Modelling the impacts of PrEP intervention on the HIV epidemic in MSM in Hong Kong

CU-16-C14

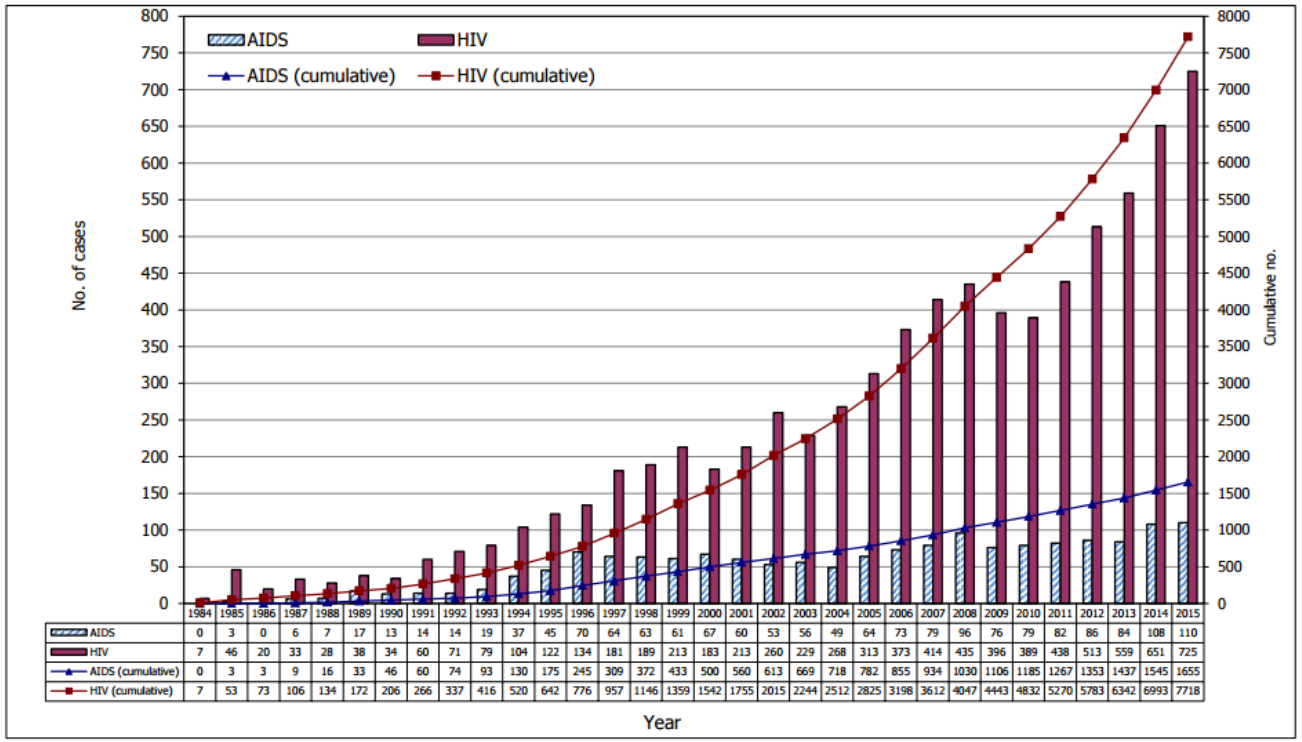
Ngai Sze Wong[1], Shui Shan Lee[1], Tsz Ho Kwan[2]

[1]Stanley Ho Centre for Emerging Infectious Diseases, The Chinese University of Hong Kong

[2]Jockey Club School of Public Health and Primary Care, The Chinese University of Hong Kong

HIV epidemiology in Hong Kong

Box 2.1 Annual and cumulative reports of HIV/AIDS cases

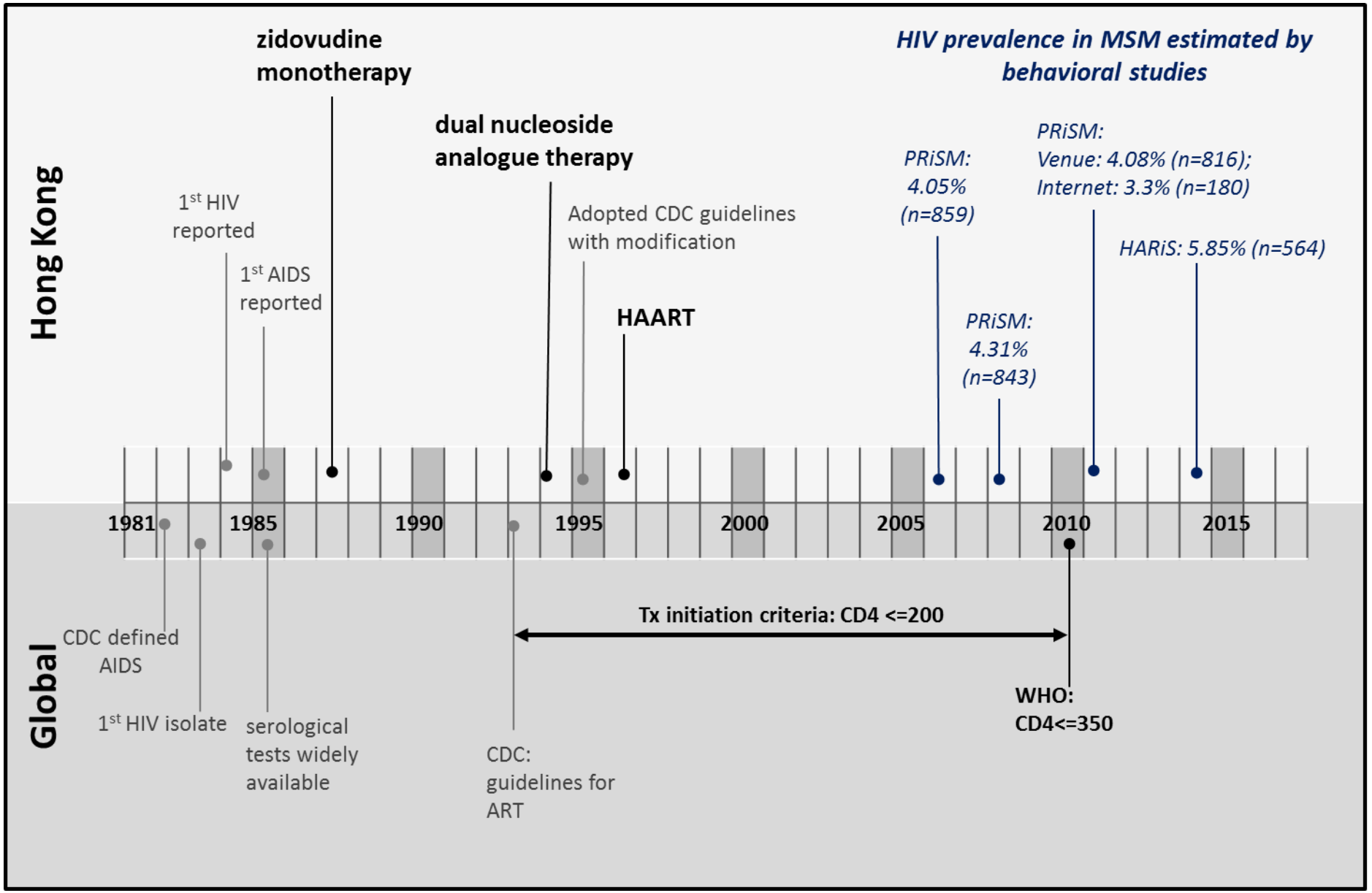


	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
AIDS	0	3	0	6	7	17	13	14	14	19	37	45	70	64	63	61	67	60	53	56	49	64	73	79	96	76	79	82	86	84	108	110
HIV	7	46	20	33	28	38	34	60	71	79	104	122	134	181	189	213	183	213	260	229	268	313	373	414	435	396	389	438	513	559	651	725
AIDS (cumulative)	0	3	3	9	16	33	46	60	74	93	130	175	245	309	372	433	500	560	613	669	718	782	855	934	1030	1106	1185	1267	1353	1437	1545	1655
HIV (cumulative)	7	53	73	106	134	172	206	266	337	416	520	642	776	957	1146	1359	1542	1755	2015	2244	2512	2825	3198	3612	4047	4443	4832	5270	5783	6342	6993	7718

By 2015, the cumulative no. of reported cases:
Heterosexual: 2806 cases (37%)
MSM: 3151 (41%)
IDU: 345 (4%)
Others: 1416 (18%)
Total: 7718

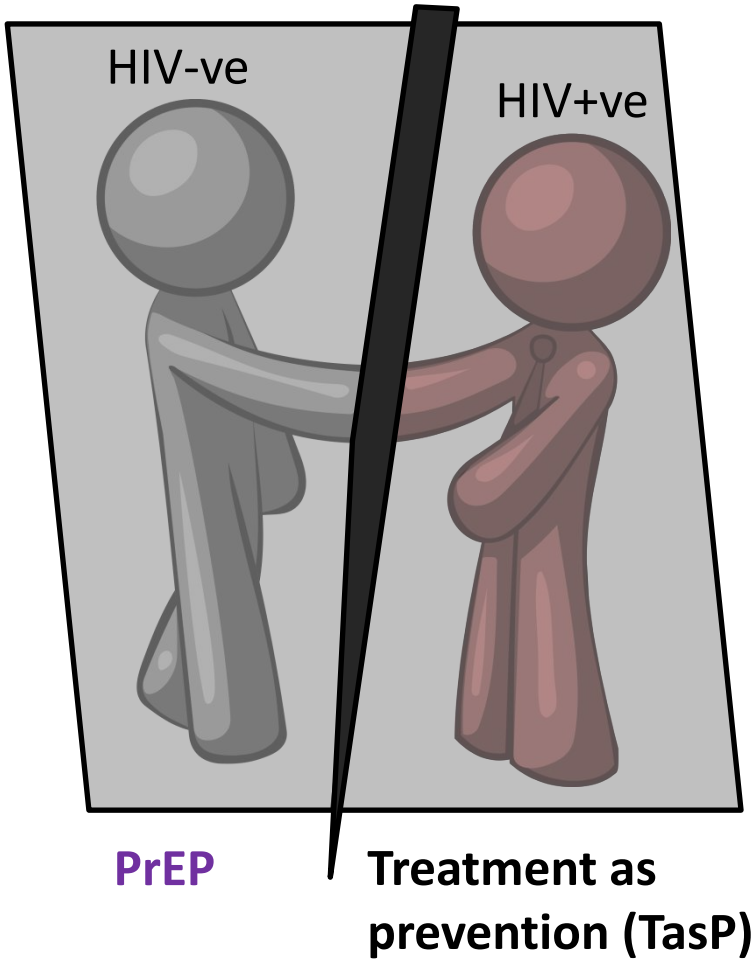
In 2015, 464 out of 725 new diagnoses were MSM (64%)

Source: http://www.info.gov.hk/aids/english/surveillance/sur_report/hiv15.pdf

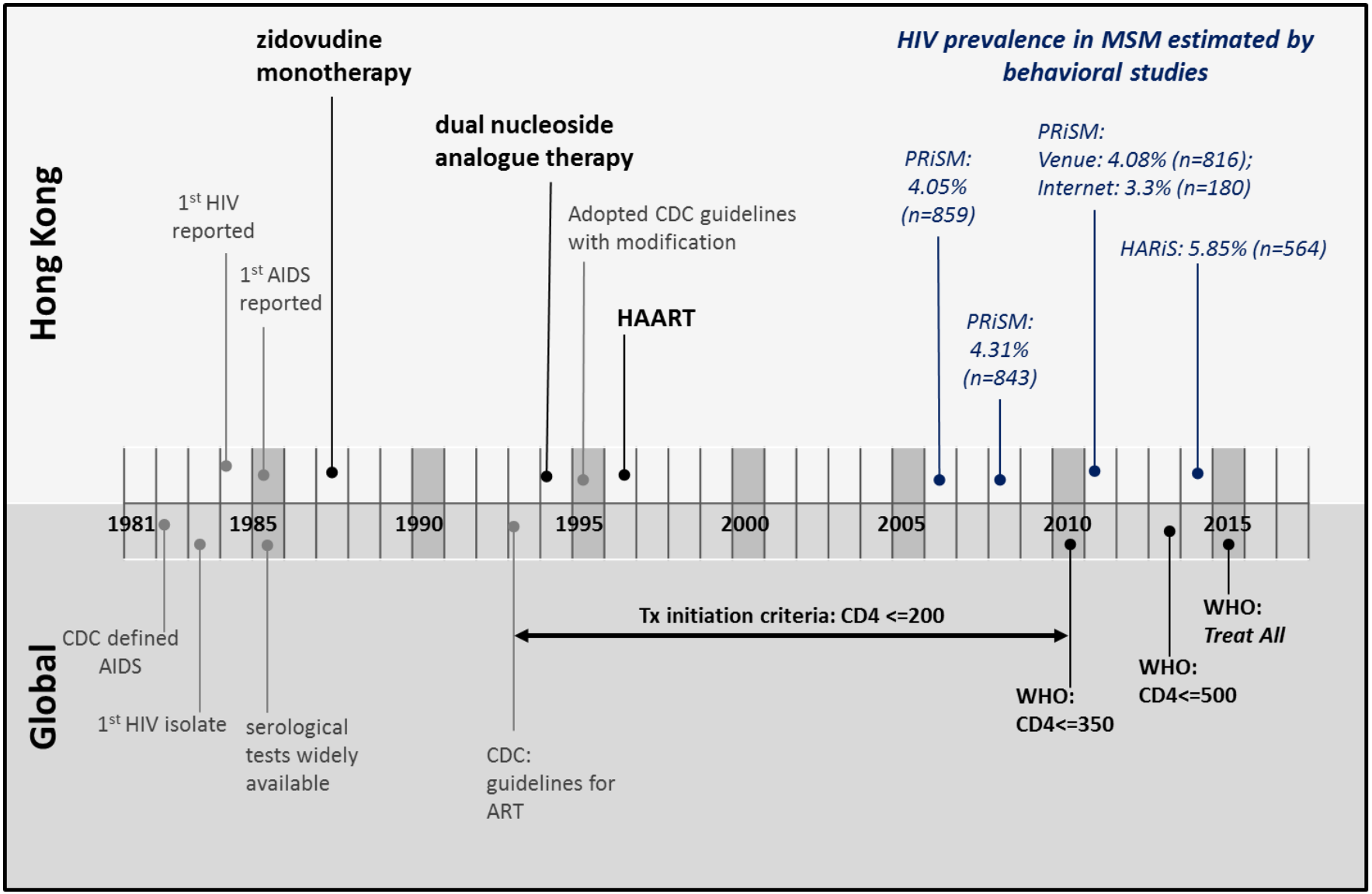


CDC – Centers for Disease Control and Prevention; FSW – female sex workers; MSM – men who have sex with men; WHO – World Health Organization

Interventions for HIV epidemic control



- Condom usage
- Harm reduction
- Circumcision



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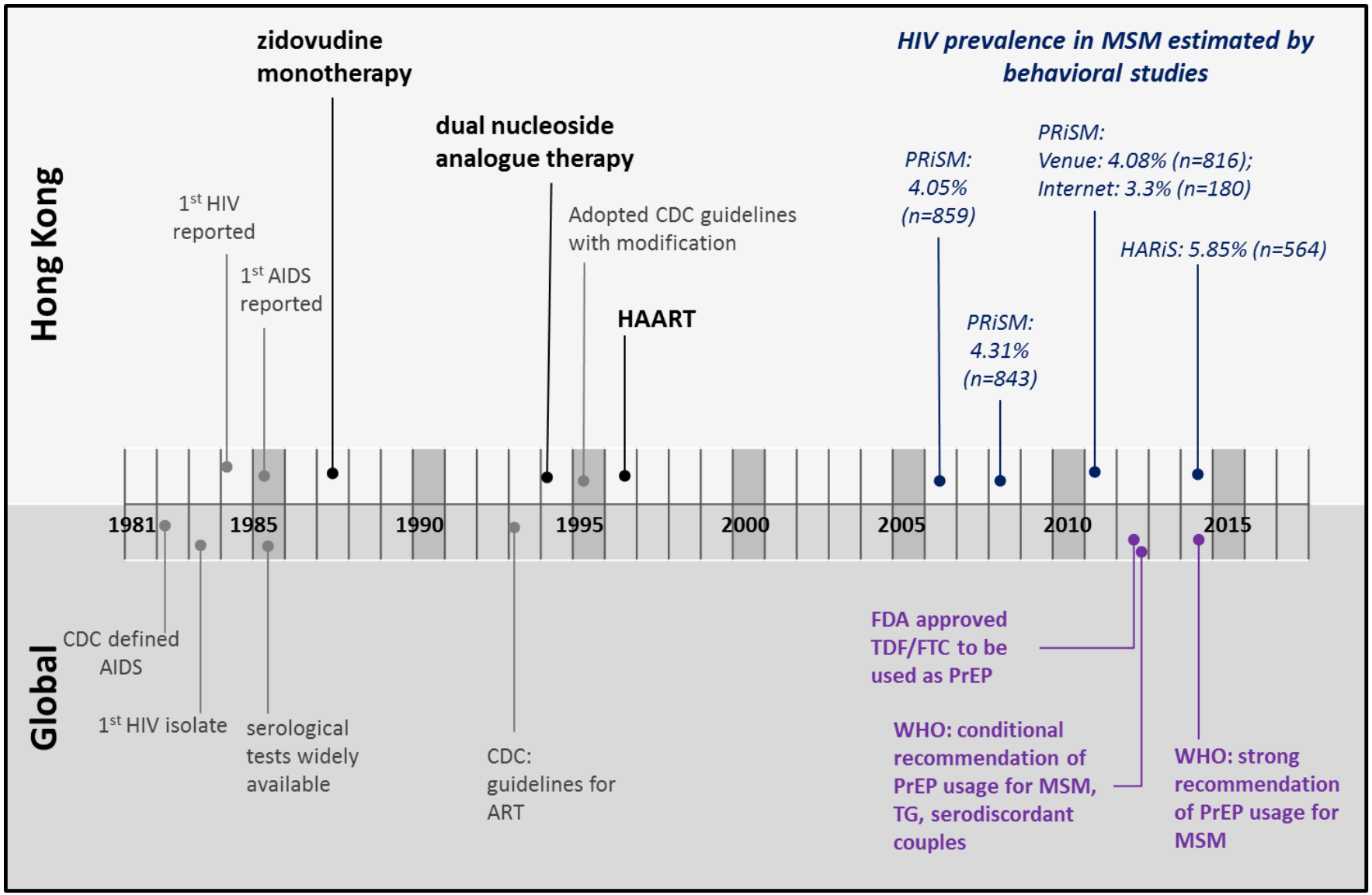

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PrEP - Pre-exposure prophylaxis

- TDF/FTC (Truvada), approved by FDA to be used as PrEP
- Preventive measure for **HIV negative** individual
- Efficacy: varied by the extent of adherence [iPrEx trial [1]]
  - 76% reduction of risk if 2 doses/week
  - can reach 99% reduction in perfect adherence (7 doses per week)
- Adverse effects: uncommon (renal toxicity is a concern)
- Dosing schedule
  - Daily oral (1 dose per day)
  - On-demand (around times of sexual activity)
  - Time-driven (2 regular doses a week plus a post-sex dose)
- ~HKD180/dose or USD23/dose

[1] Anderson PL, Glidden DV, Liu A, Buchbinder S, et al. Emtricitabine-tenofovir concentrations and pre-exposure prophylaxis efficacy in men who have sex with men. Sci Transl Med. 2012 Sep 12;4(151):151ra125.

- Demonstration projects showed high efficacy of PrEP usage
- Modelling and cost-effectiveness analyses results were positive
- World Health Organization (WHO) recommended putting populations at substantial risk of HIV infection (>3% HIV incidence place) as the first priority when offering PrEP

What about Hong Kong?

we aimed to simulate the impact of PrEP intervention in MSM in Hong Kong, through mathematical modelling

Methods description

- Data description
  - Clinical data of HIV MSM patients attending 3 major HIV specialist clinics in Hong Kong in 1985-2012 (96% of reported MSM cases)
  - HIV-1 sequences collected in 1985-2012
  - HIV surveillance reports
- Study area: Hong Kong, low HIV incidence rate (~1.1%) in MSM (~50,000 persons in 2017)
- HIV-infected MSM delineation
  - neighbor-joining method, bootstrap value ≥90 (1000 times)
- Model development
  - Deterministic compartmental model developed in R

Model assumptions

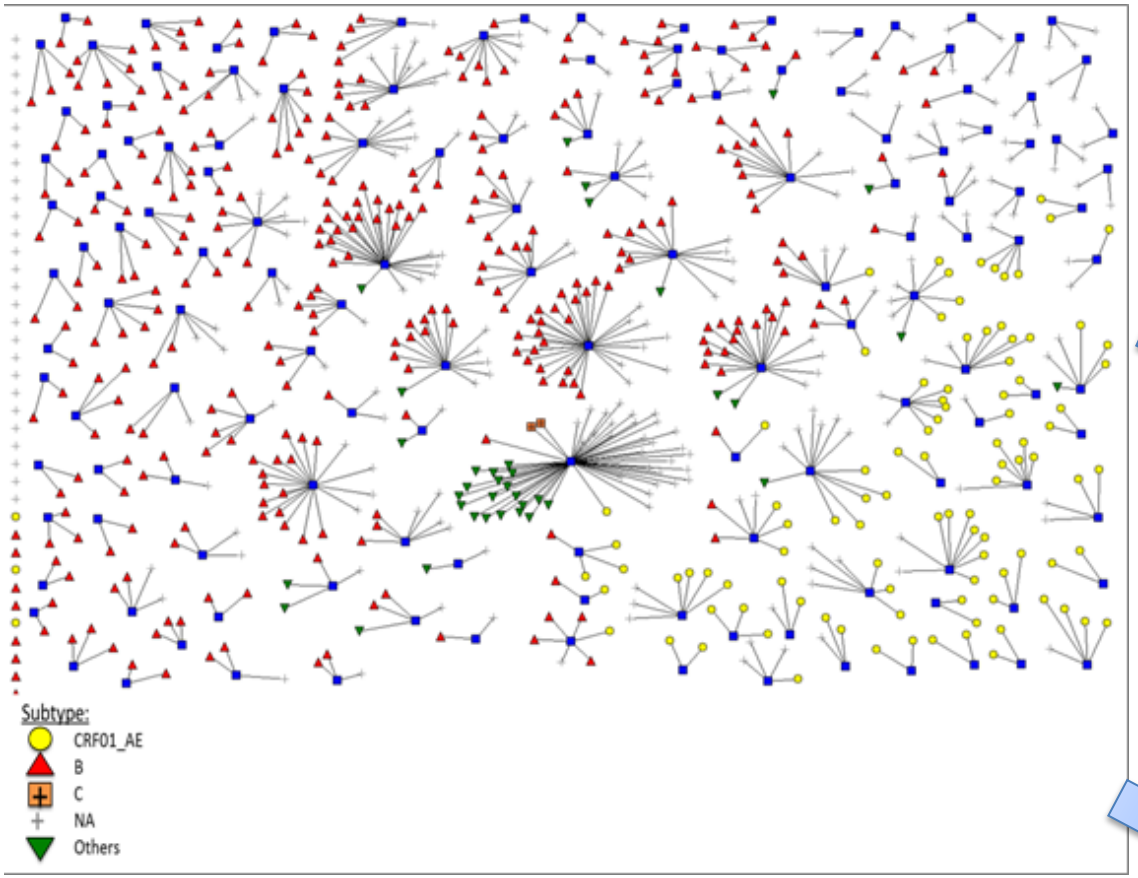
- Per-sex-act efficacy of PrEP: 93% [1,2]
- Effectiveness of high adherence PrEP (≥75% usage): 70% [1]; low adherence PrEP (<75% usage): 23%
- Dropout rate of PrEP: 20% [3]
- Annual % of change from high to low adherence: 20%; from low to high adherence: 10%
- Proportion of low-risk susceptible MSM: 57%
- High-risk MSM in random mixing partnership, low-risk MSM in serial monogamy

[1] Grant RM, Lama JR, Anderson PL, McMahan V, Liu AY, Vargas L, et al. Preexposure chemoprophylaxis for HIV prevention in men who have sex with men. N Engl J Med 2010,363:2587-2599.
[2] Donnell D, Baeten JM, Bumpus NN, Brantley J, Bangsberg DR, Haberer JE, et al. HIV protective efficacy and correlates of tenofovir blood concentrations in a clinical trial of PrEP for HIV prevention. J Acquir Immune Defic Syndr 2014,66:340-348.
[3] Mitchell KM, Prudden HJ, Washington R, et al. Potential impact of pre-exposure prophylaxis for female sex workers and men who have sex with men in Bangalore, India: a mathematical modelling study. J Int AIDS Soc 2016; 19(1): 20942

Phylogenetic analysis and results

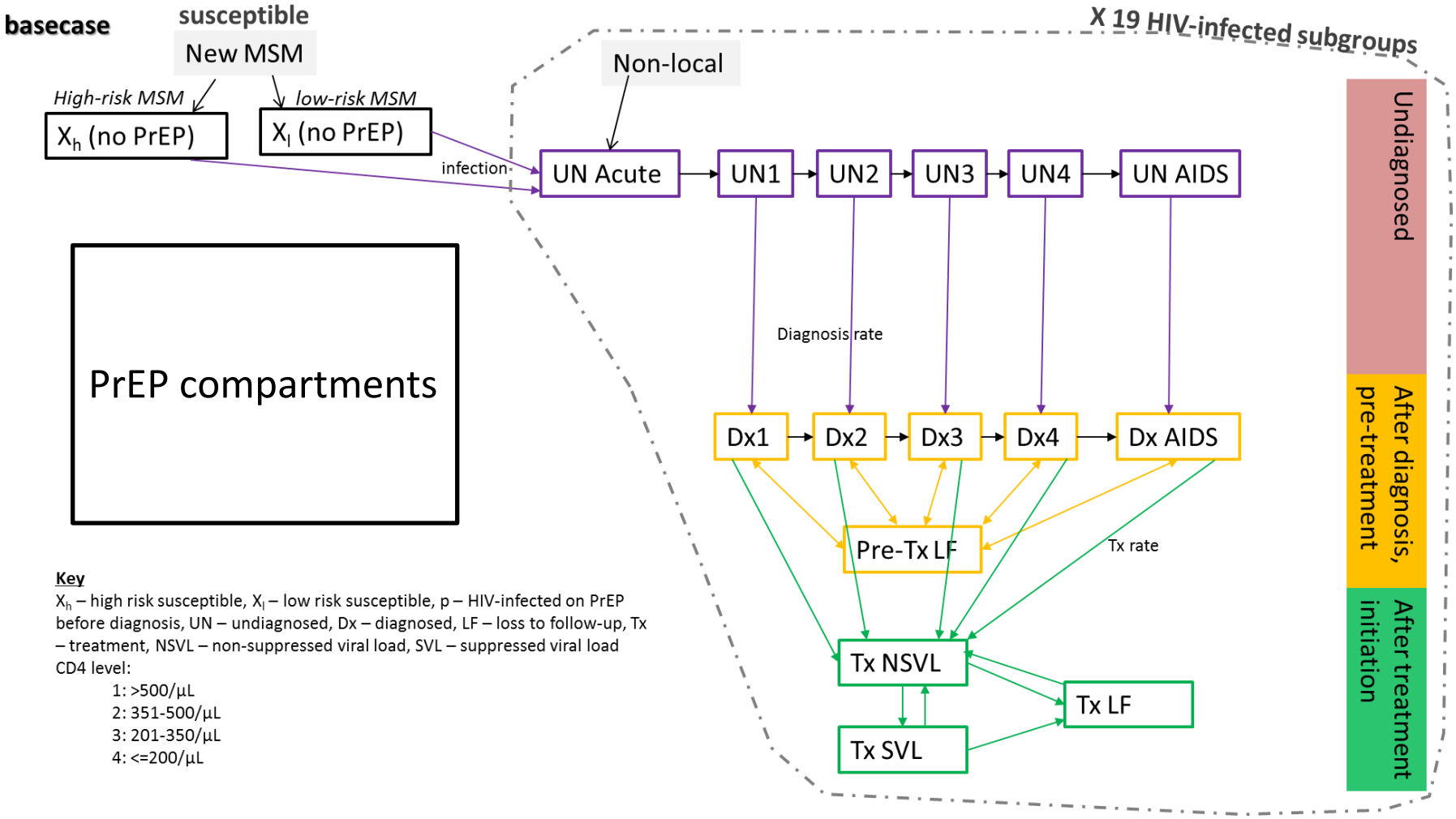
1135 HIV-1 genotype resistance testing sequences (protease and partial reverse transcriptase of pol gene)

143 clusters



11 large cluster subgroups, 3 small cluster subgroups, 4 dyads or very small cluster subgroups, 1 subgroup for all isolates

= 19 subgroups



Key

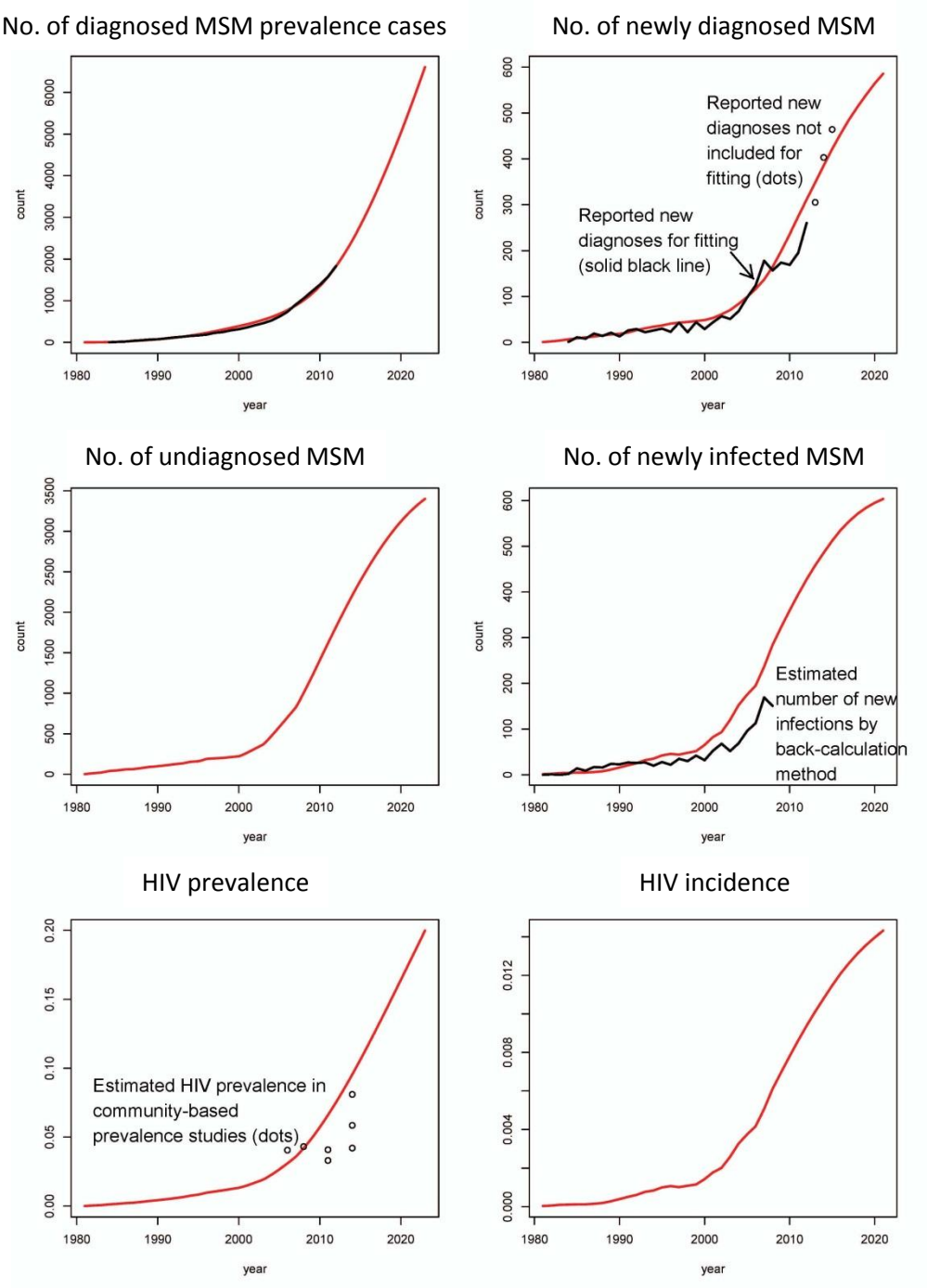
X_h – high risk susceptible, X_l – low risk susceptible, p – HIV-infected on PrEP before diagnosis, UN – undiagnosed, Dx – diagnosed, LF – loss to follow-up, Tx – treatment, NSVL – non-suppressed viral load, SVL – suppressed viral load

CD4 level:

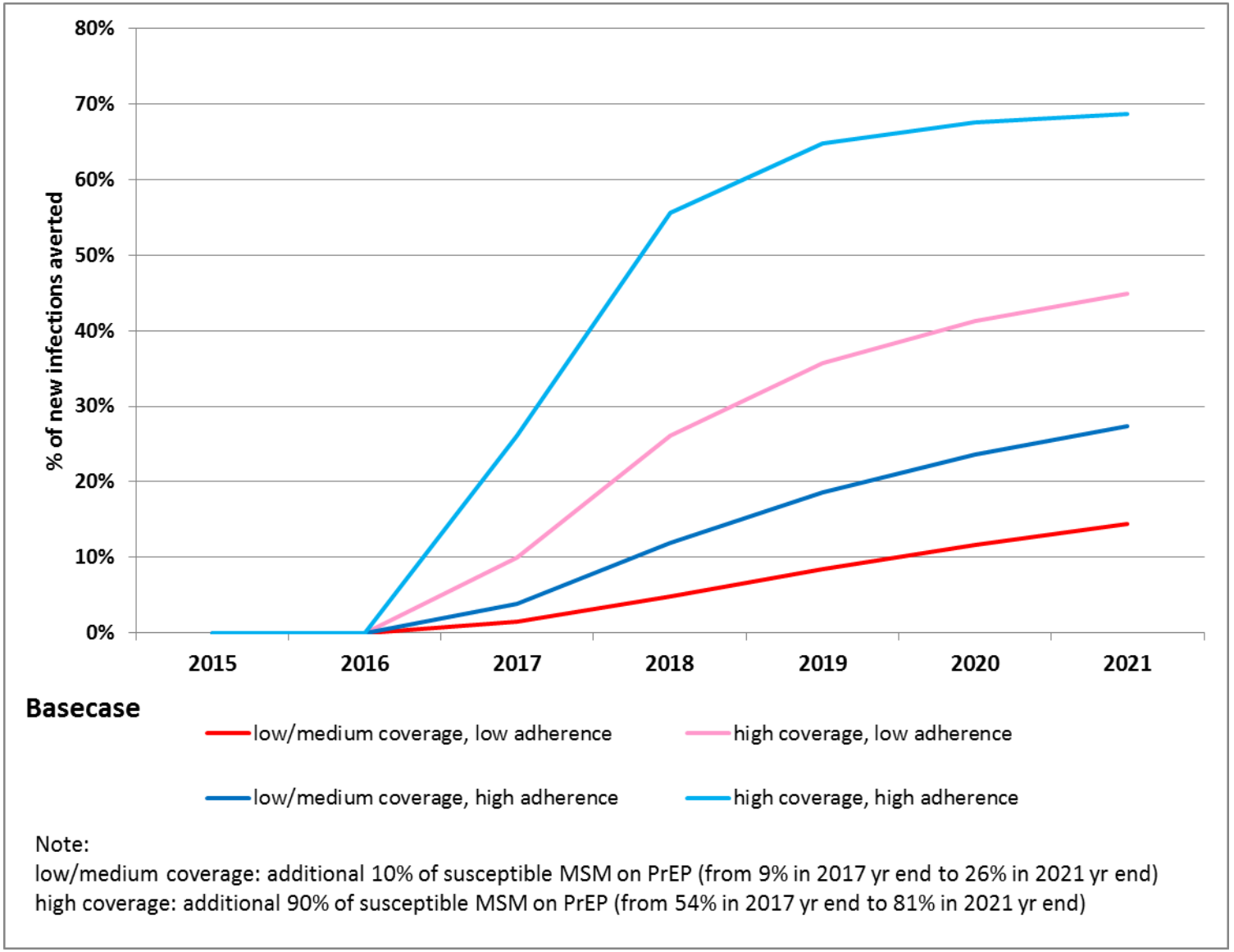
1: >500/μL
2: 351-500/μL
3: 201-350/μL
4: <=200/μL

Modelling Results

- Observed data
- basecase scenario without PrEP



Impact of PrEP implementation



Note:
low/medium coverage: additional 10% of susceptible MSM on PrEP (from 9% in 2017 yr end to 26% in 2021 yr end)
high coverage: additional 90% of susceptible MSM on PrEP (from 54% in 2017 yr end to 81% in 2021 yr end)

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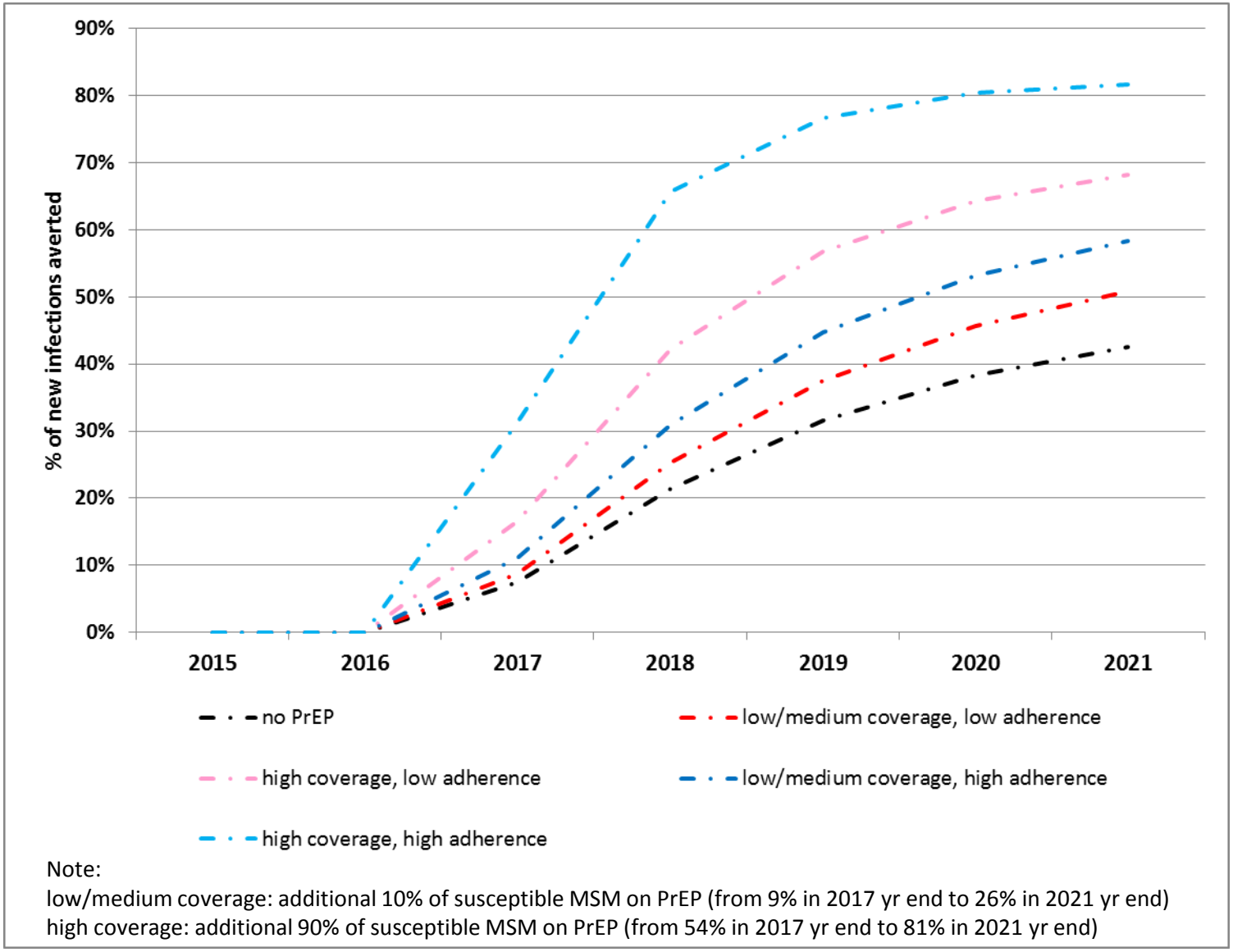

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at least 90% diagnosis rate and treatment initiation rate

Limitations

- Bisexual population
- Condom usage (intervention, risk compensation)
- Effectiveness of PrEP changed with degree of adherence and improvement of regimen (or use of new compound) over time

Preliminary conclusion

- PrEP implementation could avert 14-69% of new HIV infections in 2021 in Hong Kong, depending on the coverage and adherence of PrEP
- PrEP complements the impact of cascade of HIV care intervention (i.e. high diagnosis rate, treatment initiation rate and viral load suppression rate)

Preliminary conclusion

- Modeling results provided a reference on the possible impact of PrEP on HIV epidemic control among MSM in Hong Kong
- We are analyzing different implementation strategies: PrEP for high risk MSM only vs non-targeting approach

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(by alphabetical order)

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