Viral Load: Current Technologies and the Pipeline, including Point-of-Care Assays

Maurine M. Murtagh

Consultation on Viral Load Monitoring for African HIV Treatment Programmes
Cape Town, South Africa
18 – 20 April 2013
There are no viable POC testing options currently available, although several are under development.

However, the use of DBS is now an option for some of the commercially-available platforms.

At the present time, viral load testing is exclusively laboratory-based, with most testing done on sophisticated, high-throughput instruments by highly-trained technicians. Most of the existing options are relatively expensive and the assays are deemed to be complex; sample transport is required for patients not near central laboratory facilities.
The ability to use DBS greatly simplifies the transport of samples, providing enhanced stability and ease of use for health care workers.

The use of DBS is also cost effective.

Several studies have demonstrated good correlation between DBS and plasma, albeit lower sensitivity, using different viral-load methodologies.
## Monitoring the HIV Patient on ART HIV – Viral Load

<table>
<thead>
<tr>
<th>Company</th>
<th>Roche</th>
<th>Abbott</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Assay Name</strong></td>
<td>COBAS AmpliPrep/COBAS TaqMan v2; FDA/WHO/CE-IVD</td>
<td>Abbott RealTime HIV-1 assay; WHO/CE-IVD</td>
</tr>
<tr>
<td><strong>Specimen Type</strong></td>
<td>Plasma; DBS (RUO)</td>
<td>Plasma; DBS (RUO)</td>
</tr>
<tr>
<td><strong>Cost/test</strong></td>
<td>$20 - $30 per test in resource-limited settings; $35 - $90 per test elsewhere</td>
<td>$25 - $40 per test, volume based</td>
</tr>
<tr>
<td><strong>Number of samples/run</strong></td>
<td>3 hours, 5 minutes; Taqman 48 – 48 samples; Taqman 96 – 96 samples per day</td>
<td>5 ½ hours – 8 ½ hours. Up to 93 patient samples (+3 external controls); 288 samples per day</td>
</tr>
<tr>
<td><strong>Equipment Cost ($US)</strong></td>
<td>COBAS TaqMan 48: $40,000 - $50,000&lt;br&gt;COBAS TaqMan 96: $100,000 - $110,000&lt;br&gt;COBAS AmpliPrep: $80,000 - $100,000</td>
<td>m24sp: $90,000, m2000sp: $120,000; or manual (magnetic racks, plate cooler): and m2000rt: $38,000; add $6,000 for all manual extraction items.</td>
</tr>
</tbody>
</table>
### Monitoring the HIV Patient on ART HIV – Viral Load

<table>
<thead>
<tr>
<th>Company</th>
<th>bioMérieux</th>
<th>Siemens</th>
<th>Siemens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assay Name</td>
<td>NUCLiSENS EasyQ® HIV-1 2.0; WHO/CE-IVD</td>
<td>HIV-1 RNA (RUO); FDA/CE-IVD</td>
<td>VERSANT HIV-1 RNA 1.0 (kPCR); WHO/CE-IVD</td>
</tr>
<tr>
<td>Specimen Type</td>
<td>Plasma; DBS</td>
<td>Plasma</td>
<td>Plasma; DBS (RUO)</td>
</tr>
<tr>
<td>Cost/test</td>
<td>Average price: $23.75 per test</td>
<td>$36 - $72 per test</td>
<td>$43.25 - $57.70 per test, excluding sample prep materials, which are $10.80 - $14.40 per test</td>
</tr>
<tr>
<td>Number of samples/run</td>
<td>~1.5 hours for 48 samples; 192 samples per day</td>
<td>~24 hours, including ~2.5 hours hands-on time; up to 168 patient samples per day</td>
<td>Sample prep: &lt;10 mins; sample extraction: &lt;3 hours; run time: &lt;3 hours. Up to 178 samples per day</td>
</tr>
<tr>
<td>Equipment Cost ($US)</td>
<td>NucliSens® miniMAG: $9,000; NucliSens® easyMAG®: $95,000; NucliSens EasyQ®: $49,000</td>
<td>VERSANT™ 440 Molecular System: ~$55,400</td>
<td>VERSANT™ kPCR Molecular System: $166,200 - $221,600</td>
</tr>
</tbody>
</table>
Barriers include:

- **Cost** (both the cost of testing and cost of 2nd line regimens)
- **Infrastructure** requirements
- **Complexity** – e.g., supply chain for labile reagents, sample transport, training
- **WHO guidelines** that have counseled caution in deployment of viral load testing

**Result:**

Low rates of access have created a **vicious cycle** - low demand inflates the cost of viral load treatment, while high prices suppress demand growth.
This has led to an interest in decentralizing testing – moving it closer to where patients present for care and treatment.

So that we can:
- Simplify testing
- Improve its efficiency
- Reduce its cost
- Increase overall access to testing

But, without diminishing the quality of patient care.
New Options for Viral Load Monitoring are on the Horizon

A number of new Viral Load/EID POC diagnostics are in development.

These will have lower instrument and per-test costs, but will also have lower throughput than lab-based systems.

Perhaps two of these will launch in 2013: the Alere Q (pictured at right) from Alere and the SAMBA platform from Diagnostics for the Real World.

Additional platforms will follow over the next few years.
Viral Load Product Pipeline*

- Liat™ Analyser
- Alere Q
- EOSCAPE HIV™ Rapid RNA Assay System
- Wave 80 Biosciences
- Gene Xpert
- Cepheid
- LYNX Viral Load Platform
- NWGHF
- Viral Load Assay with BART
- Lumora
- Truelab PCR
- Molbio/bigTec
- RT CPA HIV-1 Viral Load
- Ustar
- Gene-RADAR
- Nanobiosym
- ALL
- BioHelix
- Micronics

*Estimated as of March 2013 - timeline and sequence may change. Dotted line indicates that no market launch date has been set by the company.
<table>
<thead>
<tr>
<th><strong>Company</strong></th>
<th><strong>Alere</strong></th>
<th><strong>Iquum</strong></th>
<th><strong>Wave 80</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Assay Name</strong></td>
<td><strong>Alere NAT System; Alere Q</strong></td>
<td><strong>Liat™ Analyser</strong></td>
<td><strong>Wave 80 EOSCAPE-HIV™ System</strong></td>
</tr>
<tr>
<td><strong>Market Share</strong></td>
<td></td>
<td>None</td>
<td></td>
</tr>
<tr>
<td><strong>Use Setting</strong></td>
<td>Health Centers, Mobile Facilities</td>
<td>Health Centers, Mobile Facilities</td>
<td>Health Centers, Mobile Facilities</td>
</tr>
<tr>
<td><strong>Lower LOD</strong></td>
<td>Expected to be &lt; 1,000 cp/mL</td>
<td>50 cp/mL</td>
<td>&lt;1,000 cp/mL</td>
</tr>
<tr>
<td><strong>Specimen Type</strong></td>
<td>25 µL of fingerstick, heelprick or venous blood</td>
<td>200 µL of plasma or 10 – 50 µL of fingerstick blood</td>
<td>50 µL of fingerstick blood; will also accept plasma</td>
</tr>
<tr>
<td><strong>Cost/test</strong></td>
<td>TBD</td>
<td>TBD</td>
<td>&lt;$12 per test (semi-quantitative); &lt;$20 per test (fully quantitative)</td>
</tr>
<tr>
<td><strong>Number of samples/run</strong></td>
<td>30 – 60 minutes per test; no batching; 10 samples per technician per day</td>
<td>30 – 55 minutes per test, depending on LOD desired; 8 – 15 samples per technician per day</td>
<td>50 minutes per test; &gt;50 samples per day (with 6 – 8 processing units and a single analyser)</td>
</tr>
<tr>
<td><strong>Equipment Cost ($US)</strong></td>
<td>TBD</td>
<td>~$25,000, but may be lowered for use in resource-limited settings</td>
<td>&lt;$10,000 for one unit with 2 processing units</td>
</tr>
</tbody>
</table>
The Promise of POC Testing

POC testing has the promise to:

• Reduce the need for large infrastructure investments in diagnostic equipment

• Reduce/eliminate the need for service and maintenance

• Reduce the per test cost of testing

• Yield same day results for prompt clinical decision-making

• Improve patient retention

• Reduce the need for sample transport network
POC testing has the promise to fill gaps in access and capacity, and there are some exciting POC diagnostics either here or coming over the next few years. But, there is no *silver bullet* technology yet.

Understanding the realistic value and preparing for the implementation challenges is imperative to increase access to the right populations in the right way.

**POC Testing:**
- Is generally low throughput testing and may not be cost-effective in high- to medium-throughput settings
- Does not eliminate the need to improve/strengthen laboratory systems, including HR/Training, Supply Chain, Service Delivery Design and Quality Assurance
Thank you
Acknowledgements

Thanks to UNITAID for funding my work on the HIV/AIDS Diagnostic Landscape.