Distribution of HIV Transmission by Network and Clinical Factors Among US MSM

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BACKGROUND

- Sexual role, partnership types, infection stage, and care engagement strongly determine HIV transmission rates within serodiscordant MSM partnerships.
- Previous studies to estimate the distribution of transmissions by these factors have yielded conflicting results.

  Partnership Type:
  - 35% to 68% of transmissions have been estimated to occur in main MSM partnerships.[1,2]

  HIV Stage of Infection:
  - 11% to 49% of transmissions have been estimated to occur while the infected partner was in acute-stage infection.[3-5]
- Conflicting results are likely due to heterogeneous populations and methods.
  - Parameters estimated from different data sources of MSM, different geographical regions.
  - Use of static deterministic models, dynamic network models, phylogenetic analyses.
- Estimating the distribution of HIV transmissions by these factors in one model that accounts for sexual network structure may better inform and direct prevention and treatment efforts seeking to avert new infections in US MSM.

OBJECTIVE

To assess the distribution of HIV transmissions by behavioral and clinical factors in one comprehensive US-based model for MSM in order to provide internally-consistent and actionable estimates.

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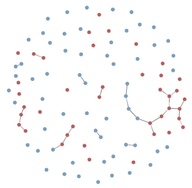
METHODS

- **Data Sources:**
  - Involve[men]t Study, an HIV cohort study of MSM in Atlanta from 2011-2014.
  - Men's Atlanta Networks (MAN) Project, a cross-sectional network study of MSM in Atlanta from 2011-2013.
  - Existing behavioral and clinical literature on estimates of key transmission factors for MSM in the United States.[6]
- **Analysis:**
  - **Network-based mathematical modeling**
  - Network model for the formation and dissolution of main, casual, and one-time MSM sexual partnerships over time using the statistical framework of **separable, temporal exponential random graph models** (STERGMs).
  - Characteristics of sexual acts, HIV transmission, and HIV disease progression were simulated on top of dynamic sexual networks using **EpiModel** (www.epimodel.org).



  - Key network, behavioral, and clinical parameters were estimated from the data sources.
  - 250 simulations were run over a period of 10 years with a population of 10,000 MSM per simulation.
  - **Population attributable fractions (PAFs)** were estimated for network and clinical factors, within partnerships and clinical status of the infected partner.

$$PAF = \frac{\sum_{i=1}^{n} number\ of\ transmissions\ that\ occurred\ under\ specified\ partnership\ characteristic\ or\ clinical\ status\ of\ the\ infected\ partner}{\sum_{i=1}^{n} number\ of\ transmissions}$$

where n = total number of timesteps in a simulation = 10 years

  - 95% credible intervals were calculated according to the variability across the 250 simulations.

RESULTS

Figure 1. Distribution of HIV Transmissions by Behavioral and Clinical Factors among US Men Who Have Sex with Men

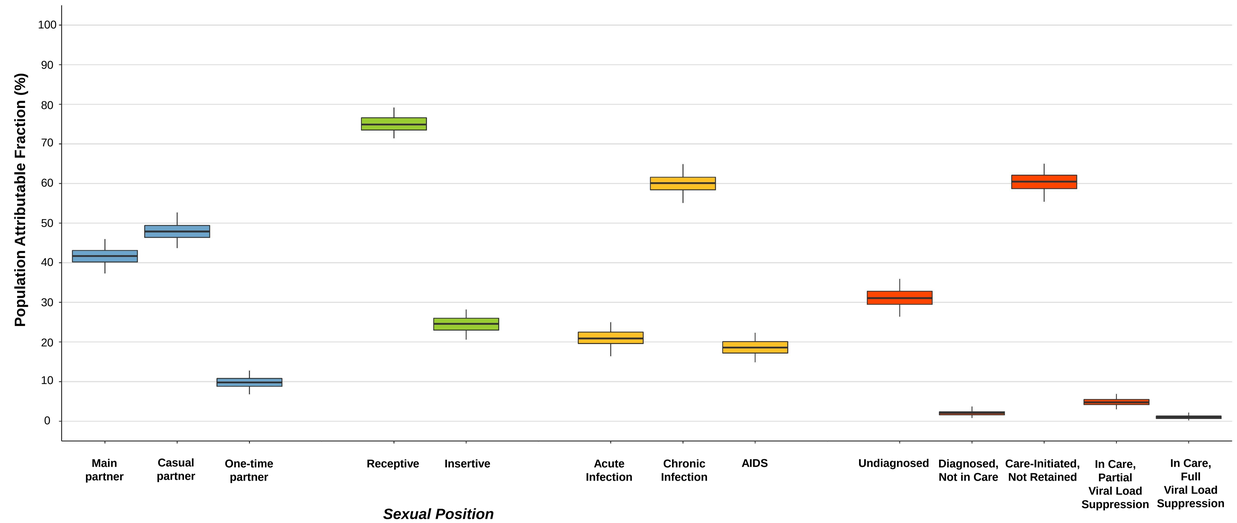


Table 1. Estimated Population Attributable Fraction (PAF) of Behavioral and Clinical Factors for Incident HIV Infections among US Men Who Have Sex With Men

	PAF	95% CrI[1]
Behavioral		
Partnership Type		
Main	41.7	37.3—46.0
Casual	47.9	43.7—52.7
One-time	9.8	6.8—12.8
Sexual Position during Anal Intercourse		
Receptive	74.9	71.4—79.2
Insertive	24.6	20.6—28.2
Clinical		
HIV Stage of Infected Partner		
Acute	20.9	16.4—25.0
Chronic	60.1	55.1—64.9
AIDS	18.6	14.9—22.3
HIV Care Stage of Infected Partner		
Undiagnosed Infection	31.1	26.4—35.9
Diagnosed, Not in Care	2.1	0.8—3.7
Care-initiated, Not Retained	60.5	55.4—65.0
In Care, Partial Viral Suppression	4.8	3.0—6.9
In Care, Full Viral Suppression	1.0	0.2—2.2

[1] 95% credible intervals across 250 simulations

DISCUSSION

- Our model suggests two high-value targets for prevention:
  - MSM in non-main partnerships
  - MSM in partnerships in which the infected partner has fallen out of HIV care
- Assessing risk behavior **specific to partnership type** remains necessary to tailoring the delivery of HIV prevention tools.
  - **For HIV-negative MSM in non-main partnerships**, targeting strategies may emphasize PrEP as partners' HIV status or care engagement may be unknown.
  - **Within main serodiscordant partnerships**, strategies may include PrEP for the HIV-negative partner and support for the HIV-positive partner to remain effectively engaged in care.
- **HIV-positive men not retained in care** contribute the majority of ongoing HIV transmissions.
  - These results are consistent with other modeling methods[7] and demonstrate importance of prevention through **clinical interventions** and **retention** programs with positive MSM.
  - Efforts to engage these men individually and through their partnerships will be challenging but essential.

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