Time from Earliest Detection of HIV Infection by Individual Donation Nucleic Acid Testing to Detection by Serological Screening in South African Blood Donors

Background

- It is critical for the quantification of residual risk of transfusion transmissible infections to have accurate estimates of the window periods of screening assays.
- The South African National Blood Service (SANBS) screened all donations during the study period (2005 to 2015) for HIV with individual donation nucleic acid testing (ID-NAT) and serology, using:
  1. Procelix Ultrio Plus multiplexed (HIV, HBV and HCV) NAT assay and positive donations with the Ultrio Plus HIV-1 discriminatory assay on the Tigris platform, and
  2. The ABBOTT PRISM HIV O Plus third-generation chemiluminescent serological assay.
- We used SANBS repeat donor data from 2005 to 2015 to estimate the delay between earliest detection using ID-NAT and earliest detection using serology.
- Further providing the first direct estimate of the diagnostic delay of the PRISM assay.

Methods

- The average duration of the NAT-yield state (i.e. Ultrio+/PRISM-) was estimated using a novel approach based on interpreting the number of NAT-yield cases as a pseudo-Poisson process.
- The inter-donation intervals (IDIs) of all HIV-positive donations were interpreted as ‘inverse exposure time’.
- We derived a formula that provides an estimate of the average duration of the NAT-only positive state, based on:
  - the number of NAT-yield cases
  - divided by the sum of inverse of IDIs for all donations detected as HIV-positive.
  - 95% confidence intervals were obtained using the properties of the Poisson and Chi-square distributions.

\[
\mu = \frac{n}{\sum_{i=1}^{N} \frac{1}{IDI_i}}
\]

with \(n\) the number of NAT-yield cases, \(N\) the number of donations from repeat donors detected as HIV-positive and \(IDI_i\) the time since previous donation of the \(i^{th}\) donor.

Study population

We used data from: 2,504 HIV-positive donations from repeat donors with median IDI of 160 days (IQR: 91-245) of which 300 were NAT-yield cases.

Results

- We found an average duration of the ID-NAT-positive/PRISM-negative state of 15.03 days (95% CI: 13.37-16.83 days).
- Using an accepted viral load growth model and the 50% limit of detection (LoD) of the Ultrio Plus assay (N. Lelie, personal communication), this suggests a total average delay from first detectability on a NAT assay with a 50% LoD of 1 RNA copy/mL to PRISM seroconversion of 15.69 days.

Conclusion

- Compared to serology alone, SANBS’s use of ID-NAT screening eliminated 15 days from the infectious window period – the bulk of the residual risk.