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Cost Effectiveness of PrEP for HIV Transmission in MSM in China

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11:40 AM - 11:50 AM

Princess Ballroom C

MSHC MELBOURNE SEXUAL HEALTH CENTRE Part of AlfredHealth

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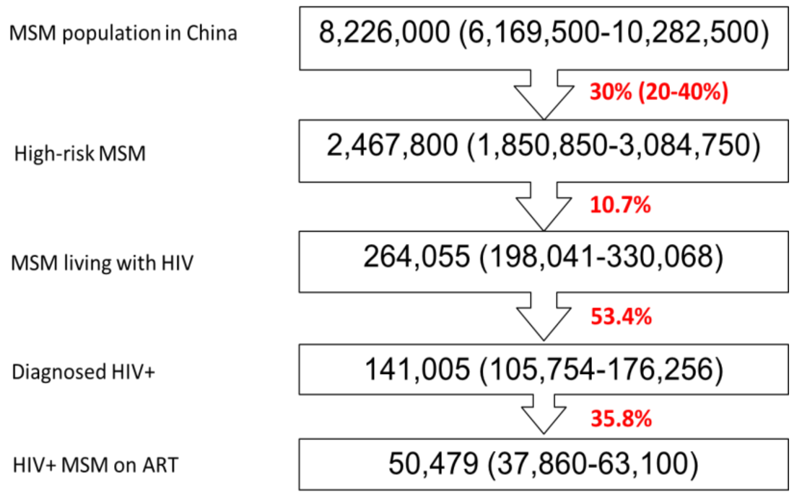
Background

- PrEP was safe and highly effective (86-96%) in reducing the risk of HIV infection across different populations (Fonner, AIDS, 2016;30(12):1973–83)
- PrEP is widely used in men who have sex with men in developed country, but less in developing countries
- Aim: to evaluate the potential population impact and cost-effectiveness of PrEP for HIV among Chinese MSM over the next two decades based on a compartmental model.

HIV treatment cascade in Chinese MSM



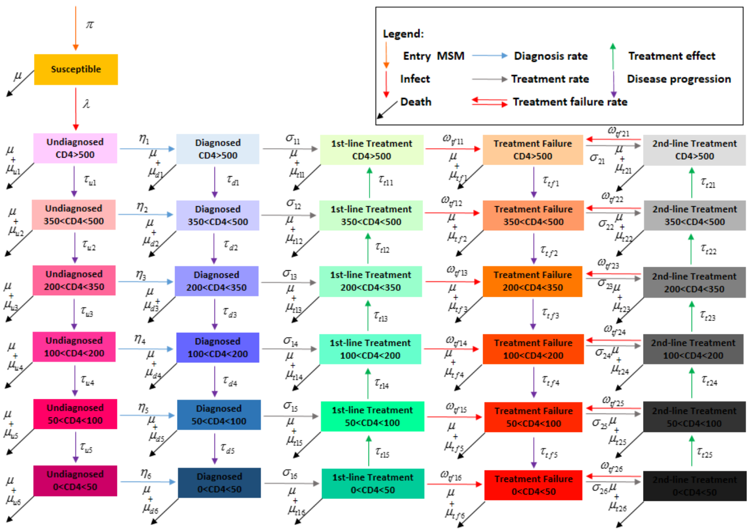
Zhang et.al., AIDS and Behavior, 2018

Estimated costs for PrEP in China

PrEP Types	Estimated Cost (USD$)	Times /year	
Daily Truvada	3,457	365	
Intermittent Truvada	1,975	208	(4 times/week)
Generic TDF	786	365	
Generic TDF+FTC	1,040	365	

Assumption: we assumed all four PrEP drug types have the same efficacy.

Model: disease progression of HIV



List of equations:

Uninfected MSM

$$\frac{dS}{dt} = \pi - \lambda S - \mu S \quad (1)$$

Infected and undiagnosed MSM

$$\frac{dU_{>500}}{dt} = \lambda S - \tau_{u1}U_{>500} - \eta_{u1}U_{>500} - \mu_{u1}U_{>500} - \mu U_{>500} \quad (2)$$

$$\frac{dU_{350\sim500}}{dt} = \tau_{u1}U_{>500} - \tau_{u2}U_{350\sim500} - \eta_{u2}U_{350\sim500} - \mu_{u2}U_{350\sim500} - \mu U_{350\sim500} \quad (3)$$

$$\frac{dU_{200\sim350}}{dt} = \tau_{u2}U_{350\sim500} - \tau_{u3}U_{200\sim350} - \eta_{u3}U_{200\sim350} - \mu_{u3}U_{200\sim350} - \mu U_{200\sim350} \quad (4)$$

$$\frac{dU_{100\sim200}}{dt} = \tau_{u3}U_{200\sim350} - \tau_{u4}U_{100\sim200} - \eta_{u4}U_{100\sim200} - \mu_{u4}U_{100\sim200} - \mu U_{100\sim200} \quad (5)$$

$$\frac{dU_{50\sim100}}{dt} = \tau_{u4}U_{100\sim200} - \tau_{u5}U_{50\sim100} - \eta_{u5}U_{50\sim100} - \mu_{u5}U_{50\sim100} - \mu U_{50\sim100} \quad (6)$$

$$\frac{dU_{0\sim50}}{dt} = \tau_{u5}U_{50\sim100} - \eta_{u6}U_{0\sim50} - \mu_{u6}U_{0\sim50} - \mu U_{0\sim50} \quad (7)$$

Infected and diagnosed MSM

$$\frac{dD_{>500}}{dt} = \eta_{u1}U_{>500} - \tau_{d1}D_{>500} - \sigma_{11}D_{>500} - \mu_{d1}D_{>500} - \mu D_{>500} \quad (8)$$

$$\frac{dD_{350\sim500}}{dt} = \eta_{u2}U_{350\sim500} + \tau_{d1}D_{>500} - \sigma_{12}D_{350\sim500} - \tau_{d2}D_{350\sim500} - \mu_{d2}D_{350\sim500} - \mu D_{350\sim500} \quad (9)$$

$$\frac{dD_{200\sim350}}{dt} = \eta_{u3}U_{200\sim350} + \tau_{d2}D_{350\sim500} - \sigma_{13}D_{200\sim350} - \tau_{d3}D_{200\sim350} - \mu_{d3}D_{200\sim350} - \mu D_{200\sim350} \quad (10)$$

$$\frac{dD_{100\sim200}}{dt} = \eta_{u4}U_{100\sim200} + \tau_{d3}D_{200\sim350} - \sigma_{14}D_{100\sim200} - \tau_{d4}D_{100\sim200} - \mu_{d4}D_{100\sim200} - \mu D_{100\sim200} \quad (11)$$

$$\frac{dD_{50\sim100}}{dt} = \eta_{u5}U_{50\sim100} + \tau_{d4}D_{100\sim200} - \sigma_{15}D_{50\sim100} - \tau_{d5}D_{50\sim100} - \mu_{d5}D_{50\sim100} - \mu D_{50\sim100} \quad (12)$$

$$\frac{dD_{0\sim50}}{dt} = \eta_{u6}U_{0\sim50} + \tau_{d5}D_{50\sim100} - \sigma_{16}D_{0\sim50} - \mu_{d6}D_{0\sim50} - \mu D_{0\sim50} \quad (13)$$

MSM on 1st-line treatment

$$\frac{dT1_{>500}}{dt} = \sigma_{11}D_{>500} + \tau_{t11}T1_{350\sim500} - \omega_{tf11}T1_{>500} - \mu_{t11}T1_{>500} - \mu T1_{>500} \quad (14)$$

$$\frac{dT1_{350\sim500}}{dt} = \sigma_{12}D_{350\sim500} + \tau_{t12}T1_{200\sim350} - \omega_{tf12}T1_{350\sim500} - \tau_{t11}T1_{350\sim500} - \mu_{t12}T1_{350\sim500} - \mu T1_{350\sim500} \quad (15)$$

$$\frac{dT1_{200\sim350}}{dt} = \sigma_{13}D_{200\sim350} + \tau_{t13}T1_{100\sim200} - \omega_{tf13}T1_{200\sim350} - \tau_{t12}T1_{200\sim350} - \mu_{t13}T1_{200\sim350} - \mu T1_{200\sim350} \quad (16)$$

$$\frac{dT1_{100\sim200}}{dt} = \sigma_{14}D_{100\sim200} + \tau_{t14}T1_{50\sim100} - \omega_{tf14}T1_{100\sim200} - \tau_{t13}T1_{100\sim200} - \mu_{t14}T1_{100\sim200} - \mu T1_{100\sim200} \quad (17)$$

$$\frac{dT1_{50\sim100}}{dt} = \sigma_{15}D_{50\sim100} + \tau_{t15}T1_{0\sim50} - \omega_{tf15}T1_{50\sim100} - \tau_{t14}T1_{50\sim100} - \mu_{t15}T1_{50\sim100} - \mu T1_{50\sim100} \quad (18)$$

$$\frac{dT1_{0\sim50}}{dt} = \sigma_{16}D_{0\sim50} - \omega_{tf16}T1_{0\sim50} - \tau_{t15}T1_{0\sim50} - \mu_{t16}T1_{0\sim50} - \mu T1_{0\sim50} \quad (19)$$

Treatment failure MSM

$$\frac{dTf_{>500}}{dt} = \omega_{tf11}T1_{>500} + \omega_{tf21}T2_{>500} - \sigma_{21}Tf_{>500} - \tau_{tf1}Tf_{>500} - \mu_{tf1}Tf_{>500} - \mu Tf_{>500} \quad (20)$$

$$\frac{dTf_{350\sim500}}{dt} = \omega_{tf12}T1_{350\sim500} + \omega_{tf22}T2_{350\sim500} + \tau_{tf_1}Tf_{>500} - \sigma_{22}Tf_{350\sim500} - \tau_{tf2}Tf_{350\sim500} - \mu_{tf2}Tf_{350\sim500} - \mu Tf_{350\sim500} \quad (21)$$

$$\frac{dTf_{200\sim350}}{dt} = \omega_{tf13}T1_{200\sim350} + \omega_{tf23}T2_{200\sim350} + \tau_{tf2}Tf_{350\sim500} - \sigma_{23}Tf_{200\sim350} - \tau_{tf3}Tf_{200\sim350} - \mu_{tf3}Tf_{200\sim350} - \mu Tf_{200\sim350} \quad (22)$$

$$\frac{dTf_{100\sim200}}{dt} = \omega_{tf14}T1_{100\sim200} + \omega_{tf24}T2_{100\sim200} + \tau_{tf3}Tf_{200\sim350} - \sigma_{24}Tf_{100\sim200} - \tau_{tf4}Tf_{100\sim200} - \mu_{tf4}Tf_{100\sim200} - \mu Tf_{100\sim200} \quad (23)$$

$$\frac{dTf_{50\sim100}}{dt} = \omega_{tf15}T1_{50\sim100} + \omega_{tf25}T2_{50\sim100} + \tau_{tf4}Tf_{100\sim200} - \sigma_{25}Tf_{50\sim100} - \tau_{tf5}Tf_{50\sim100} - \mu_{tf5}Tf_{50\sim100} - \mu Tf_{50\sim100} \quad (24)$$

$$\frac{dTf_{0\sim50}}{dt} = \omega_{tf16}T1_{0\sim50} + \omega_{tf26}T2_{0\sim50} + \tau_{tf5}Tf_{50\sim100} - \sigma_{26}Tf_{0\sim50} - \mu_{tf6}Tf_{0\sim50} - \mu Tf_{0\sim50} \quad (25)$$

MSM on 2nd-line treatment

$$\frac{dT2_{>500}}{dt} = \sigma_{21}Tf_{>500} + \tau_{t21}T2_{350\sim500} - \omega_{tf21}T2_{>500} - \mu_{t21}T2_{>500} - \mu T2_{>500} \quad (26)$$

$$\frac{dT2_{350\sim500}}{dt} = \sigma_{22}Tf_{350\sim500} + \tau_{t22}T2_{350\sim500} - \omega_{tf22}T2_{350\sim500} - \tau_{t21}T2_{350\sim500} - \mu_{t22}T2_{350\sim500} - \mu T2_{350\sim500} \quad (27)$$

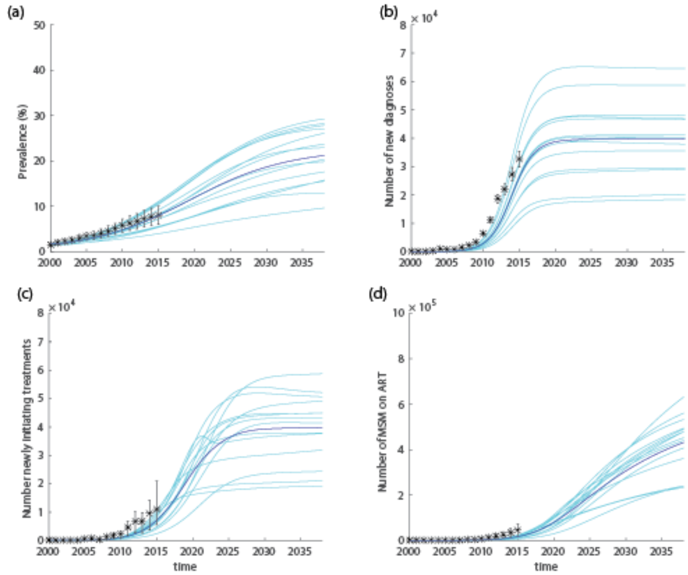
$$\frac{dT2_{200\sim350}}{dt} = \sigma_{23}Tf_{200\sim350} + \tau_{t23}T2_{100\sim200} - \omega_{tf23}T2_{200\sim350} - \tau_{t22}T2_{200\sim350} - \mu_{t23}T2_{200\sim350} - \mu T2_{200\sim350} \quad (28)$$

$$\frac{dT2_{100\sim200}}{dt} = \sigma_{24}Tf_{100\sim200} + \tau_{t24}T2_{50\sim100} - \omega_{tf24}T2_{100\sim200} - \tau_{t23}T2_{100\sim200} - \mu_{t24}T2_{100\sim200} - \mu T2_{100\sim200} \quad (29)$$

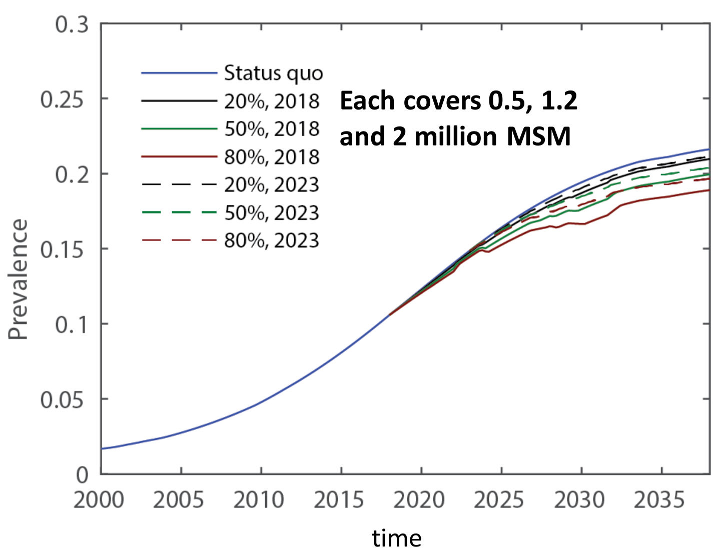
$$\frac{dT2_{50\sim100}}{dt} = \sigma_{25}Tf_{50\sim100} + \tau_{t25}T2_{0\sim50} - \omega_{tf25}T2_{50\sim100} - \tau_{t24}T2_{50\sim100} - \mu_{t25}T2_{50\sim100} - \mu T2_{50\sim100} \quad (30)$$

$$\frac{dT2_{0\sim50}}{dt} = \sigma_{26}Tf_{0\sim50} - \omega_{tf26}T2_{0\sim50} - \tau_{t25}T2_{0\sim50} - \mu_{t26}T2_{0\sim50} - \mu T2_{0\sim50} \quad (31)$$

Model calibration



Results

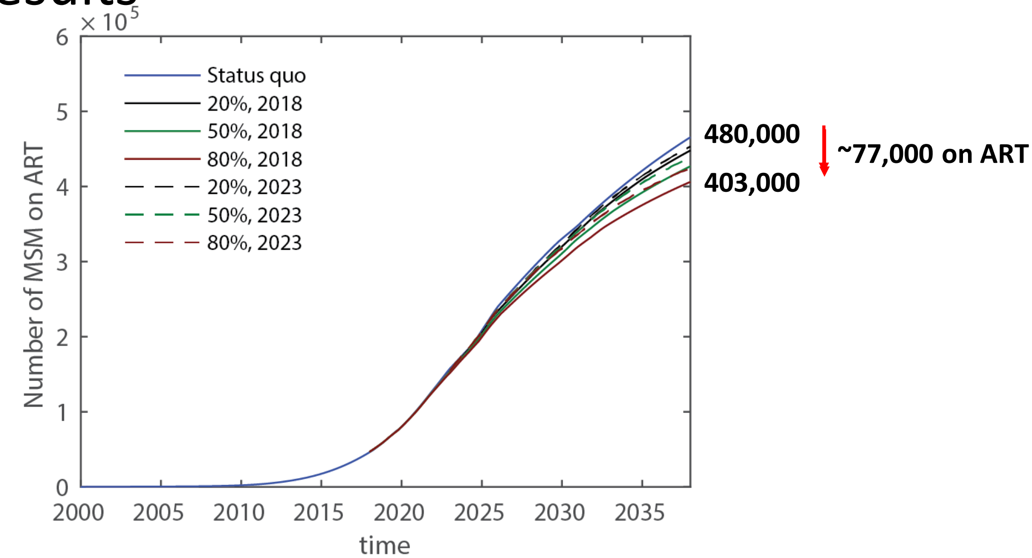


22%

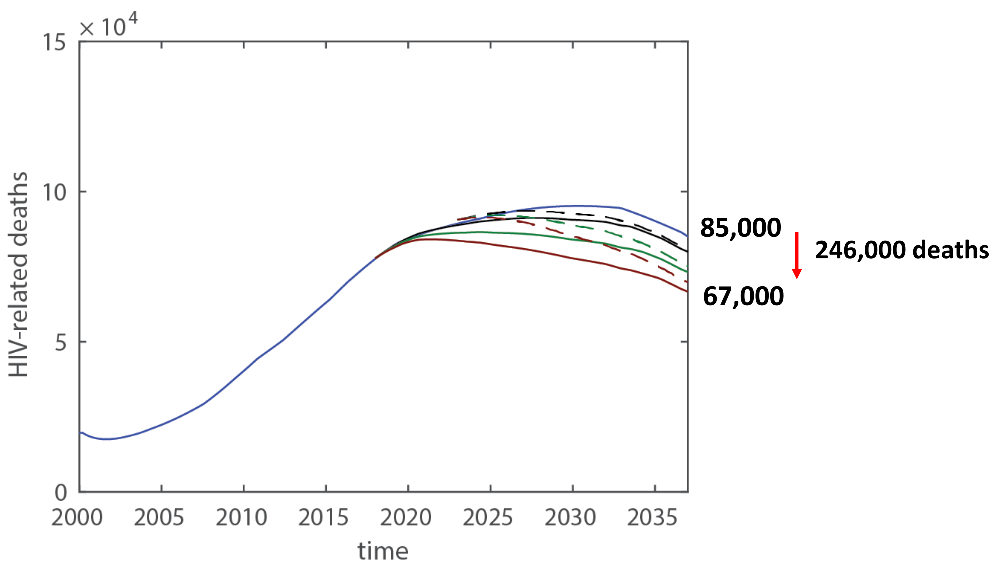
18%

~406,000 new cases

Results



Results



	2018-2037		
PrEP coverage in high-risk MSM (%)	**20%**	**50%**	**80%**
Investment			
Person year of MSM covered by PrEP ($x10^3$)	2,258	5,645	9,031
Number of extra HIV tests brought by PrEP ($x10^6$)	10.0	24.9	39.8
If using **Daily Truvada**			
Total investment cost (USD$b)	11.9	29.6	47.4
ICER (USD$)	48075	49410	50878
If using on-demand **Truvada**			
Total investment cost (USD$b)	6.3	15.9	25.4
ICER (USD$)	25733	26448	27234
If using **TDF**			
Total investment (USD$b)	2.7	6.8	10.9
ICER (USD$)	**11080**	**11388**	**11726**
If using on-demand **TDF/FTC**			
Total investment cost (USD$b)	3.6	9.0	14.4
ICER (USD$)	**14595**	**15000**	**15446**

Cost-effectiveness threshold = 3×GDP = USD$ 24,378

Delaying PrEP implementation increases ICER (less cost-effective)

Conclusion

- At Truvada's current price, in China, daily oral PrEP costs >$46,000 per DALY averted and is not cost-effective;
- On-demand Truvada reduces ICER to ~$25,000 per DALY averted, marginally cost-effective;
- Daily generic tenofovir-based regimens reduce ICER to <$15,000,which is cost-effective.
- The cost of daily oral Truvada PrEP regimen would need to be reduced by half to achieve cost-effectiveness