**Supplementary Materials**

Figure S1 HIV epidemic model of MSM population in China.

Note: there are six disease progression stages: (1) susceptible; (2) infected but undiagnosed; (3) diagnosed but untreated; (4) on 1st-line treatment; (5) treatment failure and (6) on 2nd-line treatment, where are all the people living with HIV except in the stage of susceptible which is the only susceptible population of all these stages, and people in the stages of undiagnosed, diagnosed and treatment failure are infectious, The numbers of susceptible MSM and infectious MSM would significantly affect the transmission process.

**Model formulas**

**Uninfected MSM**



**Infected and undiagnosed MSM**

 

**Infected and diagnosed MSM**



**MSM on 1st-line treatment**





**Treatment failure MSM**



**MSM on 2nd-line treatment**



Table S1 Demography and behavioristics parameters of MSM population in China.

|  |  |  |  |
| --- | --- | --- | --- |
| Parameters | Description | Values (min~max) | Source |
| *P* | Total number of MSM in 2000 | 7,500,000 (5,000,000~10,000,000) | 31s |
| *β* | Possibility of HIV transmission per homosexual behavior | 0.020(0.001~0.030) | Model simulationa |
| *Np* | Numbers of homosexual partners (in the past 12 months) | 9.870(7.400~12.340) | 32, 3s |
| *Na* | Numbers of homosexual behaviors with each partner (in the past 12 months) | 14.460(8.440~25.680) | 32s |
| *ε* | Effectiveness of condom | 0.820(0.690~0.950) | 34, 5s |
| *pc* | Condom use rate in last homosexual behavior | 0.616(0.584~0.648) | 36s |
|  | Numbers of becoming MSM each year | 50,000(35,000~70,000) | Experts estimationb |

Note: Numbers in brackets are the minimum and maximum of parameter values. a was the result of model simulation ; b was the result of experts estimation according to 1% growth rate annually in MSM population.

Table S2 Biological parameters of MSM population in China.

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Viral load | Value  | Source |
| The disease progression rate in infected and undiagnosed MSM |
|  | CD4>500 to 350-500 | 0.245 (0.226~0.264) | a |
|  | CD4 350-500 to 200-350 | 0.510 (0.470~0.553) | a37s |
|  | CD4 200-350 100-200 | 0.600 (0.320~0.880) | 38-10s |
|  | CD4 100-200 50-100 | 1.000 (0.530~1.470) | 38-10s |
|  | CD4 50-100 <50 | 1.500 (0.800~2.200) | 33, 7, 10s |
| The disease progression rate in infected and diagnosed MSM |
|  | CD4>500 to 350-500 | 0.245 (0.226~0.264) | a37s |
|  | CD4 350-500 to 200-350 | 0.510 (0.470~0.553) | a37s |
|  | CD4 200-350 to 100-200 | 0.600 (0.320~0.880) | 32, 9, 10s |
|  | CD4 100-200 to 50-100 | 1.000 (0.530~1.470) | 32, 9, 10s |
|  | CD4 50-100 to <50 | 1.500 (0.800~2.200) | 32, 4, 10s |
| The disease progression rate in MSM on 1st-treatment |
|  | CD4 350-500 to >500 | 1.626 (1.227~2.041) | b11s |
|  | CD4 200-350 to 350-500 | 0.800 (0.613~1.020) | b11s |
|  | CD4 100-200 to 200-350 | 1.664 (1.248~2.080) | b11s |
|  | CD4 50-100 to 100-200 | 2.027 (1.520~2.534) | b11s |
|  | CD4 <50 to 50-100 | 3.660 (2.740~4.581) | b11s |
| The disease progression rate in treatment failure MSM |
|  | CD4>500 to 350-500 | 0.091 (0.083~0.758) | 12s |
|  | CD4 350-500 to 200-350 | 0.157 (0.125~2.083) | 12s |
|  | CD4 200-350 to 100-200 | 0.600 (0.320-0.880) | 32, 9, 10s |
|  | CD4 100-200 to 50-100 | 1.000 (0.530~1.470) | 32, 9, 10s |
|  | CD4 50-100 to <50 | 1.500 (0.800~2.200) | 38-10s |
| The disease progression rate in MSM on 2nd-treatment |
|  | CD4 350-500 to >500 | 1.626 (1.227~2.041) | b11s |
|  | CD4 200-350 to 350-500 | 0.800 (0.613~1.020) | b11s |
|  | CD4 100-200 to 200-350 | 1.664 (1.248~2.080) | b11s |
|  | CD4 50-100 to 100-200 | 2.027 (1.520~2.534) | b11s |
|  | CD4 <50 to 50-100 | 3.660 (2.740~4.581) | b11s |
| HIV testing rate |
|  | CD4>500 | 0.005 (0.004~0.006) | Model simulationc |
|  | 350<CD4<500 | 0.005 (0.004~0.006) | Model simulationc |
|  | 200<CD4<350 | 0.020 (0.015~0.025) | Model simulationc |
|  | 100<CD4<200 | 0.070 (0.053~0.088) | Model simulationc |
|  | 50<CD4<100 | 0.200 (0.150~0.250) | Model simulationc |
|  | CD4<50 | 0.200 (0.150~0.250) | Model simulationc |
| The 1st-treatment rate |
|  | CD4>500 | 0.840 (0.630~1.050) | Model simulationd |
|  | 350<CD4<500 | 0.850 (0.638~1.063) | Model simulationd |
|  | 200<CD4<350 | 0.870 (0.653~1.088) | Model simulationd |
|  | 100<CD4<200 | 0.890 (0.668~1.113) | Model simulationd |
|  | 50<CD4<100 | 0.920 (0.690~1.150) | Model simulationd |
|  | CD4<50 | 0.950 (0.713~1.188) | Model simulationd |
| The 2nd-treatment rate |
|  | CD4>500 | 0.050 (0.038~0.063) | Model simulationd |
|  | 350<CD4<500 | 0.051 (0.038~0.064) | Model simulationd |
|  | 200<CD4<350 | 0.052 (0.039~0.065) | Model simulationd |
|  | 100<CD4<200 | 0.053 (0.040~0.067) | Model simulationd |
|  | 50<CD4<100 | 0.055 (0.041~0.069) | Model simulationd |
|  | CD4<50 | 0.057 (0.043~0.071) | Model simulationd |
| The 1st-treatment failure rate |
|  | CD4>500 | 0.043 (0.032~0.054) | 13s |
|  | 350<CD4<500 | 0.043 (0.032~0.054) | 13s |
|  | 200<CD4<350 | 0.043 (0.032~0.054) | 13s |
|  | 100<CD4<200 | 0.043 (0.032~0.054) | 13s |
|  | 50<CD4<100 | 0.043 (0.032~0.054) | 13s |
|  | CD4<50 | 0.043 (0.032~0.054) | 13s |
| The 2nd-treatment failure rate |
|  | CD4>500 | 0.231 (0.161~0.300) | 13s |
|  | 350<CD4<500 | 0.231 (0.161~0.300) | 13s |
|  | 200<CD4<350 | 0.231 (0.161~0.300) | 13s |
|  | 100<CD4<200 | 0.231 (0.161~0.300) | 13s |
|  | 50<CD4<100 | 0.231 (0.161~0.300) | 13s |
|  | CD4<50 | 0.231 (0.161~0.300) | 13s |
| Death rate |
|  | Background death rate | 0.007 (0.005~0.009) | 13s |
|  | Infected and undiagnosed: CD4>500 | 0.050 (0.038~0.063) | Assumed to be 10% higher than rates in ‘infected and diagnosed’ individuals |
|  | Infected and undiagnosed: 350<CD4<500 | 0.100 (0.075~0.125) |
|  | Infected and undiagnosed: 200<CD4<350 | 0.500 (0.375~0.625) |
|  | Infected and undiagnosed: 100<CD4<200 | 0.800 (0.600~1.000) |
|  | Infected and undiagnosed: 50<CD4<100 | 0.800 (0.600~1.000) |
|  | Infected and undiagnosed: CD4<50 | 0.900 (0.675~1.125) |
|  | Infected and diagnosed: CD4>500 | 0.045 (0.034~0.056) | Expert estimate, 14, 15 |
|  | Infected and diagnosed: 350<CD4<500 | 0.090 (0.068~0.113) |
|  | Infected and diagnosed: 200<CD4<350 | 0.450 (0.338~0.563) |
|  | Infected and diagnosed: 100<CD4<200 | 0.720 (0.540~0.900) |
|  | Infected and diagnosed: 50<CD4<100 | 0.720 (0.540~0.900) |
|  | Infected and diagnosed: CD4<50 | 0.810 (0.608~1.013) |
|  | On 1st-treatment: CD4>500 | 0.017 (0.010~0.028) | 13s |
|  | On 1st-treatment: 350<CD4<500 | 0.027 (0.015~0.048) | 13s |
|  | On 1st-treatment: 200<CD4<350 | 0.011 (0.002~0.020) | 13s |
|  | On 1st-treatment: 100<CD4<200 | 0.140 (0.105~0.175) | 13s |
|  | On 1st-treatment: 50<CD4<100 | 0.110 (0.083~0.138) | 13s |
|  | On 1st-treatment: CD4<50 | 0.195 (0.120~0.270) | 16, 17s |
|  | Treatment failure: CD4>500 | 0.045 (0.034~0.056) | Assumed to be identical to the rate in ‘infected and diagnosed’ individuals |
|  | Treatment failure: 350<CD4<500 | 0.090 (0.068~0.113) |
|  | Treatment failure: <CD4<350 | 0.450 (0.338~0.563) |
|  | Treatment failure: <CD4<200 | 0.720 (0.540~0.900) |
|  | Treatment failure: 50<CD4<100 | 0.720 (0.540~0.900) |
|  | Treatment failure: <50 | 0.810 (0.608~1.013) |
|  | On 2nd-treatment: CD4>500 | 0.170 (0.102~0.281) | 18s |
|  | On 2nd-treatment: 350<CD4<500 | 0.271 (0.154~0.477) | 18s |
|  | On 2nd-treatment: 200<CD4<350 | 0.011 (0.002~0.020) | 12s |
|  | On 2nd-treatment: 100<CD4<200 | 0.140 (0.105~0.175) | 16s |
|  | On 2nd-treatment: 50<CD4<100 | 0.110 (0.083~0.138) | 16s |
|  | On 2nd-treatment: CD4<50 | 0.195 (0.120~0.270) | 16, 17s |

Notes: Numbers in brackets are the maximum and minimum of the parameter values.

a was calculated by the average number of CD4 count annual descent in infection;

b was calculated by the average number of CD4 count annual rising in treatment;

c was the result of mathematical model simulation and was correspond with the number of new diagnosed MSM in China;

d the 1st-line and 2nd-line treatment rate were calculated by mathematical model simulation and were correspond with the number of MSM on treatment and the coverage rate of treatment after 2003 in China.

 Table S3 Item costs for HIV testing and treatment per annum among MSM.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Indicators | Types | Estimated Cost ($) | Times/year  | Sources  |
| HIV testing | Screening | 3.6  | 2 | 19s |
|  | Confirmation | 82.4 | -- | 19s |
| ART | 1st-line treatment | 473.0 | -- | a20s |
|  | 2nd-line treatment | 1488.0 | -- | a21s |
| Viral load testing |  | 102.7  | 1 | a22s |

Notes: the average cost per person-year =estimated value × times per year. (Unit: US$)

In the recent ten years (2005-2014), the yuan's exchange rate with the U. S. dollar is 6.89.

a the cost of 1st-line treatment, 2nd-treatment and viral load testing referenced the central subsidies special funding allocation table of HIV/AIDS prevention and control in Guangdong Province in 2012.



**Figure S2. Calibrated HIV epidemic curves forecast the trend of the epidemic in MSM in China, 2000 - 2025. Asterisk represents collected data; the cyan curves represents 50 simulations and the dark blue line is the median curve of the simulations.**

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