

Affordable Point-of-Care Specimen Processing

A Viral RNA Extraction and Stabilization Platform

Need

Affordable and accessible viral RNA molecular diagnostics, for diseases such as HIV, dengue, and influenza.

Proposed Solution

A low cost point-of-care (POC) pre-analytical viral RNA extraction and stabilization platform for low-resource or remote settings.

First Target:

HIV Viral Load Testing

There are currently over 3 million people on HIV antiretroviral therapy (ART). The two primary tests used for ART monitoring are CD4 and viral load (HIV copies/ml of blood) testing (VLT). CD4 is an indirect measure of a host's response to viral load, whereas the VLT directly measures viral response in a patient. VLT adds value both to patient management and for public health in terms of detecting early and true failure to respond to ART, mitigating drug resistance, and averting new infections. While VLT is the optimal test for tracking viral suppression, it is also the most expensive and technically complex analysis to perform because of its quantitative requirements.

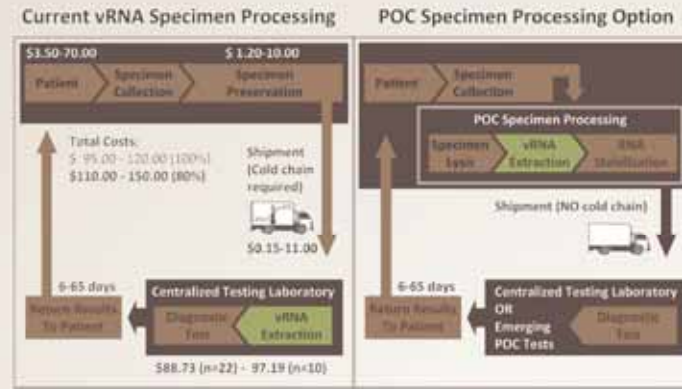
Project Activities and Results

Cost Analysis – Nicaragua Case Study

PATH conducted a detailed cost analysis to understand the costs of each step required to perform a VLT, beginning at the patient's house and continuing to when the VLT result is actually communicated back to the patient's ART care provider.

Key findings:

- The VLT remains the single most expensive component of the whole process.
- Patient distance from the specimen collection site (SCS) is a large determinant of cost.

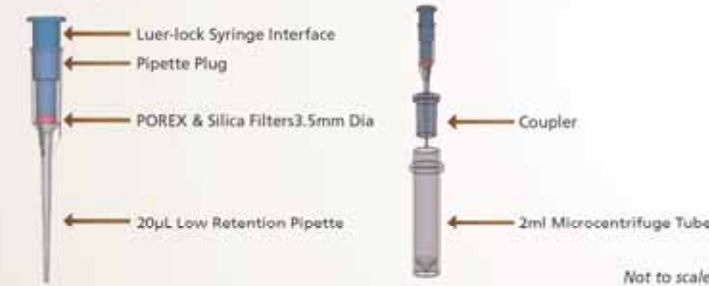


An acceptable upper price range for a POC viral RNA extraction and stabilization kit is from US\$4.08–\$21.20.

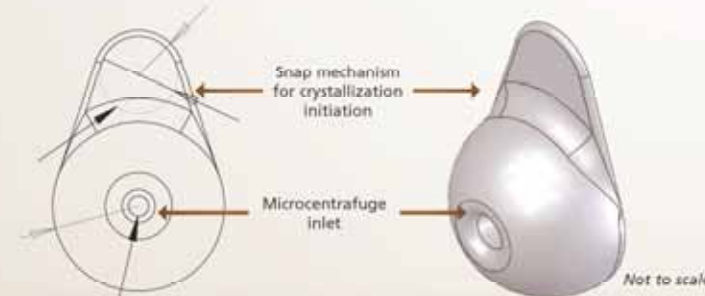
Sample Processing Platform

The below pictures illustrates the modular RNA POC extraction and stabilization platform being developed at PATH.

POC Capture Device for vRNA Biomarkers



POC Stabilization Device for vRNA Biomarkers

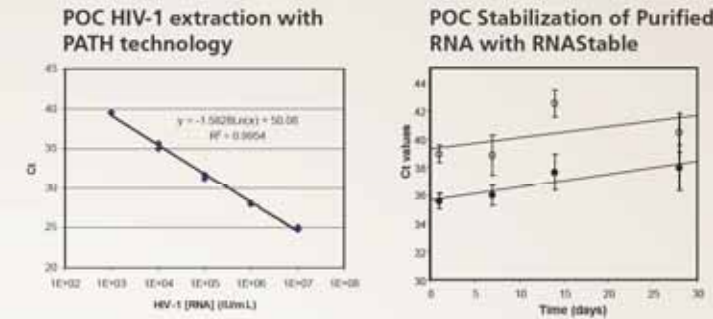


Cold form blister pack design to contain exothermic sodium acetate/water mix for incubation of the RT mix at 48°C for 30 minutes.

Key parameters in the design include:

- Low cost.
- Ease of use.
- Scalable.
- Efficient RNA extraction and elution.
- Quantitative RNA stabilization.
- Versatile.
 - Multiple specimen types.
 - Multiple specimen volumes.
 - Multiple downstream molecular diagnostic tests.

Laboratory Testing Results



Stability of HIV-1RNA in RNASable at 45°C over 28 days. Each time point represents the mean of 5 replicates at 1x10⁴ (filled circles) and 2x10³ (empty circles) HIV copies/ml levels.

Product Costing

Direct material costs are competitive to commercially available methods:

10 Specimen Batch	POC RNA Extraction	Central Lab RNA Extraction
Reagents (Home Brew):		
Sample Preparation	\$3.16	\$6.60
vRNA Stabilization	\$2.00	-
Avg Specimen Transportation Cost*	\$1.50	\$3.13
Disposables		
Sample Preparation	\$2.50	\$6.95
Total Costs per Specimen	\$9.16	\$16.68
Direct Material Cost Savings	45%	

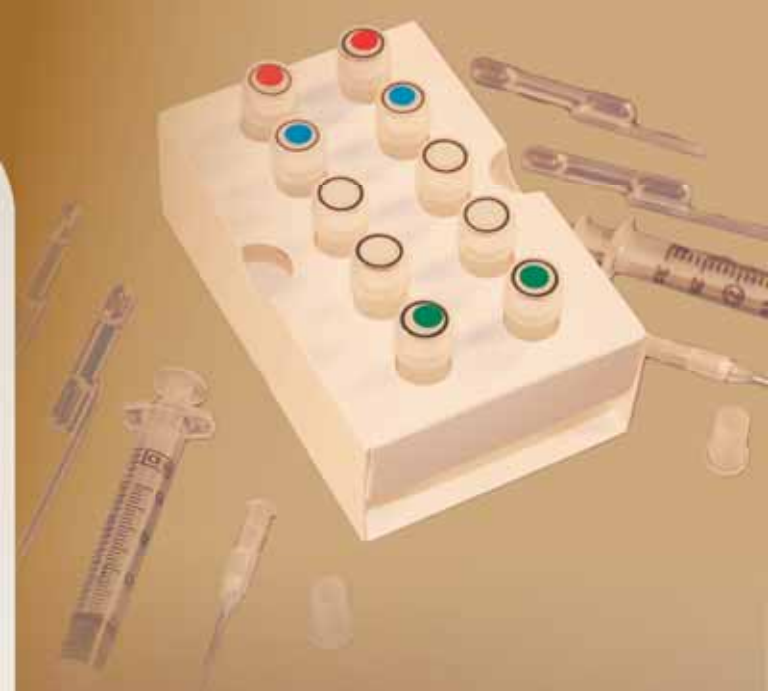
*Assumes all 10 specimens are shipped together

Outcomes

- The proposed technology eliminates cold chain storage and reduces the cost of transport of specimens to the testing laboratory.
- Our technology supports detection at 500 copies/ml and above from a 200 µl specimen. This is comparable to commercially available VLTs that require a well-equipped laboratory.
- Our technology offers a direct cost and efficiency savings to the patient and to the health care system by providing flexibility in the specimen collection process.

Considerations

- Additional training requirements of staff at peripheral SCS.
- POC RNA extraction introduces a new waste burden at the SCS.



Beddoe AG, Hubbard L, Stevens D, Gerlach J, Santos TDL, LaBarre PD, Weigl BH, Domingo GJ

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Next Steps and Spin-off Activities

- Demonstrate pre-analytical platform with clinical specimens.
- Identify manufacturing partners.
- Continue development for pilot production-ready platform.
- Technology transfer of nucleic acid extraction technologies to regional manufacturers.
- Development of cost analysis tool for monitoring and evaluation of diagnostics implementation programs.
- Development of a portfolio approach towards increasing access and affordability to VLT.

Acknowledgements

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