Is treatment-as-prevention the new "game-changer"? Economic evaluation of HIV combination prevention

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Background (1)

- On the eve of the June 2011 UN General Assembly High Level Meeting on AIDS, HIV/AIDS researchers, activists and the press described the results of the HPTN 052 randomized controlled trial (Cohen et al. 2011) as a “game-changer” in the fight against AIDS
  - Lancet Editorial 2011
  - Dickinson 2011
  - Clark 2011
  - Sidibeé 2011
  - BBC 2011
  - Economist 2011

Background (2)

- Unclear how TasP could be funded, given flat-lining or declining financial support for global HIV programs (UNAIDS 2011)
- Unclear when TasP should ideally be implemented. Policymakers could choose not to start implementing TasP until other HIV interventions have reached certain scale levels
- We investigate the cost-effectiveness of different combinations of TasP with two other interventions of proven biological efficacy
  - Medical male circumcision (MMC) (Auvert et al. 2005; Bailey et al. 2007; Gray et al. 2007)
  - Antiretroviral treatment under current eligibility criteria (ART)

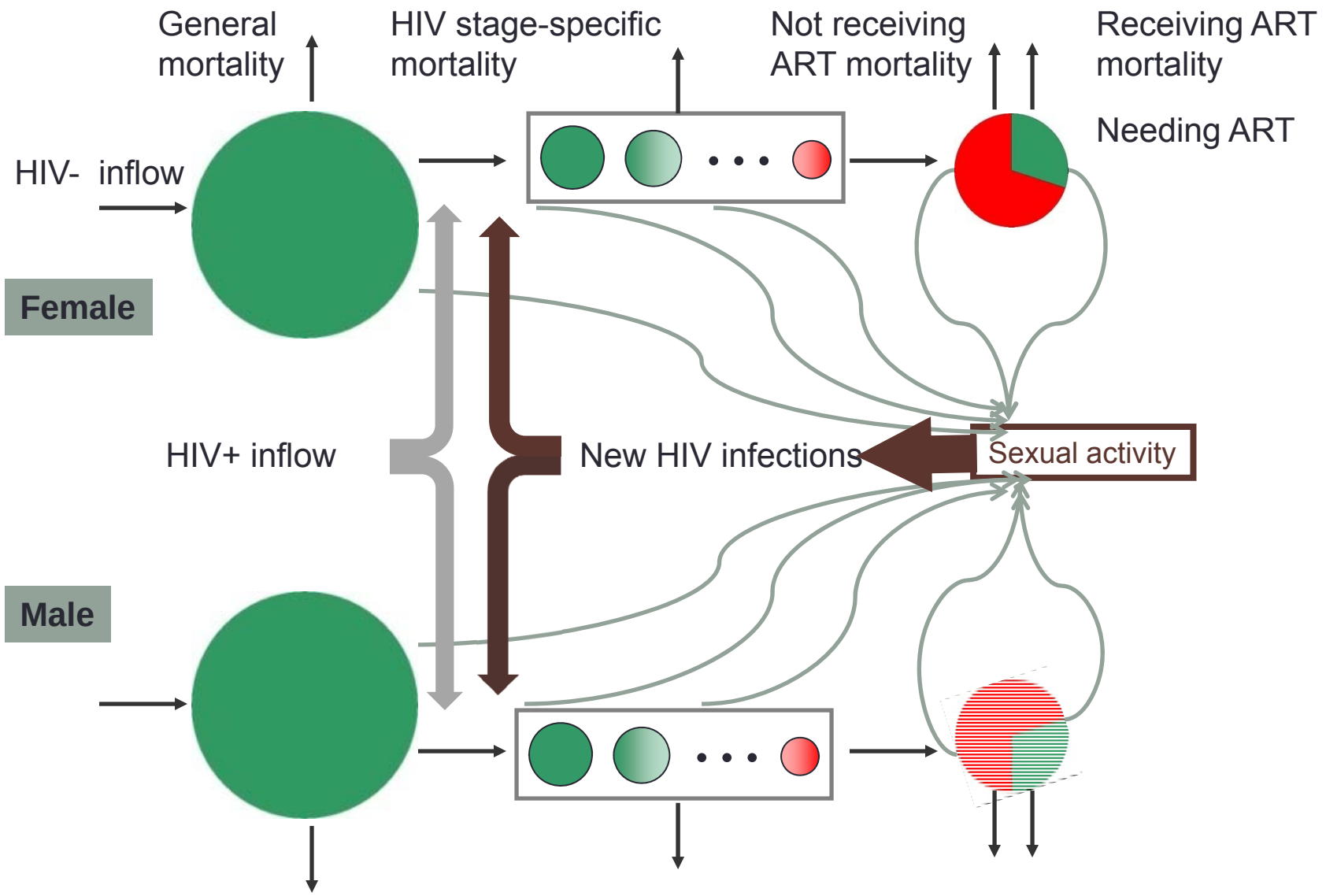
Background (3)

	MMC	ART/TasP
Delivery	Once-off	Life-long
Population in need	Larger (e.g. 14 million men for SA)	Smaller (e.g. 2.4 million for TasP for SA)
HIV prevention	Acquisition (reduced by 60% per unprotected sex act)	Transmission (reduced by 96% per unprotected sex act)
First-order effect	Immediately in men	Immediately in women and men
Mortality reduction	With delay	Immediately

Modeling approach: HIV combination prevention

- Most current models of the HIV epidemic have the limitation that they need to be calibrated to past trends
  - Limitation that calibration parameter is estimated based on historical observations and is not guaranteed to remain stable in the future under historically untried interventions (TasP)
  - Since calibration parameter is usually a black box and numerically rather than analytically derived from underlying biological and behavioral variables, it is difficult to disaggregate the effects of interventions that operate through different biological or behavioral pathways
- We thus built an analytical model, derived from underlying biological and behavioral mechanisms

Model dynamics



Scenarios

- A range of different scenarios combining MMC, ART, and TasP with the following coverage levels (the lowest levels are the current coverage estimates for South Africa)
  - MMC: 45%, 60%, and 80%
  - ART: 50%, 60%, and 80%
  - TasP: 0%, 20%, 40%, 60%, and 80%
- All combinations of coverage levels
- Coupling of ART and TasP, reflects our belief that that in a real-life scale-up of TasP, ART coverage of those currently eligible to receive treatment will increase as well

$$ART\ coverage = \min((b + x)\%, 80\%)$$

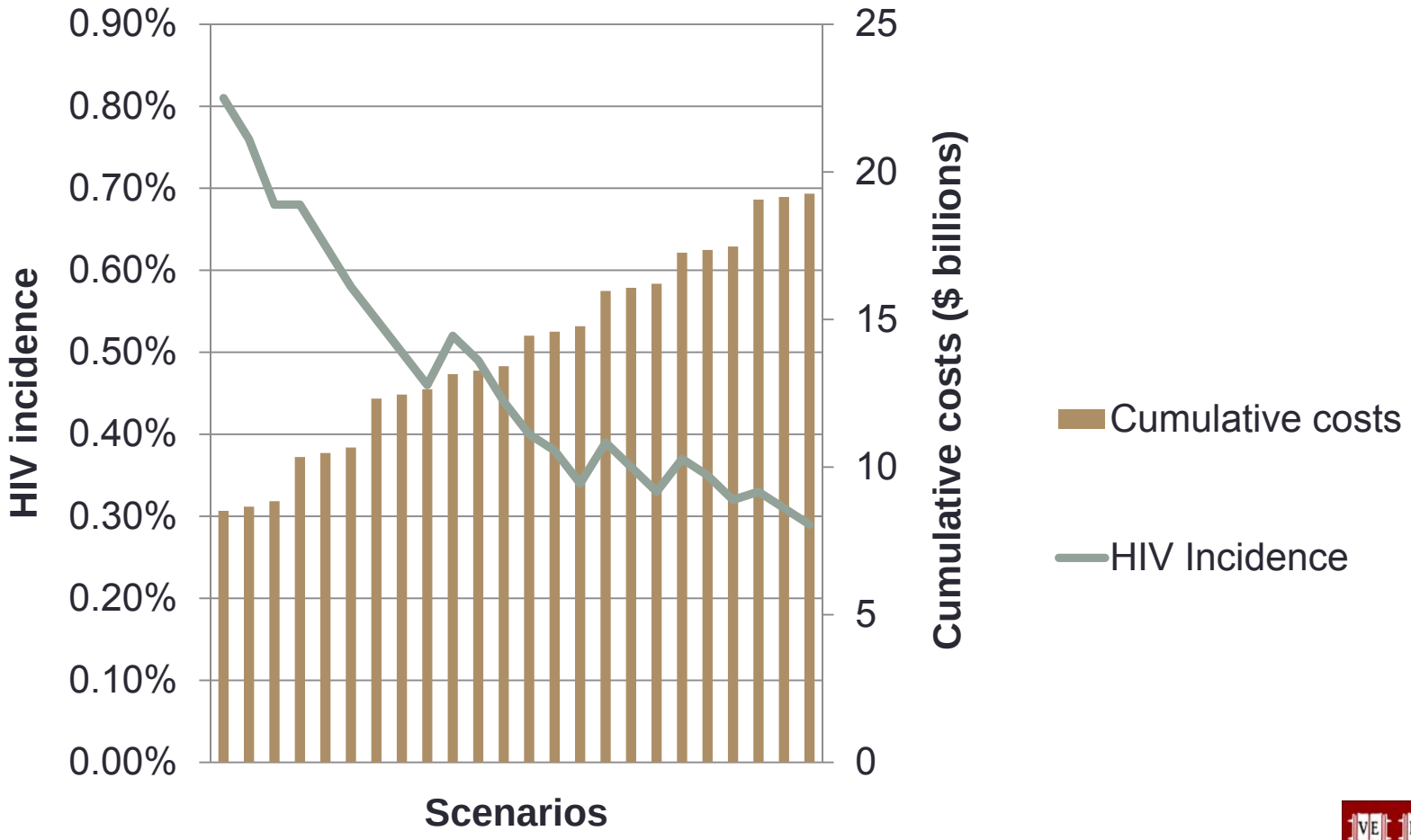
Country application: South Africa

- Largest number of HIV-infected individuals in the world (UNAIDS 2011)
- Worldwide largest number of people currently on ART and needing ART under current guidelines (WHO/UNAIDS/UNICEF 2010)
- High HIV incidence
- Political commitment to scaling up MMC but currently relatively slow rates of increase
- Good-quality empirical data

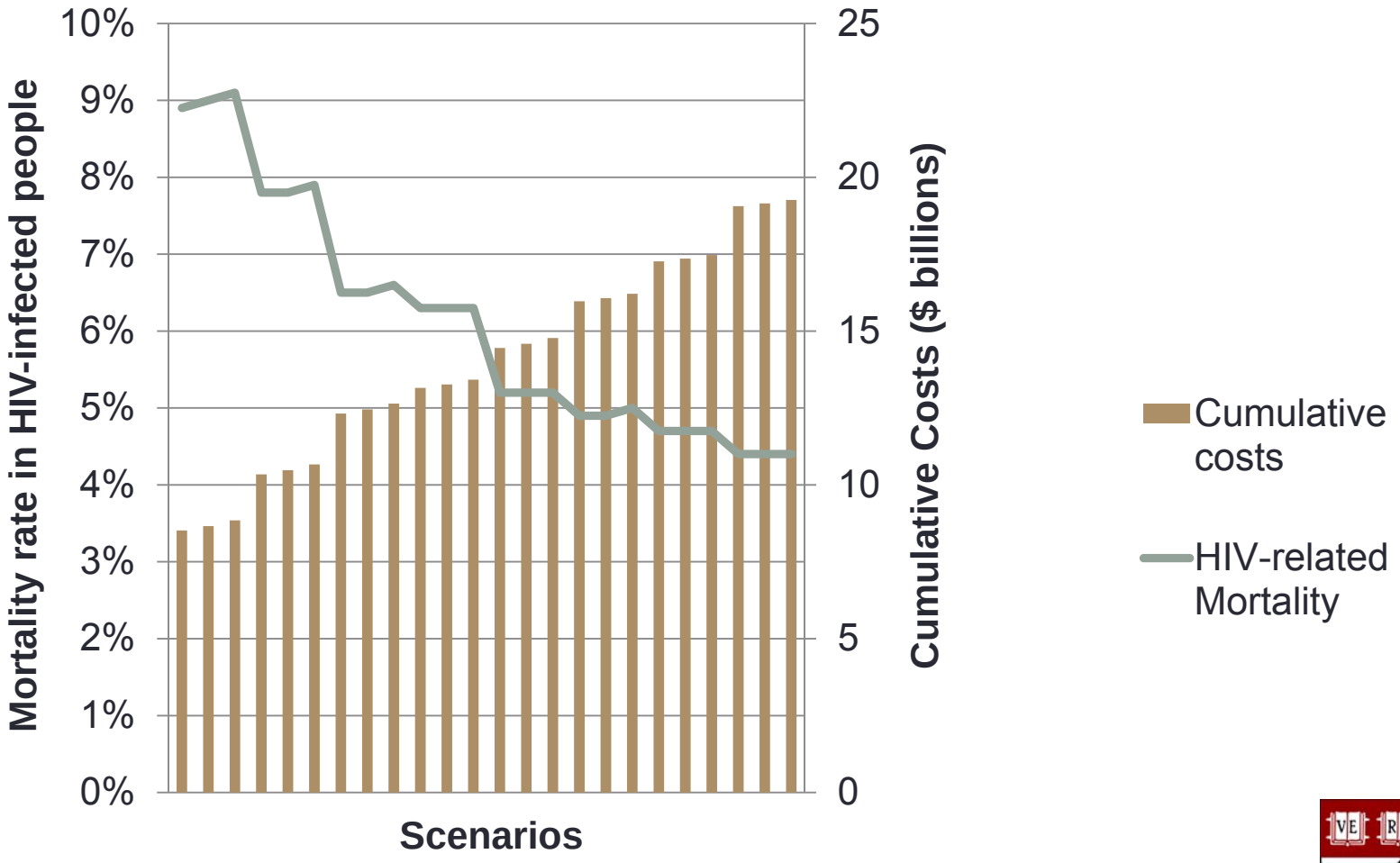
Data

- Whenever possible South African national data for base case; otherwise international sources
  - Total number HIV-infected and -uninfected: Shisana et al. 2009; StatsSA 2009
  - Disease stage distribution and ART coverage: Adam and Johnson 2009
  - Time from HIV seroconversion to disease stage: Todd et al. 2007; eART-linc 2008; WHO 2009; Minga et al. 2009
  - Annual probability of death by HIV status, disease stage and ART status: Badri et al. 2006; Braitstein et al. 2006; WHO 2009; StatsSA 2009
  - Transmission probability in different disease stages: Boiley et al. 2009
  - Number of sex partners: Shisana et al. 2009
  - Number of sex acts: Global sex survey 2005
  - MMC effect: Auvert et al. 2005; Bailey et al. 2007; Gray et al. 2007
  - TasP effect: Cohen et al. 2011
  - ART and MMC costs: Schwartländer et al. 2011

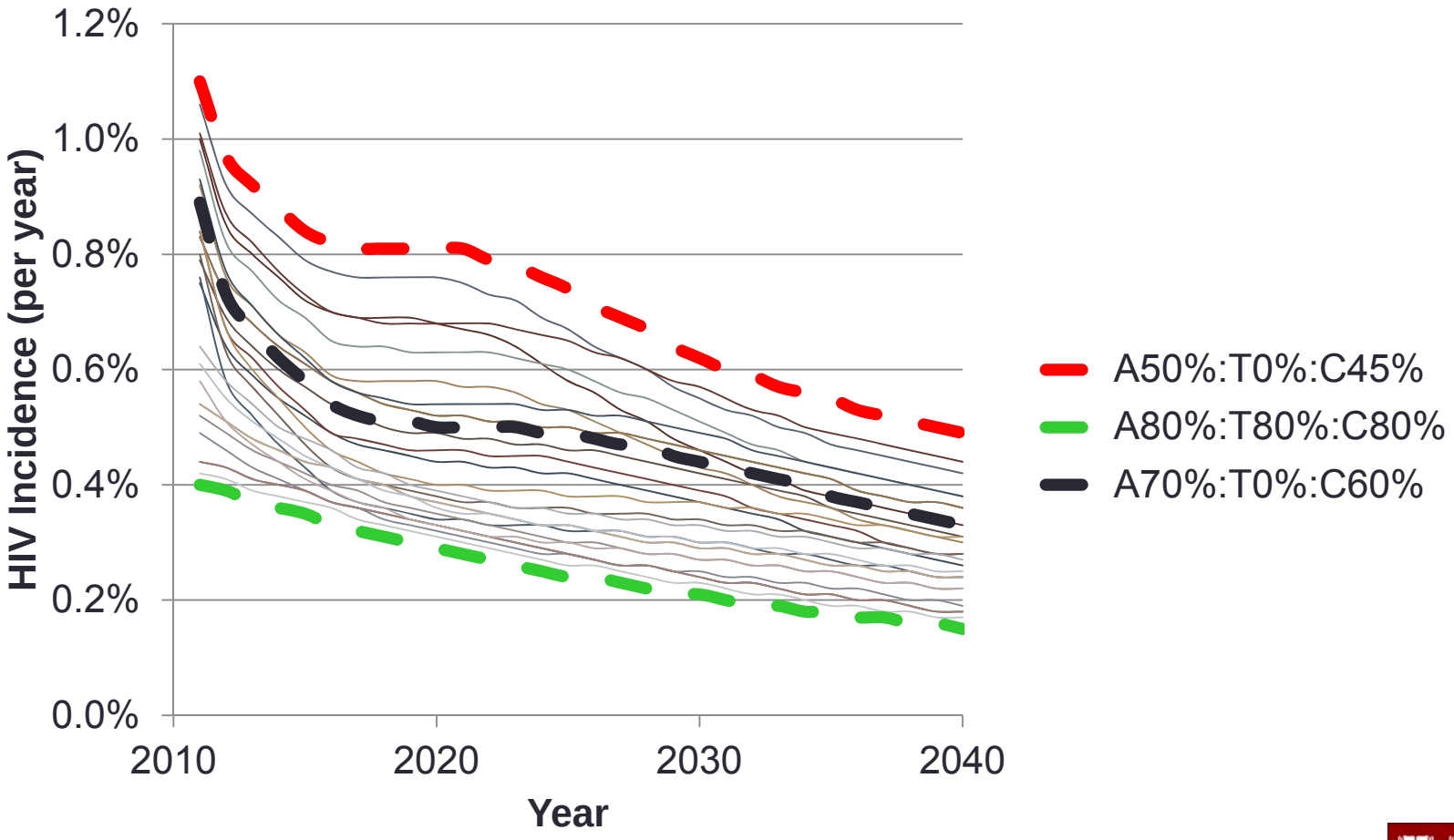
Results: costs and incidence



Results: costs and mortality

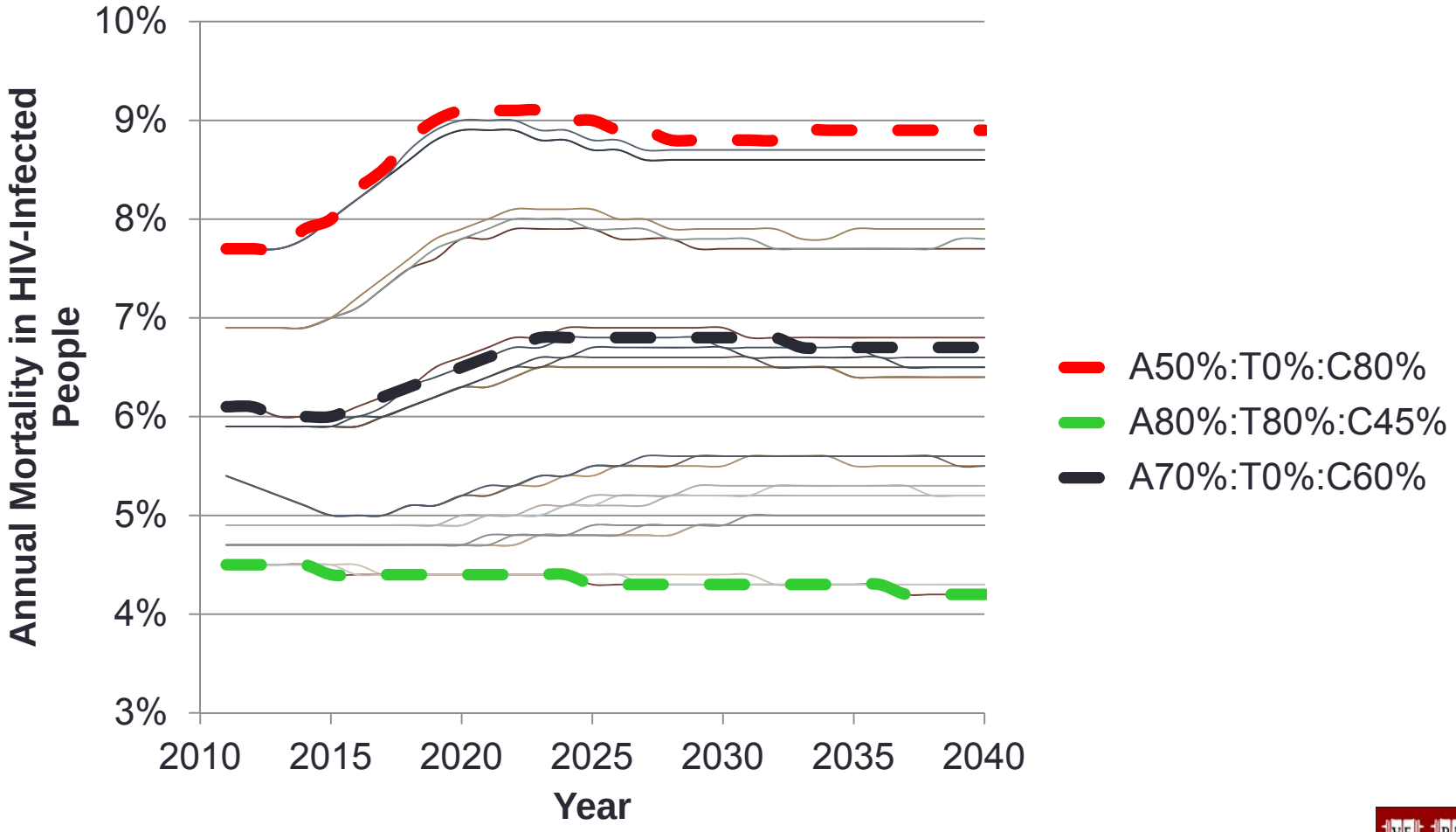


Results: HIV incidence for all scenarios



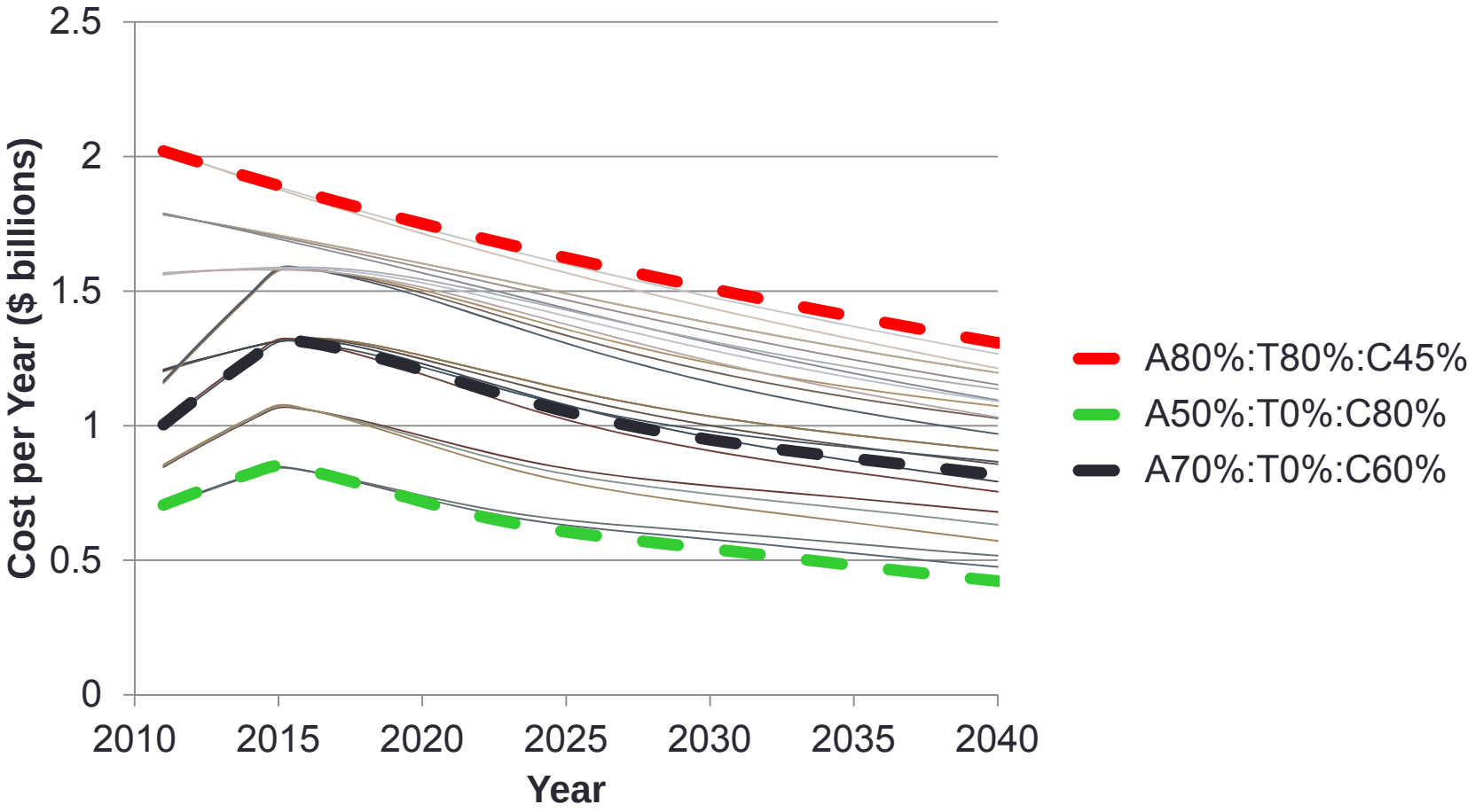
A = antiretroviral treatment (ART) under current guidelines, T = treatment-as-prevention (TasP), C = medical male circumcision (MMC)

Results: mortality in all scenarios



A = antiretroviral treatment (ART) under current guidelines, T = treatment-as-prevention (TasP), C = medical male circumcision (MMC)

Results: costs in all scenarios



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Results: incremental cost-effectiveness ratios

	ICER (US$/infection averted)
MMC (80%) vs. baseline	1,096
ART (80%) vs. baseline + MMC (80%)	7,765
TasP (80%) vs. MMC (80%) and ART (80%)	14,894

- Baseline ART 50%, MMC 45%, TasP 0%
- ICER similar for US$/death averted

Further results (1)

- Combination of high ART coverage under current guidelines and high MMC coverage provides approximately the same substantial HIV incidence reduction as TasP
- The combination of high ART and high MMC coverage is considerably less expensive than TasP, requiring approximately US$ 5 billion less over the period 2009-2020

Further results (2)

- In costs per infection averted, increased MMC coverage (with costs of about US$1000 per infection averted) outperforms high ART coverage as well as TasP (both with costs close to US$7000 per infection averted) vs. baseline
- The cost-effectiveness of MMC increases over time; and, unlike ART or TasP, MMC becomes cost-saving after 2040

Implications

- The most cost-effective implementation sequence would be to spend HIV prevention resources
  - First on substantially expanding MMC coverage to near-universal levels
  - Then on ensuring very high levels of ART coverage under the current eligibility threshold of CD4<350/µl
  - Last on adding TasP to the combination prevention package

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