Learning from the HIV programme:

Wendy Stevens, Sergio Carmona, laboratory

Ian Sanne, RTC and team

Lesley Scott, Brad Cunningham: R&D team

William McLeod (Hero) and CDW (Sue Candy and team)

Sesupo Nene, (NDoH)

Content

1. Provide a brief background
2. Present the dashboard and reports available
3. Demonstrate the outputs of the data analysed thus far (comparison between. TE site and NHLS dataset)
4. Gather input and strategic direction for the distribution and utilisation of these reports from NDoH
5. Identify possible gaps and discuss the next steps

South Africa has the largest population of HIV infected people in the world and the largest population of people on ART…

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- However the implementation of a comprehensive monitoring and evaluation (M&E) program lagged behind the implementation of the CCMT rollout.
- There is a deficit of important strategic information concerning the overall effectiveness of the treatment management programme that could be used to refine treatment strategies and direct scarce resources where they are most needed.
- The NDoH has been implementing the Tiered ART Monitoring Strategy to establish a standardized M&E system at CCMT clinics nationally for a variety of clinical and laboratory indicators.
- Meanwhile, the NHLS has an existing database that has potential as a secondary source of laboratory M&E indicators and should be utilized for this purpose.

What is the value of the laboratory data

- Analysers throughout orgnaization interfaced to one LIS: result reporting
- National laboratory data throughout the public health sector is replicated to a single national Corporate Data Warehouse (CDW).(272 labs): >80% public HIV and TB lab data
- CDW is built with raw data which is then aggregated into summary analysis.
- Currently specimen-centric due to the lack of patient identifiers, i.e. data warehouse.
- Developed a probabilistic patient algorithm in the absence of a national Master Patient Index (MPI), e.g. ID number – still in development.
- A national MPI will enable the development of a patient-centric data repository.
- Data download available: clinical data-bases, other lab databases, sms resulting

The Clinical Laboratory Data Warehouse

An Overlooked Diamond Mine

Raymond D. Aller, MD

DOI: 10.1309/TXXABU8MW75L04KF

It is important to recognize the distinction between a data warehouse and a clinical repository (or electronic medical record). The data warehouse is constituted primarily for retrospective data analysis and contains sophisticated analytic tools, and a response time of 1 to 2 minutes is quite acceptable. The data repository[4] might contain data of an equal

optimized for pulling together all clinical observations on a patient. Because the data repository is constituted to support

http://ajcp.ascpjournals.org/content/120/6/817.full.pdf

What does this mean?

All raw laboratory data is replicated from LIS to the national CDW and is available to:-

- Conduct routine monitoring and evaluation of programmes, e.g. Xpert
- Deliver programmatic information in a dashboard to line management
- Use the data to correlate against paper-based/electronic records (triangulation).
- Request data extracts for record matching and integration, e.g. Therapy Edge interface.
- Request specific extracts for research questions, e.g. linkage to care.
- Business management, operations management, quarterly reporting
- Add-ons (SaaMS or SLAMS) which provide additional functions

Limitations

- Our data is only as good as the information provided on the laboratory request form.
- Unique identifier

Connectivity: well established in labs, imperative for POC to be connected – or else loose national data, and program M&E.

Laboratory information system (LIS): instant data stream to central "powerhouse data repository"

National data

Central data warehouse

- Result reporting
- Billing
- Program M&E

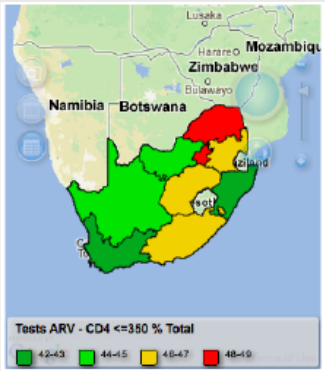
NATIONAL HEALTH LABORATORY SERVICE

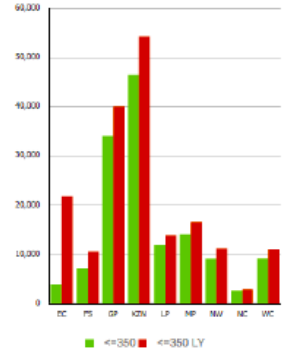
M&E Geo Analysis

Year: 2013 | Quarter: Q1 2013 | Month: Jan 2013 | National | Provincial | NHI

CD4

CD4 <= 350 (as % of Total) | CD4 <= 100 (as % of Total)

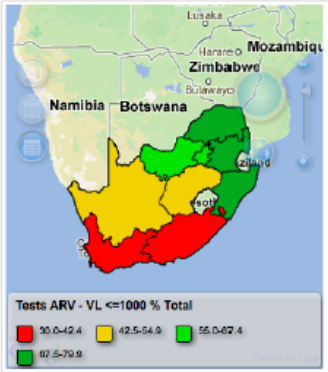


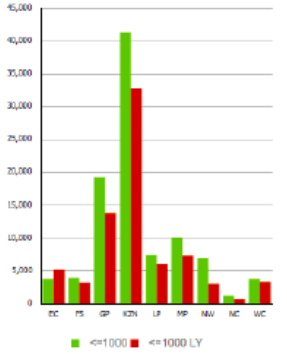


Province		Total Current	Total LY	<= 350 Current	<= 350 LY	Delta	%	% LY	
Eastern Cape	EC	8,137	39,235	3,898	21,820	(17,922)	47.9	55.6	↓
Free State	FS	15,083	20,135	7,211	10,547	(3,336)	47.8	52.4	↓
Gauteng	GP	68,860	69,130	34,039	40,009	(5,970)	49.4	57.9	↓
KwaZulu-Natal	KZN	106,177	104,483	46,542	54,269	(7,727)	43.8	51.9	↓
Limpopo	LP	23,728	25,651	11,792	13,923	(2,131)	49.7	54.3	↓
Mpumalanga	MP	30,429	30,480	14,148	16,552	(2,404)	46.5	54.3	↓
North West	NW	20,283	22,665	9,158	11,220	(2,064)	45.2	49.5	↓
Northern Cape	NC	5,893	5,796	2,615	2,952	(337)	44.4	50.9	↓
Western Cape	WC	21,547	22,981	9,187	10,983	(1,796)	42.6	47.8	↓
Total		300,117	340,556	138,588	182,275	(43,687)	46.2	53.5	

VL

VL <= 1000 (as % of Total) | VL > 1000 (as % of Total)





Province		Total Current	Total LY	<= 1000 Current	<= 1000 LY	Delta	%	% LY	
Eastern Cape	EC	10,373	12,561	3,809	5,170	(1,361)	36.7	41.2	↓
Free State	FS	9,095	8,295	3,954	3,184	770	43.5	38.4	↑
Gauteng	GP	34,845	29,988	19,203	13,794	5,409	55.1	46.0	↑
KwaZulu-Natal	KZN	52,600	43,351	41,286	32,837	8,449	78.5	75.7	↑
Limpopo	LP	10,303	8,529	7,352	6,049	1,303	71.4	70.9	↑
Mpumalanga	MP	13,332	10,151	10,085	7,270	2,815	75.6	71.6	↑
North West	NW	10,911	8,012	6,975	3,029	3,946	63.9	37.8	↑
Northern Cape	NC	2,555	2,105	1,195	767	428	46.8	36.4	↑
Western Cape	WC	11,726	10,500	3,794	3,326	468	32.4	31.7	↑
Total		155,740	133,492	97,653	75,426	22,227	62.7	56.5	

A vision for public health laboratory data

Integrated view of the patient across all health care systems:-

- Health facilities
- Laboratory
- Pharmacy
- Etc.

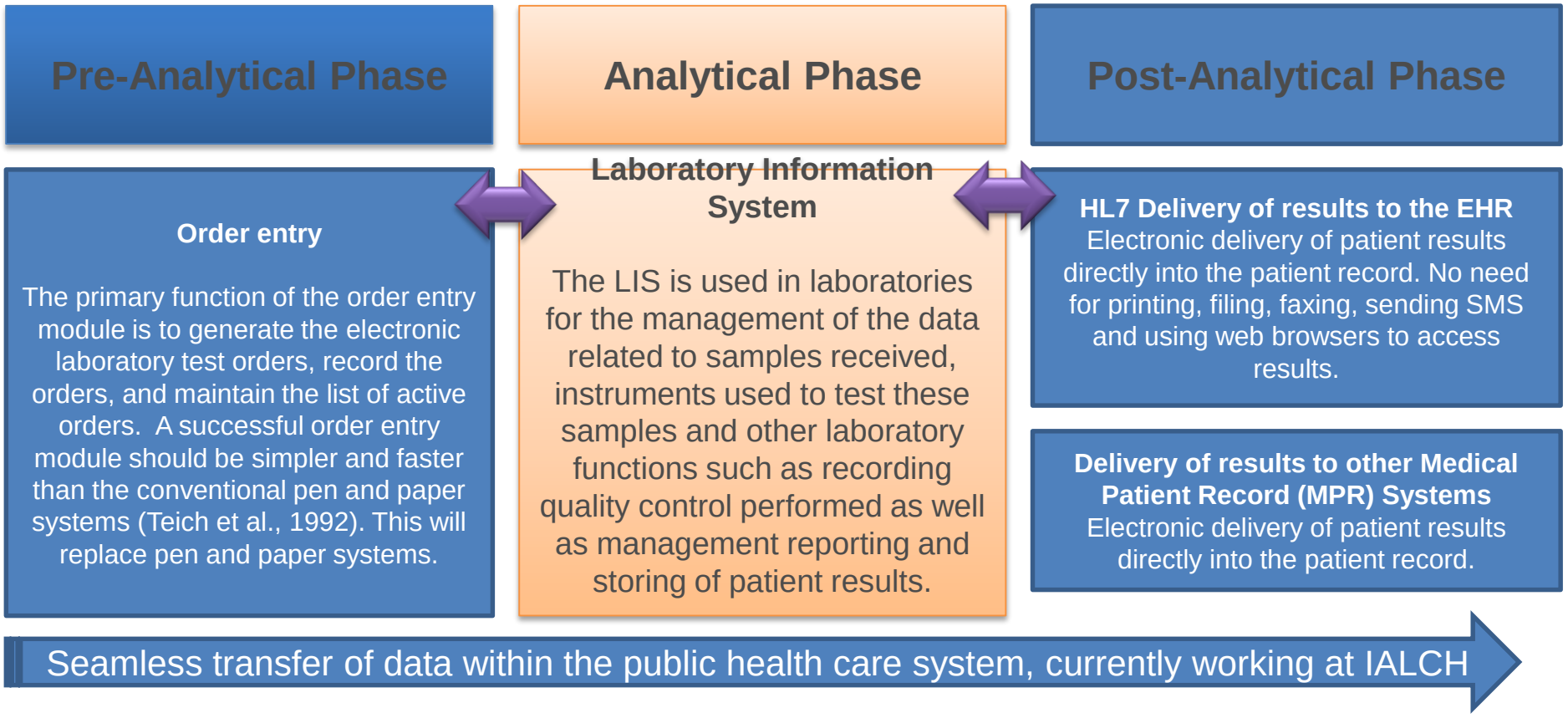
How to achieve this:-

- Implementation of Essential Health Record at all health facilities.
- Decide on data interchange standards, e.g. HL7., ASTM for analysers
- Develop national coding systems, e.g. DHIS facility code.
- Implement data interchange between systems, e.g. integration e

What this will prevent:-

- Recapture of existing patient data on multiple systems, e.g. requ
- Manual printing of laboratory results (available electronically).
- Unique identification of the patient (integrity).
- Missing laboratory results.

Laboratory innovations that are needed



This enable the shift to true data interchange and the ability to develop a **patient-centric data repository** using a single national MPI. The benefits include the ability to follow cohorts and conduct longitudinal analysis.

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Possible uses of the NHLS data to monitor and evaluate the effectiveness of the Comprehensive Care, Management and Treatment (CCMT) programme for HIV/AIDS in South Africa.

This will be performed through a number of specific aims:

1. Develop a set of M&E indicators for HIV and TB that can be measured from routinely collected NHLS data.
2. Calculate and Validate M&E indicators, to include HCT program growth in context of first CD4 test, undetectable viral load and loss to follow-up.
3. Community Viral Load evaluation for identification of focus areas for CCMT Programme (pre-ART and ART) management. This would be from district to clinic level.
4. % virological failure at facility level
5. Development of standard procedures to ensure that indicators are generated as part of a monthly narrative reports.
   e.g.Central Data Warehouse dashboard for real time indicator reporting (CD4, HIV Viral Load and HIV DNA PCR)
6. Implementation of effective reporting to NDoH on laboratory M&E indicator targets. Expansion to additional forums?

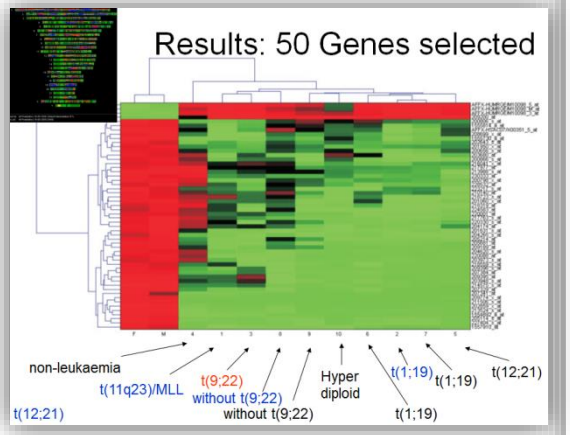
No unique identifier: To create a cohort some degree of matching is required and there are 2 types of Matching.

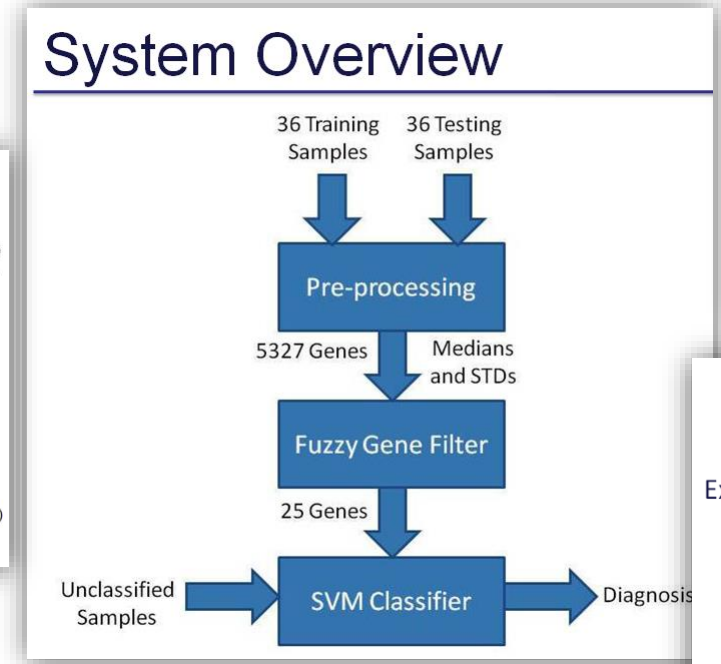
1. Exact matching: exact names, first address line, date of birth, gender and hospital id at some institutions

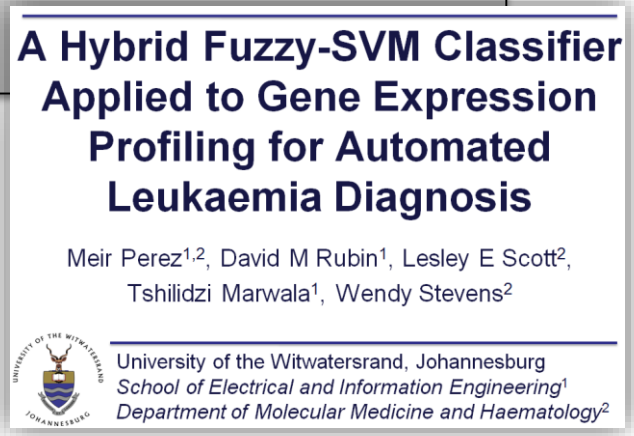
2. Probabilistic matching: all of the above but allows for some differences in spelling, dates, etc. Testing leniency with time

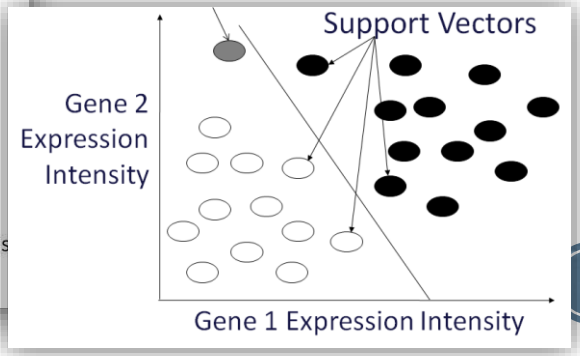
What about all tests per patient – how good are we at matching: Data analysis by Fuzzy logic

- NHLS implemented "fuzzy" linking algorithm (initially developed for Leukaemia "big data" profile analysis)
- Matching NHLS and NDoH Clinics
- Developed Data Dashboards for NDoH

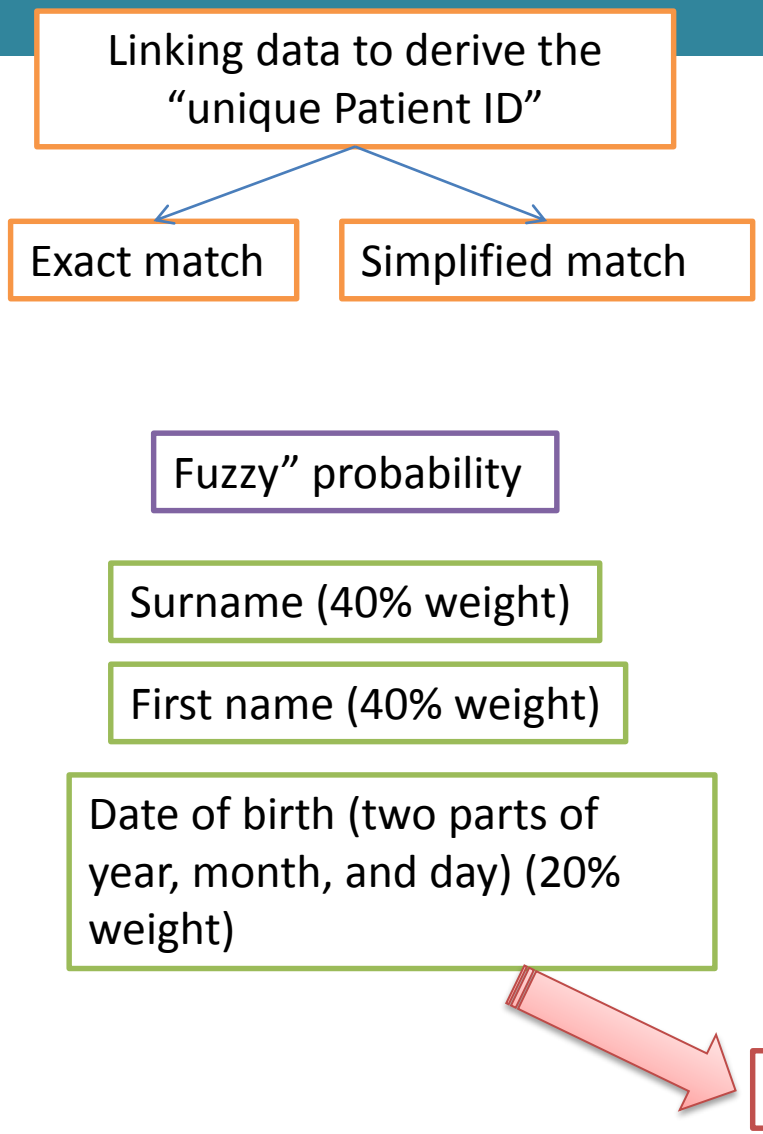








Fuzzy logic process for NHLS data: Linking



Uses entire dataset (not just HIV related testing)

Two step process:

- Exact matches on surname, first name and date of birth
- Derive "Fuzzy" probability on three parts
- If probability multiplied by weights is greater than 90% then linked

All new lab results will also be linked as they enter the system

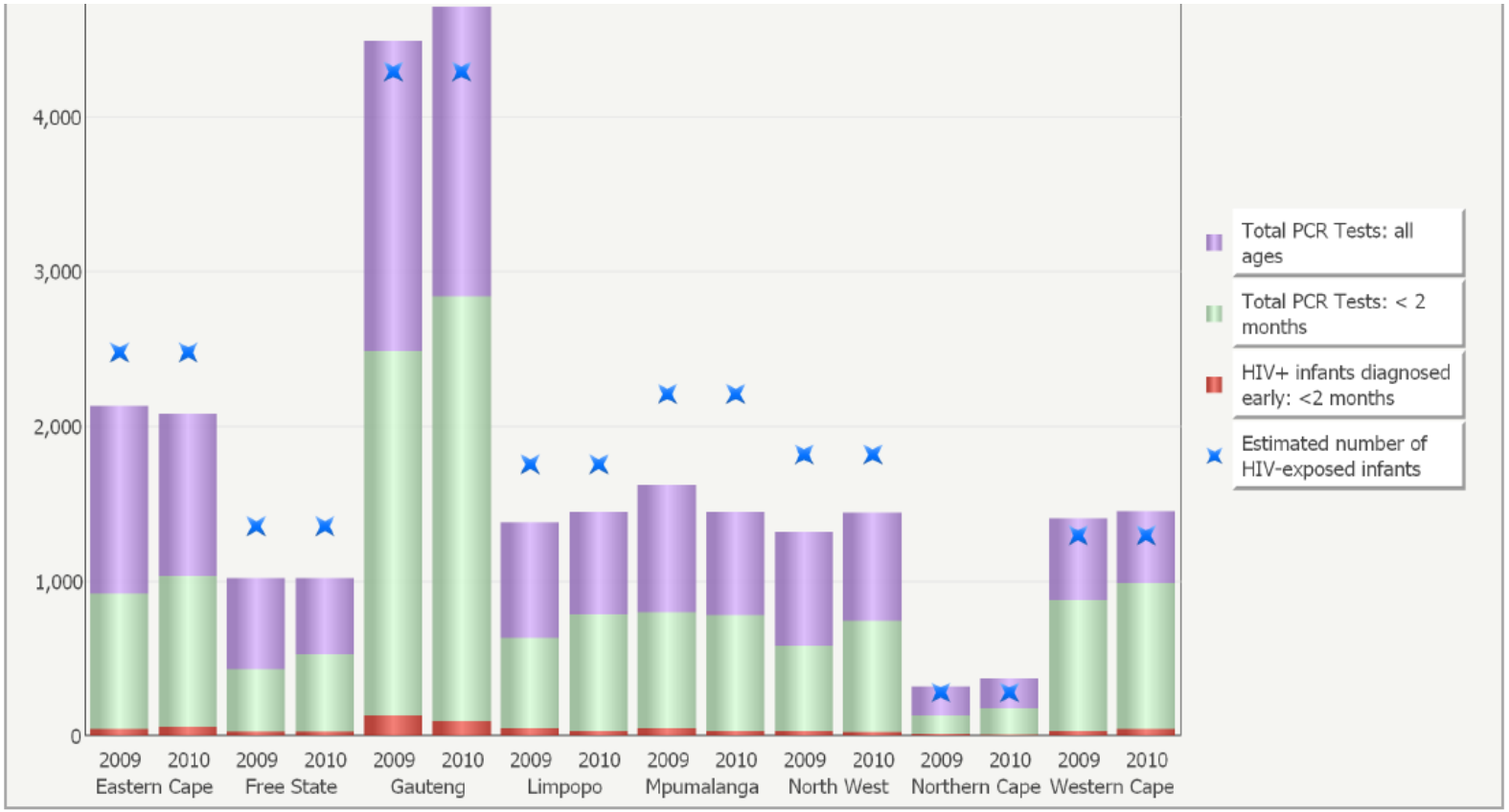
Composition of NHLS Laboratory Database

- Contains Viral Load and CD4 test results for public sector ARV Facilities
  - From 2004 to current
    - 4,000,000 viral load tests (2012) ; 6,600 000 (2013)
    - 16,446,842 CD4 tests (2012); >20 million (2013)
    - All related assays available: chemistry, haematology, microbiology and histopathology
    - Biorepository development
- Can we use these tests to monitor progress on the CCMT program?

Data Dashboards

- Report from NHLS Corporate Data Warehouse
- Provide information on
  - Number and results of viral load and CD4 tests (any assay really; except rapid HIV tests)
  - National results and by province and district
  - Comparison of current month's results to month in prior year
- HTML based and pdf formats
  - Capability to be a web-page or pushed out through e-mail
  - HTML version can be real time, weekly, or monthly
- Currently awaiting approval to begin distribution
- See active dashboards below

EID Dashboard: down to facility level + DBS training; wide distribution list



	HIV+ infants diagnosed early: <2 months		*Estimated coverage for early diagnosis*	
Year	**2009**	**2010**	**2009**	**2010**

Existing Mobile-based Rapid Strip Readers

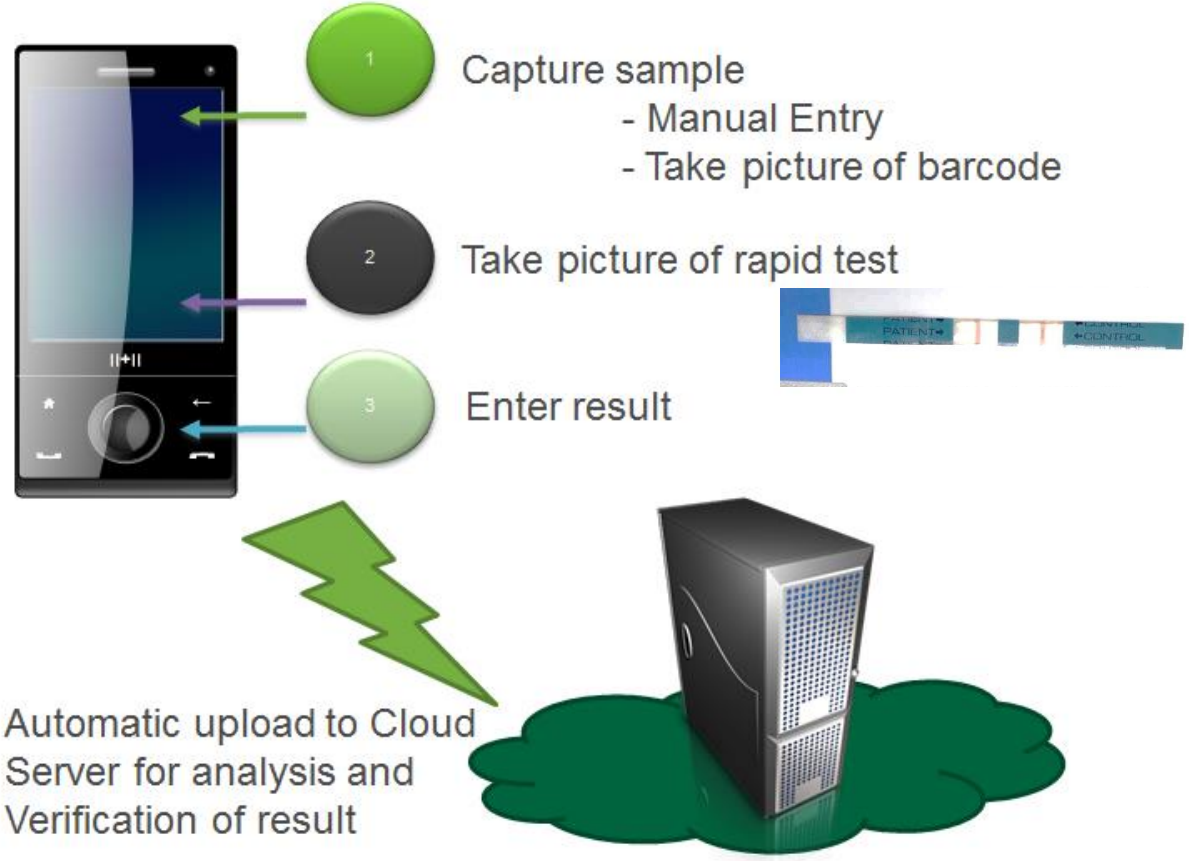
Name	Number of tests	Platform	Additional Hardware	Central Repository
Fio Corp.	'near universal'	Mobile, Android	Deki Reader	Yes
Holomic LLC	'near universal'	Mobile	RDT Reader	Yes
MobileAssay™	'near universal'	Mobile & Tablet Apple, Android, Windows	None required	Yes
Global Solutions for Infectious Disease (GSID)	'near universal'	Mobile	Phone stand	Yes
BBI Solutions and Albagaia	Custom per test	Mobile Apple, Android, Windows	None	Yes

Not entire list of available devices

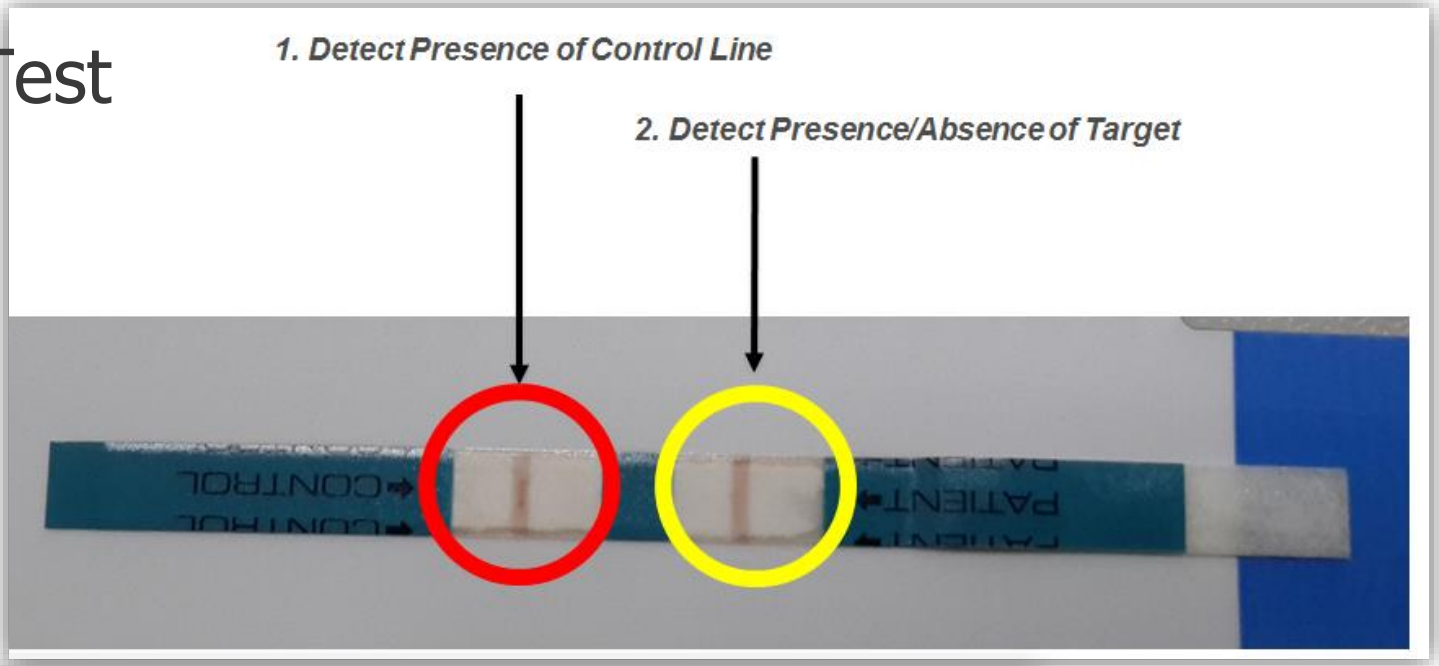
Smart Phone: data and graphic uploaded to cloud for analysis

61 million active sim cards in SA

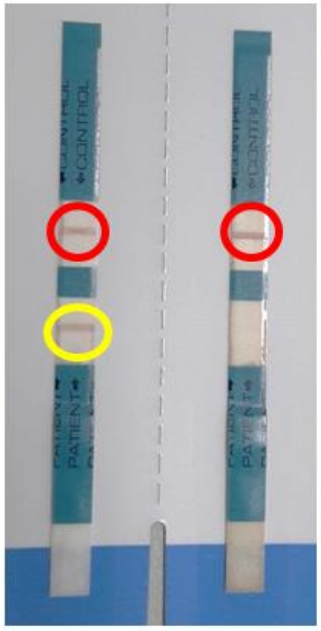
14 million smart phones



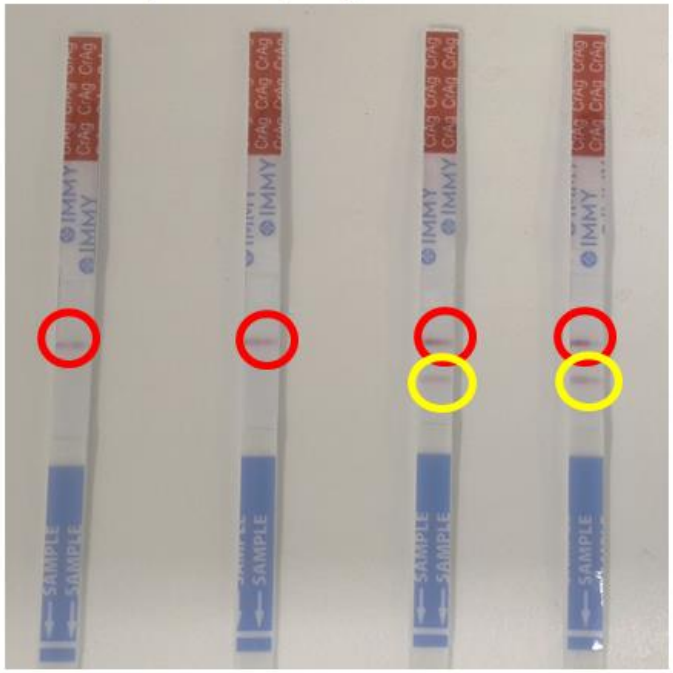
Rapid HIV Test



HIV Rapid Tests



Other Rapid Tests (Crag)



HTML formats: real-time, weekly, monthly; Who should get these?

NATIONAL HEALTH LABORATORY SERVICE

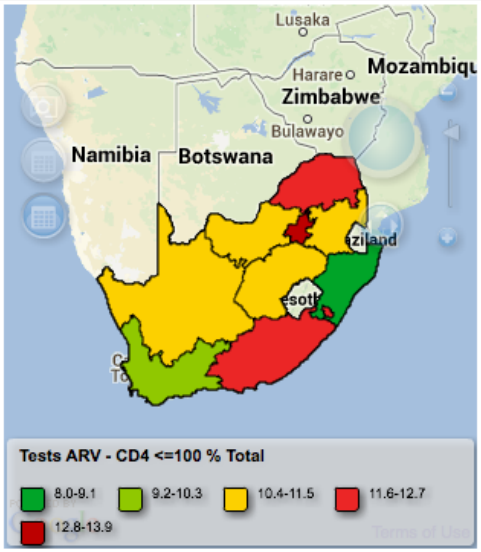
Year: 2014 | Quarter: Q1 2014 | Month: Jan 2014 | Age Range: All Ages

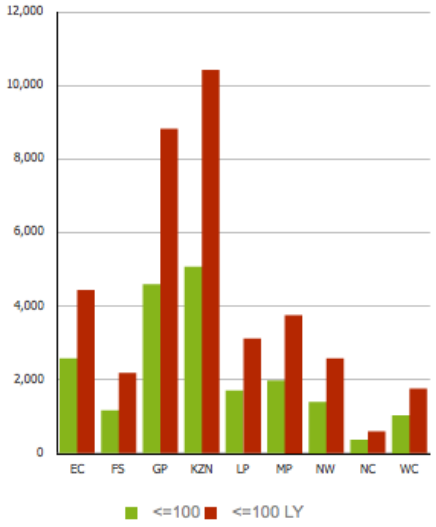
M&E Geo Analysis

National | Provincial | NHI

CD4

CD4 <= 100 (as % of Total) | CD4 <= 350 (as % of Total)

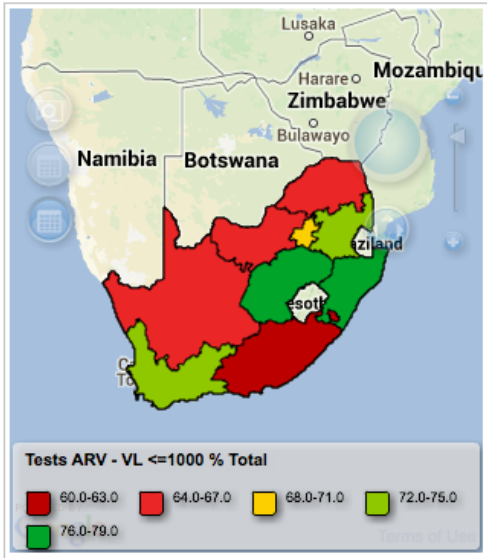


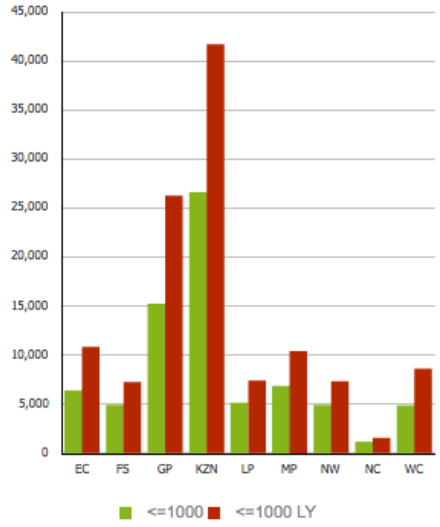


		Total		<= 100					
Province		Current	LY	Current	LY	Delta	%	% LY	
Eastern Cape	EC	20,659	37,253	2,579	4,435	(1,856)	12.5	11.9	↓
Free State	FS	10,548	19,471	1,165	2,185	(1,020)	11.0	11.2	↓
Gauteng	GP	33,613	68,753	4,593	8,818	(4,225)	13.7	12.8	↓
KwaZulu-Natal	KZN	62,563	108,538	5,069	10,417	(5,348)	8.1	9.6	↓
Limpopo	LP	13,436	23,829	1,702	3,115	(1,413)	12.7	13.1	↓
Mpumalanga	MP	17,722	31,239	1,972	3,755	(1,783)	11.1	12.0	↓
North West	NW	12,491	23,443	1,398	2,578	(1,180)	11.2	11.0	↓
Northern Cape	NC	3,343	5,873	371	596	(225)	11.1	10.1	↓
Western Cape	WC	10,223	20,173	1,036	1,756	(720)	10.1	8.7	↓
Total		184,598	338,572	19,885	37,655	(17,770)	10.8	11.1	

VL

VL <= 1000 (as % of Total) | VL > 1000 (as % of Total)





		Total		<= 1000					
Province		Current	LY	Current	LY	Delta	%	% LY	
Eastern Cape	EC	10,013	16,089	6,395	10,843	(4,448)	63.9	67.4	↓
Free State	FS	6,324	9,584	4,936	7,254	(2,318)	78.1	75.7	↓
Gauteng	GP	21,348	34,751	15,245	26,269	(11,024)	71.4	75.6	↓
KwaZulu-Natal	KZN	34,133	53,167	26,595	41,687	(15,092)	77.9	78.4	↓
Limpopo	LP	7,579	10,375	5,150	7,401	(2,251)	68.0	71.3	↓
Mpumalanga	MP	9,478	13,772	6,853	10,420	(3,567)	72.3	75.7	↓
North West	NW	7,536	11,116	4,903	7,317	(2,414)	65.1	65.8	↓
Northern Cape	NC	1,830	2,606	1,196	1,555	(359)	65.4	59.7	↓
Western Cape	WC	6,423	10,864	4,881	8,611	(3,730)	76.0	79.3	↓
Total		104,664	162,324	76,154	121,357	(45,203)	72.8	74.8	

NATIONAL HEALTH LABORATORY SERVICE

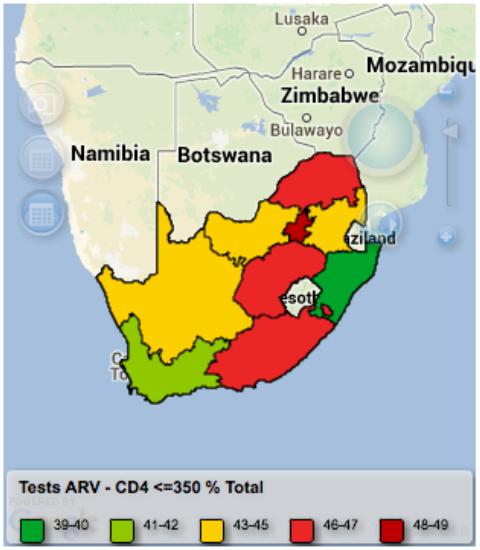
Year: 2014 | Quarter: Q1 2014 | Month: Jan 2014 | Age Range: All Ages

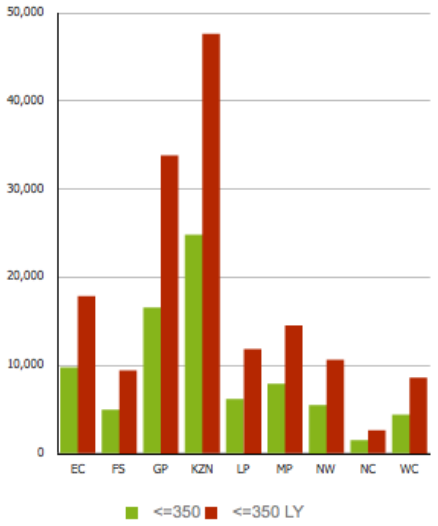
National | Provincial | NHI

M&E Geo Analysis

CD4

CD4 <= 100 (as % of Total) | CD4 <= 350 (as % of Total)





Province		Total Current	Total LY	<= 350 Current	<= 350 LY	Delta	%	% LY	
Eastern Cape	EC	20,659	37,253	9,741	17,844	(8,103)	47.2	47.9	↓
Free State	FS	10,548	19,471	4,947	9,413	(4,466)	46.9	48.3	↓
Gauteng	GP	33,613	68,753	16,551	33,823	(17,272)	49.2	49.2	↓
KwaZulu-Natal	KZN	62,563	108,538	24,790	47,604	(22,814)	39.6	43.9	↓
Limpopo	LP	13,436	23,829	6,145	11,848	(5,703)	45.7	49.7	↓
Mpumalanga	MP	17,722	31,239	7,894	14,508	(6,614)	44.5	46.4	↓
North West	NW	12,491	23,443	5,479	10,603	(5,124)	43.9	45.2	↓
Northern Cape	NC	3,343	5,873	1,486	2,594	(1,108)	44.5	44.2	↓
Western Cape	WC	10,223	20,173	4,378	8,596	(4,218)	42.8	42.6	↓
Total		184,598	338,572	81,411	156,833	(75,422)	44.1	46.3	

VL

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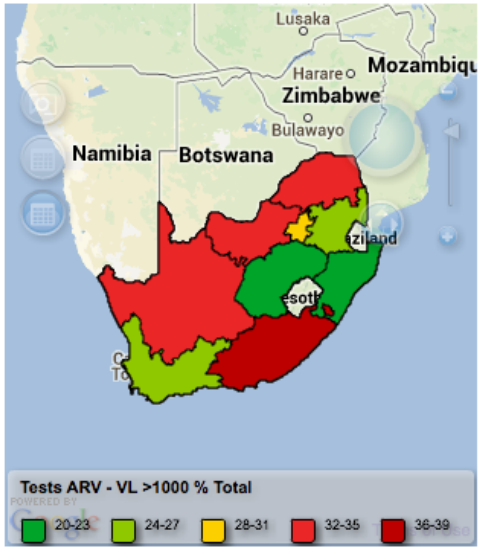
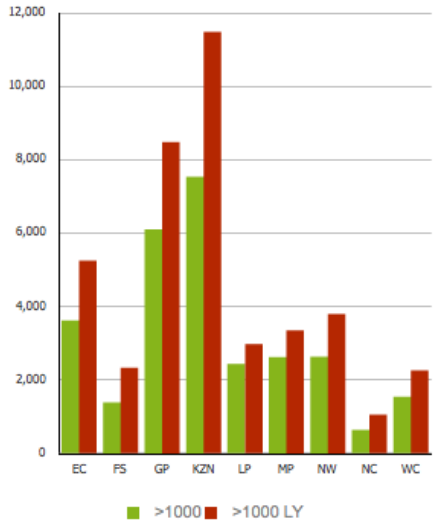




Province		Total Current	Total LY	> 1000 Current	> 1000 LY	Delta	%	% LY	
Eastern Cape	EC	10,013	16,089	3,618	5,246	(1,628)	36.1	32.6	↓
Free State	FS	6,324	9,584	1,388	2,330	(942)	21.9	24.3	↓
Gauteng	GP	21,348	34,751	6,103	8,482	(2,379)	28.6	24.4	↓
KwaZulu-Natal	KZN	34,133	53,167	7,538	11,480	(3,942)	22.1	21.6	↓
Limpopo	LP	7,579	10,375	2,429	2,974	(545)	32.0	28.7	↓
Mpumalanga	MP	9,478	13,772	2,625	3,352	(727)	27.7	24.3	↓
North West	NW	7,536	11,116	2,633	3,799	(1,166)	34.9	34.2	↓
Northern Cape	NC	1,830	2,606	634	1,051	(417)	34.6	40.3	↓
Western Cape	WC	6,423	10,864	1,542	2,253	(711)	24.0	20.7	↓
Total		104,664	162,324	28,510	40,967	(12,457)	27.2	25.2	

NATIONAL HEALTH LABORATORY SERVICE

M&E Geo Analysis

Year: 2014 | Quarter: Q1 2014 | Month: Jan 2014 | Age Range: All Ages

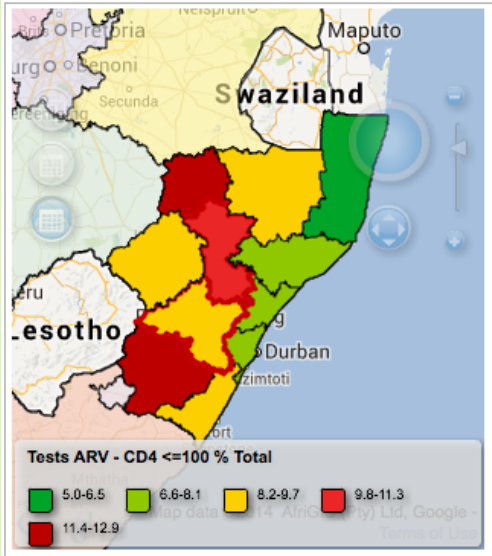
National | Provincial | NHI | Select Province: KwaZulu-Nata

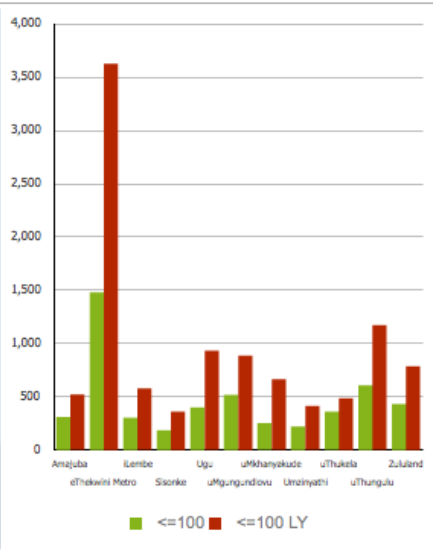
KwaZulu-Natal

Gauteng
KwaZulu-Natal
Limpopo
Mpumalanga
North West

CD4

CD4 <= 350 (as % of Total) | CD4 <= 100 (as % of Total)



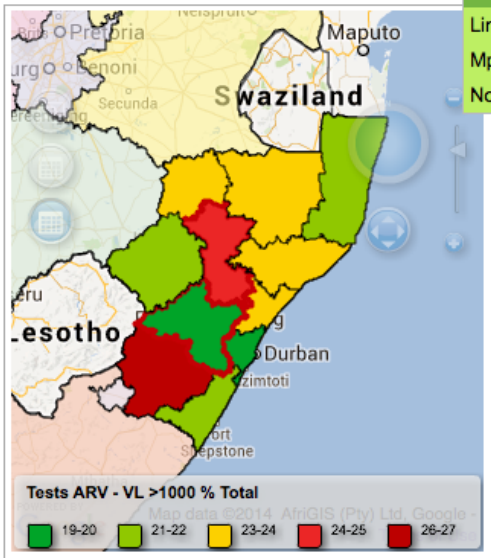


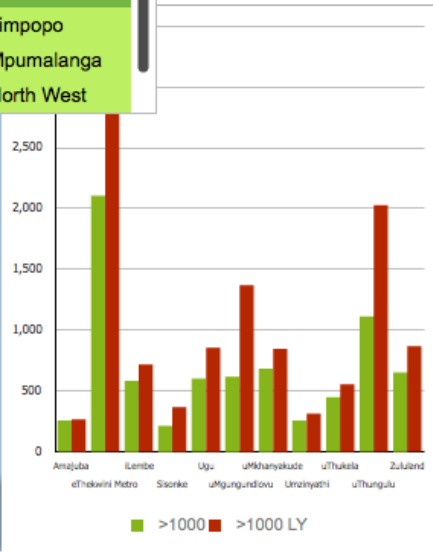
KwaZulu-Natal

District	Total Current	Total LY	<= 100 Current	<= 100 LY	Delta	%	% LY
Amajuba	2,637	4,542	310	520	(210)	11.8	11.4
eThekwini Metro	19,427	36,265	1,480	3,624	(2,144)	7.6	10.0
iLembe	4,099	6,899	303	577	(274)	7.4	8.4
Sisonke	1,535	3,449	186	361	(175)	12.1	10.5
Ugu	4,693	9,090	400	931	(531)	8.5	10.2
uMgungundlovu	6,225	11,162	518	887	(369)	8.3	7.9
uMkhanyakude	4,738	7,144	252	663	(411)	5.3	9.3
Umzinyathi	2,039	3,320	222	412	(190)	10.9	12.4
uThukela	4,120	5,299	359	485	(126)	8.7	9.2
uThungulu	8,067	12,738	608	1,170	(562)	7.5	9.2
Zululand	4,983	8,630	431	787	(356)	8.6	9.1
Total	62,563	108,538	5,069	10,417	(5,348)	8.1	9.6

VL

VL > 1000 (as % of Total)





KwaZulu-Natal

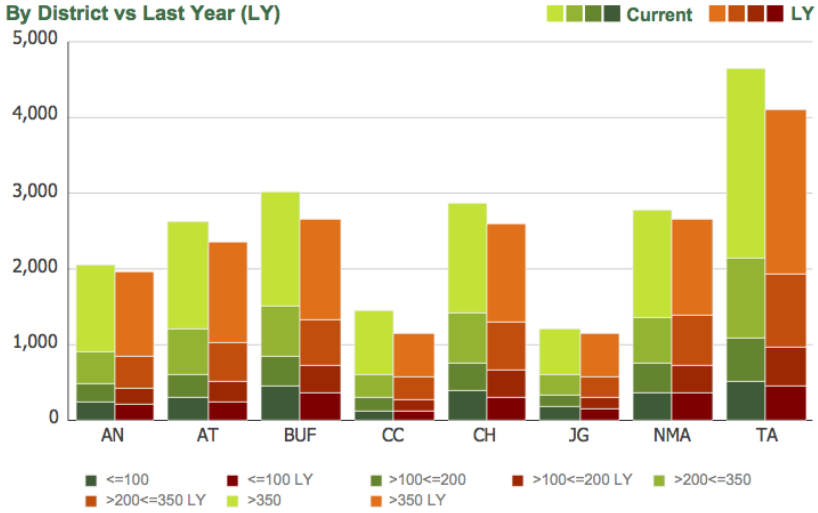
District	Total Current	Total LY	> 1000 Current	> 1000 LY	Delta	%	% LY
Amajuba	1,076	1,570	257	269	(12)	23.9	17.1
eThekwini Metro	10,253	18,591	2,103	3,289	(1,186)	20.5	17.7
iLembe	2,438	2,872	585	718	(133)	24.0	25.0
Sisonke	795	1,602	215	368	(153)	27.0	23.0
Ugu	2,765	4,142	602	856	(254)	21.8	20.7
uMgungundlovu	3,123	6,823	619	1,370	(751)	19.8	20.1
uMkhanyakude	3,183	3,641	684	847	(163)	21.5	23.3
Umzinyathi	1,033	1,335	259	315	(56)	25.1	23.6
uThukela	2,068	2,636	448	556	(108)	21.7	21.1
uThungulu	4,652	6,711	1,112	2,025	(913)	23.9	30.2
Zululand	2,747	3,244	654	867	(213)	23.8	26.7
Total	34,133	53,167	7,538	11,480	(3,942)	22.1	21.6

Static reports: who should get these

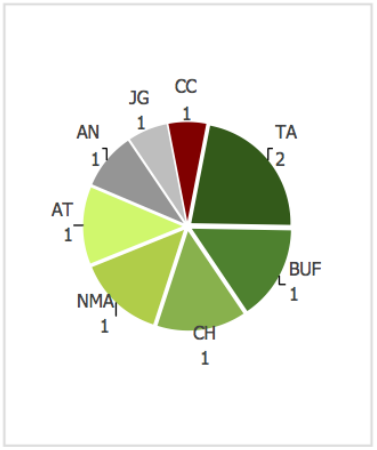
NATIONAL HEALTH LABORATORY SERVICE

CD4 Testing in Eastern Cape for the Month of Jan 2014 vs Jan 2013

By District vs Last Year (LY)

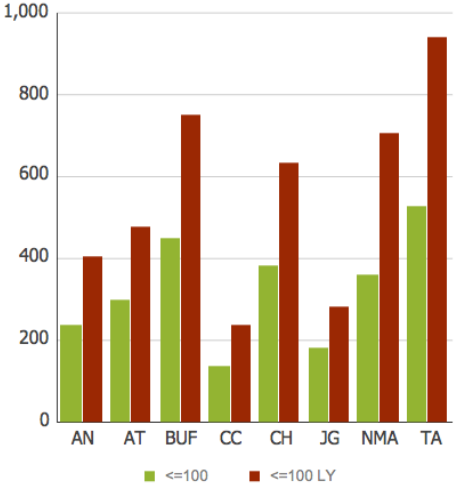


Total by District CD4 <= 350*



* In thousands

Results CD4 <= 100 by District vs Last Year (LY)



Results by Range by District vs Last Year (LY)

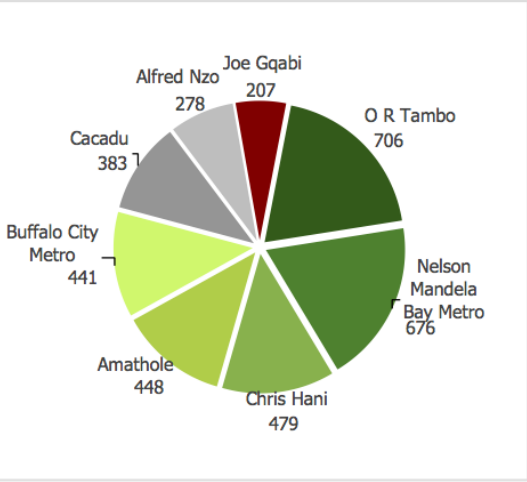
		Total		<= 100				> 100 <= 200				> 200 <= 350				> 350				Year to Date	
District		Current	LY	Current	%	LY	% LY	Current	%	LY	% LY	Current	%	LY	% LY	Current	%	LY	% LY	Current	LY
Alfred Nzo	AN	2,058	3,900	236	11.5	404	10.4	258	12.5	462	11.8	409	19.9	833	21.4	1,155	56.1	2,201	56.4	2,058	3,900
Amathole	AT	2,637	4,701	297	11.3	480	10.2	319	12.1	535	11.4	581	22.0	1,021	21.7	1,440	54.6	2,665	56.7	2,637	4,701
Buffalo City Metro	BUF	3,011	5,314	451	15.0	753	14.2	393	13.1	695	13.1	653	21.7	1,197	22.5	1,514	50.3	2,669	50.2	3,011	5,314
Cacadu	CC	1,443	2,328	139	9.6	239	10.3	162	11.2	313	13.4	297	20.6	588	25.3	845	58.6	1,188	51.0	1,443	2,328
Chris Hani	CH	2,855	5,206	384	13.5	634	12.2	387	13.6	720	13.8	643	22.5	1,218	23.4	1,441	50.5	2,634	50.6	2,855	5,206
Joe Gqabi	JG	1,217	2,294	184	15.1	281	12.2	147	12.1	308	13.4	290	23.8	538	23.5	596	49.0	1,167	50.9	1,217	2,294
Nelson Mandela Bay Metro	NMA	2,781	5,318	360	12.9	704	13.2	390	14.0	755	14.2	609	21.9	1,317	24.8	1,422	51.1	2,542	47.8	2,781	5,318
O R Tambo	TA	4,657	8,192	528	11.3	940	11.5	548	11.8	1,023	12.5	1,076	23.1	1,886	23.0	2,505	53.8	4,343	53.0	4,657	8,192
Total		**20,659**	**37,253**	**2,579**	**12.5**	**4,435**	**11.9**	**2,604**	**12.6**	**4,811**	**12.9**	**4,558**	**22.1**	**8,598**	**23.1**	**10,918**	**52.8**	**19,409**	**52.1**	**20,659**	**37,253**

CD4 is represented as cells x 10^6 per ml

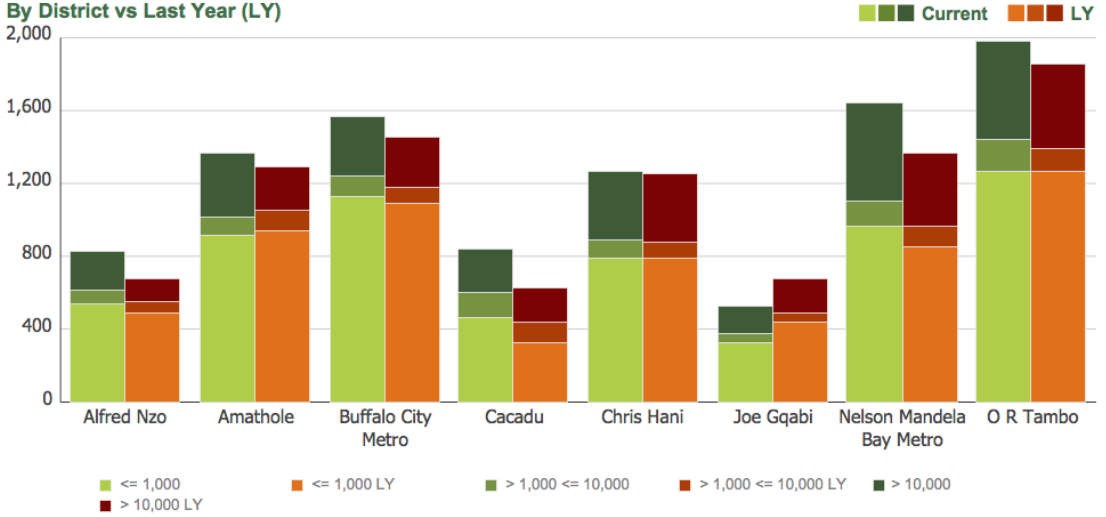
NATIONAL HEALTH LABORATORY SERVICE

Viral Load Testing in Eastern Cape for the Month of Jan 2014 vs Jan 2013

Total by District VL > 1,000



By District vs Last Year (LY)



Results by Range by District vs Last Year (LY)

	Total		<= 1,000 (log 3)				> 1,000 (log 3) <= 10,000 (log 4)				> 10,000 (log 4)				Year to Date	
District	**Current**	**LY**	**Current**	**%**	**LY**	**% LY**	**Current**	**%**	**LY**	**% LY**	**Current**	**%**	**LY**	**% LY**	**YTD**	**LY**
Alfred Nzo	821	1,174	543	66.1	850	72.4	71	8.6	115	9.8	207	25.2	209	17.8	821	1,174
Amathole	1,367	2,249	919	67.2	1,643	73.1	96	7.0	189	8.4	352	25.7	417	18.5	1,367	2,249
Buffalo City Metro	1,565	2,549	1,124	71.8	1,898	74.5	114	7.3	155	6.1	327	20.9	496	19.5	1,565	2,549
Cacadu	842	1,102	459	54.5	577	52.4	139	16.5	185	16.8	244	29.0	340	30.9	842	1,102
Chris Hani	1,270	2,203	791	62.3	1,388	63.0	95	7.5	157	7.1	384	30.2	658	29.9	1,270	2,203
Joe Gqabi	528	1,186	321	60.8	774	65.3	57	10.8	80	6.7	150	28.4	332	28.0	528	1,186
Nelson Mandela Bay Metro	1,643	2,389	967	58.9	1,493	62.5	132	8.0	191	8.0	544	33.1	705	29.5	1,643	2,389
O R Tambo	1,977	3,237	1,271	64.3	2,220	68.6	173	8.8	208	6.4	533	27.0	809	25.0	1,977	3,237
Total	**10,013**	**16,089**	**6,395**	**63.9**	**10,843**	**67.4**	**877**	**8.8**	**1,280**	**8.0**	**2,741**	**27.4**	**3,966**	**24.7**	**10,013**	**16,089**

Viral Load (VL) is represented as RNA copies per ml

District Health Barometer type reporting is possible.

- District Health Barometer 2011/12 published March 2013
- HIV and AIDS Chapter reports on:

  - HIV testing rate
  - Antenatal client HIV 1st test rate
  - HIV antenatal prevalence, HAART initiation
  - Baby initiated on HAART
  - Early infant diagnosis coverage
  - HIV PCR infant test results
  - ?????

  - Significant validation of mapping: parameter-instrument-laboratory-location-patient details

Health Barometer Additions

- Monitored Viral Load
- Viral Load > 1,000 copies/ml
- Number of viral load/CD4 tests per patient

- Number of viral load/CD4 tests per infected population
- Trend monitoring

11:30 Tuesday, May 14, 2013 1

Figure 1: Proportion of Viral Load Tests Greater than 1,000 copies/ml--Final Quarter 2011

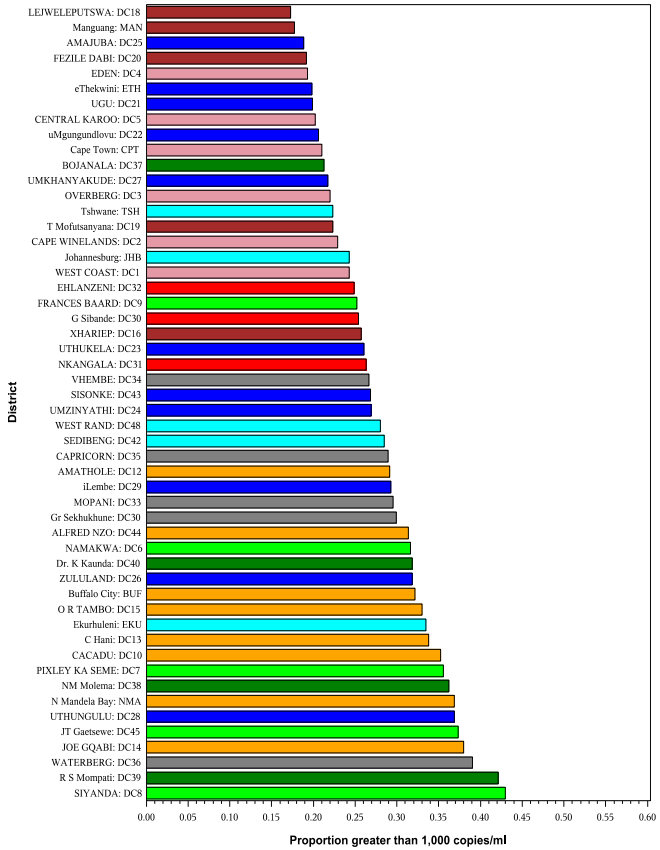


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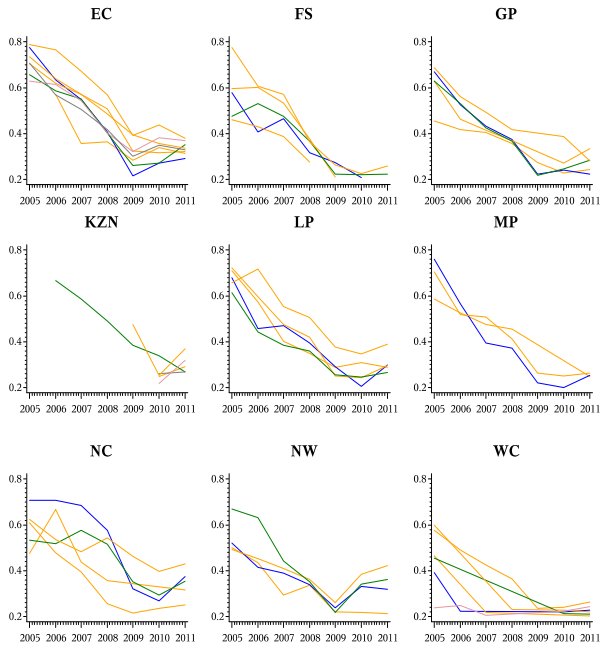
Figure 2: Annual trends in Proportion of Viral Load Tests Greater than 1,000 copies/ml--2005 to 2011

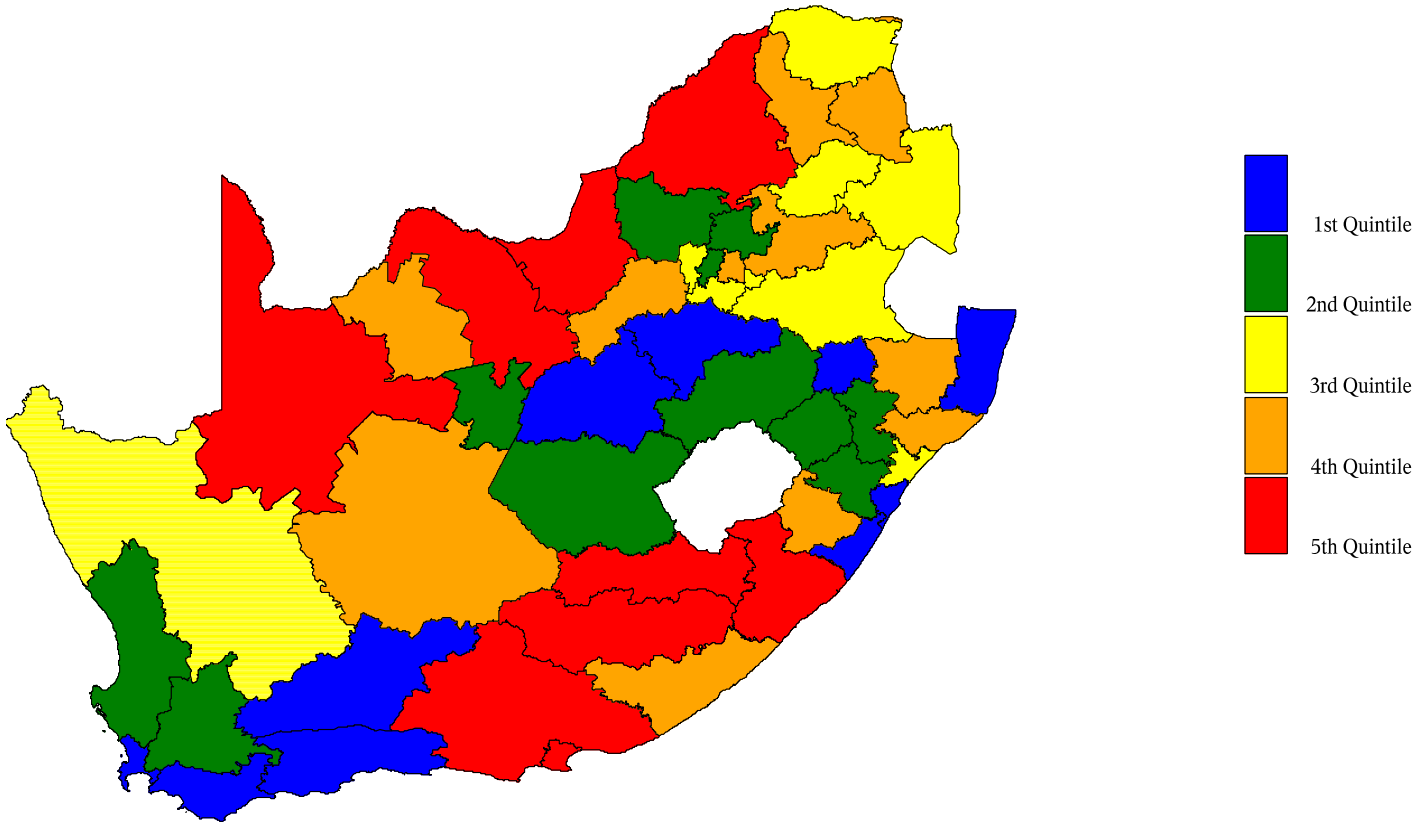


Community viral load (2004-2011)

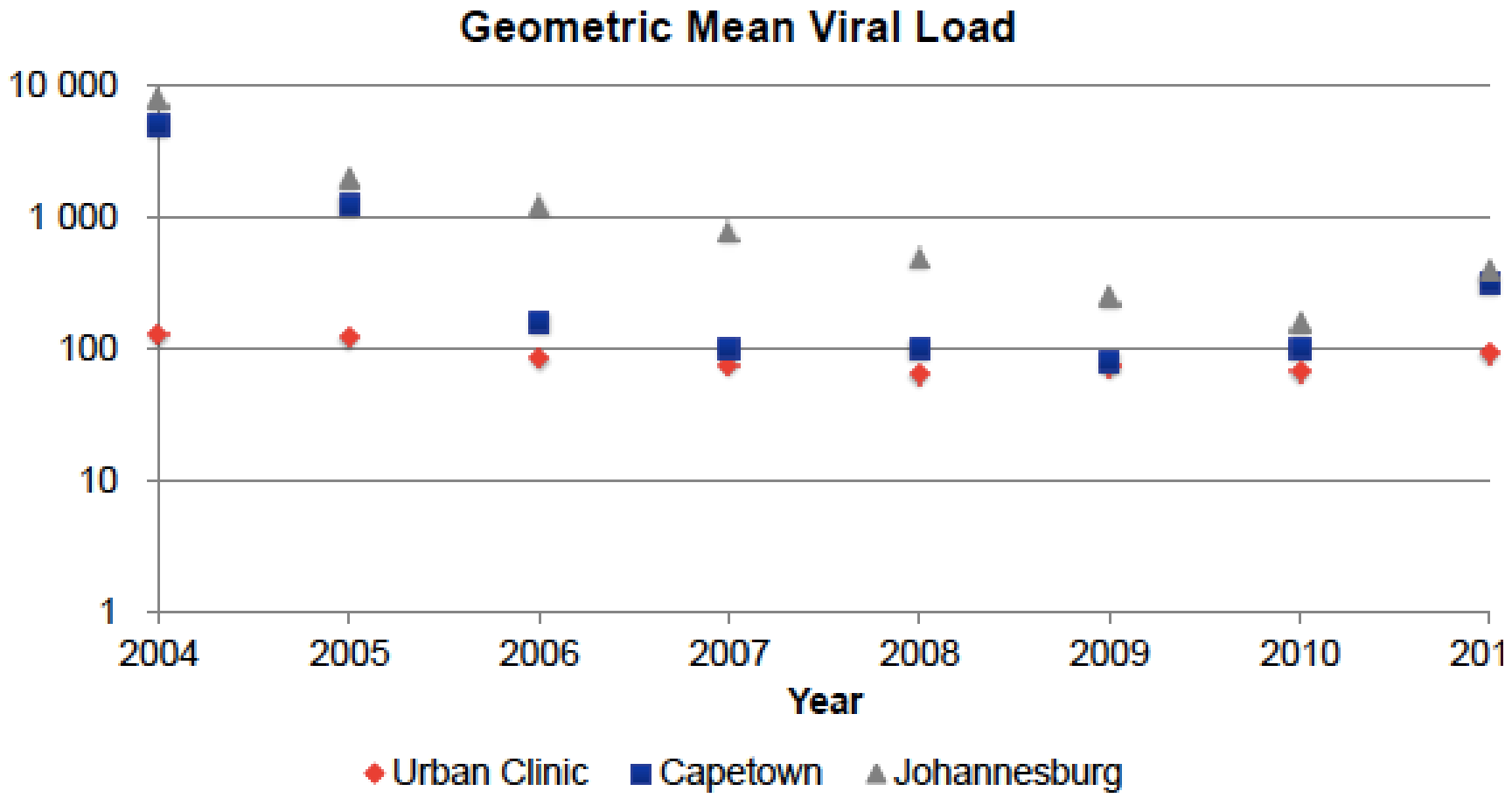
- Community Viral Load (CVL) is an indicator of amount of viral burden circulating in the population.
- A high CVL is associated with high rates of infection, infected patients initiating care with advanced stages of disease and/or a lack of compliance with therapy
- HIV viral load monitoring data from the National Health Laboratory Service (NHLS) used to compare the change in CVL in the two largest metropolitan areas in South Africa: Cape Town and Johannesburg.
- a large urban clinic with a comprehensive clinical care database in the comparison of CVL was used (gold standard).

Sergio Carmona[1,2], William B. MacLeod[3,4,5], Naseem Casim[1], Sesupo Nene[6,2], Gayle Sherman[1,2], Wendy Stevens[1,2]

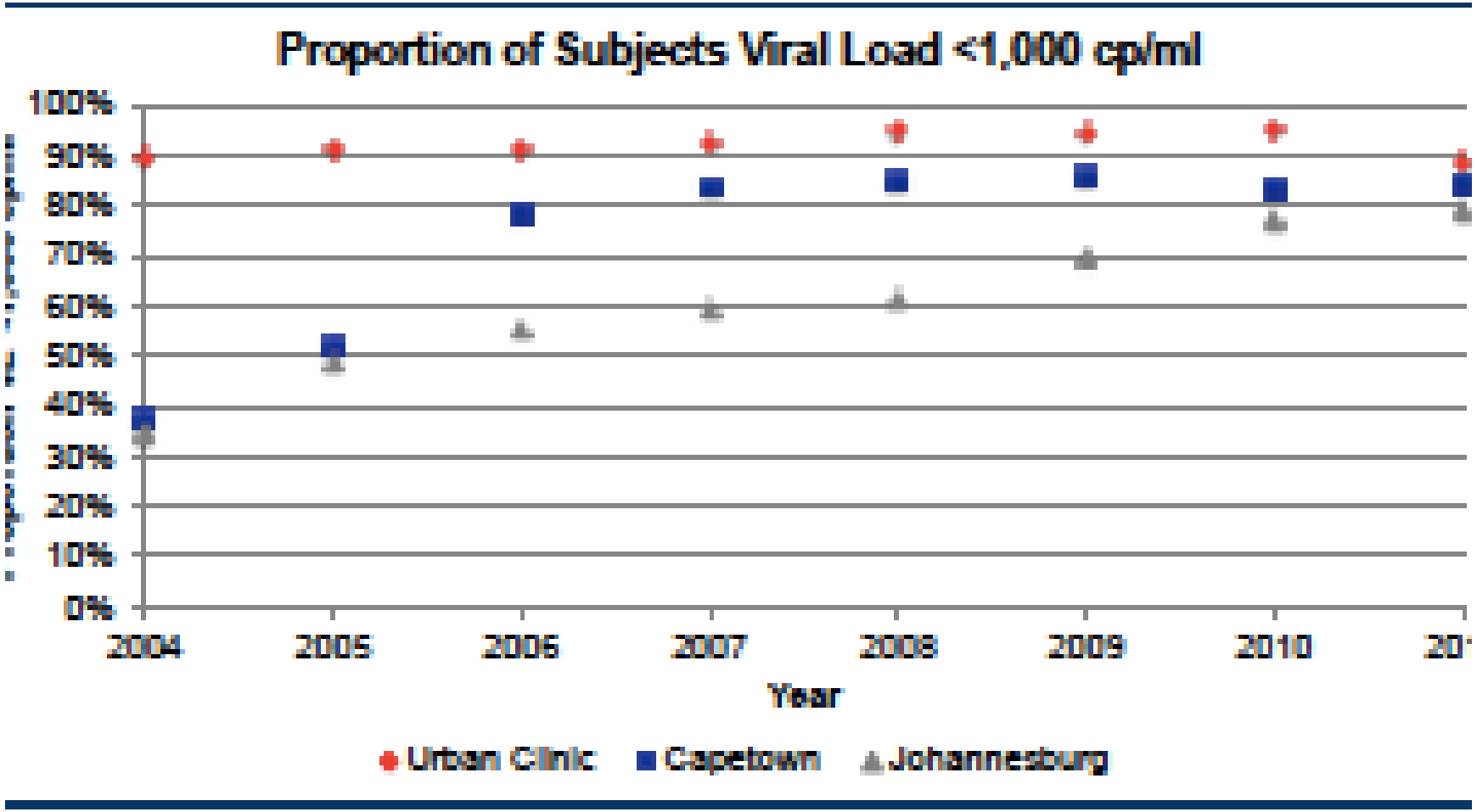
Heat map depiction of the geometric Mean Monitored Viral Load 2011 in SA.



Geometric Mean viral load



VL<1000cp/ml


Proportion of Subjects Viral Load <1,000 cp/ml
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2004
2005
2006
2007
2008
2009
2010
Year
Urban Clinic
Capetown
Johannesburg

There are 2 Ways to Analyze the Laboratory Test Results

- Cross-sectional analysis
  - Counts of tests and results of tests for a time period and geographic location
- Cohort analysis
  - Linking tests to individuals has the potential for calculating more indicators
    - Number of persons initiating therapy
    - CD4 count at treatment initiation
    - Proportion of Virological failure

Cohort Analysis

Extract Themba Lethu Clinic subjects from NHLS CDW dataset and compare results to TLC Therapy Edge Data

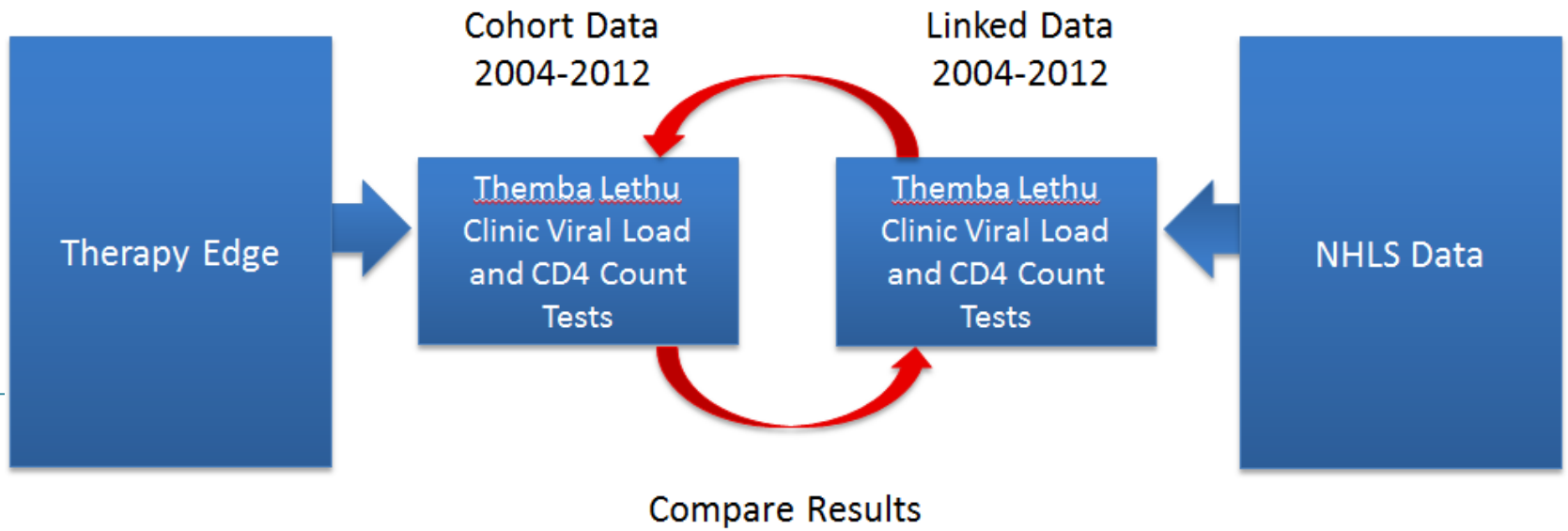
- Number initiating therapy
- CD4 count at initiation
- Proportion with suppressed viral load

Tests linked to individuals by exact match of surname, first initial and date of birth

- macleodw06091962

Out of 36,315 individuals in the TE TLC cohort this combination was only found in 43 pairs (0.24%).

Proof of Concept of Cohort Analysis



Analysis Database

Our analysis needs patients with a viral load test

Viral load test is a proxy for a patient on ART.

- Start of ART treatment
- Response to ART treatment

Assume that a patient with only CD4 count tests is pre-ART

Assume that a patient with only one VL test is unlinked

Rationale for Final Database Choice

Want to choose patient population that is followed.

- A single date for tests is relatively uninformative.
- Almost all viral load tests associated with a single CD4 Count test at the same date.
- Having at least 1 viral load test and 2 CD4 selects patients that have at least two observation dates.

Potential Bias

This patient population selection process introduces a number of potential biases

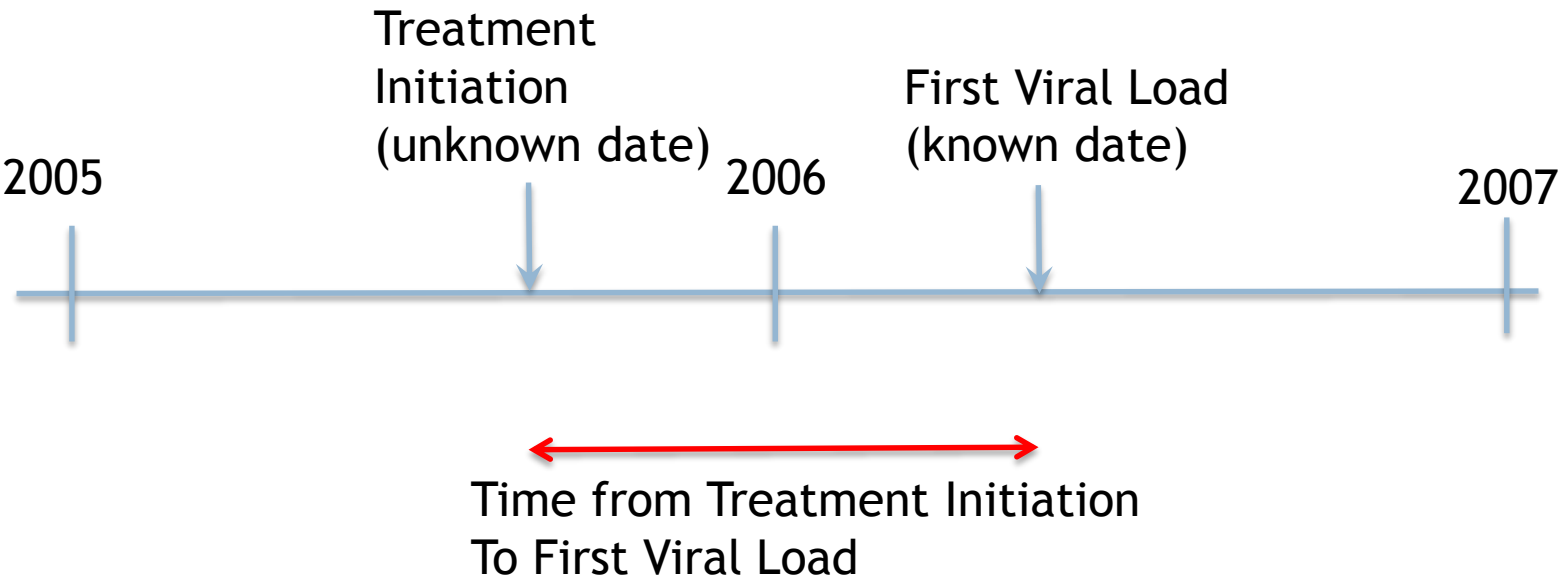
- Survivor bias—Everyone must have survived to receive a viral load test
- Information bias—Those patients with better recorded information will more likely have a match and be included in the database
- Cohort bias—Patients initiated in the recent past are more likely to be excluded

Methods for Estimating Number and Timing of Therapy Initiation

- Two Ways
  - Directly calculated frequency counts of treatment initiation date.
    - Have this data for Therapy Edge but not for NHLS
  - Indirectly estimated based upon assumption that First Viral Load in database is associated with ART treatment initiation.
    - Date of ART treatment initiation is related to timing of first viral load
      - At treatment initiation?
      - After 6 months on therapy?
      - After a year on therapy?
    - Which time do we choose?

*

Calculating Treatment Initiation Date from First Viral Load Test Date



If we know something about the distribution of time from treatment Initiation to first viral load then we can estimate time of treatment initiation.

The Timing of First Viral Load Test at TLC by Year from Therapy Edge Database

*

Year of Treatment Initiation	Observed Median Months to First Viral Load after Treatment Initiation (IQR)
2004	4 (3-5)
2005	3 (2-4)
2006	3 (0-4)
2007	0 (0-3)
2008	0 (0-3)
2009	3 (0-4)
2010	5 (3-6)
2011	5 (2-6)
2012	5 (0-6)

Reflects changes in guidelines

Estimating Initiation Date

- For each patient estimate time between First Viral Load and Treatment Initiation using a randomly assigned time (based on the normal distribution with mean equal to the median and standard deviation equal to width of IQR)
- Calculate estimated year of initiation for entire patient population
- Repeat 100 times and calculate mean number of initiates and 95% CI for each year.

The estimate # of Patients Initiating Therapy Calculated Two Different Ways

Year	Therapy Edge (Reference Date)	NHLS (Estimated Date of Treatment Initiation)
2004	1,396	192 (176 - 209)
2005	2,046	1,499 (1,463 - 1,536)
2006	2,644	2,811 (2,748 - 2,873)
2007	2,448	2,560 (2,509 - 2,611)
2008	2,320	3,023 (2,977 - 3,069)
2009	2,810	2,710 (2,651 - 2,769)
2010	2,686	2,635 (2,582 - 2,687)
2011	2,593	2,440 (2,387 - 2,493)
2012	1,361*	2,239 (2,169 - 2,310)

*Truncated because people enrolled in second half of year wouldn't have had a viral load test in 2012 and wouldn't be included in dataset.

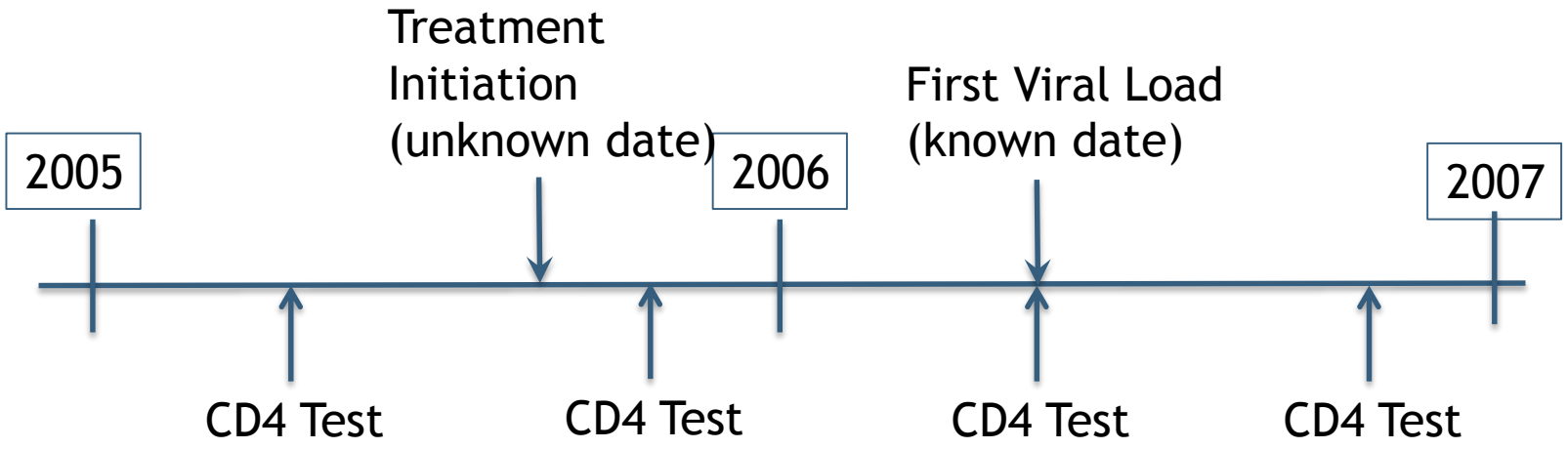
Assessment

- Calculating the number of new treatment initiations indirectly based upon the first viral load test was subject to some errors based upon the timing of the first viral load in relationship to treatment initiation.
- Excluded unlinked viral load tests likely compounded the mis-estimation.
- Estimation based upon shorter time frames (quarterly) will be attempted along with smoothing.

There are 2 proposed ways to calculate a Baseline CD4 Value

1. **Directly applied to Therapy Edge Data**
   - Mean CD4 counts up to 6 months before and 7 days after treatment initiation date.
2. **Indirectly applied to Therapy Edge and NHLS Data**
   - Choose CD4 Count test results up to 12 months prior to First Viral Load test.
   - Calculate minimum CD4 count from the values above.
   - Estimate time location of baseline CD4.

Estimating Baseline CD4 Count Value



Patient had multiple CD4 Tests—we are only concerned with tests prior to first viral load.

Baseline CD4 Count value is minimum value of all CD4 Count tests prior to first viral load.

We don't know treatment initiation date, so we estimate it based upon the Distribution of first viral loads.

Time Location of CD4 Test

- For each patient determine time between First Viral Load and baseline CD4 Count value using a randomly assigned time (based on the normal distribution with mean equal to the median and standard error equal to width of IQR)
- Calculate mean CD4 count for estimated CD4 year for entire patient population
- Repeat 100 times and calculate mean number of initiates and 95% CI for each year.

*

Mean CD4 Count at Initiation

	Therapy Edge TLC Data		NHLS Data
Year of Treatment Initiation	Directly Calculated Mean CD4 Count (6 months prior to 7 days after Treatment Initiation)	Estimated Mean CD4 Count	Estimated Mean CD4 Count adjusted for time of First Viral Load
2004	101	104	123 (118 - 129)
2005	113	115	119 (114 - 124)
2006	113	116	98 (94 - 101)
2007	120	123	120 (115 - 125)
2008	131	131	130 (123 - 137)
2009	155	154	159 (152 -167)
2010	153	168	164 (158 - 171)
2011	178	197	197 (187 - 207)
2012	218	246	211 (194 - 227)

Assessment

- Initiation CD4 count estimated from the TE data is close to both level and trend to the directly calculated initiation CD4 count.
- Initiation CD4 count estimated from the NHLS data is close in both level and trend to the directly calculated initiation CD4 count from the Therapy Edge dataset.

Proportion Viral Load Suppression and Failure

*

	Proportion VL < 400 copies			Proportion VL ≥ 1,000 copies		
Year of Test	TE Data	NHLS Data	Difference	TE Data	NHLS Data	Difference
All Years	78.4%	77.9%	-0.4%	16.1%	16.2%	0.1%
2004	70.0%	70.2%	0.2%	24.7%	25.0%	0.2%
2005	72.9%	79.5%	6.6%	20.1%	18.0%	-2.1%
2006	78.4%	80.0%	1.6%	18.9%	17.1%	-1.8%
2007	78.5%	76.8%	-1.7%	19.4%	20.8%	1.5%
2008	83.9%	83.8%	-0.1%	14.0%	14.1%	0.2%
2009	86.0%	85.5%	-0.5%	11.8%	12.2%	0.5%
2010	86.8%	87.2%	0.4%	10.2%	10.0%	-0.3%
2011	66.0%	66.0%	0.0%	21.2%	20.9%	-0.3%
2012	71.3%	72.0%	0.7%	17.8%	16.7%	-1.0%

Assessment and challenges

Viral load suppression and failure calculated directly from the NHLS and Therapy Edge Databases were very close with the largest difference less than 6.7%.

The method of calculation could have repeats of patient results and might over represent the proportion of patients with high viral loads.

Assigning a time on treatment for each individual will make these results more useful.

We measured the timing of viral load tests and first baseline empirically from TE data.

What values to use when not available empirically?

High level of linked tests in this population.

How will this translate to populations with fewer tests per person?

Get another data extract from NHLS

- Probabalistic matching?

Test with two other Therapy Edge Sites

Rif Resistance in MTB positive samples

Stable RIF resistance rates, geographical variation

Provincial GeneXpert RIF Results (MTB Detected)

Province	Inconclusive	Resistant	Sensitive	No Rif Result	Total	% RIF Resistant
Eastern Cape	409	1967	25234	271	**27,881**	**7.05**
Free State	262	1064	16476	33	**17,835**	**5.97**
Gauteng	241	1254	17389	79	**18,963**	**6.61**
Kwa-Zulu Natal	747	4037	42894	470	**48,148**	**8.38**
Limpopo	134	640	8245	118	**9,137**	**7.00**
Mpumalanga	116	795	7084	89	**8,084**	**9.83**
North West	150	860	10075	47	**11,132**	**7.73**
Northern Cape	130	566	8414	162	**9,272**	**6.10**
Western Cape	254	1083	20000	3	**21,340**	**5.07**
Total	**2,443**	**12,266**	**155,811**	**1,272**	**171,792**	**7.14**
% Total	**1.42**	**7.14**	**90.70**	**0.74**	**100**	

% RIF Concordance by LPA or DST n=9549 (March 2011-March 2013)

Probabilistic matching: No unique identifier for patients in SA

GXP Data ending 1 Jan 2013 (DST & LPA up to 25 March 2013)

Province	Rif Resistant Cases	GeneXpert Confirmation & Rif Concordance									
		DST					LPA				
		Confirmed		Rif Concordance		Pre-analytical/No result	Confirmed		Rif Concordance		Inderterminate
		#	%	#	%		#	%	#	%	
Eastern Cape	1459	22	1.5%	4	18.2%	0	86	5.9%	81	94.2%	0
Free State	838	22	2.6%	8	36.4%	0	149	17.8%	111	74.5%	22
Gauteng	1108	27	2.4%	20	74.1%	0	136	12.3%	129	94.9%	0
Kwazulu-Natal	3181	377	11.9%	368	97.6%	0	380	11.9%	325	85.5%	15
Limpopo	478	15	3.1%	13	86.7%	0	36	7.5%	25	69.4%	0
Mpumalanga	649	87	13.4%	86	98.9%	0	154	23.7%	134	87.0%	2
North West	523	16	3.1%	15	93.8%	0	54	10.3%	47	87.0%	4
Northern Cape	447	19	4.3%	12	0.0%	0	50	11.2%	44	0.0%	0
Western Cape	866	4	0.5%	1	0.0%	0	757	87.4%	730	96.4%	3
National	**9 549**	**589**	**6.2%**	**527**	**89.5%**	**0**	**1 802**	**18.9%**	**1 626**	**90.2%**	**46**

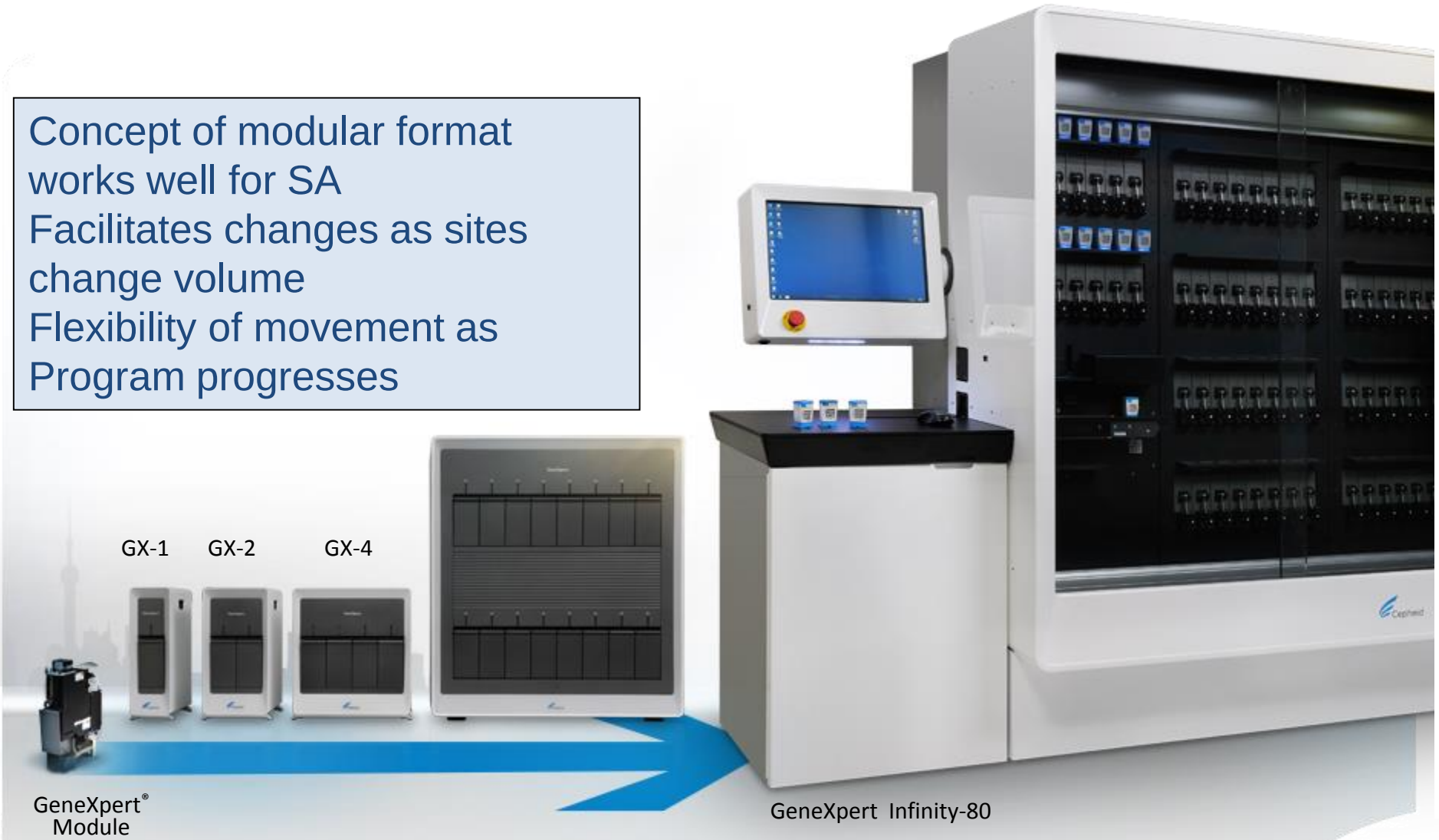
Prepared by the NHLS CDW Team

Concordance for Rif Resistance now reaching 90%: Beyong questioning accuracy

- **Algorithm adherence concerns: ~ 20-30%**
- Although small numbers E. Cape now deferring to LPA.
- **Western Cape is our role model: 87% adherence to algorithm, Rif Concordance 96-100%**
- **(only difference: two sputums collected upfront: 1 Xpert, reflex testing done by lab)**
- **KZN and W Cape: greatest number of confirmations: INH positivity: KZN (87.4% INH resistance); W.Cape: (82%)**

What happened when GeneXpert technology was implemented

Concept of modular format works well for SA
Facilitates changes as sites change volume
Flexibility of movement as Program progresses



No LIS configuration with NHLS, arrived with demonstration study data

Computer Challenges in the setting of the CLI for GeneXpert

- Does diagnostic have CIC standard communication protocol (HL7, ASTM, POCT1A)?

- No interface to NHLS LIS (in-house control DISA and Track):
  - Developed and implemented for all 289 analysers in the field (to smear microscopy laboratories).
  - Once **interfaced, results** could be uploaded and released: distributed directly to end-user: sms, phone EMR,.
- Data all transferred to Central Data warehouse for interrogation – M&E.
- But limited abilities for ongoing monitoring of **instrument performance**: error rates, invalids, calibration issues, user issues:
- Development of a **remote connectivity system (SaaS): Low cost, no hardware investment, concerns with data security (cloud)**
- When used at the **POC,** middleware software had to be installed to link to LIS.

SaaS: software as a service

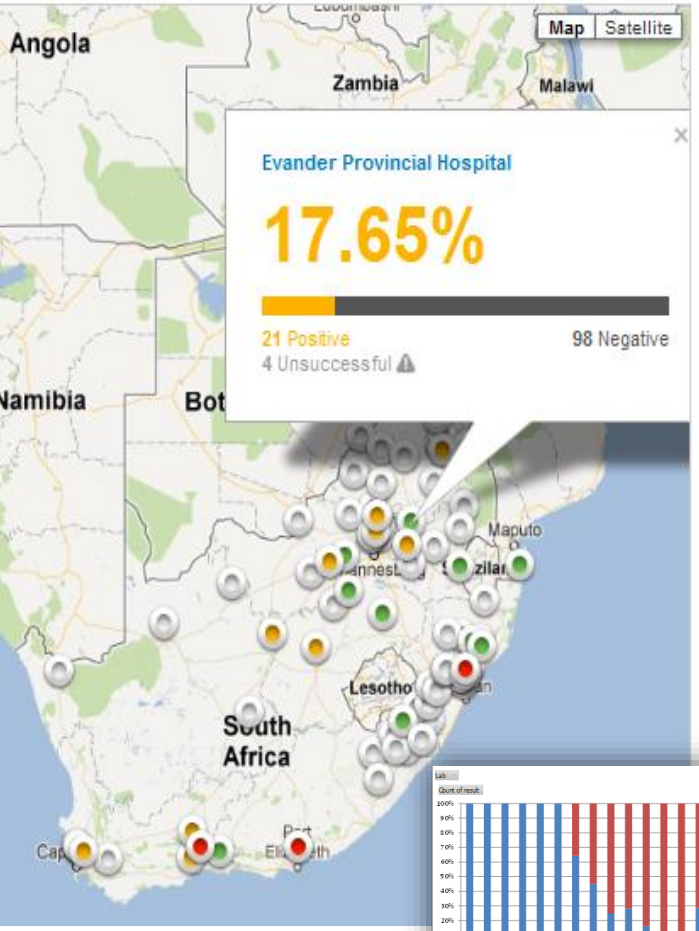
Cloud computing

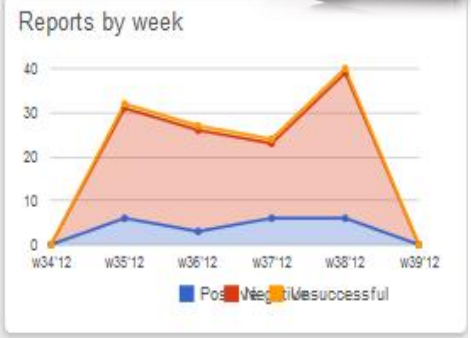
- **Cloud computing** is emerging as a new paradigm in healthcare.
- simple means of the **delivery of a service rather than a product**.
- The main enabling technology Virtualisation is the ability to allow the system to operate independently of the hardware.
- From the Cloud via the internet, one can provide information to other users of hardware or software
- resources can be shared within and between organisations to improve economies of scale. Data can be transferred in a computer network that is able to compartmentalise your needs.
- Advantages cited include increased speed, flexibility and a reduction in costs and labour.
- New work suggests the use of the “mobile cloud” which combines the use of mobile devices and the cloud (PDA’s, smart phones etc.).
- The cloud provides an affordable outsourcing model for whoever has dynamic needs for scalable computing.
- Cloud computing could facilitate global disease surveillance

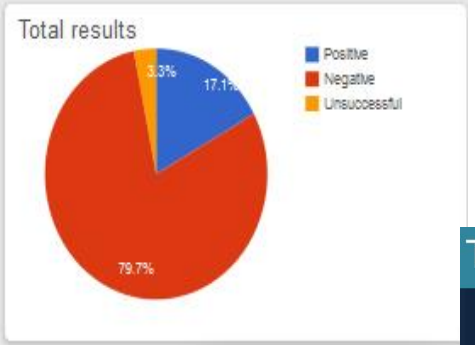
GeneXpert remote monitoring: Cepheid/NHLS under developme

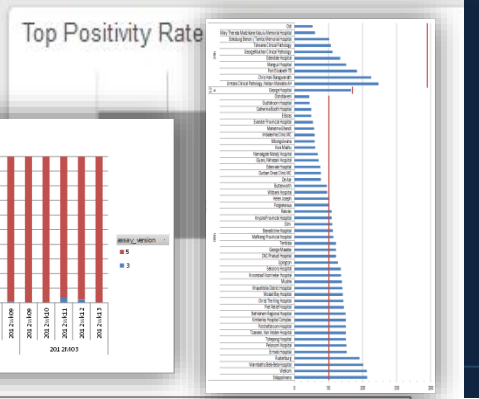
Gx verification (on installation, module maintenance) and EQA 3 x per year, but third quality monitoring component = real time monitoring.

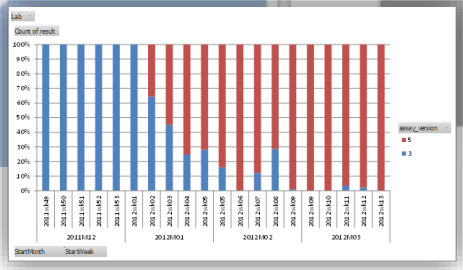
- Operational dashboard for real-time monitoring of results, errors, resistance and positivity rates
- Pre-configured on all newly installed GeneXperts

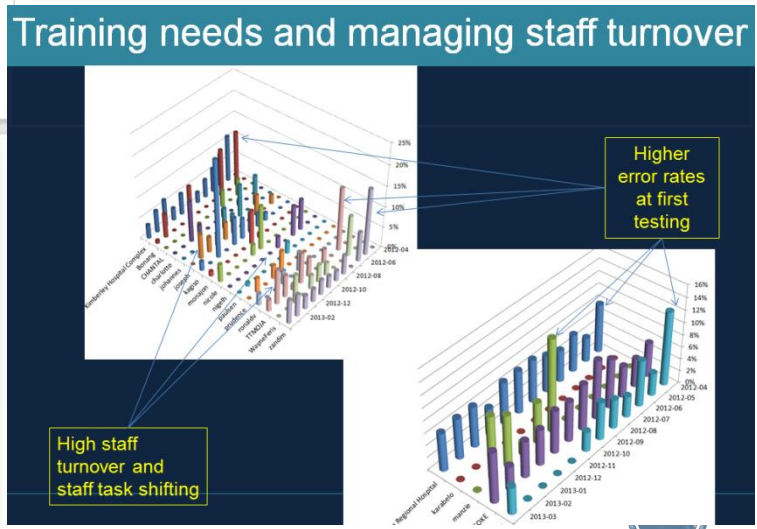






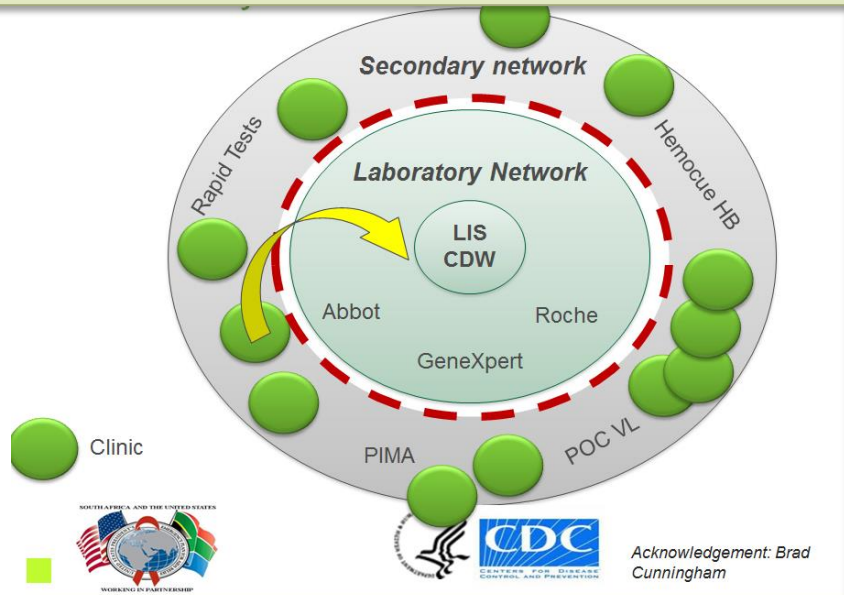




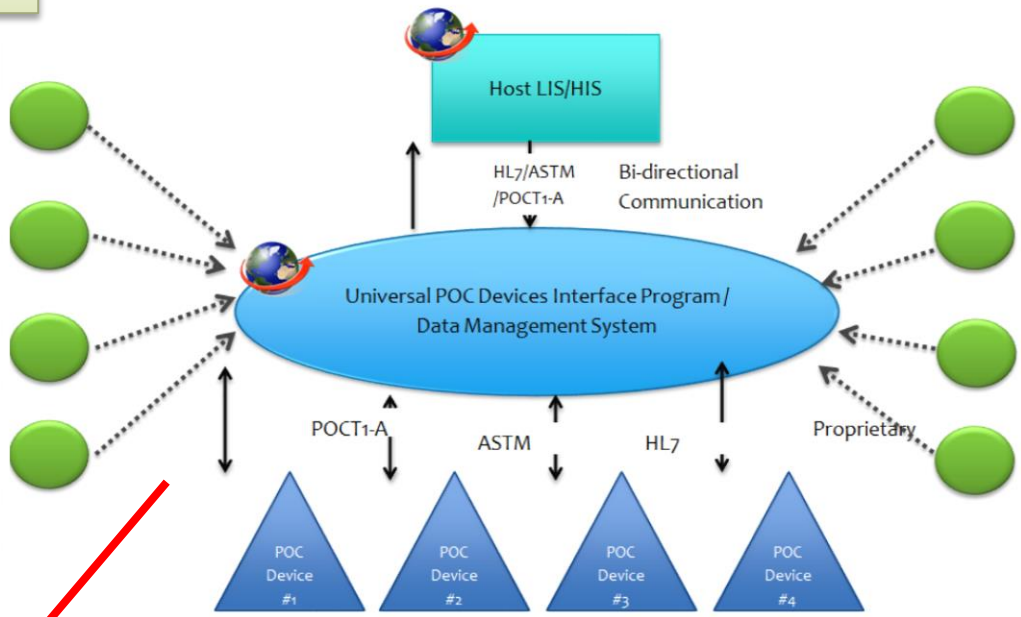


Alpha and beta testing completed, National Priority Program

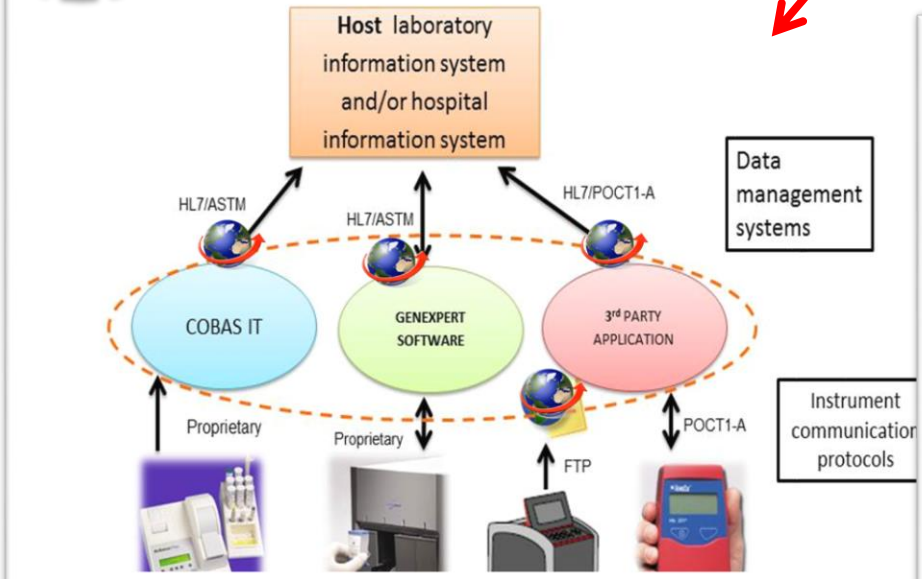
Connectivity at POC



Centralised data for decentralised testing



Reality of Connectivity for multi-disciplinary POCT



MIDDLEWARE

Available Options for POC Connectivity

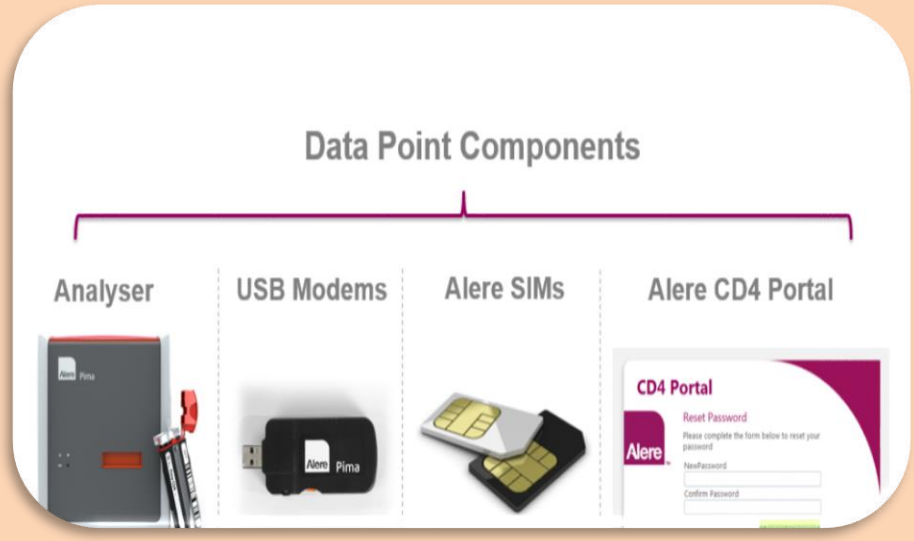
Product	Instrument Interfacing	Training and Certification	QC and instr. Management	Patient History	Result Management	Clinical Information	Visit Management
AegisPOC	Extensive	Yes	Yes	Yes	Yes	No	No
POCcelerator	Extensive	Yes	Yes	Yes	Yes	No	No
Cobas IT	Limited	Yes	Yes	No	Yes	No	No
Identicare	Development	No	No	Yes	Yes	No	Yes
Therapy Edge	None	No	No	Yes	Yes	Yes	Yes
eKAPA	None	No	No	Yes	Yes	Yes	Yes

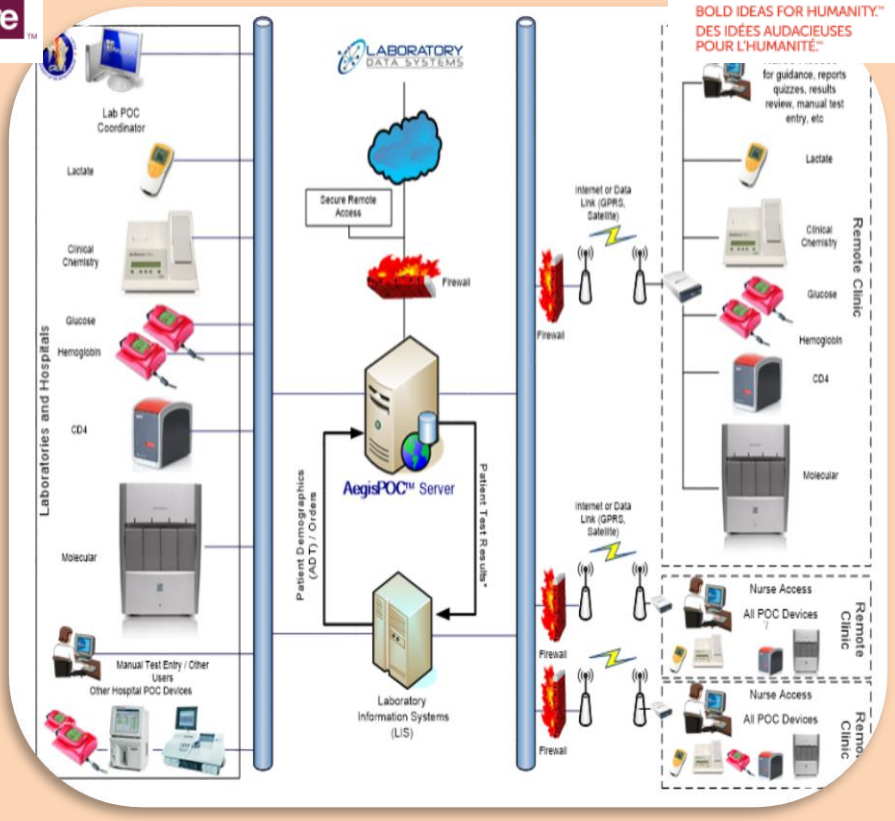
Instrument and Data Management

Patient Management

Dashboard

Middleware





PIMA connectivity:

Operational Dashboard	Middleware
Interface single instrument type/s from a specific vendor	Interfaces 100's of instruments and types – vendor neutral
Limited, more basic reports	Flexible, extensive reporting
Non-patient identifiable	Patient Identifiable
Unlinked	Linked to LIS & HIS
Free (generally)	High cost – but high cost saving

Program design

We believe there are four primary measures:

1. Coverage, i.e. equitable access
2. Quality, i.e. the number of good, valid tests
3. Capacity, i.e. can we do enough tests
4. Cost, i.e. delivered in a cost effective way

We found they are all connected in some way