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Using HIV Networks to Inform Real Time Prevention Interventions

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Background

- The frequency and type of transmission risk behaviors have been used to estimate HIV transmission risk.
- Available methods to estimate HIV transmission risk are not informed by local network structure

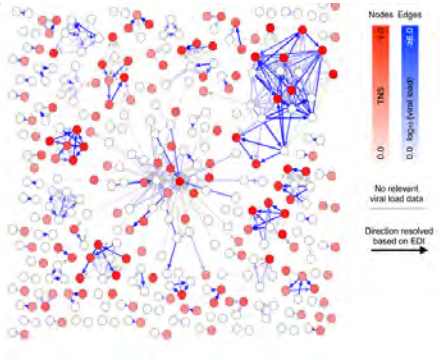
Objective

To reconstruct the local San Diego HIV-1 transmission network and determine if the network structure can be used to inform (i.e., weight) HIV transmission risk and target interventions to more efficiently interrupt transmissions.

Methods

- Screening for acute HIV-1 infection was offered between 1996 and 2011 at multiple San Diego sites and persons with acute and early infection, and their social/sexual partners were enrolled.
- An estimated date of infection (EDI) was calculated for recently infected persons and a transmission direction was assigned by comparing the EDI and sampling dates of putative partners.
- A partial transmission network was inferred based on the nucleotide genetic distances between HIV-1 *pol* sequences.
- Two individuals (i.e., nodes) in the network were linked whenever their pol sequences were ≤1.5% distant (TN93 model).
- A transmission network score (TNS) was calculated for each individual conditioned on the network, designed to estimate the risk of HIV transmission from a newly diagnosed individual to a new partner. We also estimated the impact of ART on transmission dynamics.
  - Specifically, *TNS(**d**|**N**)* = Prob *(degree of a node in N < **d**)*, with the probability computed using the best-fitting parametric density for the network **N**.
- Using the network (N) at the time of enrollment for each individual (2005 and 2010), we computed the correlation between the baseline TNS [proportion of nodes in the network with degrees less than the newly enrolled individual] and putative onward transmission events in the first year following enrollment.

Figure 1: The Inferred Transmission Network



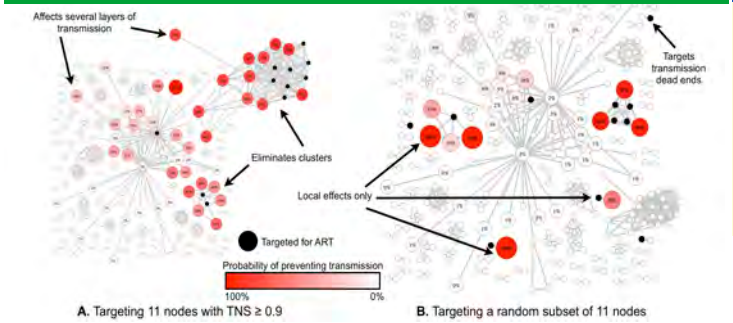
Results

- HIV-1 *pol* sequences were used to infer the transmission network from 648 individuals, including 478 (73.8%) with recent infection and 170 of their contacts, **FIGURE 1.**
- Putative transmission was highly correlated with pVL, number of sex partners and high TNS, **TABLE 1.**
- Retrospective analysis of ART use and simulations of ART targeted to persons with highest TNS (>0.95), showed significantly less network level transmission (p<0.05), **FIGURE 2**.

Table 1: Clinical Correlates of HIV Transmission

Baseline parameter	Putative transmission		Analysis	
	Yes	No	Univariate	Multivariate
Plasma VL	5.2	4.7	**P<0.01**	**OR 2.0, p<0.01**
CD4	382	469	P=0.53	
No. Sex Partners	3.0	1.5	**P=0.03**	**OR 1.8, p=0.03**
Acute/Early	72.1%	64.1%	P=0.52	
URAI, Any	76.0%	64.8%	P=0.34	
TNS (>0.75)	44.8%	15.6%	**P<0.01**	**OR=4.0, P<0.01**

Figure 2: Simulations of ART (targeted vs. random)



Conclusions

- The network-based risk score (TNS) is correlated with transmission risk behaviors and outcomes, and can be used identify and target effective prevention interventions, like ART, to those at a greater risk for HIV-1 transmission.
- While universal testing and treatment remain the goal of an effective HIV prevention strategy, targeted prevention efforts to persons at greatest risk of HIV transmission (i.e., high TNS), may offer a more efficient use of prevention resources and provide a greater reduction in network incidence.

Acknowledgements

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