==1, (0.0004*4), 0)
P_Oral_noprep_uninfected <- (1-P_Oral_noprep_infected)
P_Oral_prep_infected <- ifelse(k==1, (0.0004*4*(1-prep_efficacy*compliance)), 0)
P_Oral_prep_uninfected <- (1-P_Oral_prep_infected)
P_Anal_noprep_infected <- ifelse(k==1, (0.008*(1-0.3)*4), 0)
P_Anal_noprep_uninfected <- (1-P_Anal_noprep_infected)
P_Anal_prep_infected <- ifelse(k==1, (0.008*(1-0.3)*4*(1-prep_efficacy*compliance)), 0)
P_Anal_prep_uninfected <- (1-P_Anal_prep_infected)
while (count_I5_4<=(1.6*365.25)) {
if (probability_7[count_I5_4]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected)
{contact_I5_4 <- contact_I5_4+1
infected_I5_4 <- infected_I5_4+1}
else if (probability_7[count_I5_4]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected)
contact_I5_4 <- contact_I5_4+1
else if (probability_7[count_I5_4]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected)
{contact_I5_4 <- contact_I5_4+1
infected_I5_4 <- infected_I5_4+1}
```

```
else if (probability_7[count_I5_4]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected)
contact_I5_4 <- contact_I5_4+1
else if (probability_7[count_I5_4]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected)
{contact_I5_4 <- contact_I5_4+1
infected_I5_4 <- infected_I5_4+1}
else if (probability_7[count_I5_4]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected)
contact_I5_4 <- contact_I5_4+1
else if (probability_7[count_I5_4]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected)
{contact_I5_4 <- contact_I5_4+1
infected_I5_4 <- infected_I5_4+1}
else if (probability_7[count_I5_4]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected)
contact_I5_4 <- contact_I5_4+1
else if (probability_7[count_I5_4]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
```

```
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected+P_Care)
{care_I5_4 <- care_I5_4+1
count_I5_4 <- (1.6*365.25)}
else if (probability_7[count_I5_4]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected+P_Care+P_death)
{death_I5_4 <- death_I5_4+1
count_I5_4 <- (1.6*365.25)}
else
nothing_I5_4 <- nothing_I5_4+1
end
count_I5_4 <- count_I5_4+1
}

o <- (contact_I5_4+care_I5_4+death_I5_4+nothing_I5_4)
I5_care_day_NO_CA <- ifelse(care_I5_4==1, o, NA)

count_I5_5 <- 1
contact_I5_5 <- 0
ART_I5_5 <- 0
death_I5_5 <- 0
nothing_I5_5 <- 0
infected_I5_5 <- 0
probability_8 <- runif((1.6*365.25-o),0,1)
P_Have_Sex <- ifelse(k==1 & (ac+death_I5_4)==0, (contact_rate*0.8), 0)
P_ART <- ifelse(k==1 & (ac+death_I5_4)==0, C_A_rate, 0)
P_death <- ifelse(k==1 & (ac+death_I5_4)==0, death_T_to_C_to_A, 0)
P_Nothing <- ifelse(k==1 & (ac+death_I5_4)==0, (1-P_Have_Sex-P_ART-P_death),0)
```

```
P_Oral_Sex <- (1/2)

P_Anal_Sex <- (1/2)

P_Oral_noprep_infected <- ifelse(k==1, (0.0004*4), 0)

P_Oral_noprep_uninfected <- (1-P_Oral_noprep_infected)

P_Oral_prep_infected <- ifelse(k==1, (0.0004*4*(1-prep_efficacy*compliance)), 0)

P_Oral_prep_uninfected <- (1-P_Oral_prep_infected)

P_Anal_noprep_infected <- ifelse(k==1, (0.008*(1-0.4875)*4), 0)

P_Anal_noprep_uninfected <- (1-P_Anal_noprep_infected)

P_Anal_prep_infected <- ifelse(k==1, (0.008*(1-0.4875)*4*(1-prep_efficacy*compliance)), 0)

P_Anal_prep_uninfected <- (1-P_Anal_prep_infected)

while (count_I5_5<=(1.6*365.25-o)) {

if (probability_8[count_I5_5]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected)

{contact_I5_5 <- contact_I5_5+1

infected_I5_5 <- infected_I5_5+1}

else if (probability_8[count_I5_5]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+

P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected)

contact_I5_5 <- contact_I5_5+1

else if (probability_8[count_I5_5]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+

P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*

P_Oral_prep_infected)

{contact_I5_5 <- contact_I5_5+1

infected_I5_5 <- infected_I5_5+1}

else if (probability_8[count_I5_5]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+

P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*

P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected)

contact_I5_5 <- contact_I5_5+1

else if (probability_8[count_I5_5]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+

P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*

P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+

P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected)

{contact_I5_5 <- contact_I5_5+1

infected_I5_5 <- infected_I5_5+1}
```

```
else if (probability_8[count_I5_5]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected)
contact_I5_5 <- contact_I5_5+1
else if (probability_8[count_I5_5]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected)
{contact_I5_5 <- contact_I5_5+1
infected_I5_5 <- infected_I5_5+1}
else if (probability_8[count_I5_5]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected)
contact_I5_5 <- contact_I5_5+1
else if (probability_8[count_I5_5]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected+P_ART)
{ART_I5_5 <- ART_I5_5+1
count_I5_5 <- (1.6*365.25-o)}
else if (probability_8[count_I5_5]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
```

```
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected+P_ART+P_death)
{death_I5_5 <- death_I5_5+1
count_I5_5 <- (1.6*365.25-o)}
else
nothing_I5_5 <- nothing_I5_5+1
end
count_I5_5 <- count_I5_5+1
}

p <- (o+contact_I5_5+ART_I5_5+death_I5_5+nothing_I5_5)
I5_ART_day_NO_CA <- ifelse(ART_I5_5==1, p, NA)

#I5 stage---acute2+chronic; Test, Care, without ART(k==2)
count_I5_6 <- 1
contact_I5_6 <- 0
ART_I5_6 <- 0
death_I5_6 <- 0
nothing_I5_6 <- 0
infected_I5_6 <- 0
probability_9 <- runif((1.6*365.25),0,1)
P_Have_Sex <- ifelse(k==2 & ac==0, (contact_rate*0.8), 0)
P_ART <- ifelse(k==2 & ac==0, C_A_rate, 0)
P_death <- ifelse(k==2 & ac==0, death_T_to_C_to_A, 0)
P_Nothing <- ifelse(k==2 & ac==0,(1-P_Have_Sex-P_ART-P_death),0)
P_Oral_Sex <- (1/2)
P_Anal_Sex <- (1/2)
P_Oral_noprep_infected <- ifelse(k==2, (0.0004*4), 0)
P_Oral_noprep_uninfected <- (1-P_Oral_noprep_infected)
P_Oral_prep_infected <- ifelse(k==2, (0.0004*4*(1-prep_efficacy*compliance)), 0)
P_Oral_prep_uninfected <- (1-P_Oral_prep_infected)
P_Anal_noprep_infected <- ifelse(k==2, (0.008*(1-0.4875)*4), 0)
P_Anal_noprep_uninfected <- (1-P_Anal_noprep_infected)
```

```
P_Anal_prep_infected <- ifelse(k==2, (0.008*(1-0.4875)*4*(1-prep_efficacy*compliance)), 0)
P_Anal_prep_uninfected <- (1-P_Anal_prep_infected)
while (count_I5_6<=(1.6*365.25)) {
if (probability_9[count_I5_6]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected)
{contact_I5_6 <- contact_I5_6+1
infected_I5_6 <- infected_I5_6+1}
else if (probability_9[count_I5_6]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected)
contact_I5_6 <- contact_I5_6+1
else if (probability_9[count_I5_6]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected)
{contact_I5_6 <- contact_I5_6+1
infected_I5_6 <- infected_I5_6+1}
else if (probability_9[count_I5_6]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected)
contact_I5_6 <- contact_I5_6+1
else if (probability_9[count_I5_6]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected)
{contact_I5_6 <- contact_I5_6+1
infected_I5_6 <- infected_I5_6+1}
else if (probability_9[count_I5_6]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected)
contact_I5_6 <- contact_I5_6+1
else if (probability_9[count_I5_6]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
```

```
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected)
{contact_I5_6 <- contact_I5_6+1
infected_I5_6 <- infected_I5_6+1}
else if (probability_9[count_I5_6]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected)
contact_I5_6 <- contact_I5_6+1
else if (probability_9[count_I5_6]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected+P_ART)
{ART_I5_6 <- ART_I5_6+1
count_I5_6 <- (1.6*365.25)}
else if (probability_9[count_I5_6]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected+P_ART+P_death)
{death_I5_6 <- death_I5_6+1
count_I5_6 <- (1.6*365.25)}
else
nothing_I5_6 <- nothing_I5_6+1
end
count_I5_6 <- count_I5_6+1
}
```

```
q <- (contact_I5_6+ART_I5_6+death_I5_6+nothing_I5_6)
I5_ART_day_NO_A <- ifelse(ART_I5_6==1, q, NA)

contact_I5 <- (contact_I5_1+contact_I5_2+contact_I5_3+contact_I5_4+contact_I5_5+contact_I5_6)
infected_I5 <- (infected_I5_1+infected_I5_2+infected_I5_3+infected_I5_4+infected_I5_5+infected_I5_6)

I5_test_day <-
if(k==0){
I5_test_day <- I5_test_day_NO_TCA
}else{
I5_test_day <- NA
}

I5_care_day <-
if(k==0){
I5_care_day <- I5_care_day_NO_TCA
}else if(k==1){
I5_care_day <- I5_care_day_NO_CA
}else{
I5_care_day <- NA
}

I5_ART_day <-
if(k==0){
I5_ART_day <- I5_ART_day_NO_TCA
}else if(k==1){
I5_ART_day <- I5_ART_day_NO_CA
}else if(k==2){
I5_ART_day <- I5_ART_day_NO_A
}else{
I5_ART_day <- NA
}
```

```
r <- (k+testing_I5_1+care_I5_2+ART_I5_3+care_I5_4+ART_I5_5+ART_I5_6)
ad <- (ac+death_I5_1+death_I5_2+death_I5_3+death_I5_4+death_I5_5+death_I5_6)

#I6---acute2+chronic+I5; without Test, without Care, without ART(r==0)
count_I6_1 <- 1
testing_I6_1 <- 0
nothing_I6_1 <- 0
probability_10 <- runif((1*365.25),0,1)
P_Test <- ifelse(r==0 & ad==0, I6_testing_rate, 0)
P_Nothing <- ifelse(r==0 & ad==0, (1-P_Test),0)
while (count_I6_1<=(1*365.25)) {
if (probability_10[count_I6_1]<P_Test)
{testing_I6_1 <- testing_I6_1+1
count_I6_1 <- (1*365.25)}
else
nothing_I6_1 <- nothing_I6_1+1
end
count_I6_1 <- count_I6_1+1
}

s <- (testing_I6_1+nothing_I6_1)
I6_test_day_NO_TCA <- ifelse(testing_I6_1==1, s, NA)

count_I6_2 <- 1
care_I6_2 <- 0
nothing_I6_2 <- 0
probability_11 <- runif((1*365.25-s),0,1)
P_Care <- ifelse(r==0 & ad==0, I6_T_C_rate, 0)
P_Nothing <- ifelse(r==0 & ad==0, (1-P_Care),0)
while (count_I6_2<=(1*365.25-s)) {
if (probability_11[count_I6_2]<P_Care)
{care_I6_2 <- care_I6_2+1
count_I6_2 <- (1*365.25-s)}
```

```
else
nothing_I6_2 <- nothing_I6_2+1
end
count_I6_2 <- count_I6_2+1
}

t <- (s+care_I6_2+nothing_I6_2)
I6_care_day_NO_TCA <- ifelse(care_I6_2==1, t, NA)

count_I6_3 <- 1
ART_I6_3 <- 0
nothing_I6_3 <- 0
probability_12 <- runif((1*365.25-t),0,1)
P_ART <- ifelse(r==0 & ad==0, I6_C_A_rate, 0)
P_Nothing <- ifelse(r==0 & ad==0, (1-P_ART),0)
while (count_I6_3<=(1*365.25-t)) {
if (probability_12[count_I6_3]<P_ART)
{ART_I6_3 <- ART_I6_3+1
count_I6_3 <- (1*365.25-t)}
else
nothing_I6_3 <- nothing_I6_3+1
end
count_I6_3 <- count_I6_3+1
}

u <- (t+ART_I6_3+nothing_I6_3)
I6_ART_day_NO_TCA <- ifelse(ART_I6_3==1, u, NA)

#I6---acute2+chronic+I5; Test, without Care, without ART(r==1)
count_I6_4 <- 1
care_I6_4 <- 0
nothing_I6_4 <- 0
probability_13 <- runif((1*365.25),0,1)
```

```
P_Care <- ifelse(r==1 & ad==0, I6_T_C_rate, 0)

P_Nothing <- ifelse(r==1 & ad==0, (1-P_Care),0)

while (count_I6_4<=(1*365.25)) {

if (probability_13[count_I6_4]<P_Care)

{care_I6_4 <- care_I6_4+1

count_I6_4 <- (1*365.25)}

else

nothing_I6_4 <- nothing_I6_4+1

end

count_I6_4 <- count_I6_4+1

}


v <- (care_I6_4+nothing_I6_4)

I6_care_day_NO_CA <- ifelse(care_I6_4==1, v, NA)


count_I6_5 <- 1

ART_I6_5 <- 0

nothing_I6_5 <- 0

probability_14 <- runif((1*365.25-v),0,1)

P_ART <- ifelse(r==1 & ad==0, I6_C_A_rate, 0)

P_Nothing <- ifelse(r==1 & ad==0, (1-P_ART),0)

while (count_I6_5<=(1*365.25-v)) {

if (probability_14[count_I6_5]<P_ART)

{ART_I6_5 <- ART_I6_5+1

count_I6_5 <- (1*365.25-v)}

else

nothing_I6_5 <- nothing_I6_5+1

end

count_I6_5 <- count_I6_5+1

}


w <- (v+ART_I6_5+nothing_I6_5)

I6_ART_day_NO_CA <- ifelse(ART_I6_5==1, w, NA)
```

```
#I6---acute2+chronic+I5; Test, Care, without ART(r==2)
count_I6_6 <- 1
ART_I6_6 <- 0
nothing_I6_6 <- 0
probability_15 <- runif((1*365.25),0,1)
P_ART <- ifelse(r==2 & ad==0, I6_C_A_rate, 0)
P_Nothing <- ifelse(r==2 & ad==0,(1-P_ART),0)
while (count_I6_6<=(1*365.25)) {
if (probability_15[count_I6_6]<P_ART)
{ART_I6_6 <- ART_I6_6+1
count_I6_6 <- (1*365.25)}
else
nothing_I6_6 <- nothing_I6_6+1
end
count_I6_6 <- count_I6_6+1
}

x <- (ART_I6_6+nothing_I6_6)
I6_ART_day_NO_A <- ifelse(ART_I6_6==1, x, NA)

I6_test_day <-
if(r==0){
I6_test_day <- I6_test_day_NO_TCA
}else{
I6_test_day <- NA
}

I6_care_day <-
if(r==0){
I6_care_day <- I6_care_day_NO_TCA
}else if(r==1){
I6_care_day <- I6_care_day_NO_CA
```

```
}else{
I6_care_day <- NA
}

I6_ART_day <-
if(r==0){
I6_ART_day <- I6_ART_day_NO_TCA
}else if(r==1){
I6_ART_day <- I6_ART_day_NO_CA
}else if(r==2){
I6_ART_day <- I6_ART_day_NO_A
}else{
I6_ART_day <- NA
}

#ART to 45 years old---acute2
ART_time <- ifelse(ART_acute2_3==1, (20*365.25+30+acute2_ART_day), (45*365.25))
count_ART_acute2 <- 1
contact_ART_acute2 <- 0
nothing_ART_acute2 <- 0
infected_ART_acute2 <- 0
death_ART_acute2 <- 0
probability_16 <- runif((45*365.25-ART_time),0,1)
P_Have_Sex <- (contact_rate*0.8)
P_death <- death_after_A
P_Nothing <- (1-P_Have_Sex-P_death)
P_Oral_Sex <- (1/2)
P_Anal_Sex <- (1/2)
P_Oral_noprep_infected <- (0.0004*0.04)
P_Oral_noprep_uninfected <- (1-P_Oral_noprep_infected)
P_Oral_prep_infected <- (0.0004*0.04*(1-prep_efficacy*compliance))
P_Oral_prep_uninfected <- (1-P_Oral_prep_infected)
P_Anal_noprep_infected <- (0.008*(1-0.4875)*0.04)
```

```
P_Anal_noprep_uninfected <- (1-P_Anal_noprep_infected)

P_Anal_prep_infected <- (0.008*(1-0.4875)*0.04*(1-prep_efficacy*compliance))

P_Anal_prep_uninfected <- (1-P_Anal_prep_infected)

while (count_ART_acute2<=(45*365.25-ART_time)) {

if (probability_16[count_ART_acute2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected)

{contact_ART_acute2 <- contact_ART_acute2+1

infected_ART_acute2 <- infected_ART_acute2+1}

else if (probability_16[count_ART_acute2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+

P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected)

contact_ART_acute2 <- contact_ART_acute2+1

else if (probability_16[count_ART_acute2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+

P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*

P_Oral_prep_infected)

{contact_ART_acute2 <- contact_ART_acute2+1

infected_ART_acute2 <- infected_ART_acute2+1}

else if (probability_16[count_ART_acute2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+

P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*

P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected)

contact_ART_acute2 <- contact_ART_acute2+1

else if (probability_16[count_ART_acute2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+

P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*

P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+

P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected)

{contact_ART_acute2 <- contact_ART_acute2+1

infected_ART_acute2 <- infected_ART_acute2+1}

else if (probability_16[count_ART_acute2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+

P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*

P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+

P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*

P_Anal_noprep_uninfected)

contact_ART_acute2 <- contact_ART_acute2+1

else if (probability_16[count_ART_acute2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+

P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
```

```
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected)
{contact_ART_acute2 <- contact_ART_acute2+1
infected_ART_acute2 <- infected_ART_acute2+1}
else if (probability_16[count_ART_acute2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected)
contact_ART_acute2 <- contact_ART_acute2+1
else if (probability_16[count_ART_acute2]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected+P_death)
{death_ART_acute2 <- death_ART_acute2+1
count_ART_acute2 <- (45*365.25-ART_time)}
else
nothing_ART_acute2 <- nothing_ART_acute2+1
end
count_ART_acute2 <- count_ART_acute2+1
}

#ART to 45 years old---chronic
ART_time_chronic_3 <- ifelse(ART_chronic_3==1, (20*365.25+90+chronic_ART_day_NO_TCA), 0)
ART_time_chronic_5 <- ifelse(ART_chronic_5==1, (20*365.25+90+chronic_ART_day_NO_CA), 0)
ART_time_chronic_6 <- ifelse(ART_chronic_6==1, (20*365.25+90+chronic_ART_day_NO_A), 0)
ART_time_chronic <- (ART_time_chronic_3+ART_time_chronic_5+ART_time_chronic_6)
ART_time <-
if(ART_time_chronic==0){
```

```
ART_time <- (45*365.25)
}else{
ART_time <- ART_time_chronic
}
count_ART_chronic <- 1
contact_ART_chronic <- 0
nothing_ART_chronic <- 0
infected_ART_chronic <- 0
death_ART_chronic <- 0
probability_16 <- runif((45*365.25-ART_time),0,1)
P_Have_Sex <- (contact_rate*0.8)
P_death <- death_after_A
P_Nothing <- (1-P_Have_Sex-P_death)
P_Oral_Sex <- (1/2)
P_Anal_Sex <- (1/2)
P_Oral_noprep_infected <- (0.0004*0.04)
P_Oral_noprep_uninfected <- (1-P_Oral_noprep_infected)
P_Oral_prep_infected <- (0.0004*0.04*(1-prep_efficacy*compliance))
P_Oral_prep_uninfected <- (1-P_Oral_prep_infected)
P_Anal_noprep_infected <- (0.008*(1-0.4875)*0.04)
P_Anal_noprep_uninfected <- (1-P_Anal_noprep_infected)
P_Anal_prep_infected <- (0.008*(1-0.4875)*0.04*(1-prep_efficacy*compliance))
P_Anal_prep_uninfected <- (1-P_Anal_prep_infected)
while (count_ART_chronic<=(45*365.25-ART_time)) {
if (probability_16[count_ART_chronic]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected)
{contact_ART_chronic <- contact_ART_chronic+1
infected_ART_chronic <- infected_ART_chronic+1}
else if (probability_16[count_ART_chronic]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected)
contact_ART_chronic <- contact_ART_chronic+1
else if (probability_16[count_ART_chronic]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected)
```

```
{contact_ART_chronic <- contact_ART_chronic+1
infected_ART_chronic <- infected_ART_chronic+1}
else if (probability_16[count_ART_chronic]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected)
contact_ART_chronic <- contact_ART_chronic+1
else if (probability_16[count_ART_chronic]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected)
{contact_ART_chronic <- contact_ART_chronic+1
infected_ART_chronic <- infected_ART_chronic+1}
else if (probability_16[count_ART_chronic]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected)
contact_ART_chronic <- contact_ART_chronic+1
else if (probability_16[count_ART_chronic]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected)
{contact_ART_chronic <- contact_ART_chronic+1
infected_ART_chronic <- infected_ART_chronic+1}
else if (probability_16[count_ART_chronic]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected)
contact_ART_chronic <- contact_ART_chronic+1
```

```
else if (probability_16[count_ART_chronic]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected+P_death)
{death_ART_chronic <- death_ART_chronic+1
count_ART_chronic <- (45*365.25-ART_time)}
else
nothing_ART_chronic <- nothing_ART_chronic+1
end
count_ART_chronic <- count_ART_chronic+1
}

#ART to 45 years old---I5
ART_time_I5_3 <- ifelse(ART_I5_3==1, (20*365.25+day_AIDS+I5_ART_day_NO_TCA), 0)
ART_time_I5_5 <- ifelse(ART_I5_5==1, (20*365.25+day_AIDS+I5_ART_day_NO_CA), 0)
ART_time_I5_6 <- ifelse(ART_I5_6==1, (20*365.25+day_AIDS+I5_ART_day_NO_A), 0)
ART_time_I5 <- (ART_time_I5_3+ART_time_I5_5+ART_time_I5_6)
ART_time <-
if(ART_time_I5==0){
ART_time <- (45*365.25)
}else{
ART_time <- ART_time_I5
}
count_ART_I5 <- 1
contact_ART_I5 <- 0
nothing_ART_I5 <- 0
infected_ART_I5 <- 0
death_ART_I5 <- 0
probability_17 <- runif((45*365.25-ART_time),0,1)
P_Have_Sex <- (contact_rate*0.8)
P_death <- death_after_A
```

```
P_Nothing <- (1-P_Have_Sex-P_death)
P_Oral_Sex <- (1/2)
P_Anal_Sex <- (1/2)
P_Oral_noprep_infected <- (0.0004*0.04)
P_Oral_noprep_uninfected <- (1-P_Oral_noprep_infected)
P_Oral_prep_infected <- (0.0004*0.04*(1-prep_efficacy*compliance))
P_Oral_prep_uninfected <- (1-P_Oral_prep_infected)
P_Anal_noprep_infected <- (0.008*(1-0.4875)*0.04)
P_Anal_noprep_uninfected <- (1-P_Anal_noprep_infected)
P_Anal_prep_infected <- (0.008*(1-0.4875)*0.04*(1-prep_efficacy*compliance))
P_Anal_prep_uninfected <- (1-P_Anal_prep_infected)
while (count_ART_I5<=(45*365.25-ART_time)) {
if (probability_17[count_ART_I5]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected)
{contact_ART_I5 <- contact_ART_I5+1
infected_ART_I5 <- infected_ART_I5+1}
else if (probability_17[count_ART_I5]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected)
contact_ART_I5 <- contact_ART_I5+1
else if (probability_17[count_ART_I5]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected)
{contact_ART_I5 <- contact_ART_I5+1
infected_ART_I5 <- infected_ART_I5+1}
else if (probability_17[count_ART_I5]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected)
contact_ART_I5 <- contact_ART_I5+1
else if (probability_17[count_ART_I5]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected)
{contact_ART_I5 <- contact_ART_I5+1
infected_ART_I5 <- infected_ART_I5+1}
```

```
else if (probability_17[count_ART_I5]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected)
contact_ART_I5 <- contact_ART_I5+1
else if (probability_17[count_ART_I5]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected)
{contact_ART_I5 <- contact_ART_I5+1
infected_ART_I5 <- infected_ART_I5+1}
else if (probability_17[count_ART_I5]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected)
contact_ART_I5 <- contact_ART_I5+1
else if (probability_17[count_ART_I5]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected+P_death)
{death_ART_I5 <- death_ART_I5+1
count_ART_I5 <- (45*365.25-ART_time)}
else
nothing_ART_I5 <- nothing_ART_I5+1
end
count_ART_I5 <- count_ART_I5+1
}
```

```
#ART to 45 years old---I6
ART_time_I6_3 <- ifelse(ART_I6_3==1, (20*365.25+day_AIDS+1.6*365.25+I6_ART_day_NO_TCA), 0)
ART_time_I6_5 <- ifelse(ART_I6_5==1, (20*365.25+day_AIDS+1.6*365.25+I6_ART_day_NO_CA), 0)
ART_time_I6_6 <- ifelse(ART_I6_6==1, (20*365.25+day_AIDS+1.6*365.25+I6_ART_day_NO_A), 0)
ART_time_I6 <- (ART_time_I6_3+ART_time_I6_5+ART_time_I6_6)
ART_time <-
if(ART_time_I6==0){
ART_time <- (45*365.25)
}else{
ART_time <- ART_time_I6
}
count_ART_I6 <- 1
contact_ART_I6 <- 0
nothing_ART_I6 <- 0
infected_ART_I6 <- 0
death_ART_I6 <- 0
probability_18 <- runif((45*365.25-ART_time),0,1)
P_Have_Sex <- (contact_rate*0.8)
P_death <- death_I6_after_A
P_Nothing <- (1-P_Have_Sex-P_death)
P_Oral_Sex <- (1/2)
P_Anal_Sex <- (1/2)
P_Oral_noprep_infected <- (0.0004*0.04)
P_Oral_noprep_uninfected <- (1-P_Oral_noprep_infected)
P_Oral_prep_infected <- (0.0004*0.04*(1-prep_efficacy*compliance))
P_Oral_prep_uninfected <- (1-P_Oral_prep_infected)
P_Anal_noprep_infected <- (0.008*(1-0.4875)*0.04)
P_Anal_noprep_uninfected <- (1-P_Anal_noprep_infected)
P_Anal_prep_infected <- (0.008*(1-0.4875)*0.04*(1-prep_efficacy*compliance))
P_Anal_prep_uninfected <- (1-P_Anal_prep_infected)
while (count_ART_I6<=(45*365.25-ART_time)) {
if (probability_18[count_ART_I6]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected)
```

```
{contact_ART_I6 <- contact_ART_I6+1
infected_ART_I6 <- infected_ART_I6+1}
else if (probability_18[count_ART_I6]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected)
contact_ART_I6 <- contact_ART_I6+1
else if (probability_18[count_ART_I6]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected)
{contact_ART_I6 <- contact_ART_I6+1
infected_ART_I6 <- infected_ART_I6+1}
else if (probability_18[count_ART_I6]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected)
contact_ART_I6 <- contact_ART_I6+1
else if (probability_18[count_ART_I6]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected)
{contact_ART_I6 <- contact_ART_I6+1
infected_ART_I6 <- infected_ART_I6+1}
else if (probability_18[count_ART_I6]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected)
contact_ART_I6 <- contact_ART_I6+1
else if (probability_18[count_ART_I6]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected)
{contact_ART_I6 <- contact_ART_I6+1
infected_ART_I6 <- infected_ART_I6+1}
```

```
else if (probability_18[count_ART_I6]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected)
contact_ART_I6 <- contact_ART_I6+1
else if (probability_18[count_ART_I6]<P_Have_Sex*P_Oral_Sex*no_prep*P_Oral_noprep_infected+
P_Have_Sex*P_Oral_Sex*no_prep* P_Oral_noprep_uninfected+ P_Have_Sex*P_Oral_Sex* prep*
P_Oral_prep_infected+ P_Have_Sex*P_Oral_Sex* prep* P_Oral_prep_uninfected+
P_Have_Sex*P_Anal_Sex* no_prep* P_Anal_noprep_infected+ P_Have_Sex*P_Anal_Sex* no_prep*
P_Anal_noprep_uninfected+ P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_infected+
P_Have_Sex*P_Anal_Sex* prep* P_Anal_prep_uninfected+P_death)
{death_ART_I6 <- death_ART_I6+1
count_ART_I6 <- (45*365.25-ART_time)}
else
nothing_ART_I6 <- nothing_ART_I6+1
end
count_ART_I6 <- count_ART_I6+1
}

contact_ART <- (contact_ART_acute2+contact_ART_chronic+contact_ART_I5+contact_ART_I6)
infected_ART <- (infected_ART_acute2+infected_ART_chronic+infected_ART_I5+infected_ART_I6)

#sum
contact <- (contact_acute1+contact_acute2+contact_chronic+contact_I5+contact_ART)
infected <- (infected_acute1+infected_acute2+infected_chronic+infected_I5+infected_ART)
outcome <- c(number,contact, infected)
print(outcome)
sum_contact <- sum_contact+contact
sum_infected <- sum_infected+infected
acute_infected <- acute_infected+infected_acute1+infected_acute2
}
```

```
(R0 <- sum_infected/number)
```

Supplementary References

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