Leveraging private sector transportation/logistics services to improve the National Integrated Specimen Referral Network in Nigeria

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Abstract

Sample transportation remains a challenge in resource-limited countries. In Nigeria transport was conducted through non-standard, parallel systems, leading to long turnaround times and lack of visibility. A National Integrated Specimen Referral Network (NISRN) – established by the Nigeria Ministry of Health with donor support – as a cost-effective system currently being implemented by GHSC-PSM using third-party logistics (3PLs) providers to transport specimens from collection centers to testing laboratories. This study assesses impact of using the private sector to transport samples in the NISRN. A descriptive method was used to assess 3PL performance. Specimen quantities transported by the 3PLs providers over six months were compared to the quantities transported in the period prior to implementation. Using the 3PLs instead of health facility staff, specimens were moved from facilities with backlogs to laboratories with capacity to analyze specimens quickly through the enhanced laboratory network. Before the NISRN, 116,046 viral load samples were tested, and 6,459 packs of reagents were used to cover 1,700 facilities over six months. During a comparable six months of operationalizing the NISRN, 277,536 viral load samples were tested, and 10,369 packs of reagents used to cover 3,114 facilities, translating into a significant increase of 38% of samples tested, 21% of reagents used; and over 83% increase in the number of facilities receiving testing services. In conclusions, leveraging the private sector to transport samples enhanced testing laboratory network efficiencies. This resulted in substantial increases in viral load samples tested, reagents used, and facilities accessing testing. This approach led to an expansion of services, and a robust optimized sample referral network that can respond more easily to public health emergencies. Utilization of the private sector is a sustainable, cost-efficient framework. Utilizing 3PL providers increases patient access to services and allows facility staff to focus on their traditional role rather than transporting specimens.

INTRODUCTION

Sample transportation remains a challenge in resource-limited countries. In Nigeria, non-existence of a standardized referral system for clinical samples has been identified as a critical causative factor for in-country laboratory capacity underutilization. Through the supportive visits to healthcare facilities, it was discovered that the diagnostic landscape is characterized by multiple models of clinical sample transfer mechanisms with resultant inefficiencies such as inflated costs, long turnaround time (TAT) for results, disproportionate testing burden on labs among others. Remote and hard to reach terrains continue to pose a severe threat to the success of scale-up efforts.

In Nigeria, transport was conducted through non-standard, parallel systems, leading to long turnaround times and lack of visibility. This led to the setting up of a National Integrated Specimen Referral Network (NISRN) – established by the Nigeria Ministry of Health with donor support – is a cost-effective system currently being implemented by GHSC-PSM using third-party logistics (3PLs) providers to transport

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specimens from collection centers to testing laboratories. This study assesses the impact of using the private sector to transport samples in the NISRN project.

Integrated Specimen Referral Network (ISRN): The transportation of clinical specimen in a combination of different samples (viral load, early infant diagnosis, tuberculosis, malaria testing specimen). This is done in a combined manner from the facilities or hubs where the tests cannot be performed to the facilities where the samples will be done, and the results returned to the facilities where the specimen originated. Kebede, Fonjungo, Tibesso, Shrivastava, Nkengasong, Kenyon, and Ayana (2016) in their study of referral network in Angola said that health management authority mapped out all specimen-referring sites, specimen types, and linkages to laboratories where tests would be performed. This was primarily along regional boundaries, and the mapping had a crucial role in establishing a memorandum of understanding with all stakeholders where the appointed third party (instead of laboratory personnel) transported all samples from and results to referring facilities that were enrolled in the program.

The vision of NISRN is to support the establishment of a cost-effective, efficient, safe and secure specimen referral and storage system that enables patients to access quality laboratory testing, irrespective of their location in Nigeria. The implementation of this lofty ideals is managed through an organization guiding third-party logistics (3PL) vendors with requisite experience, equipment, and human resources to collect and deliver diagnostic clinical samples from health facilities to various testing laboratories across Nigeria. The responsibility of the 3PL includes result return from testing laboratories to the originating health facilities.

According to the African Society of Laboratory Medicine (2016), with a well-functioning specimen transportation system, the following trends should be apparent, when reviewing the national ART program indicators:

- An increased volume of specimens collected and tested over time.
- Shorter turnaround time (TAT) for results' returns to the collecting facility.
- Fewer specimen rejections at laboratories, as specimens are transported appropriately and in a timely manner.
- More health centers were offering antiretroviral therapy (ART) services because an efficient specimen transportation system encourages decentralization of services.
- Faster ART initiation for patients, as results are returned more quickly and consistently
- A reduced loss to follow up.

Uganda attempted to scale up the uptake of early infants' diagnosis (EID) samples from which only 35% of samples were assayed due to sample transportation challenge which varied from facility to facility because of the different transportation methods that were used. A pilot study carried out showed that using a hub network system, there was an increase from the 35% to 51% for samples analysis and the cost reduced by 62% while turnaround time was reduced by 47% (Kiyaga, Sendagire, Joseph, McConnell, Grosz, Narayan, ... & Musinguzi, 2013).

In establishing a referral network for CD4 clinical samples in Haiti, several facilities accessing CD4 testing for the patients increased from 27 to 113 (315%), testing volume also improved on the average of 76% and an increase in the number of people placed on antiretroviral therapy increased to about 182% (Louis, Osborne, Elias, Buteau, Boncy, Elong, ... & Balajee, 2015). Samples transfer network design is akin to supply chain network design (SCND). According to Farahani, Rezapour, Drezner, and Fallah (2014), SCND determines the structure of a chain and affects its costs and performance. Variety of decisions such as the number, size and the location of facilities in the supply chain are crucial to the supply chain network design. Similarly, Simchi-Levi and Kaminsky (2004) considered SCND as the primary and the most crucial step for decreasing or increasing the whole costs, profit inclusive, of chains. Strategic, tactical and operational decisions are involved to have an efficient supply chain network design.

In Nigeria, non-existence of a standardized referral system for clinical samples has been identified as a critical causative factor for in-country laboratory capacity underutilization. The diagnostic landscape was characterized by multiple models of clinical samples transfer mechanisms with resultant inefficiencies such as high-costs, long turnaround time (TAT) for results, disproportionate testing burden on labs among others. Remote and hard to reach terrains continue to pose a severe threat to the success of scale-

up efforts. Previous efforts to map antiretroviral treatment (ART) site to polymerase chain reaction (PCR) labs were hampered by challenges including; incomplete data, wrong geocodes and non-availability of road network analysis. According to Simchi-Levi and Kaminsky (2004), the conventional supply chain network design has an operational decision to fulfill customers' demands, the pricing and provide services. The tactical decisions are hinged on the amount of flow, transportation among the SC's facilities, transportation mode among the SC's facilities, inventory volume and type in SC's facilities, amount and type of purchase from contracted providers, and the information technology for knowledge management.

Monitoring the people living with HIV that are on antiretroviral therapy
According to National Agency for the Control of AIDS (NACA), Nigeria has the third largest infected population (2 to 3.2 million) of people living with HIV/AIDS (PLWHA) in the world after South Africa and India (NACA, n.d). Awofala and Ogundele (2018) said that the number of people estimated to be receiving ART was 747,382 with 3.0 million adult populations estimated to be living with the disease as of 2014. Nigeria adopts the World Health Organization (WHO) 2016 new guidelines with recommendations on ART for adults and adolescents that ART should be initiated in all adults living with HIV, regardless of WHO clinical stage and at any CD4 cell count (strong recommendation, moderate-quality evidence). The strategy ensures that more people living with HIV have access to the ART and they could live a meaningful life as the disease is kept in check by the treatment.
While on treatment, Nigeria also follows the laboratory guideline in the monitoring of patients that routine viral load monitoring can be carried out at 6 months, at 12 months and then every 12 months thereafter if the patient is stable on ART to synchronize with routine monitoring and evaluation reporting (WHO, 2016). The overarching objective is that with treatment progressing well, viral suppression should be achieved for less than 1000copies/ml and when the failure occurs, change of regimen would be contemplated.

The choice of third-party logistics
The services of third-party logistics (3PL) vendors had come stay in the business circle because many companies and even managers had often found that they are overwhelmed with other essential services within the organizations. The needs to take care of the employees, the management of finance, marketing strategies, ensuring the satisfaction of customers are their major concerns. These had made many organizations to engage the services of 3PLs for logistics services. For this study, the 3PL definition will be the one provided by Evangelista (2014, p. 66) that:

> Third-party logistics are activities carried out by a logistics service provider on behalf of a shipper and consist of at least transportation. In addition, other activities can be integrated into the service offering, such as warehousing and inventory management, information-related activities like tracking and tracing, and value-added supply chain activities, including secondary assembly and product installation.

Aguezzoul (2014) analyzed 67 articles published within 1994–2013 period which showed that 3PL's selection is pragmatic in nature and this depends on region or country, industrial sector, the logistics activity to be outsourced and the cost implication. As regards, their selection, 11 key components were identified, but the cost criterion is the most-widely influencing factor; followed by relationship services and the quality of services provided. These factors equally played out during the selection of the 3PLs that had been engaged to operate the specimen referral network in Nigeria. In the study by Maloni and Carter (2006), they indicated that there are three key reasons why engaging 3PLs in out-sourcing logistics services and these are for:

- Service improvement
- Cost reduction
- The desire of the organization to focus on the core area of service

One important question that this research is to answer is whether the specimen referral service has been performed better than the hitherto operated method of sample movement before the engagement of the 3PLs. It is hoped that by creating a collaborative and relational structure, there will be an improvement of performance as indicated by Leuschner, Carter, Goldsby, and Rogers (2014).

As earlier highlighted, clinical sample transportation remains a challenge in resource-limited countries like Nigeria. When countries struggle to efficiently transport specimens, fewer patients can be tested and therefore the same fewer patients have their viral load monitored. This ultimately leads to difficulty in achieving the third 90 of the UNAIDS 90-90-90 goals. The UNAIDS 90-90-90 strategy indicates that by the year 2020, 90% of people should be able to know their HIV status through testing; 90% of people that know their HIV positive status should be placed on anti-retroviral (ARV) drugs and the 90% of those placed on treatment should have viral load suppression with less than 1000copies per ml (UNAIDS, 2014). To support the third 90 in Nigeria, sample transport is often conducted through non-standardized and parallel systems, which led to underutilization of the country's instrument capacity. This led to the Global Health Supply Chain Procurement Supply Management (GHSC-PSM) funded by the United States Agency for International Development (USAID) to work closely with key stakeholders in Nigeria to address these challenges. Specifically, supporting equipment management and testing reagent logistics and procurement.

The National Integrated Specimen Referral Network (NISRN) was established in collaboration with various Nigeria Ministry of Health agencies and its donors, particularly, The US President's Emergency Plan for AIDS Relief (PEPFAR-USG), Global Fund to Fight HIV/AIDS, Tuberculosis and Malaria, and Clinton Health Access Initiative (CHAI). Prior to the implementation of NISRN, a pilot study was conducted by CHAI which showed the benefits of outsourcing transportation to a third-party logistics (3PL) company. It also showed a better utilization of resources compared to the uncoordinated methods of making use of facility staff to transport specimen and taking them away from their core duties of sample analysis. Hitherto as well, they rely on Implementing Partners' (IPs) vehicles, the Nigeria Postal System, and other commercial carriers to transport specimens thereby increasing the possibility of contamination of people and materials since these vehicles were also used for other purposes. With the commencement of NISRN operation, 3PLs provide dedicated transport services and are held accountable for timely pickup, transport, and delivery of specimens. Prior to the commencement of NISRN operation, the 3PLs were identified through a rigorous process of expression of interest, submission of bidding documents, responding to request for proposal, and technical evaluations carried out by trusted technical evaluators approved by the key stakeholders. Once identified, 3PL operators were provided with training on specimen transportation management, from the point of collection to the testing laboratories, and the return of results to collection facilities.

This study assesses the impact of using the private sector 3PLs to transport samples in the NISRN to ensure, viral load monitoring is carried out to cover over 80% of people on treatment in the country.

METHODOLOGY

A descriptive method was used to assess the following three thematic areas during the six months before and the six months after NISRN implementation:

- The 3PL performance with a focus on viral load testing conducted.
- Impact of specimen quantities transported by the 3PL providers compared to the quantities transported by facility staff.
- The volume of reagents used, and the number of tests conducted.

Nigeria has a logistics management information system (LMIS) for HIV and TB commodities where bimonthly reports are collected from facilities for analysis. Typically, the polymerase chain reaction (PCR) laboratories use the approved template (figure 1) to provide logistics information data to inform the resupply decision process.

COMBINED REPORT AND REQUISITION FORM (CRRIRF) - Laboratory Reagents/Accessories											
POLYMERASE CHAIN REACTION (PCR)											
Facility Name				Report Period:							3 Months
Facility Code											
State				Reporting Date:							1 Month
						dd/mm/yyyy					
				REPORT						REQUISITION	
Serial No.	Item Description		Reporting Unit	Beginning Balance for the Reporting Period (Unopened products in Reporting unit)	Qty Received (in Reporting unit)	Qty Used (In Reporting unit)	Number of samples done excluding controls	Losses and Adjustments (+/-) (in Reporting unit)	Physical Count (Total No of unopened products at End of Reporting Period	Maximum Stock (Qty)	Qty to Order	Remarks
				A	B	C	D	E+ E-	F	G = C x 1.5	H= G-F	J
	PCR MACHINE (Roche)											
1	CAP-CTM HIV-1 Qualitative V2.0H2QCAP 48 Test (Pack)		1 pack							0	-	
2	CAP-CTM HI2 Quantitative V2.0. 48 Test (Pack)		1 pack							0	-	

Figure 1: Combined Report, Requisition, Issue & Receipt Form (CRRIRF): Courtesy of Nigeria National Logistics Program

The form captures report for each commodity for the beginning balance, quantity received in the previous circle, the quantity used, number of tests done, losses and adjustments, physical count (stock on hand), maximum stock needed for the next two months and the quantity to be resupplied. The reports are collected in the following format: The January/February reports are submitted the first week of March for analysis and resupply decision. The reports for March and April are submitted the first week of May for analysis and resupply decision and the cycle continues. Six months' reports before the commencement of NISRN and six months after the commencement of NISRN were analyzed and compared using simple Microsoft Excel. Graphs were plotted using the data to lead into the discussion segment of the study.

RESULTS
From the analysis of the data collected from the 27 PCR laboratories supported through PEPFAR and GF funding mechanism in Nigeria, the following outcomes were observed. The contracted 3PLs moved specimens from the collection centers (health facilities) and hubs to Polymerase Chain Reaction (PCR) laboratories for analysis. Backlogs of specimens were moved by 3PLs from PCR labs with unassayed samples that cannot be analyzed within a specified period to laboratories with the capacity and capability to promptly analyze the specimens. This allowed more patients to benefit from viral load testing services. From the data analyzed, before the NISRN implementation, 365,340 viral load samples were tested, and 7,733 packs of reagents were used to cover 1,700 facilities over six months.

Within six months of the commencement of NISRN operation, 464,849 viral load samples were tested, and 10,369 packs of reagents used to cover 3,114 facilities, translating into a significant increase of 34% samples tested and reagents used with 83% increase in the number of facilities receiving testing services. There was also a 72% increase in the accumulation of unassayed samples. Samples unassayed within 2 months were moved in bulk to laboratories with capacity for immediate analysis, thereby shortening timing for results availability to monitor patients' treatment.

DISCUSSION
The volume of viral load specimen handling
The review of bimonthly data of the number of samples handled after the commencement of NISRN showed a steady increase in the number of samples transported by the 3PLs. In figure 2 below, the first period showed that before NISRN, a total of 140,758 samples were moved by the 3PLs in comparison to 116,059 samples moved through the uncoordinated method used by various partners. In the second period, it was 148,730 samples by the 3PLs as compared to 127,842 by the previous method. The final period under this study showed that 175,361 by 3PLs instead of the 121,439 through the uncoordinated method by various partners. This showed a steady increase in the number of specimens moved during the 6 months that the 3PLs had operated the NISRN program.
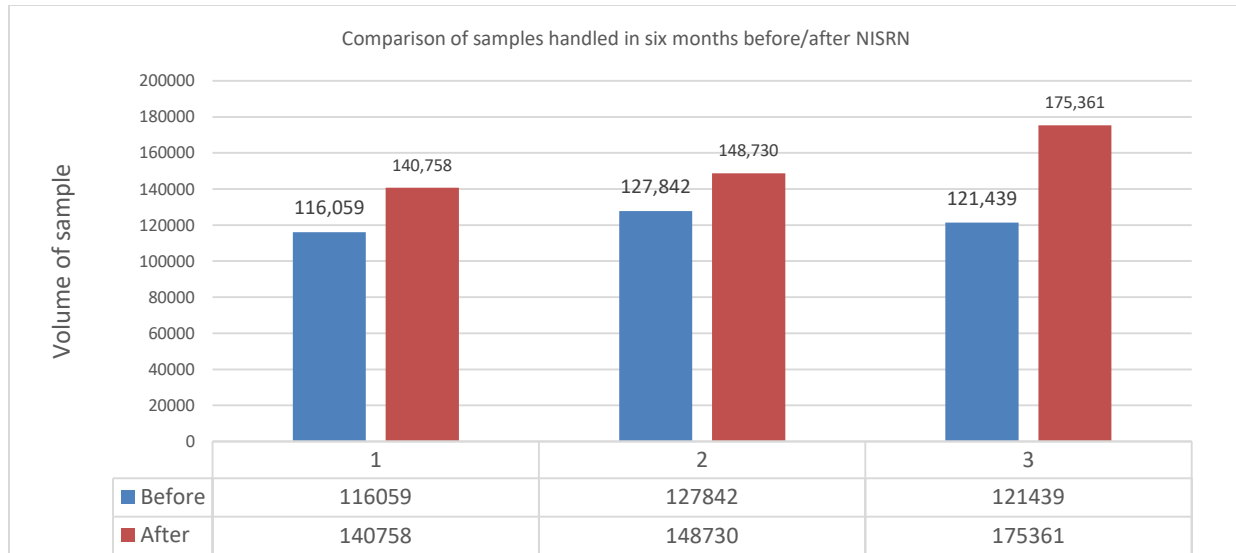
Figure 2: Comparison of samples handled in six months before and after NISRN

The increase in the number of samples handled by the 3PLs when translated into a percentage, can be graphically represented as shown in figure 3 below; where the first period showed 20,888 (16%), then 24,699 (21%) in the second period and 53,922 (44%) in the third period under consideration.
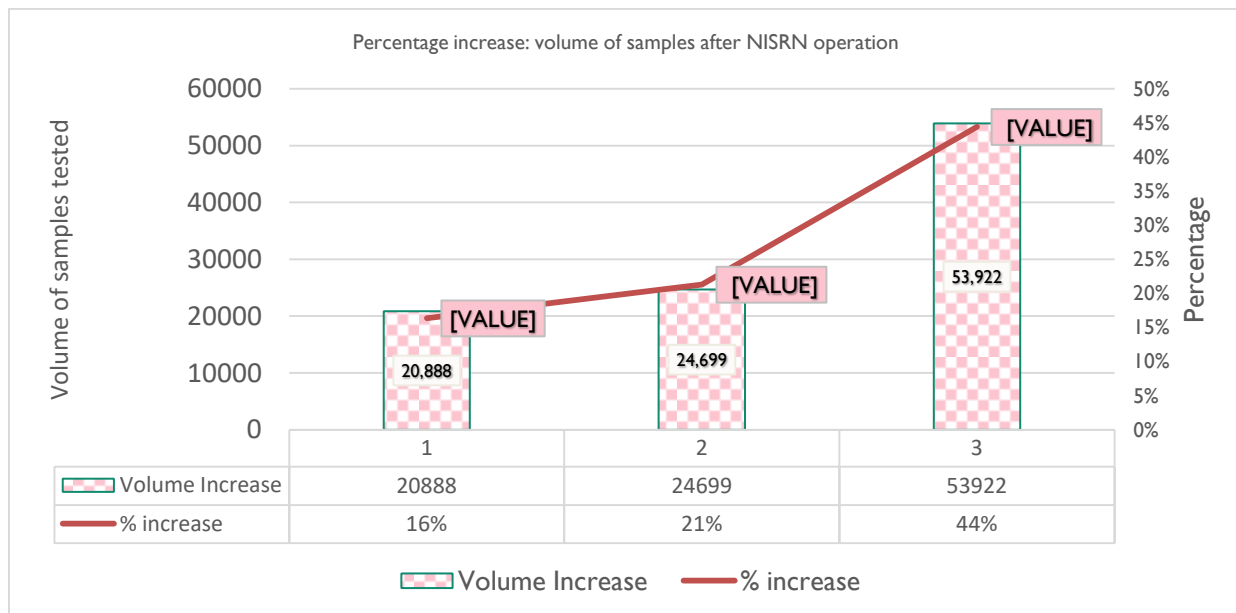

Figure 3: Percentage increase in the volume of samples after NISRN operation commencement

The volume of viral load reagents utilization

The quantity of the reagents that were utilized six months before commencement of NISRN operation was compared with six months after the commencement of NISRN; the difference is shown in figure 4 below. In the first reporting period of the bimonthly cycle; 2,380 packs of viral load for COBAS Ampliprep/COBAS TaqMan (CAP/CTM) PCR equipment were used as against 2,804 packs for the first period after the commencement of NISRN with the 3PLs transporting viral load specimens. Similarly, it was 2,549 compared to 3,762 for the second period while the third period was 2,804 compared to 3,803 packs of viral load reagents utilization.

The increase in the number, when translated into a percentage, shows the pattern clearly in figure 5 below with the following data: increase of 424 packs (18%), 999 packs (36%) and 1213 packs (48%) for the three periods that LMIS data were evaluated.
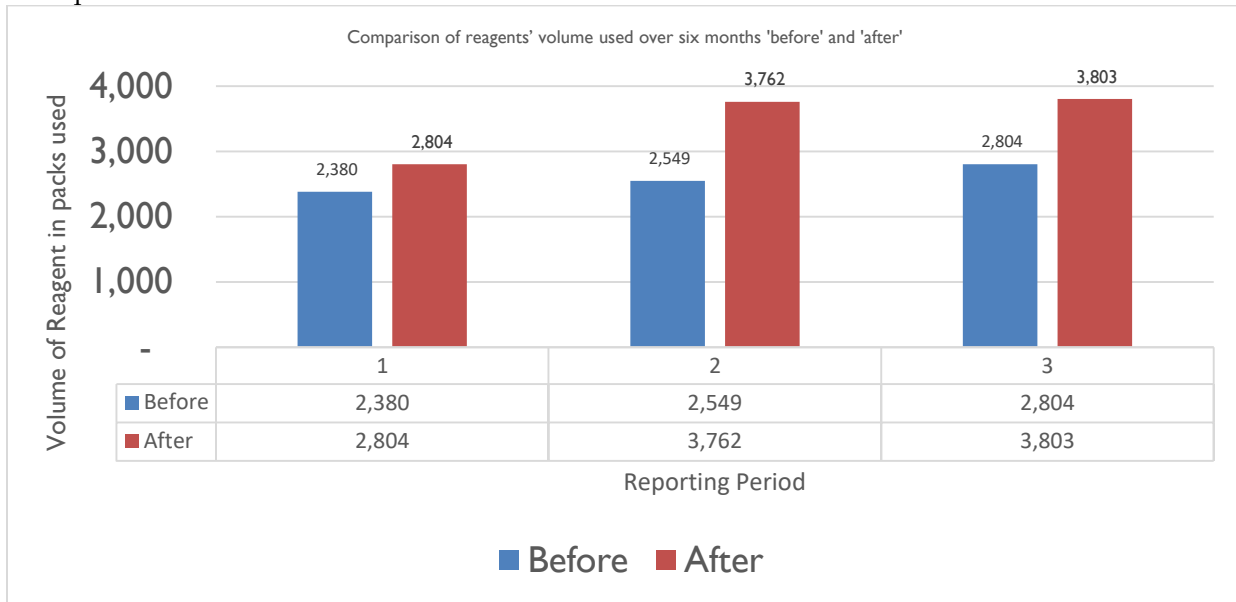

	1	2	3
Before	2,380	2,549	2,804
After	2,804	3,762	3,803

Figure 4: Comparison of reagents' volume used over six months before and after

	1	2	3
Increament	424	999	1,213
Percentage	18%	36%	48%

Figure 5: Increase in reagent volume and percentage increase after the commencement of 3PLs engagement

Comparison of the volume of viral load tests done

The volume of the tests conducted was equally impacted upon after the engagement of the 3PLs to transport viral load specimens and return results to the collection centers (health care facilities). During the first period, the number of viral load samples that were tested rose from 110,900 to 128,808 samples. In the second period it increased from 114,130 to 157,436 samples and the last period under this study, it moved from 140,310 to 178,605 samples as represented graphically in figure 6 below. Cumulatively, within the three periods, the volume of viral load test conducted rose from 365,340 to 464,849 with an increment of 99,509 as shown in figure 7 below. This is above 21% increase within a period of six months of the engagement of 3PLs to transport specimen.
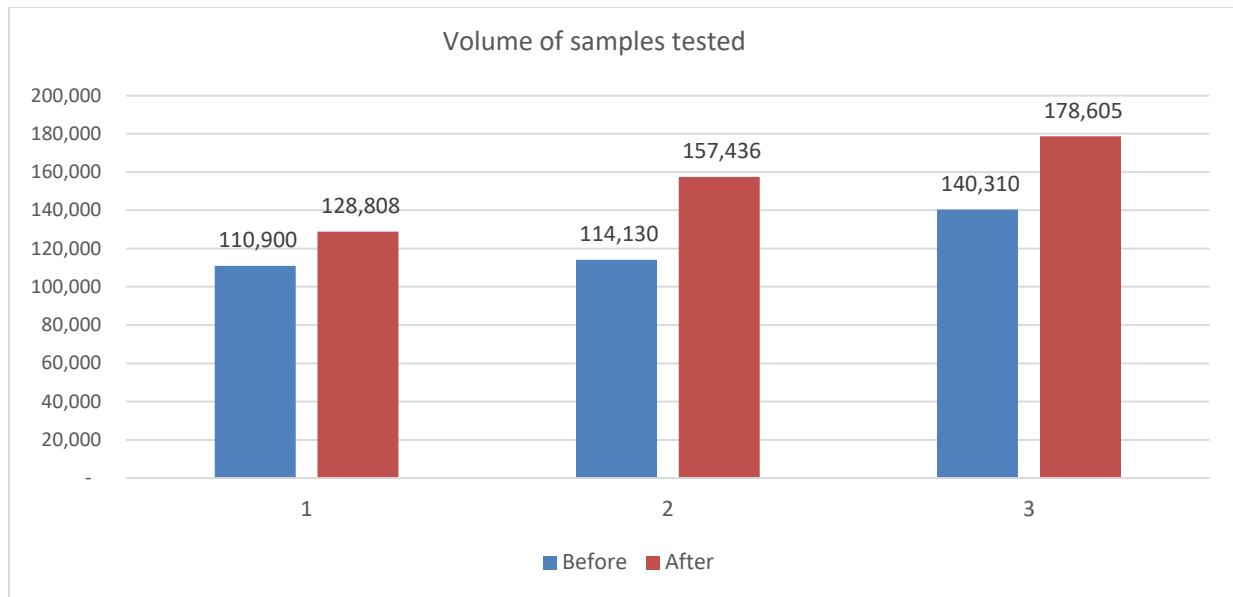
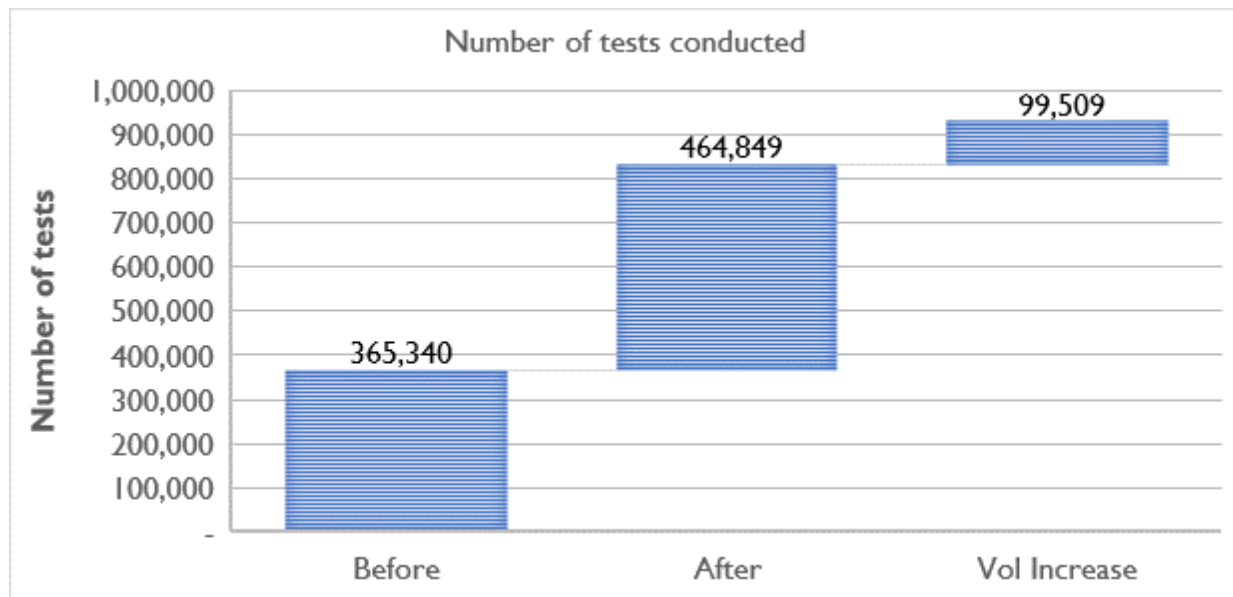*Figure 6: Comparison of volume of samples tested*

Figure 7: Volume of number of viral load test conducted

Comparison of the volume of viral load reagents utilized
Cumulatively, within the three periods, the volume of viral load reagents utilized rose from 6,459 to 10,369 with an increment of 3,910 packs as shown in figure 8 below for a better understanding of the impact as the differences showed almost 38% increase within a period of six months.
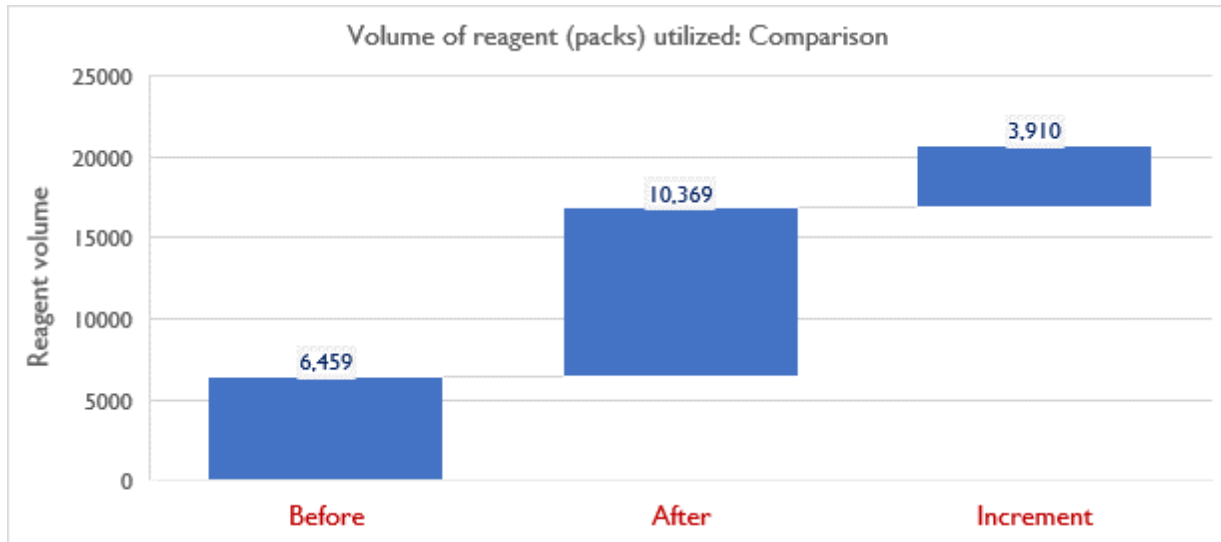
Figure 8: Difference in the volume of reagents utilized

Comparison of the number of healthcare facilities coverage

Before the engagement of three third-party logistics companies to be transporting viral load, early infants' diagnosis (EID) and sputum specimen, facilities benefiting from these services were 1,700. These facilities were the ones that Implementing Partners, the staffs of the facilities were able to move the specimens to PCR laboratories for the specimens to be tested. However, when the 3PLs were engaged, within six months, the three 3PLs were able to visit 3,114 facilities to collect specimen and transport to the PCR laboratories for analysis. This translate to about 83% increase as shown in figure 9 below.
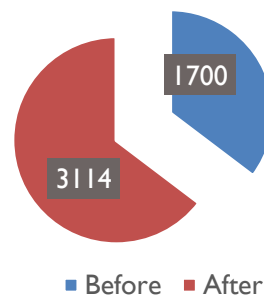

Figure 9: Increase in the number of facilities covered

Increase in the volume of unassayed viral load samples

It is not a new thing to have viral load backlog at some facilities as pointed out by Sangadi, Muhereza, Aloyo, Karamagi, and Rahimzai (2017) when a study on addressing the gap of the 3rd 90 through integrated health delivery camps in 4 health facilities in Nwoya District, Uganda was carried out. In Nigeria, it was observed within the viral load testing program that there is an uneven gap in the utilization of PCR capacity such that there are records of backlogs of viral load samples in some PCR laboratories, while there are others PCR laboratories that do not have any backlog. During the previous monitoring and supportive visit carried out in the 27 PCR laboratories in the country, backlog record for viral load samples stood at 60,525. This backlog stayed as long as 6 months in some facilities. However, with the commencement of 3PLs transporting viral load specimen, backlog rose to 104, 306 (figure 10) within the period under investigation.

However, in order to ensure backlogs were cleared within two months, the 3PLs were mandated to move these backlogs in bulks to PCR laboratories with the capacity and capability to assay them. This exercise of bulk samples movement led to the clearing of the backlogs within two months. This was possible because the hitherto scenario where Implementing Partners move the specimen to only the PCR labs being supported by them was quashed and the specimens could then be transported in bulk to any PCR lab within the country, irrespective of which Implementing Partner supports the PCR lab.
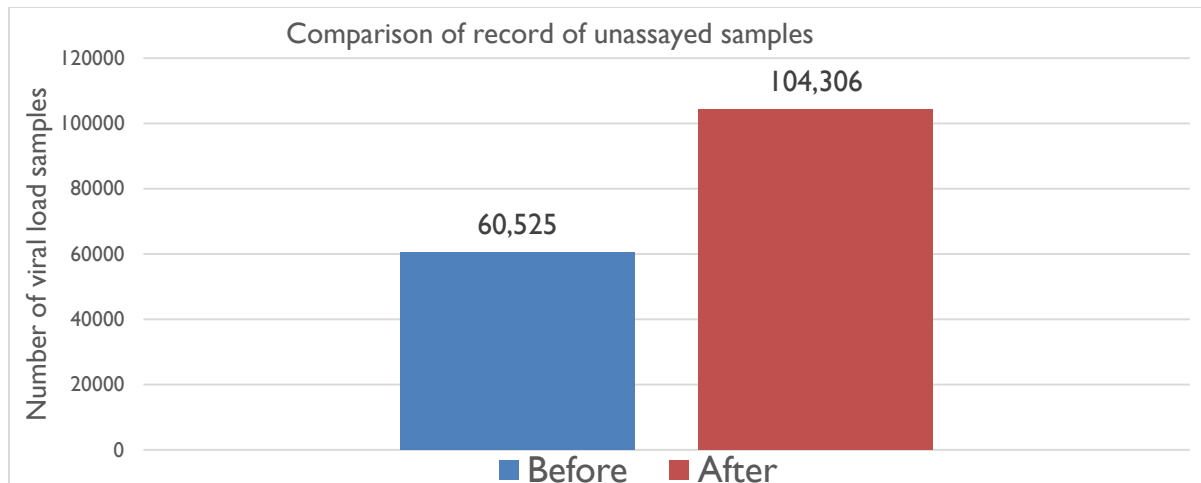

Figure 10: volume of viral load samples backlogs

Enhancement of samples transportation infrastructure

Prior to the commencement of NISRN that led to the engagement of 3PLs, Nigeria does not have adequate specialized specimen transportation company. The process of engaging the 3PLs was done in such a way that companies that were interested in providing logistics services for the movement of clinical samples should be willing to invest in the provision of equipment and other infrastructure that can meet the international best practice in the transportation of biological materials. It was observed that before NISRN, Implementing Partners were using their project vehicles and staffs to transport samples while on another necessary project assignments. Little considerations were given to providing a dedicated vehicle for this purpose. Staffs were even using their own private cars and motorbikes to transport samples which did not meet the expected standard. The 3PLs made an investment in the procurement of dedicated motorbike that can be used to quickly reach the hinterlands of the country and vehicles fitted with the required cold-boxes as well as temperature monitoring devices to ensure samples are transported at the required cold temperature. The staffs of the 3PLs were then trained on triple packaging principle and well kitted to be able to carry out their functions with utmost consideration for the safety of personnel, equipment, and environment as seen in figure 11 below.

Figure 11: Well kitted motorbike riders with appropriate equipment: Photo credit - 3PLs

DISCUSSION AND CONCLUSION
Cost-efficiency and increased access
a) Leveraging the private sector to transport samples enhanced optimization of equipment utilization at testing laboratories. This resulted in a substantial increase in viral load samples tested, reagents used, and patients and facilities accessing viral load testing service. A similar increase in sputum samples was noticed by Joloba, et al (2016) when a public-private partnership was used for the management and strengthening of Tuberculosis specimen referral network for sputum samples in Uganda. The theme for 'Ending AIDS' pandemic by 2030 (Fauci, 2017; Eisinger, & Fauci, 2018) requires the various combination of innovations (Fauci & Marston, 2015) which is a multisectoral response. In line with this, using the 3PLs in moving samples from collection centers to the testing laboratories is one smart way of monitoring the viral suppression in patients on ART and ultimately, the efficacy of the drugs being used by the patients.
b) The approach of using 3PLs led to an expansion of services, and a robust optimized sample referral network that can respond to emerging and re-emerging infectious diseases (Ebola, Monkey-pox, Lassa-fever) in the country, whenever this occurs. The preliminary assessments of the approach showed that the utilization of the private sector is sustainable and can be a cost-efficient framework to be considered and supported. Accountability for the cost of transportation also makes this a more streamlined system. This is in line with the outcome of the study by Zwetyenga, et al (2018) that ideally, countries should attempt to integrate sample collections from all systems and centralize transport to improve cost-effectiveness.
c) Utilizing 3PL providers increases patients' access to services by allowing facility staff to focus on their traditional role, rather than pulling them away from core duties to transport specimens. This outcome agrees with the study by Lydon, Raubenheimer, Arnot-Krüger, & Zaffran (2015) on outsourcing the logistics of vaccine distribution to healthcare facilities in Western Cape Province, South Africa, compare to when the government Ministry of Health agency and staff were doing the vaccine distribution.

Equipment management
a) Use of 3PL providers contributed to increased throughput of equipment capacity utilization. An assessment of this increase in overall capacity utilization revealed that there are still high volumes of untested specimens at some PCR laboratories. This insight has informed the movement of bulk samples to other locations for analysis. Thus, the engagement of 3PLs is helping the country achieve the third 90 of the UNAIDS 90-90-90 strategy.
b) At the initial contemplation to use 3PLs, there were no adequate 3PL providers in Nigeria that were specialized in specimen transport prior to the commencement of NISRN. However, with the terms of reference and engagement of potential 3PL providers, In-country capacity for clinical sample transportation is being enhanced with the ultimate or responding to an outbreak of emerging and remerging diseases in the country. This has enhanced the country preparedness to respond to emergency disease outbreaks which Voyles, et al (2015) said are on the rise due to multiple factors, including human-facilitated movement of pathogens, broad-scale landscape changes, and perturbations to ecological systems.

LIMITATION
- This study covers only six months of engaging 3PLs for sample movement; the impact over a longer period needs to be assessed.
- Inadequate equipment for sample transportation was noted in some instances during monitoring exercise for 3PLs performance and is now being corrected.
- Inadequate knowledge of 3PL personnel in the area of sample transportation could be enhanced through continuous capacity building.

- Cost implications were not included in this study. The next study should include data covering more than one year and cost of specimen transport using 3PLs to ascertain the impact on high volume specimen movement.
- Turnaround time (TAT) could not be calculated in this study due to the on-going data analysis for the TAT. This should be considered in the subsequent study.

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