Health New Zealand
Te Whatu Ora

PHF Science

HIV-1 viral load blips (lab perspective

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LabPLUS & PHF Science

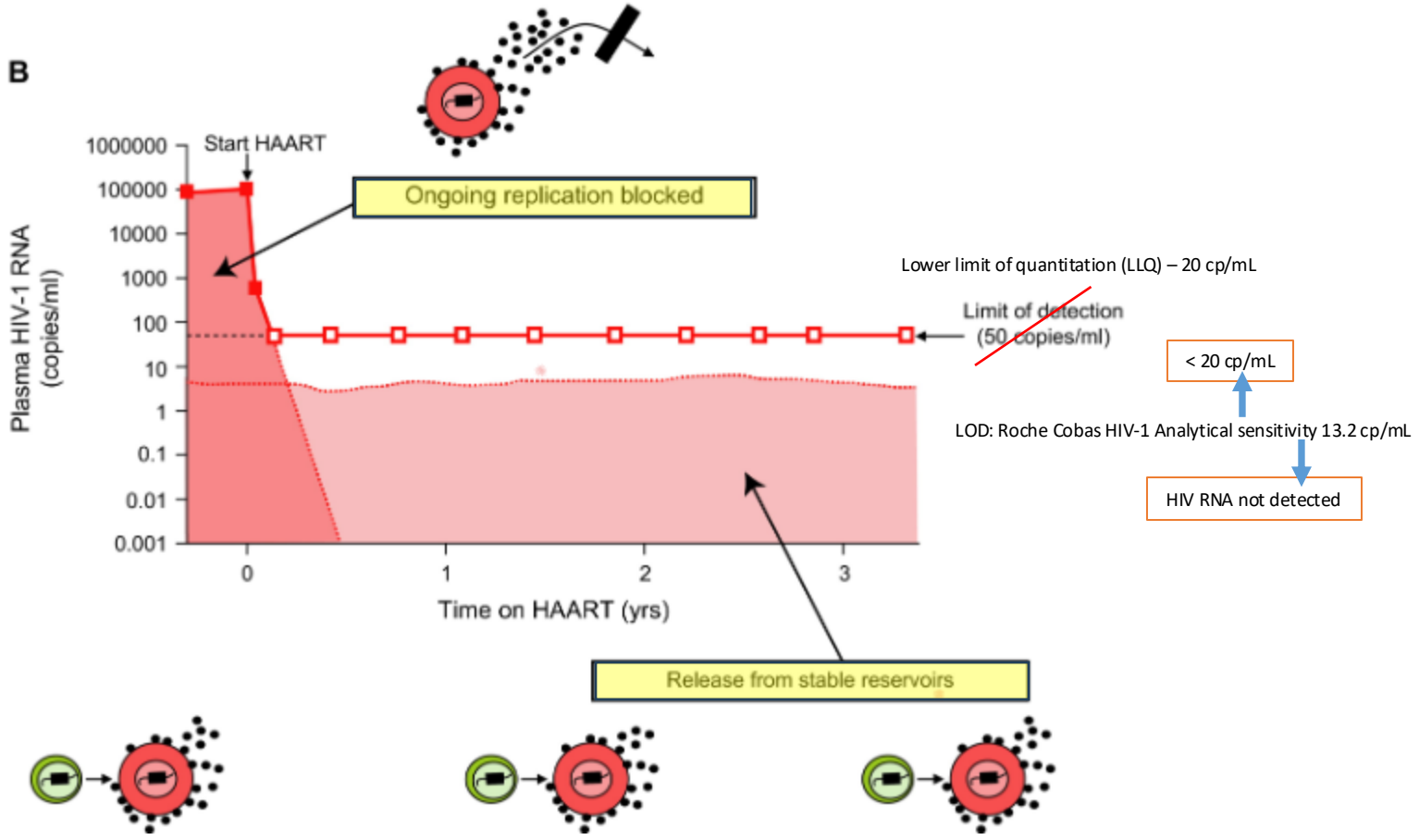
LabPLUS

LabPLUS is the largest referral hospital laboratory in Aotearoa New Zealand. We offer an extensive local and regional analytical pathology service.

Blips: When Random Factors (viral dynamics / venipuncture / test assays) Cause Intermittent Low-Level HIV-1 Viremia

- Questions to cover …
  - What is HIV viral load?
  - How do we measure it?
  - How accurate is it?
  - What factors can influence the VL result?
  - How common are blips? (what does LabPLUS data show)

Residual viraemia after successful ‘suppressive’ cART

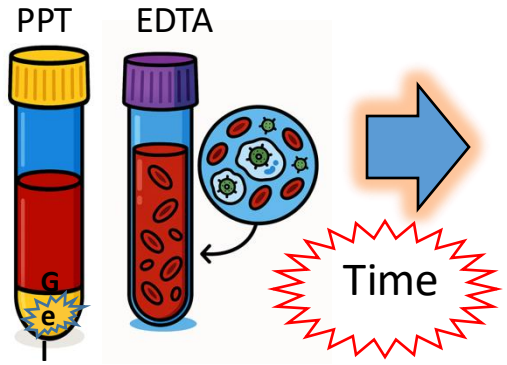


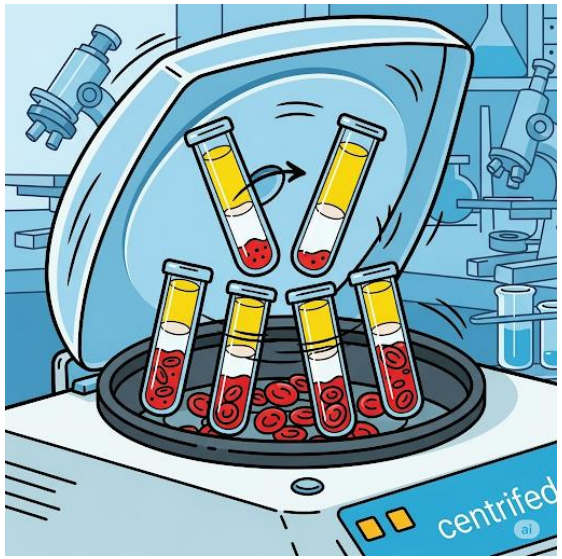
Shen L, Siliciano RF. J Allergy Clin Immunol, 2008

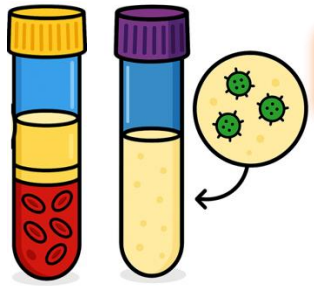
Summary of viral load dynamics

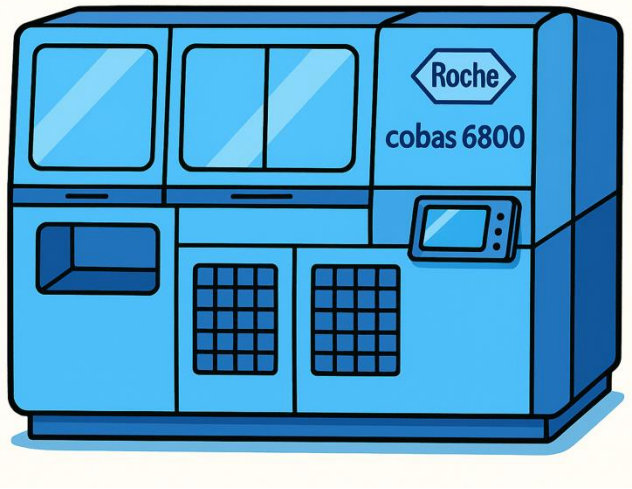
- **Higher starting viral load (VL)**: Longer time to achieve virological suppression; more frequent blips and persistent low-level viremia (pLLV).
- **Persistent low-level viremia (pLLV)**: Frequent or high-magnitude blips increase the risk of viral rebound.
- **Viral blips**: Correlated with a larger or more active HIV reservoir, increasing the speed and chance of viral rebound after stopping antiretroviral therapy (ART).
- **Older antiretrovirals**: Higher risk of virological failure (VF).
- **Caution inferring infectiousness:** Not all VLs are the same

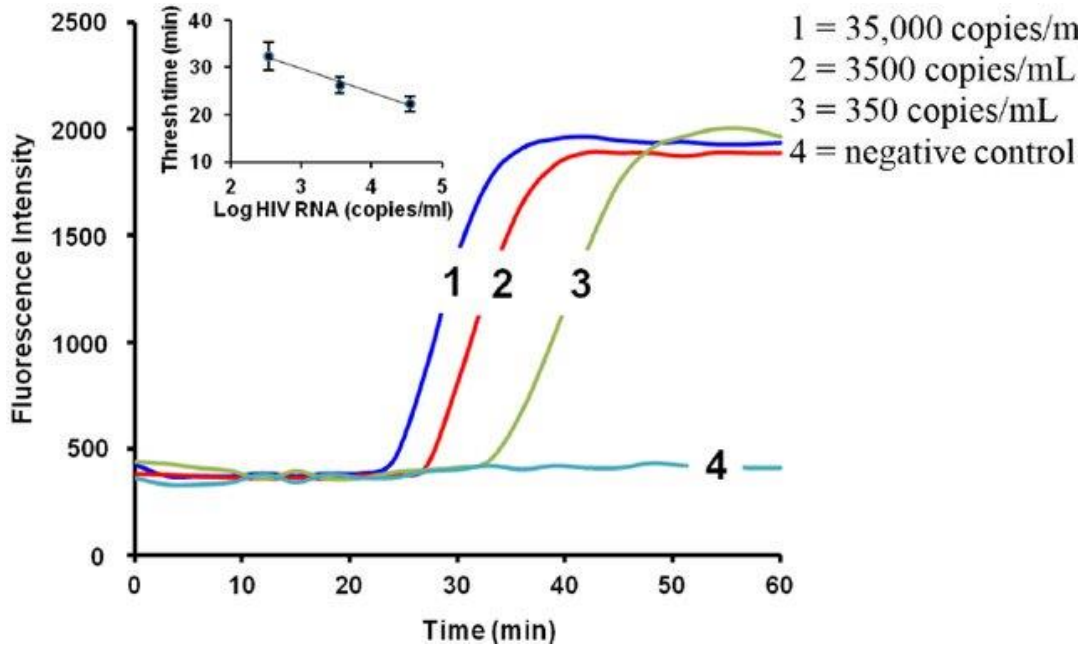
Pre-analytical and analytical factors which can influence blip occurrence

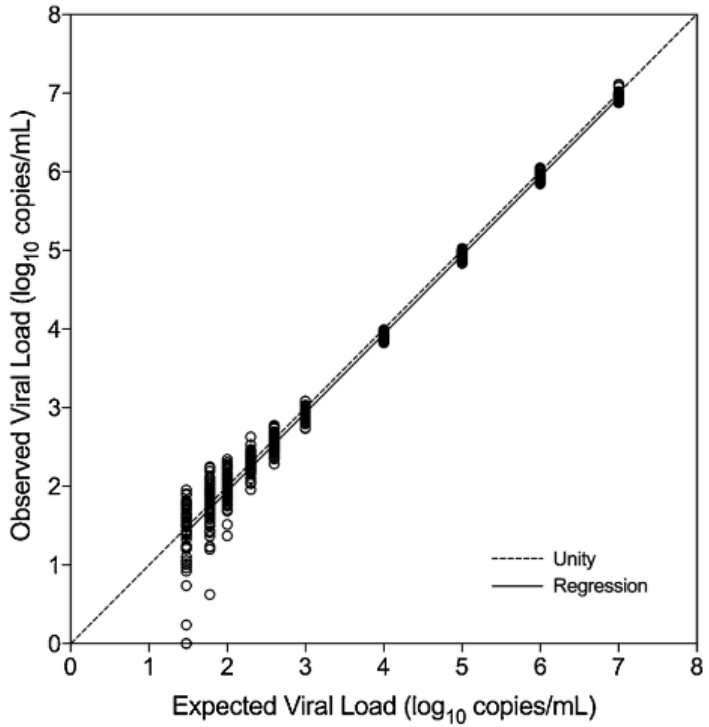












Adams P/ J Clin Virol 2019

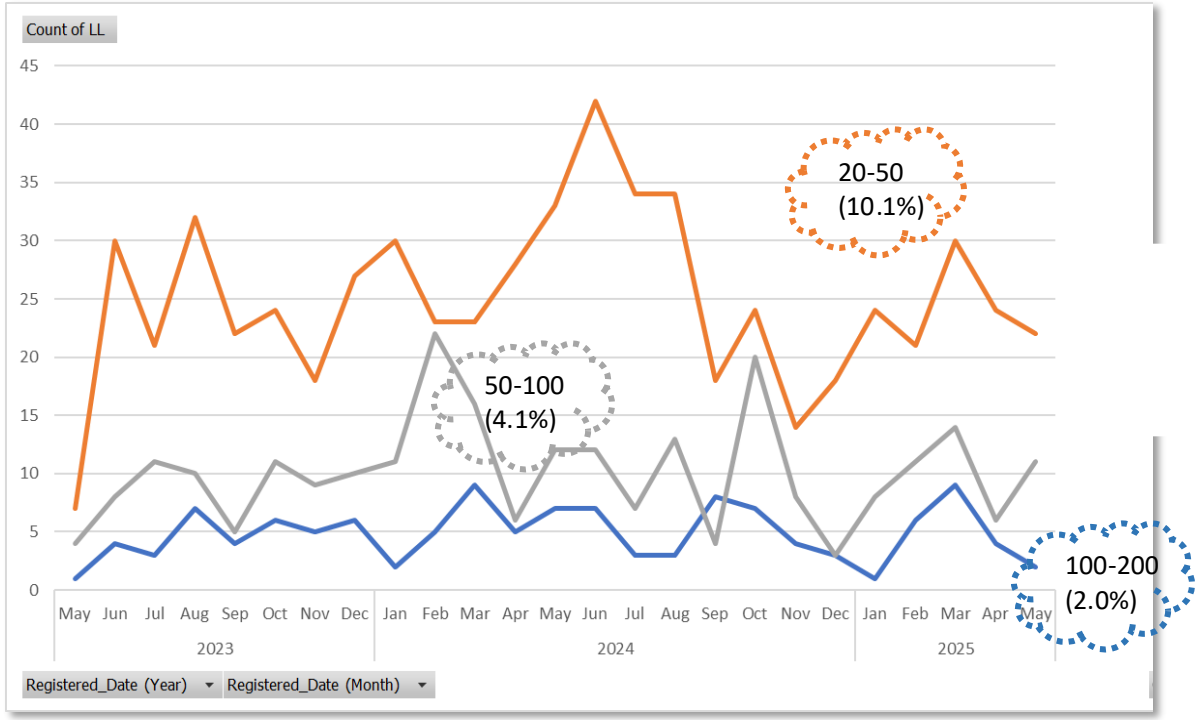
Summary of lab test accuracy

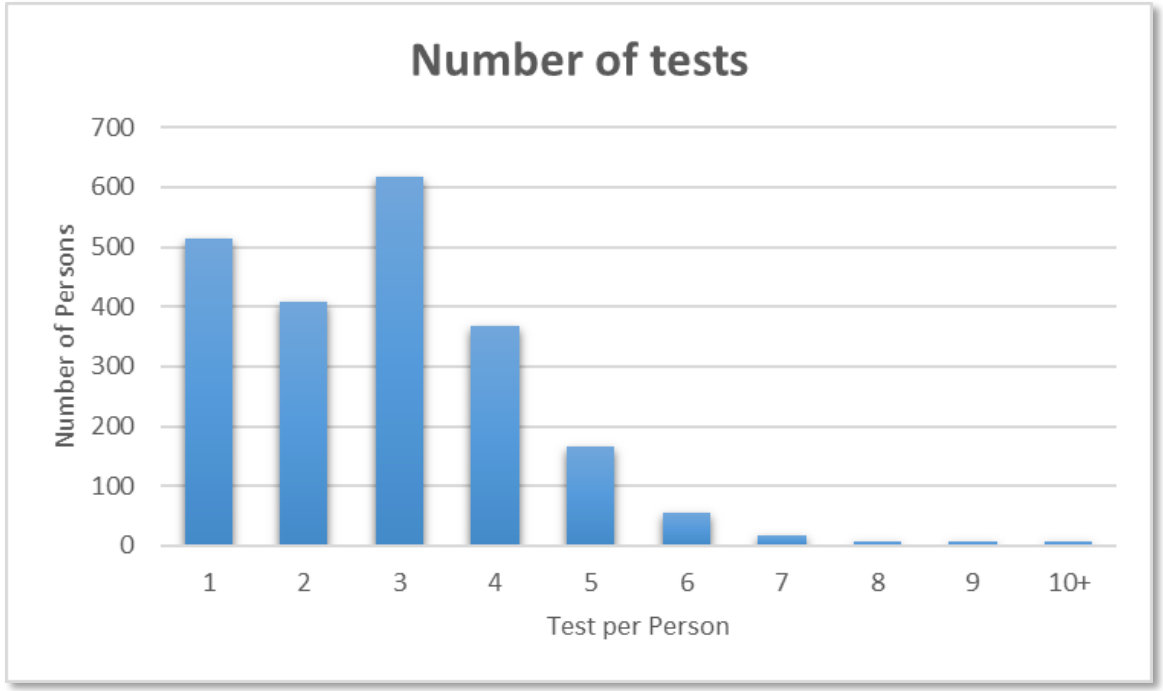
- **HIV Viral Load (VL) Assays**: Most assays amplify both RNA and proviral DNA.
- **Assay Limits**: The limit of detection (LOD) is lower than the lower limit of quantification (LLQ). Both have become more sensitive over time (e.g., from 400 to 10 cp/mL).
- **Accuracy at Low Levels**: Assay accuracy (repeatability/reproducibility) decreases as viral loads approach the LOD/LLQ.
- **Contamination Risk**: Proviral DNA contamination of plasma can be influenced by pre-analytical factors.

LabPLUS HIV-1 viral load analysis (simplistic)

- 6148 tests performed over 2-year period on 2169 different patients (Jun 2023 – May 2025)
- 514 patients (8.3%) only had 1 viral load test
- Overall **16.2%** of all tests had VL 20 –200 cp/mL
- Detectable VL in 20 –50 bracket was the most common **10.1%**
- Ratios in different VL brackets stable over time

Ratios	20 – 50 cp/mL	50 –100 cp/mL	100 – 200 cp/mL
2023	64%	24%	12%
2024	62%	26%	12%
2025	63%	25%	12%





LabPLUS HIV-1 viral load analysis (Strict blip & pLLV definition)

6148 tests performed over 2-year period on (Jun 2023 – May 2025), n = 1227 with ≥ 3 tests

Average time between sample collection and lab receipt 11hrs 50’

Samples from AH, SH, AKL hospitals & community and Northland

Mean number of tests per person: 4.0 (SD: 2.8)

3. Results and Summary Table

	Roche Cobas 6800		Roche Amplicor	Roche CAP/CTM
Metric	**50 Cut-off**	**20 Cut-off**	**50 Cut-off**	**40 Cut-off**
Persons with ≥3 tests	1,227	1,219	266	351
Number of blip events	74	98	18	113
Number of persons with ≥1 blip	52	65	0	13
% of persons with blips (≥3 tests)	4.2%	5.3%	6.8%	28.4%
Total person-years (≥3 tests)	1,498	1,489	-	-
Blip Rate (events per 100 person-years)	4.9	6.6	6.8	32.2
Mean blip copies/mL	94	54	83	90
Range blip copies/mL	50–182	20–179	53-390	40-727

Persistent Low-Level Viremia (pLLV), Only in Patients with ≥3 Tests

VL Bracket	Events	% of Persons (≥3 tests)		
20–200 copies/mL	23	1.9%		
200–1,000 copies/mL	9	0.7%		
			3.2%	4.5%

- For most, VL returned to undetectable rapidly.
- A small minority had pLLV in the 20–200 or 200–1,000 range after a blip.

Smit E, JAIDS 2009

Logistic Regression Modeling on Blip Risk (≥50 copies/mL)

Variables included:

- Age (continuous)
- Requesting Site (categorical, "ReqDr_Name")
- Tube Type (categorical)
- Time between collection and arrival (numeric, in hours)
- Frequency of ND or <20 results (proportion per person)
- Interactions: Tube type × Transport time, Transport time × Requesting Site

Predictor	Odds Ratio (OR)	95% CI	p-value
Age (per 10 yrs)	1.04	0.97–1.12	0.23
Tube type: PPT vs EDTA	1.31	1.01–1.71	0.04*
Tube type: Separated Plasma vs EDTA	1.11	0.88–1.39	0.37
Requesting Site: Community vs Ref	0.91	0.69–1.20	0.53
Transport time (per hour)	1.03	1.00–1.06	0.05
ND/<20 freq (per 10% increment)	0.84	0.72–0.98	0.03*
TubeType × TransportTime	1.12	1.01–1.24	0.03*
TransportTime × Site	1.04	0.97–1.11	0.25

Interpretation:

- **Tube type** (especially PPT tubes) and **longer transport times** significantly increase blip risk.
- **Tube type × Transport time interaction**: effect of transport time is amplified with PPT tubes compared to EDTA.
- Higher **frequency of undetectable results** protects against blips.
- No significant effect of age or requesting site alone, nor any strong joint effect for transport time × site.

Summary of LabPLUS viral load data analysis

- **Viral Load Distribution**: A review of tests shows that 16.1% of all tests have a VL between 20-200 cp/mL. The largest proportion of these detectable viral loads (10.1%) fall within the 20-50 cp/mL range.
- **Blip Rates**: Using a strict definition, 5.3% of individuals experienced blips over 20 cp/mL, with 4.2% over 50 cp/mL. These rates are lower than historical reports, possibly due to more potent cART, assay improvements and changes in follow-up protocols.
- **Factors Influencing Blips**:
  - **Protective Factor**: RNA not detected (LOD) is protective against blips.
  - **Risk Factors**: Tube type (PPT) and longer transport times significantly increase the odds of a blip.