Diagnostic Network Optimization (DNO)

Overview of the DNO Analysis in Zambia for TB/HIV testing Integration

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Monitoring & Evaluation Manager, Centre of Infectious Disease Research in Zambia (CIDRZ)
To have a functional and sustainable laboratory services for all Zambians.

To provide Zambians with high quality, accurate, timely, cost effective and appropriate laboratory services at all levels of care and as close to the family as possible.
VL/EID Testing network

Legend
- Provincial Boundary
- Conventional PCR
- Hub Lab w/GX
- Hub Labs
- Health Facility
- Route

0 90 180 360 Kilometers
Equipment Footprint - GeneXpert

Legend
- GeneXpert Placement

Est # PLHIV (FY22)
- 843 - 7120
- 7120 - 16,570
- 16570 - 34318
- 34318 - 71042
- 71042 - 283931

Data Sources:
- PLHIV: COP22 Data Pack
- GeneXpert Install base: National TB Program
Disease programme objectives

- **Expand TB programme – full coverage**
  - Increase testing demand by 200% from 230,000 GeneXpert tests to 450,000 GeneXpert tests
  - Increase the number of sites referring samples from 500 to >2000

- **Improve access** to EID and priority HIV viral load testing for Pregnant and Breastfeeding Women (PBFW) and Paediatric.
  - Shift testing from conventional centralized devices to GeneXpert
  - Increase onsite testing (especially, same-day diagnosis for EID)

Is this possible with existing capacity? If not, what additional capacity is required?
Diagnostic network optimization (DNO) is a geospatial analytics approach to

- Analyse the current diagnostic network
- Recommend the optimal type, number and location of diagnostics and an associated sample referral network to achieve national health goals
Why DNO?

- Optimize laboratory network through diagnostic integration
- Maximize utilization of existing resources
## Stakeholder Engagement

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Role in the DNO Exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ministry of Health</td>
<td>Provide oversight, coordination, defining high level objectives and alignment to <strong>both programmatic constraints as well as longer-term goals</strong></td>
</tr>
<tr>
<td>PEPFAR/CDC</td>
<td>Funding and project scoping</td>
</tr>
<tr>
<td>CIDRZ</td>
<td>Support project scoping, data preparation and Analysis</td>
</tr>
<tr>
<td>FIND</td>
<td>External technical assistance, capacity building of country Team</td>
</tr>
<tr>
<td>Implementing Partners (NTP, APHL, JSI, CIDRZ &amp; EQUIP)</td>
<td>Collation of data inputs</td>
</tr>
<tr>
<td>Technical Working Groups (Laboratory and HIV)</td>
<td>Provided insight into the scope of analysis, and refined assumptions and validation of results from the DNO analysis.</td>
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# Core Project Team

<table>
<thead>
<tr>
<th>Position Title</th>
<th>Organization</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory Advisors</td>
<td>Ministry of Health (MOH), FIND &amp; CIDRZ</td>
<td>Provided insight on the diagnostics network and refinement of the project scope</td>
</tr>
<tr>
<td>Data Analysts</td>
<td>CIDRZ</td>
<td>Support data preparation and Analysis</td>
</tr>
<tr>
<td>Supply Chain Analyst and Health Economist</td>
<td>FIND &amp; HEERO</td>
<td>Technical support, analysis, and building Capacity of MOH and in-country IPs to ensure sustainability of the DNO</td>
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</table>
Objective

- Optimizing the diagnostic network to ensure priority HIV viral load testing for PBFW, paediatric and EID can be tested onsite or shifted from conventional platforms to GeneXpert whilst ensuring TB diagnostic testing is not negatively impacted.

How can the network be optimized to improve access to EID and VL testing for PBFW & Paediatric?

Is there enough capacity for this if we close all Roche CAP/CTMs?

Is there enough capacity for SARS-CoV-2 and HPV testing?
Methods

- Using OptiDx software, we first established the **baseline diagnostic network** based on 2020 testing demand, referral linkages, testing sites, platforms, and costs for the HIV and TB programmes respectively.

- Next, we incorporated **future testing demand** and programme expansion targets.

- To improve access, we integrated priority HIV testing, including EID, on **GeneXpert platforms**, historically only utilized by the TB programme; and closed CAP/CTMs.

- We then calculated the annualized device **cost**, variable cost/test, and sample transport cost for each scenario.

- Lastly, we assessed how adding **additional devices** would impact results.
1. We can expand the TB programme and improve HIV testing access within current capacity but a number of sites are operating over-capacity.

2. Closing all Roche CAP/CTMs +shifting EID/priority VL on GX results in large access benefits in terms of shorter sample transportation distances (10-fold decrease).

3. Placement of GX-XVIIs at higher volume laboratories results in cost savings of 4% from reduced reagent prices as can meet minimum tests per device requirement for rental agreement.

4. Recommend placing GX-16s at high demand sites, and/or extending shifts of GX-IV devices.
Can we expand the TB programme AND improve HIV access with current capacity?
There is available GeneXpert capacity to accommodate priority HIV testing.

Historical Baseline

Number of priority VL/EID tests by device

- CAP/CTM: 122666
- COBAS: 20962
- GX: 23930
- Hologic: 1424

Majority of Priority VL/EID tests performed on CAP/CTM at baseline – reflected in test cost distribution.

Proportion of tests on GeneXpert by test type

- TB
- Priority HIV

Average utilization of GeneXpert is 16%
There is available GeneXpert capacity to accommodate priority HIV testing

Future demand scenario

Number of priority VL/EID tests by device

- COBAS: 372,307
- GX: 3,000
- Hologic: 1,000
- Mpima: 3,000

Total test cost ($)

- COBAS: 3,000
- GX: 4,000
- Hologic: 5,000
- Mpima: 6,000

Proportion of tests on GeneXpert by test type

- TB: 48%
- Priority HIV: 52%

Shift to GX for Priority VL/EID

Average utilization of GeneXpert is 48%
It is possible to expand the TB programme AND improve TB/HIV access

**Baseline - Avg km travelled/sample**

<table>
<thead>
<tr>
<th></th>
<th>VL(15+yr)</th>
<th>TB</th>
<th>Priority VL</th>
<th>EID</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>11</td>
<td>90</td>
<td>96</td>
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</table>

**Future - Avg km travelled/sample**

<table>
<thead>
<tr>
<th></th>
<th>VL(15+yr)</th>
<th>TB</th>
<th>Priority VL</th>
<th>EID</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>10</td>
<td>103</td>
<td>10</td>
</tr>
</tbody>
</table>

Avg km/sample decreases for samples (except Adult VL). **10-fold for EID/priority VL**

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**Number of tests performed onsite increases** for TB and HIV despite large programme expansions

**Baseline**

<table>
<thead>
<tr>
<th></th>
<th>Number of tests conducted onsite and referred</th>
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<tbody>
<tr>
<td>TB</td>
<td>165,769</td>
</tr>
<tr>
<td>Priority VL</td>
<td>7,238</td>
</tr>
<tr>
<td>EID</td>
<td>10,005</td>
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</tbody>
</table>

**Future**

<table>
<thead>
<tr>
<th></th>
<th>Number of tests conducted onsite and referred</th>
</tr>
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<tbody>
<tr>
<td>TB</td>
<td>213,184</td>
</tr>
<tr>
<td>Priority VL</td>
<td>42,249</td>
</tr>
<tr>
<td>EID</td>
<td>139,353</td>
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</table>
Decentralization of both the TB and priority HIV programme and closing CAP/CTM platforms places pressure on a number of smaller laboratories with GeneXpert IV instruments:

- **10 sites operating over 100% capacity**
  - 9/10 are GeneXpert IV where the majority of tests are TB (>75%)

- **84 sites are operating at >80% capacity.**
  - Largely GeneXpert IV devices operating 1 shift.

Solutions?
1. Add more GeneXpert devices
2. Re-locate under-utilized devices
3. Extend shifts

Whilst average utilization is below 50%, a number of sites are operating over-capacity.
Recommendations

- **Recommendation 1**: Place GX-XVIs at high demand facilities to ensure minimum test requirements are met (and lower reagent rental prices).

- **Recommendation 2**: Re-locate devices that are underutilized to sites with expected high utilization or sites that are overwhelmed when distance constraints are enforced.

- **Recommendation 3**: Extend shifts of 1-shift GX-IV devices where possible to accommodate increases in demand and reduce utilization from > 80%.

Next steps

- Implementation of recommendations
In FY 22, 123 sites were adopted to begin POCT
Process for implementation

- Site Assessment
- Site Training and Distribution of Materials
- Site Activation
- Installation of LIS
- Continuous Monitoring & TSS

- 83/123 Recommended HFs Assessed
- 82 sites activated for POC Priority VL & EID
- Installed LIS POC in 73 sites
Routine Implementation Monitoring

• LIS on POC platforms have been activated

• Monthly National Multi-disease update meetings held to monitor progress towards integration
Impact evaluation
In 2022, 32,241 EID tests, 114,860 TB tests and 2566 viral load tests, were conducted on the GeneXpert platform.

Average Lab TAT= 1 day
Average Patient TAT= 2 days

Functional Courier from RHCS to Hubs
Annual VL, EID & TB Testing Trends Review

VL POC Activation

<table>
<thead>
<tr>
<th>Month</th>
<th>VL POC</th>
<th>EID</th>
<th>TB</th>
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</thead>
<tbody>
<tr>
<td>Jan</td>
<td>1807</td>
<td>6304</td>
<td>2000</td>
</tr>
<tr>
<td>Feb</td>
<td>2147</td>
<td>7883</td>
<td>4000</td>
</tr>
<tr>
<td>Mar</td>
<td>2590</td>
<td>9238</td>
<td>6000</td>
</tr>
<tr>
<td>Apr</td>
<td>2461</td>
<td>9229</td>
<td>8000</td>
</tr>
<tr>
<td>May</td>
<td>250</td>
<td>9786</td>
<td>10000</td>
</tr>
<tr>
<td>Jun</td>
<td>3217</td>
<td>3395</td>
<td>12000</td>
</tr>
<tr>
<td>Jul</td>
<td>147</td>
<td>3090</td>
<td>14000</td>
</tr>
<tr>
<td>Aug</td>
<td>129</td>
<td>3261</td>
<td></td>
</tr>
<tr>
<td>Sep</td>
<td>70</td>
<td>3650</td>
<td></td>
</tr>
<tr>
<td>Oct</td>
<td>309</td>
<td>3207</td>
<td></td>
</tr>
<tr>
<td>Nov</td>
<td>309</td>
<td>3416</td>
<td></td>
</tr>
<tr>
<td>Dec</td>
<td>702</td>
<td>3580</td>
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2022
EID: POC vs Conventional testing

2021
- Conventional: 91%
- POC: 9%

2022
- Conventional: 75%
- POC: 25%
Sustainability of DNO Recommendations

- **Access to testing**
  - Increased testing capacity – multiple tests can be conducted without additional equipment/HR making it scalable to accommodate increasing demand over time.

- **Cost-effectiveness**
  - Cost savings through reagent rental agreements
  - Reduced transportation costs (resulting in long-term cost savings)
  - Lower training costs
  - Reduced infrastructure costs: GeneXpert POC tests can be performed in decentralized settings
  - Lower maintenance costs compared to conventional platforms

- **Supply chain management**
  - Easily coordinated and integrated supply chain
Challenges

• DNO is a data driven approach and requires data in specific formats. Challenges include;
  – Data received is in different formats. This delays data collation and preparation
  – Unavailability of data on some test types in formats required for DNO e.g CD4, Chemistry, Heamatology - Data is not routinely collected.
## Ongoing works

<table>
<thead>
<tr>
<th>Project</th>
<th>Status</th>
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<tbody>
<tr>
<td>1. Integration of tuberculosis and HIV testing on GeneXpert</td>
<td>Complete (In the process of rerunning to account for changes)</td>
</tr>
<tr>
<td>2. Optimization of CD4, HPV, Heamatology &amp; Chemistry testing?</td>
<td>In progress</td>
</tr>
</tbody>
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### Evaluation of the Impact of DNO

- Protocol development under underway
The integration of tuberculosis and HIV testing on GeneXpert can substantially improve access and same-day diagnosis and benefit tuberculosis programmes: A diagnostic network optimization analysis in Zambia

Sarah Girdwood, Mayank Pandey, Trevor Machila, Ranjit Warrier, Juhi Gautam, Mpande Mukumbwa-Mwenechanya, Mariet Benade, Kameko Nichols, Lunda Shibemba, Joseph Mwewa, Judith Mzyece, Patrick Lungu, Heidi Albert, Brooke Nichols, Powell Choonga

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https://journals.plos.org/globalpublichealth/article?id=10.1371/journal.pgph.0001179
Thank you!