HIV-1 Superinfection in the Swiss HIV Cohort Study: a Large Scale Screen

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OBJECTIVE

Determine the incidence of HIV-1 superinfection in the Swiss HIV Cohort Study (SHCS)

WORKFLOW

The Swiss HIV Cohort Study (SHCS)

Longitudinal study
>20,000 HIV-Infected individuals in Switzerland
Follow up approximatively every 3 months with detailed questionnaires every 6 months
Biobank and separate clinical and epidemiological data
Aims to provide optimal care, reduce transmission and study HIV

The Zurich Primary HIV Infection Cohort Study

>360 patients with documented PHI
95% of the patients are in the SHCS

Sequences from the genotypic resistance tests of HIV pol region including the protease and the reverse transcriptase
25,378 sequences

1st Filtering step
Patients information matching
Remove non-cohort patients
21,872 sequences ⇔ 11,738 patients
(include 312 ZPHI patients ⇔ 538 sequences)

Pairwise alignment
Muscle program using HXB2 reference gene: pol 2,253-3,870
Remove alignment gaps
MIT MEME package

Tree construction
FastTree software

Phylogenetic tree obtained with the 21,872 sequences from 11,738 patients

2nd Filtering step
Remove patients with only one sequence available
4,558 patients ⇔ 1,224 patients
(include 27 ZPHI sequences ⇔ 6 patients)

1st Selection criteria
Remove monophyletic clusters with the condition that ≥20 patients must be included in the smallest cluster that includes all of the focal patient’s sequences
4,558 patients - 3,627 patients in monophyletic clusters
= 931 patients

2nd Selection criteria
The genetic distance between the focal patient’s sequences ≥5%
Genetic distance > 5% ➔ 341 patients

330 potential superinfection cases when applying selection criteria 1 and 2 simultaneously.
(include 7 candidates in the ZPHI)

Hypothetical mislabelling categories

Categories based on the number of longitudinal sequences per patient and the spatial positioning of these sequences in the phylogeny.

RESULTS

1 Category 3 patients are the superinfection candidates that cannot be explained by mislabelling of one sequence.
25 out of 31 patients with ≥ 4 sequences (1 ZPHI patient)
With these 25 patients out of the 1,224 individuals with ≥ 4 longitudinal sequences, we estimated a minimum rate of superinfection in our cohort of 2%.

Longitudinal plasma samples from patients in these categories will undergo full-length HIV-1 sequencing using next generation sequencing for further analysis

A special thanks to the patients for their participation, the study nurses and the physicians of the Swiss HIV Cohort Study and the Zurich Primary HIV Infection Cohort Study

TAKE HOME MESSAGES

We estimated a minimum rate of superinfection in our cohort of 2%.
Our molecular epidemiology approach is the largest screening to identify HIV-1 superinfection using longitudinal samples to date.
This work sets the basis to validate and characterize HIV-1 superinfection using next generation sequencing in our cohort.

CHALLENGES

1. The superinfecting strain may outcompete or be outcompeted by the first strain
2. Superinfection is difficult to discern from co-infection
3. Intra-subtype superinfection is difficult to prove, especially if caused by viruses from similar transmission clusters
4. The sampling frequencies are too low and the systematic screenings of large populations to date are missing due to lack of needed longitudinal samples in untreated patients

HIV-1 SUPERINFECTION

Infection with strain 1
Superinfection with strain 2
Major population

Time

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