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Evaluation of Laboratory Logistics Management Information System in HIV/AIDS Comprehensive Health Facilities in Bayelsa State, Nigeria

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Abstract

This study was a facility based cross-sectional descriptive study to assess the status of laboratory logistics management information system for HIV/AIDS laboratory commodities in HIV/AIDS comprehensive health facilities in Bayelsa state. Quantitative data collection methods were employed with interviews for persons responsible for managing laboratory commodities at the study facilities using structured questionnaire. There was also review of stock keeping records and observation of physical inventory of HIV/AIDS laboratory commodities available at the time of visit to the facilities. This study found the existence of a well-designed and effective LMIS for HIV/AIDS laboratory commodities in the 17 facilities assessed, with established inventory control procedures and standard LMIS forms for managing and reporting of commodities. The identified constraints of LMIS implementation for HIV/AIDS commodities include lack of standard operating procedure to guide implementation of LMIS, deterioration of commodities due to poor power supply, lack of computers and internet for electronic LMIS implementation. The factors that constrain implementation of LMIS of HIV/AIDS laboratory commodities in the facilities assessed include lack of training for some laboratory personnel involved in LMIS, inadequate supply from SCMS during resupply cycle, long lead time and inadequate space for laboratory store. Even though the use of stock cards was in practice in all the facilities assessed, there was poor documentation in some. There was a high amount of expired laboratory commodities in the facilities while some key HIV/AIDS monitoring laboratory commodities were stock out at some facilities. Based on findings, the supply of standard operating procedure on LMIS to all health facilities is recommended. There also the need to put in place effective and efficient mechanisms for redistribution of surplus commodities from facilities that have large quantities to those with low stock to prevent large expiries.

Keywords: Laboratory Logistics, Management Information System, HIV/AIDS Comprehensive Health Facilities, Bayelsa State.

Introduction

Logistics is a branch of management that studies the process of planning, implementing and controlling the efficient, cost effective flow and storage of goods, services and related information from point of origin to point of consumption for the purpose of conforming to customer requirements in the least possible time (Edward, 2002). Laboratory logistics management information system (LMIS) is the management of laboratory commodities, such as reagents, consumables, chemicals and equipment and other durables in a systematic and standardized way by collecting, processing and utilizing timely logistics data to inform quantification, procurement, storage and distribution of laboratory commodities (USAID/DELIVER PROJECT, 2009).

This means that LMIS is a system that helps personnel involved in the management of health commodities in the timely documentation, collection and management of the information necessary to support sound and objective decision making in managing the supply chain of the commodities, so as to ensure an uninterrupted supply of commodities and to identify any problems in the supply pipeline. It provides the data required to maintain an inventory control system, such as quantity at hand at service delivery point, quantity received and quantity used within a reporting period, number of people that were served per the period and the quantity of the commodity required to bring it to the accepted level (maximum level) per time in the reporting period. To achieve this, forms and documentation are used to move items from one point to another within the health facility and to other facilities, track usage, maintain records and produce reports on the logistics system. The data collected through LMIS helps the facility to determine if the stock available at the facility is enough to serve its patients or whether to make an emergency order to the supplying facility or not before the order interval, when there will be comparison of stocks available to established maximum stock level and order the quantity needed to bring stock levels to maximum.

The Supply Chain Management System(SCMS), which is the higher level in the supply chain, uses the LMIS data to track consumption in the facilities to identify whether there are overstock of commodities and therefore redistribute them to prevent wastages, identify exceptionally high levels of product expiry and then initiate action to prevent this situation from recurring or determine the quantity to issue to the facility to bring it up to established maximum stock or under stock and therefore redistribute from neighbouring health facilities. The data is also used for the determination of national level consumption and for planning, budgeting and quantification for the procurement of commodities. A failure in any of the levels of the system could result in stock out of health commodities and therefore inability to attend to patients who visit such facilities for their healthcare needs.

LMIS is currently being practiced in Nigeria for most donor-funded health interventions like HIV/AIDS, malaria, TB, immunization, etc. but not for health commodities used for hospital routine patients. It is important for all public health commodities distribution systems. It is especially critical for Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome (HIV/AIDS) commodities that have high value and requires special handling procedures (JSI/Deliver, 2004). Without effective and efficient LMIS implementation, HIV/AIDS programmes will inevitably waste valuable resources through prolonged and frequent stock outs, overstocks and losses (Owens &Wanner, 2003). A well implemented LMIS reduces the likelihood of stock outs and overstocks that can waste scarce resources and lead to product expiration, especially given the short shelf life of some HIV/AIDS commodities (JSI/Deliver, 2005).

Laboratory logistics data are collected, processed and reported through a LMIS which increases the likelihood of an adequate supply of all HIV/AIDS laboratory commodities for all facilities (USAID/DELIVER PROJECT, 2009).LMIS is an essential tool for supply chain managers and policy makers to make sound decisions, ranging from routine resupply decisions at the local level

to long-term forecasting and procurement decisions at the national level (JSI/Deliver, 2004).

An assessment by Nigatu *et al.* (2009) of the impact of the national HIV/AIDS laboratory LMIS on the harmonization of laboratory commodities in Ethiopia reported that after implementation of the national HIV/AIDS laboratory LMIS, stock outs, number and frequency of emergency orders and commodity wastage were decreased dramatically and that laboratory reagents and related supplies were arriving on time in quantities needed, which, in turn, reduced patients waiting time for tests significantly.

Managing supply chains in support of laboratory services is a formidable challenge, especially in developing countries like Nigeria (USAID/DELIVER PROJECT, 2009). HIV/AIDS programs require strong and supportive laboratory services that depend on the availability of the required commodities to perform critical tests, with most tests requiring multiple commodities to be available simultaneously (USAID/DELIVER PROJECT, 2008). Improved availability of affordable health commodities depends on effective logistics systems to move essential commodities down the supply chain to the service delivery point and, ultimately, to the end user (USAID/DELIVER PROJECT, 2008).

The effectiveness of a supply chain can determine the success or failure of a public health programme. Without a reliable supply of the appropriate laboratory reagents, consumables and drugs, such a programme cannot offer quality treatment to patients. An effective HIV/AIDS treatment programme requires an uninterrupted supply of antiretroviral drugs and laboratory commodities. The efficient management of health commodities is imperative in the current environment of increasing demand and limited resources (USAID/DELIVER PROJECT, 2008).

Often when a health program is being designed, the logistics component is overlooked. When a health facility is fully stocked with the commodities required to attend to its patients, patients gain confidence in that facility and they are more likely to return (Deliver, 2000). A carefully planned logistics system can ensure a dependable supply of health commodities for patients who need them. Patients without a reliable supply of health commodities that they need can lead to a worsening of their disease condition through development of resistance and even death (JSI/Deliver, 2005).For instance, a patient that has developed resistance to first line antiretrovirals (ARVs) will not be switched to second line except there is at least 3 CD4 tests over a defined period showing a decline in the patient's CD4. This may lead to the death of the patient as the drugs are no longer able to suppress the disease despite adhering to the medication.

An efficient logistic system can reduce morbidity and mortality rates among population affected. A dependable supply of HIV/AIDS commodities at service delivery points determines the success of HIV/AIDS programmes; supply interruptions introduce risk of drug resistance which can develop from incomplete suppression of HIV replication (Yasmin, 2000). A strong and efficient logistics system will help create a successful health program on many levels. The opposite, an inefficient logistic system, can cause a stock out of critical and essential products, leaving clients underserved and which adversely affect the patients, or overstocking of facilities leading to waste of scarce resources through expiry (JSI/Deliver, 2005).

A reliable, responsive logistics system makes the difference between a client consistently receiving the right commodities at the right time, in the right place, for the right cost resulting in his satisfaction and a client walking away unsatisfied (empty-handed) because his/her needs have not been met. The success of a health program therefore depends on the strength of its logistics system (USAID/DELIVER PROJECT, 2008; USAID/DELIVER PROJECT, 2008).

Nigeria has a well-designed logistics management information system for HIV/AIDS commodities for health facilities involved in HIV/AIDS services, which is customer driven and all logistics functions within the supply chain work effectively to ensure commodity availability

(FMOH, 2011). Logistics information available through the LMIS drives all decisions in the supply chain, and enables managers to operate supply chain functions including forecasting, quantification, and inventory management (USAID/DELIVER PROJECT, 2008).This also apply to public health facilities in Bayelsa State. The logistics system provides quality customer service by fulfilling six rights: ensuring that the right information on the right laboratory commodity in the right quantities at the right time and right place for making the right decisions on what, when and how much to order (USAID/DELIVER PROJECT, 2008). If the laboratory LMIS is not functioning well, service delivery points (SDPs) will be forced to experience either stock outs or excess stocks finally leading to dissatisfaction of clients or wastage of commodities (JSI/USAID, 2000; Chandani *et al*., 2006).

The essential logistics data collected, processed and utilized for decision making arestock on hand, consumption, losses and adjustments (Raja & Mohammad, 2005). These data need are collected,processed and analysed at all levels of service delivery and stores for decision making.

HIV/AIDS comprehensive health facilities (HCC) are health facilities that provide comprehensive antiretroviral therapy care and treatment, prevention of mother-to-child transmission of HIV services, HIV counselling and testing services, Tuberculosis diagnosis, prevention and treatment services, early infant diagnosis of HIV services, injection safety services, psychosocial care, nutritional support and have laboratories with full complement of chemistry, haematology and CD4 laboratory analyzers for the monitoring of ART care and treatment or refer the samples of their patients to other facilities with laboratory analyzers for analysis.

Most health facilities in Bayelsa state have been in existence for as long as the creation of the state in 1996 (some before) but started the provision of HIV/AIDS services between 2008 and 2014. There are currently 24 HCCs in Bayelsa state, spread across the 8 local government areas of the state. All HCCs in Bayelsa state operate LMIS for all HIV/AIDS commodities. Implementation of LMIS starts in a facility as soon as it is activated for the provision of comprehensive HIV/AIDS services. The facilities order HIV/AIDS laboratory commodities using standard inventory control procedures, receive commodities from Supply Chain Management System (SCMS) and store, use and report about the commodities using recording and reporting forms. They use inventory control forms and registers to document the use of the commodities in the facility.

The functionality or otherwise of logistics management of commodities in Bayelsa state is assessed every quarter by the State Logistics Management Coordination Unit (SLMCU) of the state. The SLMCU is made up of staff of the state ministry of health and representatives of SCMS and project-implementing partners in HIV/AIDS, malaria, Tuberculosis, family planning, immunization, etc. It reviews LMIS reports from the various facilities and thereafter releases the state quarterly stock status report of programme health commodities in facilities in the state, which provides information on the stock status of HIV/AIDS and other programmes commodities in Bayelsa State and put forward possible reasons for observed stock imbalances and gives recommendations to address the imbalances to ensure commodity security. The quarterly report for July to September 2014 reported high stock level of some HIV/AIDS laboratory commodities, which it attributed to possible capacity gap, low consumption, inaccurate reporting of utilization at service points or poor LMIS reports from health facilities. It also reported that a number of stock imbalances were observed with CD4 reagents stock levels and that the reasons identified for this include poor power supply in some health facilities and equipment breakdown that resulted in non-utilization of the commodities.

In view of the aforementioned report, this study sought to assess laboratory LMIS implementation in health facilities providing HIV/AIDS services to determine if the report is a true reflection of the state of LMIS in Bayelsa state.

Objectives of the Study

i. To assess the extent of effectiveness of LMIS on the supply of HIV/AIDS laboratory commodities in health facilities in Bayelsa state
ii. To ascertain the constraints in logistics management information system of HIV laboratory commodities in comprehensive HIV/AIDS health facilities of Bayelsa state.
iii. To identify factors that constrain logistics management information system as applied to HIV/AIDS laboratory commodities in comprehensive HIV/AIDS health facilities of Bayelsa state.
iv. To find out the extent of stock out of key HIV/AIDS commodities in HIV/AIDS comprehensive health facilities in Bayelsa state
v. To identify the causes of stock out of key HIV/AIDS commodities in HIV/AIDS comprehensive health facilities

Research Questions

i. To what extent has LMIS been effective in the supply of HIV/AIDS laboratory commodities in HIV/AIDS comprehensive health facilities in Bayelsa State?
ii. What are the constraints of using LMIS for HIV/AIDS laboratory commodities in HIV/AIDS comprehensive health facilities of Bayelsa state?
iii. What factors constrain the implementation of LMIS in HIV/AIDS comprehensive health facilities of Bayelsa state?
iv. What is the extent of stock out of key HIV/AIDS commodities in HIV/AIDS comprehensive health facilities in Bayelsa state?
v. What are the causes of stock outs of key HIV/AIDS laboratory commodities in HIV/AIDS comprehensive health facilities of Bayelsa State?

Methodology

Research Design

This study was a facility based cross-sectional descriptive study. Quantitative datacollection methods were employed. Interviews for persons responsible for managing laboratory commodities at the study facilities using structured questionnaire (survey) was conducted. There was also review of stock keeping records (documentation) and observation of physical inventory (participant observation) of HIV/AIDS laboratory commodities available at the time of visit to the facilities.

Source Population

The source population were all laboratory professionals ofallHIV/AIDS comprehensive health facilities in Bayelsa state involved in the supply chain of HIV/AIDS laboratory commodities. This includes all public health facilities providing laboratory services for HIV diagnosis, monitoring and treatment services.

Population of Study

A total of 37 laboratory professionals (Medical Laboratory Scientists, Medical Laboratory Technicians and Medical Laboratory Assistants) from 17 HIV/AIDS comprehensive public health facilities providing laboratory services for HIV/AIDS diagnosis, monitoring and treatment services constituted the population of study in this study.

The spread of the laboratory professionals is as follow:

1. Federal Medical Centre Yenagoa (4)
2. Niger Delta University Teaching Hospital Okolobiri (7)
3. Cottage Hospital Otuasega (2)
4. General Hospital Brass (4)
5. General Hospital Nembe (2)
6. Comprehensive Cottage Hospital Otuoke (2)
7. Tuberculosis and Leprosy Referral Hospital Igbogene (3)
8. Cottage Hospital Okpoama (1)
9. Cottage Hospital Biseni-Tein (1)
10. Cottage Hospital Egbemo-Angalabiri (1)
11. Cottage Hospital Okoloba (1)
12. General Hospital Odi (2)
13. Cottage Hospital Lobia 2 (1)
14. Cottage Hospital Sangana (1)
15. Comprehensive Health Centre Amassoma (2)

16. Comprehensive Health Centre Sagbama (2)
17. Comprehensive Health Centre Toru-Ndoro (1)

Sample Size and Sampling Method

The sample size was calculated using Taro Yamane formula (Yamane, 1967) with 5% error of margin.

$n = N/1+N(e)^2$
Where,
n = Sample size
N = population size (37)
1 = Constant
e = level of significance (0.05)
$= 37/1+ 37 (0.05)^2$
≈ 34

The study employed purposive sampling to obtain the study units of 34 laboratory professionals involved in the management of HIV/AIDS laboratory commodities and therefore could provide the needed information for the study in the 17 HIV/AIDS comprehensive centers. Of the 34 laboratory professionals, 18 (52.9%), 13(38.2%) and 3 (8.8%) were Medical Laboratory Scientists, Medical Laboratory Technicians and Medical Laboratory Assistants respectively. The 17 health facilities were selected from the 8local government areas of Bayelsa state, with some being in the riverine areas and others in upland. Five (29%) of the facilities have CD4 testing platform, 4 (24%) have chemistry testing equipment and 4 (24%) have haematology testing machines. Also, some are in rural areas while others are in urban areas. Interviews were conducted for the 34 laboratory professionals managing HIV/AIDS laboratory commodities at all the 17 selected facilities using structured questionnaire which was originally developed by JSI/DELIVER, (2008) but adapted for this study.

Method of Data Collection

A structured questionnaire which was originally developed by JSI/DELIVER (2008) but adapted for this study was used to collect quantitative information from the health facilities.

The questionnaire had 58 questions. In addition to the information collected through interview using the structured questionnaire, physical counts of the laboratory commodities were done in order to assess data quality by comparing the actual counts with available stock-keeping records. Inventory stock-keeping records were also checked for accuracy.

The laboratory commodities covered in this assessment are ART monitoring chemistry (GPT, GOT, creatinine, Glucose and potassium), haematology (Cellpack, Stromatolyser and Cellclean) and CD4 (CD test reagents, Control, Facsflow/sheath fluid, Facsclean/cleaning solution and Facsrinse/decontamination solution) reagents, HIV rapid test kits (RTKs), Hepatitis B and VDRL rapid diagnostics kits (RDKs) and general laboratory consumables.

Instrument

The instrument was used to provide information on the indicators like the availability of laboratory commodities for HIV/AIDS service on day of visit and six months before, stock out frequency and average duration of stock outs, Reasons for stock outs, percentage of facilities with personnel trained in logistics, percentage of facilities that had expired commodities and the reasons for the expiries, percentage of facilities with stock /bin cards available and accuracy of stock keeping records.

The above indicators were measured as follows: (1) commodity availability by conducting a physical inventory, (2) duration of stock outs by collecting information from both bin cards and interviewees, (3) stock data quality by comparing stock/bin cards to physical inventory and reports to LMIS (4) percentage of facilities with adequate stock levels by calculating months of stock on hand and comparing to minimum and maximum stock levels, and (5) percentage of facilities with inadequate and over stock levels by calculating months of stock on hand and comparing to minimum and maximum stock levels.

The indicators that were measured were quantities of expired stock, percentage of facilities stocked out of one or more HIV/AIDS commodities on day of visit, percentage of facilities where HIV/AIDS laboratory commodities physical inventorycount matches balance on at least one stock/bin card, percentage of facilities holding appropriate stock levels (i.e. between minimum and maximum stock levels), percentage of facilities holding more than appropriate maximum stock levels of the selected HIV/AIDS commodities, percentage of facilities holding less than appropriate maximum stock levels of the selected HIV/AIDS commodities, percentage of facilities that were stock out of the selected HIV/AIDS commodities, percentage of facilities with stafftrained in laboratory logistics system, percentage of facilities recording essential logistics data properly, percentage of facilities stocked out of the selected commodities on the day of visit, frequency of stock outs, average number of stock out, percentage of facilities with expired selected commodities on the day of visit, percentage of facilities sending logistics data to the next higher level of the system via email, percentage of facilities in compliance with each proper storage guidelines.

Stock availability is if the facility had within the established minimum/maximum stock levels. The established minimum and maximum stock level was 2 and 4 months respectively. The current stock on hand was divided by average monthly consumption to determine how many months of stock on hand was available. Months of stock on hand were compared with established minimum and maximum stock levels. Stock out is a situation where the commodity is temporary unavailable on the shelf of the laboratory or in the store, due to extremely prolonged supply lead time or over consumption of commodities. Expired laboratory commodities were defined as a commodity that was stored beyond the manufacturers expired date, at which the manufacturer cannot guarantee the full potency and safety of the commodity. The quantity of expired laboratory commodities that were in the laboratory store were captured from stock/bin cards and physical inventory were done to count the actual quantities.

Method of Data Analysis

The quantitative data was analyzed using simple percentage and tables. Descriptive statistics was computed and results presented using tables.

Results

Table 1: Order Fill/Resupply Rate of Commodities in Last Resupply Cycle

HIV/AIDS laboratory commodities	No of facilities that ordered the commodity (n)	% of facilities that received lesser quantity of commodities ordered n (%)	% of facilities that received quantities of commodities ordered n (%)	% of facilities that received more quantity of commodities ordered n (%)
1	2	3	4	5
Rapid test kits				
Determine (kit)	17	0 (0%)	17 (100%)	0 (0%)
Stat Pak (kit)	17	0 (0%)	17 (100%)	0 (0%)
Unigold (kit)	17	0 (0%)	17 (100%)	0 (0%)
Chemistry reagents				
GPT/ALT (kit)	4	0 (0%)	4 (100%)	0 (0%)
GOT/AST (kit)	4	0 (0%)	4 (100%)	0 (0%)
Creatinine (kit)	4	0 (0%)	4 (100%)	0 (0%)
Glucose (kit)	4	0 (0%)	4 (100%)	0 (0%)

Potassium (kit)	4	0 (0%)	4 (100%)	0 (0%)
Elitriol I Control Normal (bottle)	4	0 (0%)	4 (100%)	0 (0%)
Elitriol II Control Abnormal (bottle)	4	0 (0%)	4 (100%)	0 (0%)
Haematology reagents				
Cell Pack (pack)	4	0 (0%)	4 (100%)	0 (0%)
Cell clean (bottle)	4	0 (0%)	4 (100%)	0 (0%)
Stromatolyser (bottle)	4	0 (0%)	4 (100%)	0 (0%)
Haematology control	4	0 (0%)	4 (100%)	0 (0%)
CD4 reagents				
CD4 reagent (kit)	5	2 (40%)	0	0 (0%)
BDFACS flow/sheath fluid (pack)	5	0 (0%)	5 (100%)	0 (0%)
BDFACS clean/Cleaning solution (pack)	5	5 (100%)	0 (0%)	0 (0%)
BDFACS Rinse/ decontamination fluid (pack)	5	0 (0%)	0 (0%)	0 (0%)
BDFACS control/count check bead (kit/bottle)	5	0 (0%)	0 (0%)	0 (0%)
Laboratory Consumables				
BD Vacutainers needle (pack)	17	0 (0%)	0 (0%)	17 (100%)
BD Vacutainers tube 2ml (pack)	17	0 (0%)	0 (0%)	17 (100%)
BD Vacutainers tube 4ml (pack)	17	0 (0%)	0 (0%)	17 (100%)
BD Vacutainers Serum Separator Tube (pack)	17	0 (0%)	0 (0%)	17 (100%)
Jik/Bleach (bottle)	17	0 (0%)	0 (0%)	17 (100%)
Methylated spirit (bottle)	17	0 (0%)	0 (0%)	17 (100%)
Hand gloves Large (pack)	17	0 (0%)	0 (0%)	17 (100%)
Hand gloves Small (pack)	17	0 (0%)	0 (0%)	17 (100%)
Cotton wool (roll)	17	0 (0%)	0 (0%)	17 (100%)

Table 1: Percentage of Facilities that Received the Quantity Ordered by Type of Laboratory Commodities in the Last Resupply Cycle

Table 2:Training of laboratory professionals on LMIS

Facility type trained	Medical Laboratory Scientists	Medical Laboratory Technician	Medical Laboratory Assistant	Total Number trained (both formally and informally)
Tertiary Hospitals	5 (55.6%)	0 (0%)	0 (0%)	5 (19.2%)
General Hospitals	3 (33.3%)	4 (26.7%)	1 (50%)	8 (30.8%)
Cottage Hospitals	1 (11.11.9%)	5 (33.33%)	1 (50%)	7 (26.9%)
Referral Hospital	0 (0%)	2 (13.33%)	0 (0%)	2 (7.7%)
Health Centers	0 (0%)	4 (26.7%)	0 (0%)	4 (15.4%)
Total	9 (34.6%)	15 (57.7%)	2 (7.7%)	26

Table 2: Training of laboratory professionals on LMIS by facility type

Table 3: Facilities that had stock on hand within the minimum-maximum stock levels of HIV/AIDS monitoring laboratory commodities

Commodities	Facilities with less than the minimum stock level n (%)	Facilities with higher than the maximum stock level n (%)	Facilities within the minimum-maximum stock level n (%)
CD4 Commodities			
CD4 Reagent (Kit)	0 (0%)	0 (0%)	5 (100%)
FACS flow/Sheath fluid (pack	1 (20%)	0 (0%)	4 (80%)
Facsrinse/decontamination solution (Pack)	0 (0%)	5 (100%)	0 (0%)
Facsclean/cleaning solution (Pack)	4 (80%)	0 (0%)	1 (20%)
CD4 control (Kit/Bottle)	0 (0%)	0 (0%)	5 (100%)
Chemistry Commodities			
Potassium (Bottle)	0 (0%)	0 (0%)	4 (100%)
GPT (Bottle)	0 (0%)	0 (0%)	4 (100%)
GOT (Bottle)	0 (0%)	0 (0%)	4 (100%)
Creatinine (Bottle)	0 (0%)	0 (0%)	4 (100%)
Glucose (Bottle)	0 (0%)	0 (0%)	4 (100%)
Chemistry Control (Bottle)	0 (0%)	0 (0%)	4 (100%)
Haematology Test Commodities			
Cellpack (Pack)	0 (0%)	0 (0%)	4 (80%)
Cellclean (Bottle)	0 (0%)	0 (0%)	4 (80%)
Stromatolyser (Bottle)	0 (0%)	0 (0%)	4 (80%)
Haematology control (Bottle)	0 (0%)	0 (0%)	4 (80%)

HIV Rapid Test Kits (RTKs)			
Determine	1 (5.9%)	0 (0%)	16 (94.1%)
Stat Pak	0 (0%)	17 (100%)	0 (0%)
Unigold	0 (0%)	17 (100%)	0 (0%)
Rapid Diagnostic Kits (RDKs)			
Hepatitis B	0 (0%)	15 (88.2%)	2 (11.8%)
VDRL	0 (0%)	15 (88.2%)	2 (11.8%)
General Laboratory Consumables			
BD EDTA Vacutainers Tube (Pack)	0 (0%)	10 (58.8%)	7 (41.2%)
BD SST Vacutainers Tube (Pack)	0 (0%)	10 (58.8%)	7 (41.2%)
BD Vacutainers Needles (Pack)	0 (0%)	10 (58.8%)	7 (41.2%)
Hand gloves (Pack)	0 (0%)	10 (58.8%)	7 (41.2%)
Methylated spirit (Bottle)	0 (0%)	10 (58.8%)	7 (41.2%)
Cotton wool (Roll)	0 (0%)	10 (58.8%)	7 (41.2%)

*For Haematology and Chemistry reagents number of facilities that manage them (n=4) and CD4 (n=5)
*For Rapid test kits, Rapid diagnostic kits and General laboratory consumables (n= 17)

Table 3: Number/Percentage of facilities that had stock on hand below, above and within the minimum/maximum of ART monitoring laboratory commodities stock levels on the day of visit

Table 4: Stock Outs at the Time of Visit

Commodities	No of Facilities	Facilities stock Out on the day of visit n (%)	Facilities stock out any time in the past months n (%)	Mean # of days (range) of stock outs in the past 6 months	Mean # of times stock outs in the past 6 months
CD4 Commodities					
CD4 Reagent (Kit)	5	0 (0%)	1 (20%)	180	1
FACS flow/Sheath fluid (pack	5	1 (20%)	1 (20%)	30	1
Facsrinse/decontamination solution (Pack)	5	0 (0%)	0 (0%)	0	0
Facsclean/cleaning solution (Pack)	5	4 (80%)	4 (80%)	3	1
CD4 control (Kit/Bottle)	5	0 (0%)	0 (0%)	0	0
Chemistry Commodities					
Potassium (Bottle)	4	0 (0%)	0 (0%)	0	0
GPT (Bottle)	4	0 (0%)	0 (0%)	0	0
GOT (Bottle)	4	0 (0%)	0 (0%)	0	0
Creatinine (Bottle)	4	0 (0%)	0 (0%)	0	0

Glucose (Bottle)	4	0 (0%)	0 (0%)	0	0
Chemistry Control (Bottle)	4	0 (0%)	0 (0%)	0	0
Haematology Test Commodities					
Cellpack (Pack)	0 (0%)	0 (0%)	0 (0%)	0	0
Cellclean (Bottle)	0 (0%)	0 (0%)	0 (0%)	0	0
Stromatolyser (Bottle)	0 (0%)	0 (0%)	0 (0%)	0	0
Haematology control (Bottle)	0 (0%)	0 (0%)	0 (0%)	0	0
HIV Rapid Test Kits					
Determine	17	0 (0%)	1 (5.9%)	10	1
Stat Pak	17	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Unigold	17	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Rapid Diagnostic Kits					
Stat Pak	17	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Unigold	17	0 (0%)	0 (0%)	0 (0%)	0 (0%)
General Laboratory Consumables					
BD EDTA Vacutainers Tube (Pack)	17	0 (0%)	0 (0%)	0 (0%)	0 (0%)
BD SST Vacutainers Tube (Pack)	17	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Vacutainers Needles (Pack)	17	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Hand gloves (Pack)	17	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Methylated spirit (Bottle)	17	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Cotton wool (Roll)	17	0 (0%)	0 (0%)	0 (0%)	0 (0%)

*For Haematology and Chemistry reagents number of facilities that manage them (n=4) and CD4 (n=5)
*For Rapid test kits, Rapid diagnostic kits and General laboratory consumables (n= 17)

Table 4: Percentage of facilities stock out for laboratory commodities on the day of visit, reported stock outs during the last 6 months, average duration of stock outs and mean number of stock outs in the last 6 months, August 2014 to January 2015

Discussion

Public health laboratory systems and programmes in developing countries struggle to make important laboratory commodities available to those who need them. A strong laboratory logistics management information system is critical for successful supply chain management implementation and laboratory commodity security, especially to ensure consistent commodity availability for HIV/AIDS testing and monitoring service (USAID/DELIVER PROJECT, 2009). Several studies have been conducted on the status of logistics management system and logistics management information system of HIV/AIDS commodities elsewhere. However, an assessment of laboratory LMIS at facility level in Bayelsa state (and Nigeria in general) has not been done till date. Therefore, this studywas to assess the laboratory logistics management information system in the comprehensive HIV/AIDS health facilities of

Bayelsa state and identify the strengths and weaknesses of the existing laboratory LMIS, with a view to providing useful information to health policy makers and patients who visit the facilities to access care.

This study was a facility based cross-sectional descriptive study. Quantitative data collection methods were employed. Interviews for persons responsible for managing laboratory commodities at the study facilities using structured questionnaire (survey) was conducted. There was also review of stock keeping records (documentation) and observation of physical inventory (participant observation) of HIV/AIDS laboratory commodities available at the time of visit to the facilities.

Twenty (59%) and 14 (41%) of the study participants in this study reported very high and high effectiveness of LMIS in the supply of HIV/AIDS commodities to their facilities compare to the what obtained before the introduction of LMIS. None of the participants reported low and very low effectiveness. They reported that they now receive working laboratory commodities periodically unlike having stock out of working materials for up to 4 to 6 months due to delay in procurement before the introduction of LMIS.

The present study showed that expired HIV/AIDS laboratory commodities were found in 14 (82.4%) of the facilities. This is greater than the 42% reported by Lijdsman *et al*. (2003) in their study in Rwanda and 23% in the study in Uganda by MAUL (2013), implying poor stock management. Expired stocks of CD4 reagents, Facsflow/sheath fluid and Facsclean were found in 3 (60%) facilities that manage those commodities and GPT, creatinine, glucose, potassium, GOT, stromatolyser and cellclean were found at 2 (50%) facilities that mange those commodities. Similarly 10 (58.8%) facilities had expired Determine Rapid test kits on the day of the assessment. This is lower than 75% reported by Desale *et al.* (2013) but higher than 0.3% reported by Jabulani *et al.* (2005) for RTKs in their studies in Ethiopia and Zimbabwe respectively. The reasons they gave for expiration were receiving the commodities near expiry date due to push from SCMS and frequent industrial action by health workers in the state leading to non-usage of the commodity which are locked up during the period, equipment breakdown, lack of power supply to use equipment that utilize such commodities, failure to follow the principle of first to expire, first out and lack of an efficient mechanism for the redistribution of surpluscommodities from facilities that have large quantities to those under stocked or out ofstock of such commodities.

All the 17 (100%) facilities have received RTKs close to their expiration date at least once before but none has received such commodities in the last 6 months. All 4 (100%) facilities managing chemistry commodities have received commodities close to their expiration date at least in the last 6 months. None of the 4 facilities managing CD4 commodities has received commodities close their expiration date.

Some facilities in the riverine areas of the state reported receiving commodities that were damaged when they received supplies from SCMS at least once but none has received damaged commodities at resupply in the last 6 months.

Seventeen (100%) of all the assessed facilities and 4 (100%) of the facilities that manage the commodities reported always receiving the quantity of RTKs and haematology, chemistry and some CD4 commodities respectively they requested for in the last 6 months. This agrees with the report of the study by Barry *et al* .(2005). However, 2 (40%) and 5 (100%) of facilities managing CD4 commodities reported having received less than the quantity of CD4 reagents and Facsclean/cleaning solution respectively ordered for at least once in the last 6 months.

All 4 (100%) facilities that manage chemistry and haematology reagents and 17 (100%) facilities that ordered for RTKs received the quantity of commodities they requested for in the last ordered they made to SCMS. All 17 (100%) facilities received laboratory consumables more than the quantity requested or ordered for. Less quantity of

CD4 reagents and/or Facsclean/cleaning solution than requested were received in all the 5 (100%) facilities that managed the commodity in the last resupply cycle.

The constraints of using LMIS for HIV/AIDS commodities reported by study participants include lack of standard operating procedure (SOP) to guide implementation of LMIS, deterioration of commodities due to poor power supply, lack of computers for electronic LMIS implementation, computer illiteracy amongst managers of commodities, lack of internet facilities to send bimonthly reports and other information to SCMS by email and inability of non-laboratorians using commodities to prepare and send quality reports for the facility bimonthly report.

All the assessed facilities were currently using standardized LMIS forms for reporting, requesting and ordering commodities. This is contrary to the report by MAUL (2013) that only 5% of the studied facilities are using standardized LMIS reporting forms and that none of the sites had ordering tools for HIV/AIDS laboratory commodities and that by Allers and Riwa (2008) in Sierra Leone where it was reported that facilities lacked standard LMIS tools for collection and reporting of essential logistics data. The difference may be due to availability of the tools and regular supportive supervisory visits to the facilities studied. Ten (29%) of the study participants reported having problem correctly filling bi-monthly CRRIRF to report and request for commodities.

All 17 (100%) of the assessed facilities were currently using stock/bin cards and consumption registers for all HIV/AIDS laboratory commodities managed, which is better than 70% reported in a similar study in Malawi by Butao*et al*, 2009 and 50% reported by Desale *et al*. (2013) in their study in Ethiopia. The difference may be due to availability of stock/bin cards in all the facilities. Majority of stock/bin cards were updated with accurate information matching with the physical count done at the time of visit. The average accuracy of stock/bin cards matched with physical count as observed was about 85%.This is higher than the 38.9% overall accuracy reported by Desale *et al*. (2013) and the 60% reported by Jabulani *et al*. (2005) in similar studies in Ethiopia and Zimbabwe respectively. This may be due to the programmed supportive supervision and monitoring visits by implementing partners and ministry of health officials to comprehensive HIV/AIDS facilities in Bayelsa state. Fifteen (44%) of the study participants reported having challenge with regularly and properly updating stock/bin cards. None reported having challenge with using and updating consumption registers.

Ten (59%) of the facilities assessed reported the non-availability of SOP on Nigerian LMIS, hence no document to guide the day to day implementation of LMIS in their facilities. This agrees with the report by MAUL (2013) that availability of SOP was low in facilities in Uganda. They reported that the lack of SOP affects the quality of their documentation and reporting of LMIS activities.

All the study participants reported delay in getting resupply after submitting their request, with lead-time of between one month to one and half months between ordering and receiving laboratory commodities. They reported that they have had to place calls to follow up with supplying body when their stock is getting low before they are supplied.

Four (24%) of the facilities studied have functional computers. This is close to the 22.7% reported by MAUL (2013) in Uganda. 27 (79%) of the study participants reported that they are computer literate. However, none of the facilities with computer uses them to prepare and send LMIS reports and requests because of lack of internet facilities. According to MAUL (2013), 22.7% of the facilities had internet connection. The difference may be because most part of Bayelsa State are rural and this study was restricted to a state as against a national assessment in Uganda by MAUL (2013).

According to the study participants, the factors that constrain implementation of LMIS of HIV/AIDS commodities in the assessed facilities include lack of training for some laboratory

personnel involved in LMIS, inadequate supply during resupply, delay in supply getting to their facilities after submitting reports (long lead time), inaccurate logistics data from some point of service manned by non-laboratorians within the facility, computer illiteracy for those that have computers in their facilities, lack of internet facilities to send LMIS report to SCMS, inadequate space for laboratory store and poor power supply to properly store cold-chain commodities.

In this study, it was found that 26 (76%) of the 34 laboratory professionals involved in LMIS were trained in LMIS, which is in contrast with the study done by Jabulani *et al*. (2005) in Zimbabwe and Desale *et al*. (2013) in Ethiopia where a few number of laboratory professionals were trained in LMIS. However, most of those trained in this study did not attend a formal training but were trained by on-the-job mentoring. Of the 8 (24%) not trained on LMIS, 5 (63%) reported having challenges in the implementation of LMIS in their facilities.

All 17 (100%) facilities in this study received supervision in the last 2 months that included commodity management where physical counts were conducted and compared with stock/bin cards, LMIS reports and storage conditions were checked and expired stock removed from usable stocks. This is in contrast with the report by JSI/DELIVER (2003) that only 78% of facilities in Tanzania received supervision and that by Akwei *et al*. (2006) that supervision of laboratories in Ghana is weak, irregular and does not include review of logistics responsibilities such as records and reports, physical inventory and inventory management.

All the study participants reported delay in getting resupply after submitting their request, with lead-time of between one month to one and half months between ordering and receiving laboratory commodities. They reported that they have had to place calls to follow up with supplying body when their stock is getting low before they are supplied. This does not agree with the report of 13% of the facilities assessed receiving timely delivery of the commodities they ordered.

This present study showed that about 90% of the facilities practiced first expiring, first out (FEFO) procedures better than the study done in Lesotho in which only 33% of facilities practiced it (Pharasi, 2007) and 83% reported by Akwei *et a.l* (2006) but lower than the 96% reported by MAUL (2006). Ten (29%) of the 34 study participants reported having challenge with practicing FEFO either because of inadequate space for storage of commodities (items are not properly arranged) or unrestricted access to storage areas for those not involved in commodities management, hence haphazard removal of items. This is in agreement with studies that were done in Tanzania (JSI/DELIVER, 2003), Lesotho (Pharasi, 2007) and Malawi (Butao *et al*., 2009).

Of the 17 facilities studied, 4 (24%) do not have public power supply to their facility. However, 2 of the 4 facilities without power supply depend on power generating set for power supply during work hours only. Five (29%) of the 17 facilities manage cold chain commodities. The 5 facilities that manage cold chain items have had deteriorated commodities in the last 6 months. This they attributed to challenge with power supply, faulty refrigerator or industrial action by health workers.

In a well-designed laboratory logistics system, facilities request laboratory commodities based on the established inventory control procedures and supposed to receive the quantity requested (JSI/USAID, 2000). Facilities use an inventory control system with established maximum-minimum stock levels to determine quantity of laboratory commodities they order and receive. This study found that the established inventory control procedures were known and utilized by all the facilities' laboratories. This result is in contrast with the studies done in Lesotho by Pharasi (2007), Rwanda by Lijdsman *et al*. (2003), Uganda by Francis *et al*. (2006) and Malawi by Butao *et al*. (2009), where they reported that basic procedures for recording and storing information were in place but insufficient, not standardized or incomplete and therefore has major implications on planning ordering of supplies.

Four (100%) of facilities that manage the commodities had within the established minimum-maximum (min-max) stock levels for creatinine, glucose, GPT, GOT, Potassium, cellpack, cellclean, stromatolyser, haematology control (that is, chemistry and haematology reagents). Two (11.8%) of the facilities had within the established minimum-maximum (min-max) stock levels for Hepatitis B and VDRL RDKs. Five (100%) of facilities had stock on hand within the min-max levels for CD4 reagents and control. Four (80%) of facilities had stock status within the min-max stock level for CD4 Facsflow/sheath fluid and 1 (20%) of the facilities had stock status within the min-max stock level for CD4 Facsclean/cleaning solution. Sixteen (94.1%) of facilities had stock on hand within the min-max stock levels for Determine.Furthermore, 7 (41.2%) of the facilities had within the min-max stock levels for all the general consumables. This agrees with the findings of a study done in Ghana by Akwei *et al*. (2006), which revealed that facilities had adequate stock for CD4 and chemistry reagents.

Four (80%) of the facilities had stock status less than the min-max stock level for CD4 Facsclean reagents/cleaning solution. One (20%) of facilities had stock on hand less than the min-max stock levels for CD4 Facsflow/sheath fluid. One (5.9%) of facilities had stock on hand less than the min-max stock levels for Determine RTK. No health facility had less stock levels than the min-max levels for haematology and chemistry test reagents.

Our data showed that all (100%) of facilities had higher stock levels than the maximum level for Unigold and Stat Pak rapid test kits that was higher than Jabulani*et al*, (2005) findings which was 39%. The difference might be due to the fact that Unigold and Stat Pak are used as a 2nd line screening and tie-breaker kit respectively in our case, which are hardly used except when a positive case of HIV test arises (and it is rare in most facilities).

Five (100%) of the facilities had stock levels higher the min-max levels for Facsrinse/decontamination solution. Fifteen (88.2%) of facilities had stock levels higher the min-max levels for Hepatitis B and VDRL RDKs. Ten (58.8%) of the facilities had higher than the min-max stock levels for all the general consumables. No health facility had higher levels than min-max stock levels for haematology and chemistry test reagents.

One (5.9%) of the facilities reported that they usually run out of at least one ART monitoring laboratory commodities before resupply. The most frequently stock out HIV/AIDs laboratory monitoring commodities were general laboratory consumables, which was comparable with the study done in Rwanda Lijdsman *et al*. (2003). Three (17.6 %) facilities had stock outs at the time of visit for at least one laboratory commodity. The highest stock out rate was for CD4 Facsclean/cleaning reagent in 3 (17.6%) facilities and CD4 Facsflow/Sheath fluid in 1 (5.9%) facility. CD4 reagent, Facsflow/sheath fluid, Facsclean/cleaning solution and Determine had stock outs one time in the last six months. Overall the number of stock outs was generally low. Moreover our study showed that none of the 4 facilities that manage haematology reagents were stock out for the reagents in the past 6 months. In contrast to our finding, all facilities were stock out for haematology reagents as shown by Pharasi (2007) in Lesotho. The difference might be due to the absence of functional procurement unit for ART monitoring laboratory commodities in Lesotho at that time.

Of the number of the facilities that had stock cards/bin cards the average duration of stock outs in days was found to be lowest for Facsclean/cleaning solution and Determine 3 and 10 days respectively. The highest average duration of stock outs were for CD4 reagent and Facsflow/sheath fluid 180 and 30 days respectively.

Four (23.5%) of the assessed facilities placed one emergency order each for at least one ART monitoring laboratory commodities respectively in the last six months. This finding is lower than the 70% reported by Butao *et al.* (2009) and 66% reported by MAUL (2013). The remaining 13 (76.5%) did not place any emergency order for

any ART monitoring laboratory commodities in the last six months.Reasons given by study participants for placing emergency orders were deterioration of cold chain laboratory commodities due to power challenge, failure to follow the principle of first expire, first out (FEFO) in the usage of commodities which led to expiration of some commodities, none-use of stock/bin cards and data capturing registers used in some points of service in the facilities and failure to properly fill and update stock/bin cards and data capturing registers used in some points of service in the facilities, inclusion of expired commodities in physical count of usable commodities, hence giving false stock status, and inability of SCMS to supply the quantity of commodities requested for in bimonthly reports.

Reasons for the stock outs given by participants include non-supply of quantity requested for/inadequate supply, occasional upsurge in consumption, supply of near expiration laboratory commodities, delay in resupply of laboratory commodities (increased lead time), damage while transporting commodities to the facilities using speed boats and lack of power supply, hence commodities were transferred to other facilities to prevent deterioration, and deterioration of commodities. Some of the reasons given agree with those reported by Desale *et al*. (2013).

This study found out that stock out in facilities were handled by the participating facilities by sending request to SCMS for re-supply and/or borrowing commodities from other facilities and making positive adjustment on their tally cards and referral of samples to other facilities for analysis.

Conclusion

This study was conducted to assess laboratory logistics management information system for HIV/AIDS laboratory commodities in HIV/AIDS comprehensive health facilities of Bayelsa state. The study found out that:

There is a well-designed and effective logistics management information system for HIV/AIDS laboratory commodities with standardize forms for managing commodities and for LMIS reporting in HIV/AIDS comprehensive health facilities in Bayelsa State.This has ensured the availability of working commodities for HIV diagnosis and for monitoring the care and treatment of people living with HIV/AIDS in Bayelsa State.

Majority of laboratory professionals involved in the management of HIV/AIDS commodities were trained on LMIS (through formal and informal training), which has led to the successes recorded in laboratory LMIS implementation across the facilities that participated in this study. However, there is the need to train those who have not been trained and conduct refresher training for those who have been trained, especially those trained through informal method, to ensure everyone is on the same page as far LMIS is concerned.
A few facilities had stock out of HIV/AIDS monitoring laboratory commodities at the day of the assessment and during six months before the assessment. This led to patients who came for laboratory tests been turned back. Utilization of the logistics recording and stock/bin cards usage were in practice in all the facilities assessed but there was poor documentation in some of them. This led to the placing of emergency order in some facilities, as there was the use of false stock status in generating bimonthly CRRIRF reports and therefore reduction in stock actually available for laboratory analysis.

High amount of laboratory commodities were expired due to poor implementation of LMIS, especially supply of commodities that are close to expiration and failure to follow the principle of first to expire, first out (FEFO). Expiration of commodities was also caused by frequent industrial action by health care workers in the state and lack of an efficient mechanism for the redistribution of surplus commodities from facilities that have large quantities to those under stocked or out of stock of such commodities. Some facilities in this study had no standard operating procedure (SOP) on LMIS, hence no document to guide the operations of those managing commodities in such facilities. Most facilities lack computers and internet connection for electronic LMIS. Some of those that have

computers are not computer literate while others do not use the computers for electronic LMIS.The lead time for resupply of commodities is usually longer than the 2 weeks stipulated by the Nigerian LMIS policy, hence some facilities fall below the minimum stock levels before they get supplies at times. Most facilities lack adequate space for the storage of laboratory commodities, hence affecting the practice of FEFO due to poor arrangement of the store. Overall, the number of stock outs of laboratory commodities was generally low

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