Laboratory diagnostics performance in Uganda: A survey of test availability and constraints

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ABSTRACT

Introduction: Clinical laboratory services are a critical component of the health system for effective disease diagnosis, treatment, control and prevention. However, many laboratories in Sub-Saharan Africa remain dysfunctional. This study assessed the functionality of laboratories based on test menus and the associated constraints in Uganda. **Methods:** This cross-sectional quantitative study involved an assessment of 100 laboratories randomly selected in 20 districts from four regions of the country. The laboratory in charge and managers in each of the selected laboratories were interviewed. Data was analyzed using Excel and STATA 14. **Results:** Most health center III laboratories can conduct basic urine (84.2%, 48/57) and stool analysis (63.2%, 36/57) with a few exceptions due to non-functioning equipment and lack of reagents. All the Health center IV laboratories conducted HIV tests, malaria and pregnancy tests. None of the Health center IV laboratories performed pneumonia (blood/sputum culture tests) and ulcer (H pylori tests), electrolytes tests and only 1/18 (5.6%) performed chemistry tests; this was due to non-functioning equipment, lack of equipment, reagents and limited staff skills. Almost all tests supposed to be conducted at hospital-level laboratories, were conducted except for chemistry (73.7%, 14/19) and electrolytes (47.4%, 9/19) tests. Full blood count tests were missing in 25% (4/16) of the hub laboratories mainly due to lack of equipment. The majority (62.5%, 10/16) of the hubs routinely refer specimens for tests that are supposed to be carried out in these laboratories due to lack of reagents (70.0%, 7/10) and non-functional equipment (60.0%, 6/10). Hub laboratories lacked a list of essential supplies. **Conclusion:** Most laboratories performed well for the common tests. However, many laboratories did not meet testing requirements for the advanced tests due to non-functioning equipment, lack of equipment and reagents. Therefore, there is a need to provide equipment to laboratories, repair the non-functional ones and develop an essential list of supplies for the hub laboratories.

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Introduction

Clinical laboratory services are a critical component of the health system because they aid effective disease diagnosis, treatment, control and prevention [1]. Over the past decade, there has been an increased demand for laboratory testing services to manage infectious and non-infectious diseases including emerging and re-emerging diseases [1].

In Uganda, laboratory services are a key driver for the effective delivery of the Uganda National Minimum Health Care Package (UNMHCP) [2]. However, most of the laboratories in Uganda function below capacity and are characterized by unavailability of vital tests, tests of low quality and clinically unreliable results [3]. The quality of laboratory services has been hindered by several factors including lack of standardized laboratory test menus, equipment, techniques, and supplies list for the various levels of healthcare delivery among others [4, 5]. In order for laboratories to operate efficiently and cost-effectively, they need an uninterrupted supply of reagents, functioning equipment, supplies and personnel. The inability to conduct tests delays and disrupts clinical care, prevention activities and public health programs [6].

Laboratory services in Uganda are regulated under the Allied Health Professionals Act of 1996, which mandates the Allied Health Professionals Council (AHPC) to register and license all laboratory professionals. The Uganda National Health Laboratory Services (UNHLS) is the national body mandated to provide nationwide stewardship for laboratory services strengthening the regulatory framework of laboratory services and enabling AHPC to effectively perform its mandate. The National Drug Authority (NDA) plays a role in regulating laboratory supplies and reagents, equipment and diagnostic devices [7].

Several initiatives have been implemented to improve the quality of testing services in African laboratories [8, 9]. Some of these include the establishment of the East Africa Public Health Laboratory Network Project, World Health Organization (WHO) which is reported to have led to the establishment of initiatives like Stepwise Laboratory Quality Improvement Process Towards Accreditation (SLIPTA), and Strengthening Laboratory Management Toward Accreditation (SLMTA) [10]. In 2013, Uganda embarked on the process of standardizing the laboratory test menus and supplies for the various tiers of laboratories in the laboratory network to improve the quality of testing services [11]. Despite these advances, most of the laboratories in the country are still not performing to the set standards. Therefore, we established the functionality of the laboratories based on the availability of test menus and supplies across the different laboratory levels in Uganda.

Laboratory service testing menus in Uganda

Laboratory testing menus are intended to define the minimum testing services expected at the various levels in the tiered laboratory network [11]. Uganda has a well-defined laboratory-tiered network that is aligned with public health service delivery. At the lowest level, closest to the community, Health Centre Three (HCIII) the basic (simple common) laboratory tests are offered and subsequently at each higher level of service delivery those tests which are not available at the lower levels are offered.

Laboratory Hubs

In order to increase access to quality laboratory services and improve accuracy, efficiency and immediacy in disease diagnosis, laboratory hubs were established in Uganda in 2006. Laboratory hubs provide enhanced services on-site or refer to a higher-level facility that has the capacity to perform the test [12]. The laboratory test menus for the laboratory at each level of service delivery are summarized in Figure1.

The functionality of the laboratories based on test menus and availability of supplies remains unknown in Uganda [3]. This information deficit is a detriment to public health because it undermines service delivery and quality improvement efforts. This study therefore sought to assess laboratory functionality based on test menus and supplies availability in Uganda. This study presents policymakers and public health authorities in Uganda, with viable information for strengthening laboratory testing services.

Methods

Study design and setting: This cross-sectional study was conducted in the four regions (Northern, Western, West Nile, and Eastern) of Uganda.

Study population and sampling

The four regions (West Nile, Eastern, Northern, and Western) of the country were included in the sample. In each of the regions, five districts were randomly selected using a computer random number generator. Therefore, a total of 20 districts were included in the study. This number was based on economic feasibility. Purposive sampling was done to select five laboratories in each district. Careful consideration was made to ensure that at least each level of the health facility with a laboratory was included in the study in each of the districts. We made sure that health centre threes (HC III), health centre fours (HCIV), hospital, and regional referral hospital (RRH) were included in the study in each of the districts. The laboratories were drawn from both private and public health facilities. A total of 100 laboratories were included in the study, of which 100 laboratory managers and their charges were interviewed. Of all the 100 laboratories assessed, 16 were hub laboratories, while 84 were non-hub laboratories. The hub laboratories included 2 HC IIIs, 2 HCIVs, 7 hospitals, and 5 RRH laboratories. HCIIs were not included in this study because they have no laboratories.

Data collection procedures

The data was collected between December 2015 and January 2016. Data on the availability of testing services, and diagnostic capacities were assessed using a laboratory assessment tool, a semi-structured questionnaire, adapted from the WHO and the United States Agency for International Development (USAID) assessment tool for laboratory services and supply chain (ATLAS), 2006. A checklist for laboratory supplies adapted from the Essential Medicines and Health supplies list for Uganda, (2012) was used to assess the availability of testing supplies. These were done through interviews and observations survey questions administered in person to the laboratory managers or in-charges at each laboratory facility. Test menus, specimen and test referrals, availability of supplies and reasons for lack of tests were documented at each laboratory level.

Data management and analysis

Quantitative data were entered in EPI Info version 7 software, cleaned and analyzed using Excel and STATA. Test and supplies availability were obtained by comparing the available tests and supplies with standard testing menus (WHO, 2017) and standard essential lists for supplies respectively based on the level of health facilities (WHO, 2012). Proportions of facilities offering a given test based on the standard testing menus and availability of supplies were obtained.

Ethics approval and consent to participate

We obtained ethical approval from the Makerere University School of Public Health Higher Degrees Research and Ethics Committee (protocol number HDREC 364). All the participants consented before being interviewed.

Results

Background characteristics

A total of 57 HCIIIs, 18 HCIVs, 19 hospital laboratories and 6 regional referral hospital laboratories were assessed. Sixteen of these laboratories were hubs and 84 were non hubs. The laboratories had been in operation for an average of 15 years, ranging from 1 to 80 years.

Tests performed at facility level according to Test menus

Health center III laboratories: Most health center III laboratories can conduct basic urine (84.2%, 48/57) and stool analysis (63.2%, 36/57) with a few exceptions due to non-functioning equipment and lack of reagents. All HCIIIs conducted HIV tests, malaria and pregnancy tests. None of the HC III laboratories performed blood grouping and sickle cell screening due to non-functioning equipment, and lack of equipment and reagents. Full blood count (8.8%, 5/57) and basic chemistry (8.8%, 5/57) tests were grossly lacking due to non-functioning equipment, lack of equipment, reagents and skilled staff. A few HC III laboratories 5/57(8.8%) performed advanced tests which were not in their

mandate, including full blood count and chemistry tests Table 1.

Health center IV laboratories: All the Health center IV laboratories conducted HIV tests, malaria and pregnancy tests. None of the Health center IV laboratories performed pneumonia (blood/sputum culture tests) and ulcer (H pylori tests), electrolytes tests and only 1/18 (5.6%) performed chemistry tests; this was due to non-functioning equipment, lack of equipment, reagents and limited staff skills. The majority of diabetes (Random/Fasting blood sugar) 83.3% (15/18), Hepatitis (HBsAg) 77.8% (14/18) and complete blood count (CBC) 66.7%, 12/18) tests were referred mainly due to broken down equipment and lack of reagents at the time of the assessment Table 1.

Tests performed at Hospital laboratories: Almost all tests supposed to be conducted at hospital-level laboratories, were conducted except for chemistry (73.7%, 14/19) and electrolytes (47.4%, 9/19) tests. Slightly more than half (52.6%, 10/19) of laboratories did not conduct electrolyte tests due to nonfunctioning equipment, lack of equipment, reagents and skilled staff. Only five hospital laboratories (26.3%) did not conduct chemistry tests; this was due to nonfunctioning equipment and lack of equipment Table 2.

Tests performed at Regional Referral hospital laboratories: Almost all tests supposed to be conducted at regional referral laboratories were available at the time of the assessment. However, half of the laboratories did not conduct electrolyte tests (3/6) and this was due to a lack of reagents and equipment. One laboratory (16.7%) did not conduct full blood count tests due to a lack of reagents Table 2.

Tests performed at hub laboratories according to test menus and reasons for non-availability of tests

All the hub laboratories had malaria tests and TB screening. Less than half (43.8%, 7/16) of the hub laboratories were able to perform electrolyte tests; the rest of the laboratories (9/16) could not due to lack of equipment, non-functioning equipment and lack of reagents. Also 4 out of 16 hub laboratories assessed, could not conduct full blood count tests due to lack of equipment. Only 3/16 (18.8%) hub laboratories were not able to conduct chemistry tests and this was due to lack of equipment and nonfunctioning equipment Table 3.

Tests and specimen routinely referred

Generally, 93.0% (93/100) of the laboratories visited routinely referred specimen. Almost half (48.4% , 45/93) of them referred specimen for tests that could be performed in the laboratories. This was mainly due to lack of reagents (44.1%, 41/93) and lack of equipment (39.8%, 37/93). More than half of laboratories at all levels received referred results more than a week from the time the specimens were referred, with HC IVs having the highest number (66.7%, 6/9) of laboratories receiving results after a week.

Health center III laboratories: Slightly less than half (42.1%, 24/57) of the health center III laboratories routinely referred tests for which they are mandated to perform. The main reason for routine referral of these tests was lack of reagents.

Health center IV laboratories: Half 9/18 (50.0%) of the health center IV laboratories routinely referred specimen for tests that could be carried out in the laboratory. These mainly included TB culture (9/9), CD4 (7/9), Viral load (9/9), chemistry (4/9) and hematology (3/9). The main reasons for referral included lack of reagents (88.8%) and broken equipment (55.6%).

Hospital level laboratories: More than half (11/19, 57.9%) of the general hospital laboratories routinely referred specimen for tests that could be carried out in the laboratory. These mainly included Polymerase Chain Reaction (PCR) (11/11), Histology (7/11), Tuberculosis (TB) culture (8/11) and Viral load (8/11). The main reasons for referral of tests included lack of reagents (72.7%, 8/11), broken equipment (72.7%, 8/11) and lack of staff (9.1%, 1/11).

Regional referral hospital laboratories

Only two of the six (33.3%) of the regional referral hospital laboratories routinely referred specimen for tests that could be carried out in the laboratory. These were mainly PCR (2/2), TB culture (2/2) and viral load (2/2). The main reason for referral of specimens was lack of reagents.

Hub Laboratories

The majority (10/16, 62.5%) of the hub laboratories routinely referred specimens for tests that are supposed to be carried out in their laboratories. These tests included PCR (9/10, 90.0%), Histology (4/10, 40.0%), TB culture (10/10, 100.0%), chemistry (4/10, 40.0%), Clusters of differentiation 4 (CD4) (6/10, 60.0%) and Viral load (10/10, 100.0%). The main reasons for specimen referral by the hub laboratories included lack of reagents (7/10 70.0%) and nonfunctional equipment (6/10.60.0%).

Availability of essential and vital laboratory supplies and reagents at different laboratory levels

Overall HIV testing kits, Malaria rapid tests strips, urine strips, were well stocked at all laboratory levels with 96/100 96% (96/100) of the laboratories having those supplies. At all levels, there was a general shortage of Igm (tubex) (7/100; 7%), reconstituted laboratory reagents for malaria, CBC, TB screening and opportunistic infections tests (34/100, 34%).

Health center III laboratories

Of the supplies mandated to be available at this level, majority of the HC III laboratories were stocked with HIV testing kits (94.7%, 54/57), malaria rapid diagnostic tests (93.0%, 53/57) and about half (50.9%, 29/57) were stocked with blood glucose test strips. The least stocked/available supplies were IgM tubex (8.8%, 5/57), reconstituted laboratory reagents for malaria, CBC , tuberculosis and opportunistic infections (28.1%, 16/57), chemicals (31.6%,18/57), blood grouping anti-sera (42.1%, 24/57) and about (38.6%, 22/57) had glassware and apparatus Table 4.

Health center IV laboratories

For the supplies supposed to be available at Health center IV laboratories, almost all of them had HIV testing kits (94.4%,17/18) and malaria rapid test strips (94.4%,17/18). None of the laboratories had CD4 Reagents, EasyCD4 (GUAVA), Sysmex 3-part reagent kit, Cobas C 111 equipment reagents, Cobas c 311 liver profile test kits, reagents for Selectra, and blood collection sets and only 33.3% (6/18) had been stocked with glassware Table 4.

Hospital-level laboratories

All hospital laboratories were stocked with HIV, malaria and urine test strips. The least stocked supplies and reagents were blood collection supplies (28.0%, 7/25), CD4 reagents (20.0%, 5/25), Anti-microbial sensitivity disc kit (20.0%, 5/25), culture media (16.0%, 4/25), and coagulation reagents (12.0%, 3/25). None of them were stocked with reagents for selectra and biochemistry reflotron reagents. Slightly more than than half of the laboratories were stocked with human liver function test kits (52%, 13/25), blood grouping anti sera 64% (16/25), blood collection supplies 28.0% (7/25) while none of them were stocked with reagents for selectra and biochemistry reflotron reagents Table 4.

Hub level laboratories

Availability of supplies according to supplies menus at Hub laboratories level could not be assessed due to lack of a supplies list for these hub laboratories.

Discussion

The functionality of the laboratories in terms of test menus is critical in guiding clinicians in diagnosing and giving the appropriate course of treatment to patients and also guiding public health workers on the effectiveness of health interventions and health programs [13]. Therefore, the main purpose of this study was to establish the functionality of the laboratories based on the availability of test menus and supplies across the different laboratory levels in Uganda. In this study, we found that many laboratories performed well regarding the common tests of malaria, HIV, urine and stool analysis, with low performance of advanced tests like chemistry, electrolytes and full blood counts in laboratories mandated to perform such tests. The main reasons for the unavailability of tests were non-functioning equipment, as well as lack of equipment and reagents.

The study indicated that generally, most basic tests were available at the time of assessment across the different laboratory levels. The most frequently done tests included malaria tests, stool and urine analysis, syphilis and TB screening. This finding concurs with the results of a survey in Kampala which revealed that stool analysis, urinalysis, syphilis and malaria tests were among the most available tests in the city

[14]. However, many laboratories did not meet testing requirements, especially for the advanced tests according to standard testing menus for Uganda. A few HC III laboratories performed advanced tests which were not in their mandate. These could have been privately owned laboratories with the capacity to perform such tests. A similar study conducted in ten low and middle-income countries reported limited availability of the most essential diagnostic services, including HIV testing, with median availability under 40% in the basic primary care tier [15]. It is indicated in this study that there was a dismal performance on the full blood count, electrolytes and chemistry tests at HC IV, hospital and regional referral levels where these tests are supposed to be conducted. The poor performance in these tests was highest at HCIV, which is the first point of referral.

This dismal performance is attributed to mainly the lack of functional equipment for these tests. This underscores the need for regular maintenance of the equipment. Similar observations were reported in southwestern Ethiopia where clinical chemistry performance was very low and the quality of clinical chemistry test services was below standard [16]. This was also consistent with a study conducted in ten LMICs which reported low availability of many essential diagnostic tests, including basic chemistry tests, automatic complete blood count, Gram stain, tuberculosis testing, x-ray, at the hospital tier [15]. The most common reason for not having these tests was the lack of equipment followed by a lack of reagents to run the tests. This is consistent with the findings of a Kampala, Uganda study [17] which revealed that 92% of the laboratories reported that tests were not carried out due to lack of equipment and reagents. Thus, to improve the quality and availability of clinical chemistry, electrolytes and full blood count tests, there is a need for strategies to support laboratories with essential and vital supplies and key equipment.

Regarding functionality of hub laboratories, although hub laboratories were equipped to perform full blood count, chemistry tests and electrolytes tests to service a wider area and act as referral laboratories for the region, a quarter of the hub laboratories could not perform Full Blood Count (FBC) due to lack of equipment. Only less than half were able to conduct electrolytes due to non-functioning equipment, lack of equipment and reagents. Since these hub laboratories are intended to bridge gaps in service availability, they should be supported to consistently conduct electrolyte and chemistry tests by availing the required chemistry equipment, regularly repair non-functioning equipment and ensure consistent supply of reagents.

The study revealed that about half of the laboratories routinely referred specimens for tests that they should be performing according to standard menus. These gaps were more pronounced in HCIV and hospital laboratories. Furthermore, unexpectedly, a high number of hub laboratories routinely referred specimens for tests that they should be conducting compared to non-hub laboratories. The main reason for the referral of the specimen was the lack of reagents and functional equipment. According to the National Laboratory Strategic Plan (2010-2015), lack of or frequent breakdown of equipment and frequent stock out of supplies were the reasons many laboratories did not fulfil the testing requirement. Hub laboratories offer a prime opportunity to further improve access and quality of services. These hubs should be further supported by MOH to mitigate their persisting challenges of equipment breakdown and stockouts of reagents. Upgrading some of these hub facilities would reduce the need to refer samples even further away from the requesting facilities and thereby reduce waiting times regionally. Quality improvement initiatives are still needed especially at the hub, HC IV and hospital-level laboratories so that they can perform tests according to standard.

Regarding availability of supplies, most of the laboratories were well stocked with HIV testing kits, Malaria RDTs, TB reagents kits and gram stain kits. This was probably because of an additional source of funding both from donors and implementing partners in most of the laboratories. However, laboratories were less stocked with blood glucose test strips which are critical for detection of diabetes which is one of the prevalent non communicable diseases in Uganda at 3.6% among adult population [18]. There were also less stock of chemicals, blood grouping anti sera, IgM tubex and glassware. It was further observed that stock outs of chemistry reagents were a critical challenge for the high-level laboratories. This was probably because government was the sole source of funding for most of the chemistry reagents. Similar observations were noted in Ethiopia where most of the laboratories did not have adequate chemistry reagents and chemicals to

do all the necessary tests and thus health decisions could be possibly made based on incomplete laboratory test results [16]. Therefore, there is a need to ensure that high-level laboratories are equipped with adequate vital and essential supplies, especially for the advanced tests since these constitute the main referrals. Hub laboratories are officially recognized in the laboratory service delivery structure, however, there is no specified list/menus for essential and vital supplies for hubs. This makes these laboratories vulnerable to missing out on the most critical supplies and hence compromises their ability to perform some tests. Therefore, there is a need to develop and institute an essential supplies list of supplies menus for hub laboratories to ensure that the most vital and essential supplies are supplied to boost functionality. However, we acknowledge that this study was done in 2015. A number of health systems strengthening initiatives have been implemented since then. Hence the current picture of the status of laboratories in the country in 2024 may be different.

Conclusion

In this study it was revealed that many laboratories performed well regarding the basic tests of malaria, HIV, urine and stool analysis but poorly with regard to availing advanced tests like chemistry, electrolytes and full blood counts in laboratories which are mandated to perform such tests including some of the hub laboratories and high-level laboratories. To mitigate wastage and improve the quality of services provided by laboratories harmonized efforts to be made to repair existing equipment, train staff where needed and to provide necessary supplies for functionality. The goal should be to make Hub laboratories fully functional while addressing supplies and capacity gaps where equipment exist at lower levels of care.

What is known about this topic

- Clinical laboratory services support effective disease diagnosis, treatment, control and prevention.
- Many laboratories in Sub-Saharan Africa remain dysfunctional.

What this study adds

- This study provides evidence on the functionality of laboratories based on test menus and the associated constraints in Uganda.
- This study presents policymakers and public health authorities in Uganda, with viable information for strengthening laboratory testing services.
- There is need to provide equipment to laboratories, repair the non-functional ones and develop an essential list of supplies for the hub laboratories.

Competing interest

The authors declare no competing interests.

Authors´ contribution

SNK and ANK wrote the protocol of the study. NN and MA analyzed and interpreted the data. NN drafted the initial manuscript, NN, SNK MA, KS, WB and ANK contributed to the first draft and all authors read and approved the final manuscript.

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Tables and figure

Table 1: Tests performed at Health Center IIIs and Health center IV according to test menus

Table 2: Tests Performed at Hospital and Regional Referral hospital laboratories according to testing menus

Table 3: Tests available at Hub laboratories according to Test menus

Table 4: Availability of selected essential and vital supplies and reagents according to the menus at the time of assessment

Figure 1: Laboratory test menus for Uganda (MOH, 2017)

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Table 1: Tests performed at Health Center IIIs and Health center IV according to test menus		
Test Menus	**HC III N=57 n (%)**	**Reasons for unavailability of tests**
Bacteriology tests		
Stool analysis	36 (63.2)	*&
Urine Analysis	48 (84.2)	*&
AFB (TB screening)	40 (70.2)	*#&
Serology		
Syphilis test	52 (91.2)	*#&
HIV test	57 (100.0)	-
Pregnancy test	57 (100.0)	-
Rapid Blood Sugar	44 (77.2)	&
Parasitology		
Malaria test	57 (100.0)	-
Hematology		
Full blood count	5 (8.8)	*#&
Blood grouping	0 (0.0)	*#&
Sickle cell screening test	0 (0.0)	*#&
Chemistry test	5 (8.8)	$*#&
Test Menus for HCIV	*HCIV N=18 n (%)*	*Reasons for unavailability of tests*
Bacteriology		
Stool analysis	16 (88.9)	&
Urine Analysis	17 (94.4)	#
AFB (TB screening)	17 (94.4)	&
Serology		
Syphilis test	16 (88.9)	*#
HIV test	18 (100.0)	-
Pregnancy test	18 (100.0)	-
Hepatitis (BDsAg)	14 (77.8)	&
Rapid Blood Sugar	3 (16.7)	&
Parasitology		
Malaria test	18 (100.0)	-
Electrolytes	0 (0.0)	$*#&
Hematology		
Full blood count	6 (33.3)	*#&
Blood grouping	9 (50.0)	&
Sickle cell screening test	7 (38.9)	&
Chemistry test	1 (5.6)	$*#&
*$-Staff not trained, *-nonfunctioning equipment, #-No equipment, &-No reagents, bold-weak areas*		

Table 2: Tests Performed at Hospital and Regional Referral hospital laboratories according to testing menus		
Test Menus	**Hospital n=19 n (%)**	**Reasons for unavailability of Tests**
Bacteriology		
Stool analysis	19 (100.0)	-
Urine Analysis	19 (100.0)	-
AFB (TB screening)	19 (100.0)	-
Serology		
Syphilis test	18 (94.7)	#
HIV test	19 (100.0)	-
Pregnancy test	19 (100.0)	-
Rapid Blood Sugar	19 (100.0)	-
Parasitology		
Malaria test	19 (100.0)	-
Electrolytes	9 (47.4)	*#$&
Hematology		
Full blood count	16 (84.2)	*#
Blood grouping	18 (94.7)	&
Sickle cell screening test	18 (94.7)	&
Chemistry test	14 (73.7)	*#
Test Menus	RRH 6 (%)	Reasons for unavailability of Tests
Bacteriology		
Stool analysis	5 (83.3)	&
Urine Analysis	5 (83.3)	#
AFB (TB screening)	6 (100.0)	-
Serology		
Syphilis test	5 (83.3)	#
HIV test	6 (100.0)	-
Pregnancy test	6 (100.0)	-
Rapid Blood Sugar	6 (100.0)	-
Parasitology		
Malaria test	6 (100.0)	-
Electrolytes	3 (50.0)	#&
Hematology		
Full blood count	5 (83.3)	&
Blood grouping	6 (100.0)	-
Sickle cell screening test	6 (100.0)	-
Chemistry test	6 (100.0)	**-**
$-Staff not trained, *-nonfunctioning equipment, #-No equipment, &-No reagents, bold-weak areas		

Table 3: Tests available at Hub laboratories according to Test menus		
Test Menus	**N = 16 (%)**	**Reasons for unavailability of tests**
Bacteriology		
Stool analysis	14 (87.5)	&
Urine analysis	14 (87.5)	#&
AFB (TB screening)	16 (100.0)	-
Serology		
Syphilis test	14 (87.5)	#
Parasitology		
Malaria test	16 (100.0)	-
Electrolytes	7 (43.8)	*#&
Hematology		
Full blood count	12 (75.0)	#
Chemistry	13 (81.2)	*#
*$-Staff not trained, *-nonfunctioning equipment, #-No equipment, &-No reagents, bold-weak areas*		

Table 4: Availability of selected essential and vital supplies and reagents according to the menus at the time of assessment

Supplies Menus	**HC III N=57 n (%)**	**HC IV N=18 n (%)**	**Hospitals N=25 n (%)**	**All Facilities N=100 n (%)**
HIV testing kits	54 (94.7)	17 (94.4)	25 (100.0) 96/100	96 (96%)
Specimen containers	42 (73.7)	13 (72.2)	20 (80.0)	75 (75%)
Blood glucose test strips	29 (50.9)	7 (38.9)	21 (84.0)	57 (57%
HCG pregnancy test strips	45 (79.0)	12 (66.7)	24 (96.0)	81 (81%)
Brucella abortus Ag	*	5 (27.8)	14 (56.0)	19 (44.2%)[@]
IgM (tubex)	5 (8.8)	1 (5.6)	1 (4.0)	7 (7%)
Malaria rapid	53 (93.0)	17 (94.4)	25 (100.0)	95 (95%)
RPR test strips	48 (84.2)	13 (72.2)	19 (76.0)	80 (80%)
Treponema	15 (26.3)	6 (33.3)	15 (60.0)	36 (36%)
Urine test strips	51 (89.5)	16 (88.9)	25 (100.0)	92 (92%)
Reconstituted laboratory reagents for malaria, CBC, TB	16 (28.1)	7 (38.9)	11 (44.0)	34 (34%)
Tuberculosis reagents kit	48 (84.2)	15 (83.3)	25 (100.0)	88 (88%)
Malaria fields stain reagents kit	29 (50.9)	7 (38.9)	15 (60.0)	51 (51%)
Gram stain kit	32 (56.1)	12 (66.7)	24 (96.0)	68 (68%)
Chemicals	18 (31.6)	5 (27.8)	16 (64.0)	39 (39%)
CD4 Reagents	*	0 (0.0)	5 (20.0)	5 (11.6%)[@]
BD FACS Count reagents	*	1 (5.6)	10 (40)	11(25.6%)[@]
CD4 point of care machine	*	12 (66.7)	9 (36.0)	21 (48.8%)[@]
PointCare Now	*	2 (11.1)	1 (4.0)	3 (7.0%)[@]
HUMAN liver function test	*	1 (5.6)	13 (52.0)	14 (32.6%)[@]
Blood grouping anti sera	24 (42.1)	12 (66.7)	16 (64.0)	52 (52%)
Blood collection sets	*	0 (0.0)	7 (28.0)	7 (16.3%)[@]
Blood giving sets	*	5 (27.8)	20 (80.0)	25 (58.1%)[@]
Anti-microbial sensitivity disc kit	*	*	5 (20.0)	5 (20%)[#]
Glass ware and apparatus	22(38.6)	6(33.3)	25(100.0)	53 (53.0 %)
Culture media	*	*	4(16.0)	4 (16%)[#]
Coagulation reagents	*	*	3(12.0)	3 (12%)[#]

** Supplies not in test menus for that level of health facility, [@]N=43, [#]N=25*

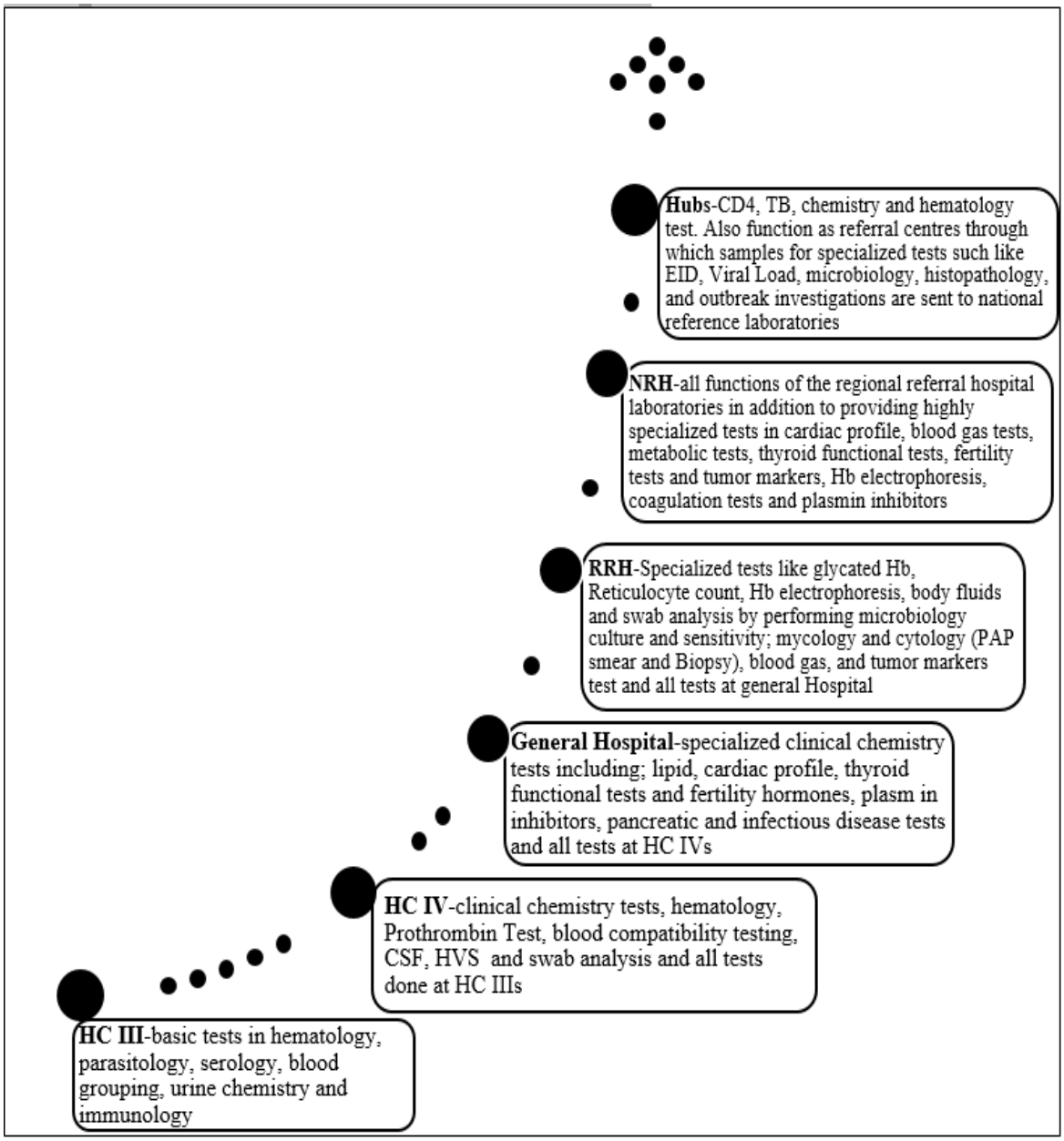

Figure 1: Laboratory test menus for Uganda (MOH, 2017)