

A pan-European phylodynamic study of HIV-1 transmission networks

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Background



As of 2009, 2.2 million people were living with HIV/AIDS in Europe and central Asia with no decrease in incidence in recent years. This study reconstructs HIV transmission networks and investigates patterns of epidemic growth.

The EuResist project

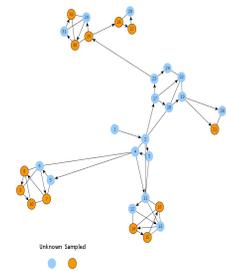
Transmission type

Heterosexual	6144
MSM	5676
IVDA	4285
Unknown	15001

Country

Italy	9513
Germany	2420
Sweden	1348
Unknown	12237
Total patients	31725

Working principle

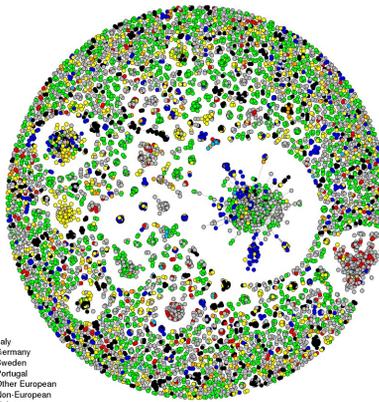


HIV is transmitted over a contact network, evolving and spreading on similar time scales

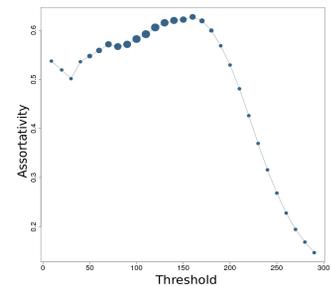
Epidemic spread

Reconstructing the transmission graph

- Calculate pairwise log-det distance, a measure of evolutionary divergence
- Construct transmission graph by thresholding distance
- Find optimal threshold using social network measures like edge density



Reconstructed transmission graph composed of transmission clusters

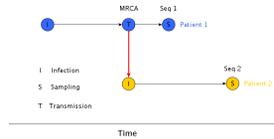


Assortativity is the propensity for vertices from the same country to form edges. Point size is inversely proportional to edge density. Optimal threshold is at largest point.

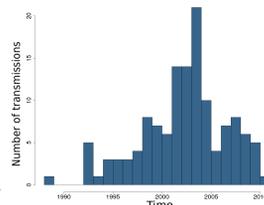
Epidemic growth and transmission interval

Phylogenetic tree reconstruction

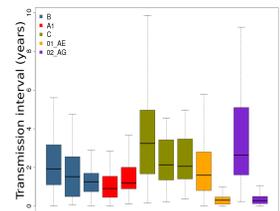
- Reconstruct phylogenetic tree for each large cluster
- Model evolution as a GTR + Γ substitution process
- Estimate model parameters and tree topology in a Bayesian MCMC framework



Time of transmission is estimated from time of divergence



Epidemic growth of a subtype B cluster



Transmission intervals for 13 large clusters

Conclusions

- High assortativity suggests that the HIV epidemic has spread endogenously as opposed to pan-European mixing
- Episodic growth suggests that once HIV infects an individual it rapidly spreads via the underlying contact structure

References

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- [2] Lawyer et al. Endogenous or exogenous spreading of HIV-1 in Nordrhein-Westfalen, Germany, investigated by phylodynamic analysis of the RESINA Study cohort. *Med Microbiol Immunol*. 2012 Aug; 201(3): 259-269
- [3] Lewis et al. Episodic sexual transmission of HIV revealed by molecular phylodynamics. *PLoS Med*. 2008 Mar 18; 5(3): e50
- [4] Hughes et al. Molecular phylodynamics of the heterosexual HIV epidemic in the United Kingdom. *PLoS Pathog*. 2009 Sep; 5(9): e1000590



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