INVENTORY MANAGEMENT PERFORMANCE FOR LABORATORY COMMODITIES IN SELECTED PUBLIC HOSPITALS OF JIMMA CITY AND JIMMA ZONE, OROMIYA REGIONAL NATIONAL STATE, ETHIOPIA

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A THESIS SUBMITTED TO THE SCHOOL OF PHARMACY, FACULTY OF HEALTH SCIENCES, INSTITUTE OF HEALTH JIMMA UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR DEGREE OF MASTER OF SCIENCE IN PHARMACEUTICAL SUPPLY CHAIN MANAGEMENT

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Abstract

***Background**: Inventory management is the continuous process of planning, organizing and controlling laboratory commodities that aims at minimizing the investment in inventory while balancing supply and demand. It is comprised of ordering, receiving, storing, issuing, and reordering of these commodities. Good practice of inventory management is of paramount importance for any hospital for it deals with patients. There is limited information on laboratory commodities inventory management performance in Jimma City and Jimma Zone.*

***Objective**: To assess laboratory commodities inventory management performance in selected public hospitals in Jimma City and Jimma Zone, Oromiya Regional National State, south west Ethiopia.*
***Methods**: A facility based cross-sectional descriptive study accompanied by qualitative method was conducted from 01-30 May, 2019. Seven public hospitals, 322 bin cards, Internal Facility Report and Resupply Forms and 46 laboratory commodities were considered in the study in addition to key informants. The collected data were cleared and analyzed using Excel and SPSS 24. Qualitative data were summarized and analyzed thematically.*

***Result**: All the seven public hospitals were included in the study. Logistics Management Information Systems tools such as bin cards, Internal Facility Report and Requisition and Report and Requisition forms (RRF) were available in all, 7(100%) of the studied public hospitals. About 69.88% of the commodities had bin-cards, and 58.07% of them were updated. The inventory accuracy was 30.43%. The stock out was 58.07% with mean stock out duration of 18 days. The wastage rate was 8.73%. Percentage of public hospitals with desirable storage conditions fulfilled was 14.3% and the average condition conditions was 70.9%. The identified challenges were budget constraint, lack of administrative prompt support, lack of staff commitment, higher and frequent stock out from the supplier side.*

***Conclusion and Recommendations**: The laboratory commodities inventory management performance of the studied hospitals was found to be weak which was described by poor bin-card updating practice, poor stock record accuracy and the storage conditions was below the standard. There was also higher stock out and wastage rates. Therefore, public hospitals of Jimma City and Jimma Zone should give attention for the improvement of the laboratory commodities inventory management; and supportive supervision should also be conducted by the management of these hospitals.*

***Keywords:** Inventory management**,** Laboratory service, Jimma, laboratory commodities, performance*

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Table of Contents

List of Tables

List of Figures

List of Acronyms

AMC	Average monthly consumption
ART	Antiretroviral therapy
ATLAS	Assessment tool for laboratory service and supply chain
CED	Chief Executive Director
CEO	Chief Executive Officer
EPHI	Ethiopian Public Health Institute
EPSA	Ethiopian Pharmaceutical Supply Agency
FMoH	Federal Ministry of Health
HCMIS	Health commodity management information system
IFRR	Internal Facility Report and Resupply Form
IMAT	Inventory management assessment tool
IPLS	Integrated Pharmaceutical Logistics System
LIAT	Logistics indicators assessment tool
LMIS	Logistics Management Information System
LSAT	Logistics system assessment tool
PSCM	Pharmaceutical Supply Chain Management
RRF	Report and Requisition Form
RRUC	Record for Returning Unusable Commodities
SOP	Standard Operating Procedure
TB	Tuberculosis

1. Introduction

1.1. Background

Laboratory services are indispensable for the delivery of quality health service in health facilities (1, 2). Applicability of these services includes accurate diagnosis, formulation and monitoringof treatments. These services provide information on epidemiological and surveillances and are used in the detection of disease during epidemics(3). Sufficient, well-trained workforces; uninterrupted supplies of consumables, chemicals and reagents; functioning devicesand facilities are required for this service. This designatesthat laboratory commodities are vital for the provision of laboratory services in order to guarantee services by maintaining desired stock level to satisfy customers(1, 4).

Inventory may be defined as a stock of health commodities for future needs (5). It includes raw materials, work-in-progress, finished commodities (6). The value of pharmaceutical commodities, which includes laboratory commodities remains increasing due to variation of the commodities and associated costs (5, 7).

Inventory management is a set of techniques used to manage the level of inventory in a supply chain (8, 9). It can be used to protect organizations from unexpected changes in customer demand. In contingencies, inventory guarantees a normal supply for a certain period of time; reduces the risk of storage and stock outs (10-13). This shows that inventory management is a fragment of the supply chain network that protects the delivery of healthcare against disruption of service provision (7). It is aimed to reduce inventory costs as much as possible while maintaining the service levels required by customers (14-16). Inventory management is comprised of ordering, receiving, storing, issuing, and reordering of pharmaceutical commodities (17). It is a function of stock decisions on policies, activities and procedures to ensure that the correct amount of each item is kept in stock at all times. It is a system that plans and controls inventories based on the product, the customer, and the process that makes the product available(4, 5).

Inventory control is the set of activities that coordinates the purchase, production and distribution of laboratory commodities to serve customers (18). It provides relevant information to store

managers and supply management officers: when to order or issue, how much to order or issue and how to maintain an adequate stock of laboratory commodities in order to avoid shortages and oversupplies(19, 20). This confirms that the information obtained from inventory control can be used to make sound decisions in inventory management (21).

In addition to the inventory control, for the successful inventory management of laboratory commodities,a system that tracks the inventory in storage and on order, reliable forecast the commodities, knowledge of lead times and lead time variability, reasonable estimates of inventory holding costs, ordering costs, and shortage costs and a classification system for inventory items in terms of their importance are critically important requirements.(22).

As part of monitoring and evaluation of inventory management, undertaking performance management is very important. A lot of metrics exists for measuring inventory management performance. The objective and context of an organization determines the choice of inventory management performance metrics to be utilized. Some of these measures include: inventory accuracy, months of supply, inventory turns, inventory aging, inventory loss or obsolescence, average safety inventory, seasonal inventory, order fill rate, and fraction of time out of stock (7, 9, 20, 23).

Most of studies on Inventory management focused on medicines rather than laboratory commodities. On top of this, the special features of laboratory commodities make inventory management somewhat challenging (24). And there is a limited study on the performance of Inventory management on laboratory commodities nationally as well as in Jimma City and Zone. In order to measure the performance of inventory management of laboratory commodities, the following indicators were used in this study: stock out rate, bin card updating practice, inventory accuracy rate, Logistics management Information system (LMIS) data quality, and storage condition.This is because these indicators were used nationally to measure inventory management of health commodities (25).

1.2. Statement of the Problem

Effective laboratory supply chain is expected to meet the six “Rights” of logistics: availing the rightlaboratory commoditiesin the right quantities, in the right condition, delivered to the right

place, at the right time, for the right cost. The uninterrupted supply of these laboratory commodities can only be guaranteed by selecting, designing and properly managing of an appropriate inventory management system (20, 26).The diagnosis and treatment of any disorder including emerging infections depends only on the availability of laboratory commodities (27).

Laboratory services in developing countries like Africa are neglected; suffering from shortage of equipment and supplies, poor maintenance system and lack of close follow-up and supervision (28-30). Because of these factors access to reliable medical laboratory service remains challenging (29, 31-33). And there are still countless substantial reports of ailments and preventable diseases as a consequence of these (34).

The presence of stock-outs, oversupplies, inaccurate inventory records, high-level of expiry, inadequate storage capacities and condition are indications of poor inventory management practices. Stock-outs of reagents and supplies translate into the inability of a laboratory to perform tests(4, 5, 35).

Ethiopian Pharmaceuticals Supply Agency (EPSA) had invested about 14% (667,999,963.35 Birr) of its pharmaceuticals' purchasebudget on laboratory chemicals and reagents in the 2011EFY (36). Unless this huge investment is managed in appropriate way, the public grievance will tend to increase. Inappropriate ways of managing these inventories will end up in wastages, shortage and overage of laboratory commodities, increase in out-of-pocket expenditure and decline in quality of laboratory services.

In Ethiopia, even if a lot has been done to strengthen the laboratory system of the country, the service is weak and limited, which is explained by absence of well-designed laboratory rooms, and poor follow-up and supervision and shortage of commodities- even absence of common and simple tests (37, 38).In addition to these, the services are characterized by lower patient satisfaction (39-43).

In addition to aforementioned problems, insufficient stock, poor storage practice, traditional inventory management were reported (44-46). The Ethiopian Public Health Institute (EPHI) has also reported frequent stock-outs of laboratory reagents and supplies at both the national and facility level (38).

Studies limited to HIV/AIDS and tuberculosis laboratory commodities in Rwanda, Zimbabwe,Southern Tanzania and Ethiopia reported either stock out or shortage of test kits. The logistics management information system tools usage was also poor. Bin cards were not available in some facilities, and the updating practice was also poor. On top of these, lack of skills in commodity management, inadequate supply of laboratory commodities, limited fund for procurement, poor records and weak information flow practices leading to improper quantification, losses and wastages were became challenges (27, 47-50). The storage conditions of laboratory commodities was not according to the standard; flammable and hazardous chemicals were stored with other commodities, and absence of frozen storage facilities was a challenge at health facilities level. The absence of capacity building regarding laboratory commodities supply chain management for the store managers intensifies the problems associated with the management of these commodities (51).

These studies showed that there is presence of ineffective and inefficient laboratory commodities inventory management.These gaps lead to poor commodity security which will impair the use and exchange of available laboratory commodities (26). Furthermore, poor inventory management systems usually lead to ad hoc decisions about order frequency and quantity, inaccurate stock records, and a lack of systematic performance monitoring. Malpractice of professionals involved in the inventory management of laboratory commodities, unwillingness to comply to standard operating procedures (SOP) also intensifies the poor inventory management (4).

However,there are limited studies conducted on laboratory commodities inventory management, their focus was on program items. And numerous studies were conducted on inventory management of medicines (52-56). On top of this, these laboratory commodities do have special features than medicine; and there is an increased public grievances on the laboratory service,that is,lower customer satisfaction(24).

To this point, inventory management of laboratory commodities was under investigated nationally and specifically in Jimma City and Jimma Zone. This study was therefore, designed to assess the inventory management performance of laboratory commodities and associated challenges at JimmaCity and Jimma Zone, Oromiya Regional National State and provides

baseline information to track changes in laboratory commodities inventory management over time.

1.3. Significance of the Study

Inventory management is a core activity which is important for the successful operation of laboratory commodities supply chain Management. Poor inventory management hinders operations, reduces customer satisfaction, and increases operating costs (15). It brings higher expenses of resources, higher stock out of vital commodities, and deteriorated health outcomes. Most of the poor practices were due to inaccurate stock records, absence of follow up (monitoring and evaluation), and low attention given to the pharmaceutical sector at facility level (4, 57).

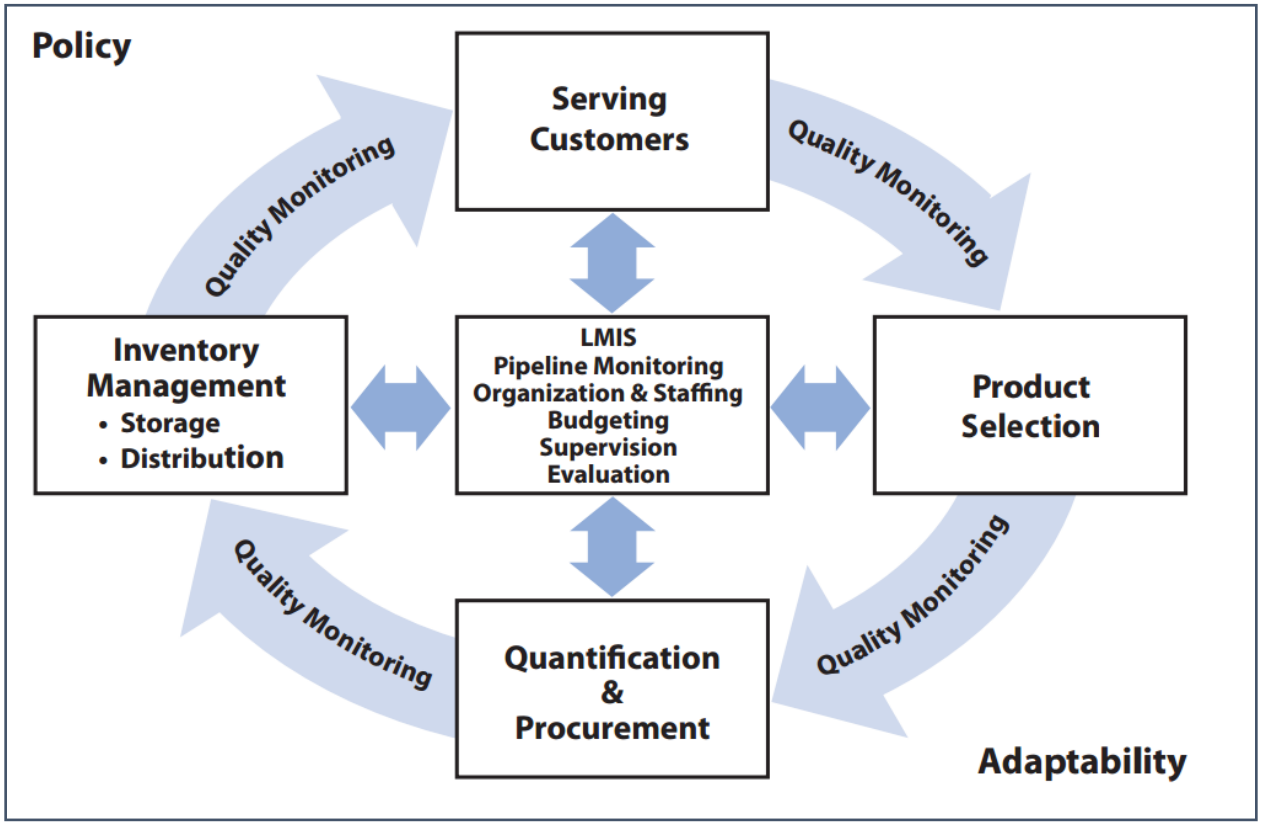
Therefore, studying the inventory management of laboratory commodities in the study area could have given a potential to evaluate performance level and associated challenges which have a significant public importance. This leads to a room for improvement and combatting the challenges surrounding the commodity for the betterments of the laboratory service. Thefindingof this study may help to promote evidence-based intervention on the existing laboratory commodities inventory management by identifying the gap and provide possible recommendations based on the findings of the result in order to take corrective actions.

Public hospital managers, health personnel involved in health logistics activities and laboratory science technologists will use this study as a baseline; and may planto fill gaps to minimize the challenges associated with the laboratory commodities inventory management. Furthermore, policy makers, EPSA and EPHI may intervene with the inventory management malpractice of laboratory commodities. Academicians,students and those interested on further investigation on similar topics may use the findings as baseline information.

2. Literature Review

2.1. Health Supply Chain Management

A health commodity supply chain is a network of interconnected organizations that ensures the availability of health commodities to those who need them. For a healthcare system to function better, effective supply chain management system that fulfills customers' satisfaction is required (58). The supply chain management in health care that comprised of cyclic activities and must be organized in a logical and orderly manner so that sound decision will be made. As shown in figure 1, this cycle is comprised of selection, sourcing, inventory management and customer Services(20).



Source: USAID | DELIVER Project (59)

Figure 1: The Logistics Cycle

Selection and quantification are concerned with identifying needs, developing and updating a list for the identified needs. This step decides the quantity of the commodities required for a

specified period by considering assumptions. Next to selection and quantification, the next step is procurement which considers fair price, international shipping costs, sources of supply, quotation management, and procurement guidelines. The third part of the cycle, inventory management deals with the inventory control, distribution to the service delivery points (stations, dispensing units). The fourth step of the cycle is serving customers which deals with dispensing the commodities to meet customer needs(59, 60). LMIS which is located at the center is important as a driving engine of the of the cycle. In addition to the LMIS, supplementary activities that are the heart of the cycle include: organization and staffing, Budget, supervision, monitoring and evaluation.

One of the major components of healthcare costs is Pharmaceuticals. Globally US$ 1,135.1 trillion was spent to this sector in 2017 and Africa expends 10% (61).It was estimated in 2016 that the Ethiopian market was expected to reach about USD 800 Million with annual growth rate of 25 to 35%, and in 2018 it was expected to reach one Billion USD(62). Pharmaceuticals save or improve life, promotes trust and participation in health services, they are different from other non-pharmaceutical products, and substantive improvements in the supply and use of pharmaceuticals are possible. As a result of these reasons, due attention should be given to this sector besides the cost component(4).

Medical laboratories play a vital role in assessing and improving global public health (63); by identifying the cause of disease, assessing its nature, providing appropriate treatment to achieve therapeutic benefits, monitoring the impact of the treatment provided and identifying strains of drug resistance(64). The 2008 Maputo Declaration on strengthening laboratory systems called for harmonization and standardization of tests, reagents, consumables and instruments at each level of a tiered laboratory system (65).

2.2. Inventory Management

Inventory is a physical stock of laboratory commodities in stock to meet expected demand, which is an important component of the laboratory service provision. If these commodities are not well managed, the money tied to these inventories will lead to inefficiencies (66). An efficient inventory management keeps the costs low and improves the service (8, 67). Good

management of storage and inventory involves monitoring expiration dates, inventory levels, unexplained losses (leakage), and storage conditions for laboratory commodities (68).

Accurate and updated stock records of laboratory commodities are critically required for need assessment and quantification exercises. Inaccurate or less quality records will, lead to inaccurate quantification, shortages and overages, wastages, and inability to utilize scarce resource. Therefore, due attention should be given to regular monitoring and evaluation of the inventory management of these commodities (4).

2.3. Functions of Inventory Management

The role of Inventory Management is to maintain a desired stock level of specific products or items; i.e. availing the right laboratory commodity in the right quantity, at the right time, in the right place, for the right cost (4, 17). This will lead to commodity security; and then client satisfaction (35).In doing so, the items to be held in stock, LMIS, and the balance between service levels, i.e., the stock out costs, ordering costs and inventory holding costs has to get attention. Furthermore,policy regarding when and how much to order and reorder intervals should be considered(4).

In health facilities,well organized inventory management will strength the laboratory supply chain system for efficient health care services delivery; it minimizes stock-out and wastage due to expiries; harmonizes commodities for quality monitoring and consolidates procurement for cost savings, i.e. leads to economy of scale.(10-13, 69, 70).

2.4. Inventory Control System

The information obtained from an inventory control system is used to make sound decisions on when and how much to order and to maintain an appropriate stock level to satisfy customers(59). This indicates that a well operated inventory control system is important to prevent shortages, oversupply, and wastage of laboratory commodities(55, 71).

In order to control inventory, the previous pharmaceutical fund and supply agency (PFSA) but now re-named as Ethiopian Pharmaceutical Supply Agency, has implemented an integrated pharmaceutical logistics system (IPLS) since 2009. In this system maximum months of stock,

minimum months of stock and emergency order point were established for each public health facilities so as to maintain adequate stock of health commodities. In Ethiopia a forced ordering maximum/minimum inventory control system was used. So public health facilities are required to report on a fixed schedule, and then based on the reports the health facilities will be resupplied by a nearest EPSA branch (72).The problem of this system is that the full applicability of IPLS is limited to health program commodities, as only RRF is generated to these commodities.

2.5. Logistics Management Information System of Laboratory Commodities

In managing inventory both paper and computer-based information management system can be used. Effective inventory management is supported by a LMIS. In LMIS data related to laboratory commodities are collected, organized and reported to concerned bodies to take sound decision. According to IPLS, the essential data items that must be captured by the LMIS are stock on hand, consumption data and losses/ adjustments. Standardized forms for inventory management to be used in public health facilities include: Bin Card, Stock Record Card, Internal Facility Report and Resupply Form (IFRR), Report and Requisition Form (RRF) and Record for Returning Unusable Commodities (RRUC) (3).

A cross-sectional descriptive study was conducted in comprehensive health facilities in Bayesal State, Nigeria on Laboratory Logistics Management Information in 2017. This study showed that all the assessed health facilities, (n=17) 100%, were using stock/bin cards, and the accuracy level of records on bin cards with that of the physical stock was 85% on average (73). In another study conducted in Malawi, the use of bin-cards/stock cards was found to be 70% (74). In a national assessment to evaluate the HIV/AIDS Medical Supplies and Laboratory Commodities Supply Chain in Lesotho the reported figure was 56 %(75). In another study conducted in Zimbabwe to assess the HIV & AIDS Logistics System, 33.1% of the bin cards of rapid test kits were not updated (47).

In a study aimed at assessing the laboratory logistics management information system practice for HIV/AIDS and tuberculosis in selected public health facilities in Addis Ababa, 50% of the assessed hospitals and 46% of the health centers were not using bin cards (50). And in another study conducted in 2014 to assess the IPLS for the management of HIV/AIDS and Tuberculosis diagnostic commodities in public health facilities of Addis Ababa, Ethiopia, the bin card

updating, completing IFRR and RRF was practiced in 61.5%, 84.6% and 92.6% of the assessed facilities respectively (45).

In an assessment made on HIV/AIDS Medical Supplies and Laboratory Commodities Supply Chain in Lesotho, November 2007, it was found that 67% of laboratories assessed did not have a set of minimum stock level for reagents and consumables at which orders needed to be placed, while 83% reported that they did not have maximum stock levels for reagents and consumables(75).These findings show that there is a variation in LMIS tools utilization across Africa and even in Addis Ababa health facilities

2.6. Inventory Management of Laboratory Commodities

The presence of stock-outs, oversupplies, inaccurate inventory records and high level of expiry are indications of poor inventory management. Stock-outs of reagents and supplies translate into the inability of a laboratory to perform tests. From 17 comprehensive health facilities assessed in Bayesal state, Nigeria 14(82.4%) of them have experienced expiry of HIV/AIDS laboratory commodities. In a study conducted by Lijdsman et al in Rwanda (2003) the expiry rate of laboratory commodities was 42%(27); and in Uganda it was 23% (76).

In a srudy conducted in 2003 in Rwanda 39 % and 42% health facilities experienced stock out of HIV/AIDs kits and reagents, respectively (27). Shortage of rapid tests to diagnose HIV was reported in Kilombero and Ulanga districts in southern Tanzania (48). Forty percent of the assessed facilities of Zimbabwe were overstocked for Uni-gold; and 60% of the facilities recorded stock on hand that differed from physical inventory (47).

A descriptive cross-sectional study undertaken in Addis Ababa (2014) showed that majority (92.6%) of facilities have encountered and reported stock out for one or more laboratory commodities during the last six months of study; and stock out for SGPT, EDTA test tube, and 1% Carbol Fuchsin on the date of visit was 41.6%, 54.5%, and 46.7%, respectively (45). In another study conducted in health facilities of Addis Ababa, the stock out was 25% for KHB and 75% for Unigold in Hospitals in 2013 (49).

Concerning the inventory accuracy rate, a study conducted in Zimbabwe, the reported figure was 60%(47). In a study conducted to evaluate laboratory logistics management information system

practice for HIV/AIDS and tuberculosis laboratory commodities in selected public health facilities in Addis Ababa, Ethiopia in 2013, the inventory accuracy was below 25% (50). These data affirm that there is a problem in wastage and stock management of laboratory commodities across the African continent.

2.7. Storage Conditions of Laboratory Commodities

In a study conducted in Sierra Leone to evaluate the supply chain for ARV drugs and HIV test kits, the storage conditions of the facilities were found to be poor. The storage space was insufficient, there was a difficulty to maintain the cold supply chain due to recurrent power interruption, temperature monitoring of the cold supply chain was not monitored (77).More 50% of the assessed facilities in Malawi were storing laboratory commodities appropriately and there was a proper cold chain storage. Hazardous chemicals were stored with other commodities, there was poor compliance with first-to-expire, first-out management of commodities, and poor handling of damaged and expired products(74).A study conducted in Addis Ababa showed more than half (50%) of the study participants did not get any training on storage of the laboratory commodities; 73.6% of the assessed hospital stores stored flammable and hazardous chemicals with other commodities; and more than 90% of the storage facilities didn't have frozen storage facility The reasons behind the poor storage conditions was that the storage spaces were not constructed for storage purpose rather constructed for other purposes(51).

2.8. Challenges and Other Factors Associated with Inventory Managementof Laboratory Commodities

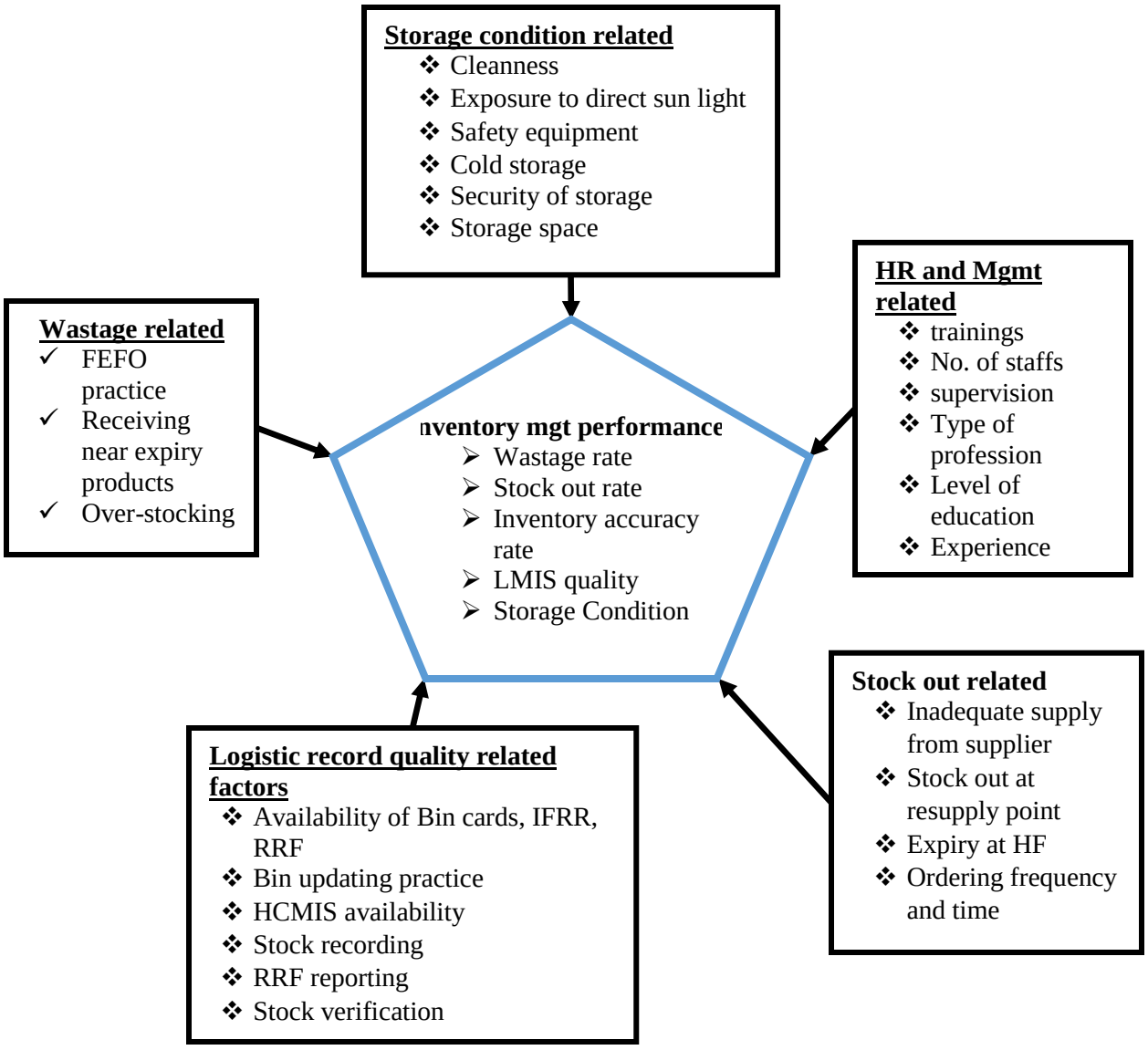
Poor stock management was noted in terms of storage conditions, availability and accuracy of recordsin health facilities of Tanzania(65). Scarce record keeping; lack of training and skills on accurate recording procedures, inadequate monitoring and evaluation, poor storage conditions were characteristics of inventory management of Namibia (78). Inappropriate use, wastage, stock-outs were also reported in Kenya. These challenges were faced due to inadequate procurement practices, inappropriate management, and poor quality of laboratory commodities (79).

Generally, the challenges reported in connection with inventory management of laboratory commodities includes: frequent stock outs of reagents, weak or no standard ordering process and

procedures, no established pipeline, multiple vertical pipelines (one for HIV tests, one for TB laboratory supplies, etc), often because of program involvement in the resupply process, rationing of commodities, associated products not ordered concurrently (buffer solution, lancets, etc.) and existing pipeline too long (19).

In a study aimed at assessing factors affecting quality of laboratory services in public and private health facilities in Addis Ababa, Ethiopia, there was a report of poor management support (57.3%), poor equipment quality (53.4%), lack of knowledge (23.3%) (80).

2.9.Conceptual Framework of the Study



Keys: ⬟Dependent Variables ☐Independent variable

Figure 2: Conceptual frameworkfor the performance of laboratory commodities inventory management

3. Objective

3.1. General Objective

The aim of the study is to assess laboratory commodities inventory management performance in selected public hospitals ofJimma City and Jimma Zone, Oromiya Regional National State, southwest Ethiopia.

3.2. Specific Objectives

The specific objectives are:

- to assess the LMIS data quality of laboratory commodities;
- to determine the stock out, wastage and inventory accuracy rates of laboratory commodities;
- to evaluate the storage conditions of laboratory commodities; and
- to assess the challenges related to laboratory commodity inventory management.

4. Methods and Materials

4.1. Study Area and Period

A total of 733 health facilities were found in Jimma Zone and 37 were in Jimma City. From the total health facilities 7 were governmental hospitals, 110 health centers, 486 health posts, 28 higher private clinics, 128 medium private clinics, 2 army hospitals, one private hospital, 4 non-governmental clinics, and 4 diagnostic laboratories. From the total health facilities 87 were giving laboratory service.

This study was conducted in public hospitals found in Jimma City and Jimma Zone from May 1-30, 2019.

4.2. Study Design

Hospital based cross-sectional descriptive study design complemented with qualitative method was employed to assess the performance of inventory management laboratory commodities in selected public hospitals ofJimma City and Jimma Zone.

4.3. Population

4.3.1. Source Population

All public health facilities found in Jimma City and Jimma Zone, all health professionals involved in laboratory commodity management, all logistics documents including expired laboratory commodities list, and all laboratorywere considered as a source population for the study.

4.3.2. Study Population

Seven public hospitals found in Jimma City and JimmaZone were included in the study. All bin cards including health commodity management information system (HCMIS), Model 19/health, Model 22/health, RRF, IFRR, expired laboratory commodities list/report used from January 2018-Dec 2018 of laboratory commodities, and central store keepers were interviewed.

4.4. Inclusion and Exclusion Criteria

4.4.1. Inclusion Criteria

In order to get sufficient data for analysis, all public hospitals that function at least for 15 months prior to data collection were included. Store managers, pharmacy heads and laboratory heads with minimum 6 months' service were included.

4.4.2. Exclusion Criteria

Health centers and health posts were excluded from the study since majority of the studied laboratory commodities were not found at these health facilities. Public hospitals that started providing service 15 months prior to data collection were not considered. Private and army hospitals found in both Jimma City and JimmaZone were excluded from the study. Those healthcare personnel who were unwilling to participate on the study and those who were on leave during the study period were excluded. Pharmacy and laboratory heads appointed as heads less than 6-months period at the time of data collection were not selected.

4.5. Sample Size Determination and Sampling Procedures

Seven public hospitals found in both Jimma City and JimmaZone were considered. According to of ATLAS 2017 (81), all the recommended keylaboratory commodities (n=46) were included in this study.Regarding bin cards, 46 commodities x 7 facilities totally 322 were recruited. IFRRs of the commodities were checked for availability.

Regarding the interview, purposive sampling technique was employed, and 3 key informants from every hospitalwere identified based on their decision-making ability on inventory management of laboratory commodities.These respondents were pharmacy heads, laboratory heads and central pharmacy store managers; and in the absence of the pharmacy head - pharmacy supply officer; and in the absence of laboratory head - laboratory logistics officer were recruited.

4.6. Data Collection Procedure

4.6.1. Data Collection Tools

Tools adopted from Logistics indicators assessment tool (LIAT) (82), USAID measuring supply chain performance (83)and Inventory management assessment tool (IMAT) (84) and assessment tool for laboratory service and supply chain (ATLAS) was used to collect data. The questionnaires and checklists were semi-structured. For qualitative study, logistics system assessment tool (LSAT) (85) was adopted.

4.6.2. Quantitative Data

Availability of the commodities was checked physically during data collection using checklist/questionnaire.Logistic records of one year (Jan. 2018 – Dec. 2018) were reviewed for each key laboratory commodities to evaluate LMIS data quality and assess the inventory management performance of the laboratory commodities.

4.6.3. Qualitative Data

Health personnel in Jimma City and Jimma Zone public hospitals that might be involved in the inventory management of laboratory commodities decision making activities directly or indirectly were in-depth interviewed; these include: store manager, laboratory head and pharmacy head). In the absence of the pharmacy and laboratory heads, logistics officers of both respectively were considered. The principal investigator conducted the interview. The interview was recorded using a recorder. The interview took 45 minutes on average. The language of the interview was Amharic and English.

4.7. Data Quality Assurance

The data collection tool was tested on Bedele hospital which was located in Bedele town to ensure the validity of the tools. A two days training was given for data collectors on data collection tools and procedures. The principal investigator conducted regular supervision during data collection on the completeness of the collected data. Consistency and completeness of the collected data was checked during data collection and after data collection. Qualitative data were collected by principal investigator to increase the consistency of the information.

4.8. Data Processing and Analysis

Quantitative data was entered in to Epi data 3 and, cleaned. Then data were exported to SPSS version 24.0 and Microsoft Excel 2016 for analysis. The analyzed quantitative data was presented using percentages, frequency distributions and appropriate graphs. The analysis of qualitative data was done manually. The data was summarized and analyzed thematically and relevant quotations were used to illustrate themes in the presentation of the study findings. The data were categorized thematically as challenges, possible solutions and customer satisfaction. Then the analyzed qualitative findings were triangulated with quantitative findings.

4.9. Variables

4.9.1. Dependent Variables

- Inventory management performance
    - Stock out rate
    - Inventory accuracy rate
    - Wastage rate
    - LMIS data accuracy
    - Storage condition

4.9.2. Independent Variables

a) Storage conditions related

- Cleanness
- Exposure to direct sun light
- Safety equipment
- Cold storage
- Security of storage
- Storage space

b) HR and Management related

- ❖ trainings
- ❖ No. of staffs
- ❖ supervision
- ❖ Type of profession
- ❖ Level of education
- ❖ Experience

c) Wastage related

- ❖ FEFO practice
- ❖ Receiving near expiry products
- ❖ Over-stocking

d) Logistic record quality related factors

- ❖ Availability of Bin cards, IFRR, RRF
- ❖ Bin updating practice
- ❖ HCMIS availability
- ❖ Stock recording
- ❖ RRF reporting
- ❖ Stock verification

e) Stock out related

- ❖ Inadequate supply from supplier
- ❖ Stock out at resupply point
- ❖ Expiry at HF
- ❖ Ordering frequency and time

4.10. Ethical Consideration

Ethical clearance was obtained from the Institutional Review Board of Jimma University, Institute of Health. Then officials and responsible bodies working in the seven public hospitals were communicated through letter. After the purpose of the study was explained, verbal informed consent was obtained from each study subjects prior to the interview.

4.11. Limitations of The Study

Some structural/administrative factors of the study setting/area were not considered; i.e. there are six regional and one federal teaching hospitals in the study area. Private hospitals, health centers and health posts were excluded from the study. In addition, as the updating practice of bin cards was found poor and only few commodities were candidate for RRF (program items), RRF data quality was not analyzed.

4.12. Plan for Dissemination of Finding

The findings of the study are disseminated to JMC,Jimma Zone Health Desk, Jimma Town Health Office, Oromiya Health Bureau and Jimma University in either hard or soft copy. The manuscript of the results of the study will be published on an international peer reviewed journal at least indexed and abstracted on DOAJ.

4.13. Operational Definitions

Laboratory Commodities: All key supplies, chemicals, reagents, test kits utilized for the clinical laboratory provision in Jimma City and Jimma Zone.

Stock out: Depleted supply of laboratory commodities; a zero-stock balance; a situation in which the demand or requirement for an item cannot be fulfilled from the current inventory in Jimma City and JimmaZone.

Good bin card updating practice: A bin card updating practice characterized by greater than 80% updated bin cards.

Poor bin card updating practice: A bin card updating practice characterized by less than 80% updated bin cards.

Stock out on the day of the visit: Lack of the laboratory commodity from the health facility on the day that the data collector arrived in Jimma City and JimmaZone

Inventory accuracy rate: It is a measure of the accuracy of laboratory commodities stock balances recorded in a bin card, or automated system over a range of items as a percentage of physical stock balances reviewed for accuracy. Percentage of availability of physical stock-on-hand compared to the one on the bin card. There are three terms used in related to inventory accuracy rate: accurate, near accurate and not accurate.

A) Accurate: this term indicates for 100% the inventory accuracy rate.
B) Near accurate: when the inventory accuracy rate deviates ± 10% from accurate.
C) not accurate: when the inventory accuracy rate deviates ± 10% beyond (82).

Wastage rate: It is the percentage of laboratory commodities for an item that is unusable because of expiration or damage during a period of one year to the total quantity of that item received during a year plus the quantity of that items found during the beginning period of the year in Jimma City and JimmaZone.

Inventory management: is the process of ordering, receiving, storage and distribution or issuing of laboratory commodities.

Inventory control: It is the purpose of identifying/determining when and how much to order and to maintain laboratory commodities an appropriate stock level to meet the clients' need.

Acceptable/Desired Storage Conditions: facilities or medical stores that fulfilled at least 80% of the storage conditions defined to evaluate evaluation of stores.

5. Results

5.1. Socio-Demographic Factors and Administrative Supports

The study revealed that4(57.7%) of the central store managers were druggists;on the other hand, 3(42.86%) of the store managers had an experience of 19 - 24 months and the mean service year of the respondents was 18.3 ± 4.546 months(Table 1).

Table 1: Socio-demographic information of respondents in the selected public hospitals, Jimma City and Jimma Zone (1-30 May, 2019)

Variable	Number	Percent
store manager profession		
Pharmacists	3	42.9%
Druggists	4	57.1%
Service year as a store manager		Mean: 18.3 ± 4.546
Seven - 12 months	1	14.29%
Thirteen - 18 months	3	42.86%
Nineteen - 24 months	2	28.57%
Above 24 months	1	14.29%
Trained on IPLS		
Yes	7	100%
No	0	0

Regarding the supportive supervision, all the public hospitals were supervised by either regional health bureau, or ministry of health or EPSA (higher level technical group or partners); of which 6(85.71%) of the public hospitals wereoverseen by RHB in the past 3 - 6 months prior to data collection. The areas of supply management addressed by the supportive supervision were bin card, reporting practice, storage conditions and expired stock management (Table 2).

Table 2: Recent supervision conducted on the selected public hospitals, Jimma City and Jimma Zone (1-30 May, 2019)

Variable	Number	Percent
Supportive supervision was conducted by		
FMoH	1	14.29
RHB/ZHD	6	85.71
When did you receive the most recent supervision		
within the last month	1	14.3
within the last 3 months	3	42.9
within the last 6 months	3	42.9
Recent supervision includes (refer to Q. 2)		
Bin card	6	85.71
Reports	4	57.7
Expired stock	2	28.6
Storage conditions	4	57.7

5.2. LMIS Performance

5.2.1. Availability of LMIS tool

The study shown that 6(85.71%) of the studied hospitals were using both paper-based and computerized LMIS. Bin cards and RRF were available in all selected public hospitals, but the utilization was not consistent among the hospitals (observation); IFRR was utilized in all facilities. Among 6(85.7%) of the studied hospitals RRF and order book were the major requisition formats for laboratory commodities. Preprinted IFRR pads were used in 5(71.4%) of studied hospitals (Table 3).

Table 3: Availability of LMIS in the selected public hospitals, Jimma City and Jimma Zone (1-30 May, 2019)

Variable	Number	Percent
Is there LMIS system in your facility?		
Yes	7	100
No	0	0
Type ofLMIS system implemented		
Paper based only	1	14.3
Computerized only (HCMIS or Dagu)	0	0
Both	6	85.7
What LMIS forms does the hospital use? (reported)		
Bin card	7	100
Stock card	0	0
IFRR	7	100
RRF	7	100
What forms does the hospital use for ordering supplies?		
Order book	3	42.9
RRF	6	85.7
Requisition and order voucher	1	14.29
What forms does the hospital use for receiving supplies?		
Delivery note	7	100
Does the hospital laboratory have standard preprinted requests and reporting forms (IFRR)?		
Yes	5	71.4
No, manually written form is used	2	28.6

5.2.2. Bin card Utilization and Updating Practice

The number of bin cards assessed in the seven studied hospitals were 322, that is, in each of the seven hospitals 46 commodities were assessed. From the total assessed commodities, 225(69.88%) of the items had bin-cards. And 130(58.07%) of the bin cards were updated. The study showed that 48% of the bin cards of the laboratory commodities were not updated; showing there was a gap in bin cards updating practice following every transaction of laboratory commodity (Figure 3).

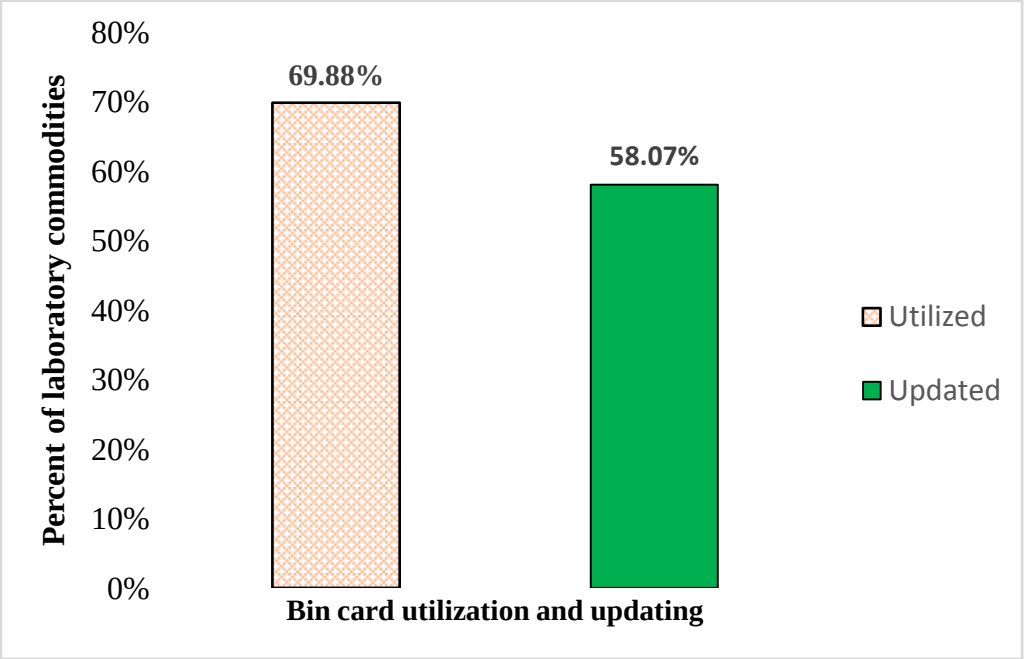


Figure 3: Bin card utilization and updating practice in selected public hospitals, Jimma City and Jimma Zone (1-30 May, 2019)

5.3. Inventory Management Performance of Laboratory Commodities

5.3.1. Ordering and Receiving Laboratory Commodities

In 4(57.1%) studied hospitals how much to order was determined by a pharmacy. And average monthly consumption (AMC) data was used to calculate how much to order in 5(71.4%) of the studied hospitals. On the other hand, all of the facilities sent their orders to EPSA-Jimma hub for resupply, and private suppliers were also used as a supplier to majority (71.4%, n = 5) of the studied health facilities. Among 3(42.9%) of the hospitals purchase order was initiated when

need arises only. In 4(57.1%) of the studied hospitals last report/order was prepared and sent two months prior to data collection. Regarding the emergency order, 4 (57.1%) of the studied hospitals placed one or two orders in the past 6 months prior to data collection (Table 4).

Table 4: Purchase order management in the selected public hospitals, JimmaCity and JimmaZone, May 2019

Variable	Number	Percent
Who determines how much to order?		
Pharmacy	4	57.1
Laboratory	1	14.3
Both	2	28.6
Which data elements do you use to calculate how much to order?		
Average monthly consumption	5	71.4
Number of tests	1	14.3
Stock remaining in the laboratory	1	14.3
Set maximum stock level for reagents	0	0
Where does this facility send its order for resupply?		
Jimma EPSA hub	7	100
Private suppliers/open market	5	71.4
How often do you place orders?		
Quarterly	2	28.6
every six months	2	28.6
When need arises	3	42.9
When was the last time you sent an order/report for products from this		

Variable	Number	Percent
facility?		
within last month	3	42.9
2 months ago,	4	57.1
How many emergency orders have you placed in the last 6 months?		
None	3	42.9
One to 2	4	57.1
Above 2	0	0
Time taken to receive the order		
Less than two weeks	2	28.6
2 weeks to a month	3	42.9
Between 1-2 months	2	28.6

5.3.2. Physical Inventory

The study also revealed that 6(85.7%) of the public hospitals conducted physical inventory either quarterly (n=3, 42.9%) or annually (n=3, 42.9%), and the rest 1\914.3%) conducted physical inventory every six months (Table 5).

Table 5: Stock verification of laboratory commodities in selected public hospitals, Jimma City and Jimma Zone (1-30 May, 2019)

Variable	Number	Percent
How often is a physical inventory of reagents and consumable supplies conducted in the central medical stores?		
Every quarter	3	42.9
Bi annually	1	14.3
Once annually	3	42.9

5.3.3. Inventory Accuracy

An evaluation of the accuracy of stocks record keeping of studied commodities was done at central stores and presented in Figure 4. The analysis showed that the percentage of stock records that is accurate was 30.43%. The percentage of recorded balances that is greater than and less than the physical counts was 41.3% and 28.26% respectively.

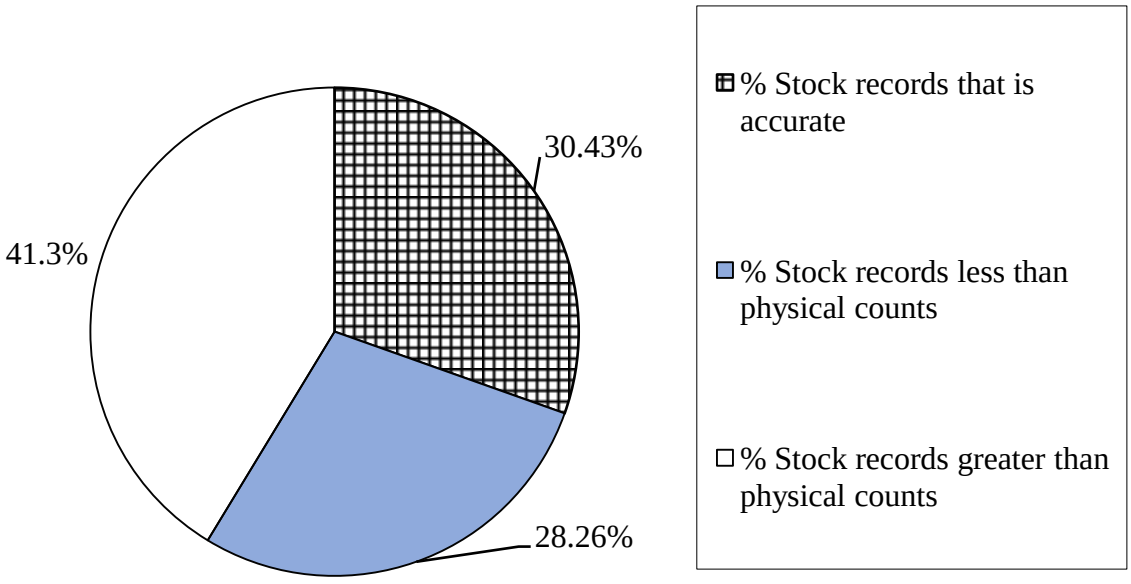


Figure 4: Inventory accuracy of laboratory commodities in selected public hospitals, Jimma City and Jimma Zone (1-30 May, 2019)

5.3.4. Stock Out of Laboratory Commodities

One hundred twenty-five (39.75%) of the line items experienced stock out during the time of data collection. The figure was higher in the past six months (58.07%) with mean stock out duration of 18 days. The average percentage of time that the studied commodities were out of stock in the past 100 days was 8.55% (Table 6).

Table 6: Stock out of laboratory commodities in selected public hospitals, Jimma City and Jimma Zone (1-30 May, 2019)

Variable	Number	Percent
Sock out (line items)		
At the time of data collection	125	39.75
In the past 6 months	187	58.07
Days out of stock within the last 100 days (Average percentage of time out of stock) `	8.5 days	8.55%
Mean duration of stock out in the past 6 months	18.3 days	

5.3.5. Wastage Rate

In this study the wastage rate for the studied laboratory commodities was calculated using the percent of wasted laboratory commodities by quantity and by value. The total monetary value of expired/damaged commodities in the studied hospitals was 277,291.31 Ethiopian Birr. The percentage of wasted laboratory commodities by value was 8.73%. On the other hand, the percent of expired/damaged laboratory commodities by quantity was 3.19% (Figure 5).

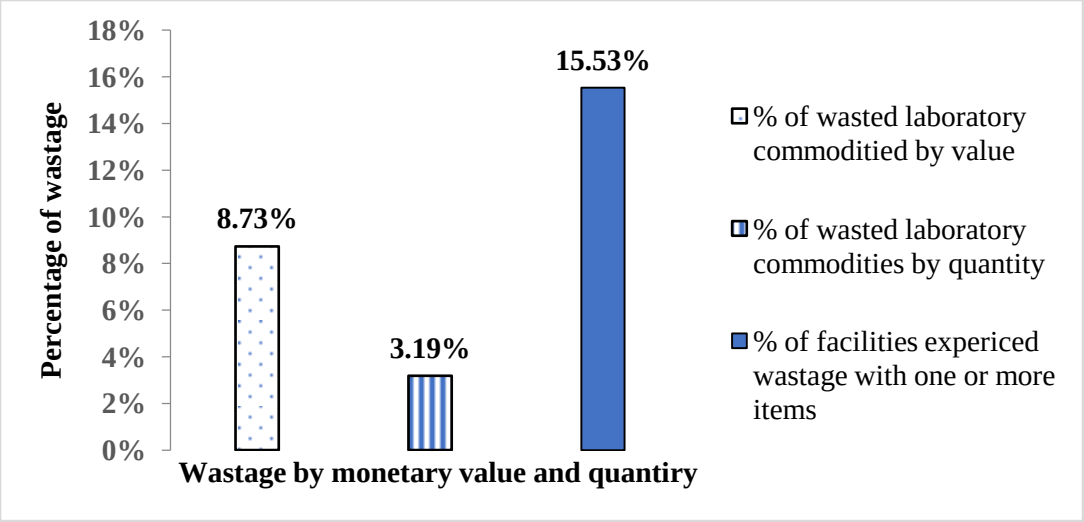


Figure 5: Wastage rate of laboratory commodities by value and quantity in selected public hospitals, Jimma City and Jimma Zone, May 2019

5.4. Storage Conditions

The studied public hospitals that fulfill acceptable or desirable storage conditions (≥ 80%) were1(14.3%), and the average storage conditions fulfilled by the studied public hospitals was 70.59%. Storage conditions fulfilled by all the seven hospitals include: visibility of identification labels, expiry dates and/or manufacturing dates; protection from direct sunlight; security of the storage with lock and accessibility to only authorized personnel. On the other hand, in none of the studied hospitals flammable and hazardous products were stored separately from other health commodities. Among 3(42.86%) of the studied hospitals expired or damaged products were not separated from the normal stock, the commodities were not protected from the direct sun light during all season, fire safety equipment was not available or accessible and the current storage space was not sufficient for existing products (Table 7).

Table 7: Adherence of the selected public hospitals to storage guideline, Jimma City and Jimma Zone (1-30 May, 2019)

Variable	Number	Percent
Products that are ready for distribution are arranged so that identification labels and expiry dates and/or manufacturing dates are visible.	7	100
Products are stored and organized in a manner accessible for first-to-expire, first-out (FEFO) counting and general management.	5	71.43
Cartons and products are in good condition, not crushed due to mishandling. If cartons are open, determine if products are wet or cracked due to heat/radiation (fluorescent lights in the case of condoms, cartons right-side up.	1	14.3
The facility makes it a practice to separate damaged and/or expired products from usable products and removes them from inventory.	4	57.14
Products are protected from direct sunlight at all times of the day and during all seasons.	7	100
Cartons and products are protected from water and humidity during all seasons.	4	57.14
Storage area is visually free from harmful insects and rodents. (Check the storage area for traces of rodents [droppings or insects].)	6	85.71
Storage area is secured with a lock and key, but is accessible during normal working hours; access is limited to authorized personnel.	7	100
Products are stored at the appropriate temperature during all seasons according to product temperature specifications.	6	85.71
Roof is always maintained in good condition to avoid sunlight and water penetration.	7	100
Storeroom is maintained in good condition (clean, all trash removed, sturdy shelves, organized boxes). 120	7	100
The current space and organization are sufficient for existing products and reasonable expansion (i.e., receipt of expected product deliveries for foreseeable future).	4	57.14

Products are stacked at least 10 cm off the floor.	5	71.43
Products are stacked at least 30 cm away from the walls and other stacks.	3	42.86
Products are stacked no more than 2.5 meters high.	7	100
Fire safety equipment is available and accessible (any item identified as being used to promote fire safety should be considered).	4	57.1
Products are stored separately from insecticides and chemicals.	0	0
Average	12	70.59
% of facilities that fulfill desirable storage conditions (n=7)	1	14.3

5.5. Qualitative result

The findings of qualitative study were reviewed carefully and categorized into three themes using a thematic approach. Finally, the information obtained was summarized and presented with narration as follows.

5.5.1. The Inventory and Logistics Information Management

In most of the hospitals inventory management was supported by HCMIS. The laboratory logistics officer/focal person was working with the pharmacy team in ordering (deciding how much to order). During ordering, sometimes, previous consumption data and tests performed were used as a source of data for procurement. The document review showed haphazard type of ordering; particularly waiting till the products gets stock out. The HCMIS was supported by a partner known as AIDS free project. Although there is a continuous support from the partner, adherence to updating the system is not as anticipated.

A) Challenges

i. Availability of the commodities

Most of the laboratory commodities were not available at the supplier side (both EPSA and private suppliers, especially the sole suppliers, and this problem was exaggerated by using closed system of the laboratory machines. These closed system machines utilize reagents supplied by

the sole suppliers. These sole suppliers do not supply with requested amount of the commodities. The suppliers complained for foreign exchange issues.

> *"…. I am a DSM officer assigned at the hospital and worked for the past two years. The sole suppliers did not respond to the request of the hospital. We did not obtain the quantity we ordered. For instance, 40 units were requested and supplied with 2 units only."*

ii. Administrative, financial and facility related challenges

Budget scarcity was one of the complains raised by the interviewees. Laboratory service heads reported that the budget allocated for the medical supplies was not sufficient. The pharmacy heads of the studied hospitals complained the attention the managers gave to the pharmacy service is weak. Delayed procurement due to unable to provide vehicles timely, and the stocks got depleted from the suppliers' side; this is because of the administration of the hospitals can not differentiate the vital commodities from the stationeries.

> *"… the hospital management provides very low attention for pharmacy department; if some department requests for any service and vehicle is requested by pharmacy for collecting commodities from suppliers, priority was given to other units. After an order is processed at hospital level, and the hospital management was notified, more than a month was waited; during this period the commodities got stock out from the supplier store. And when arriving the suppliers store, no stock or few were collected. As a result of this the complaint for the laboratory service and clients increasing from time to time."*

The majority of the refrigerators available in the studied public hospitals were not medical refrigerators, i.e., were home/kitchen refrigerators and did not have temperature monitoring devices either ingrained or external monitoring device. There were no data loggers attached to the refrigerators to check past performance of the refrigerators. There is high electric power interruption in the studied hospital. The back-up generator was not connected to one of the study hospitals. The network discontinuation in one of the hospitals was also another challenge.

"... we have applied for electric backup generator and network maintenance a lot of time, but the facility did not respond. It was due to the limited capacity of the generator. As a result of this the cold chain is not fully functional during power break up."

iii. Commitment of the supply chain staffs

Unless bin cards are updated timely after each and every transaction, the logistic data will not be reliable. The amount received, distributed/issued, damaged/expired will not be known; and the stock level will not be clearly defined. This may be related with professionals' negligence, specially the store managers. In this study, it was found that bin card updating was poor in most of the facilities.

"... there is no clear reason why the store managers were not updating bin cards, it is only due to poor attitude and sometimes negligence. When requested why they did not do the activity, their response is busy."

iv. Capacity building related

The store managers do not have sufficient knowledge on the management of laboratory commodities. There is a curriculum gap for pharmacy professionals on laboratory commodities management. In addition to this, lack of quantification skills on laboratory commodities, planning sourcing were also challenging.

"... I am a store manager working in a hospital, there is no training related to laboratory commodities management and supply chain management of this commodities. It was more than a year that I was assigned at this store, but there was no a single capacity building in this period. I was challenged during quantification, and purchase order preparation of these commodities."

B) Possible solutions to the challenges

The government should allocate sufficient budget for the hospitals for the procurement of laboratory commodities and backup laboratory machines. Arranging long term framework for at least annual procurement contract. Notifying the annual laboratory reagents need to the supplier

early and collecting the items as per the agreement. In addition to the procurement of the commodities, maintenance of the laboratory commodities should get attention.

Working in a team was also a forwarded solution. The pharmacy staffs should work as a team with laboratory staffs in selection, quantification, sourcing and distribution of the commodities. In addition to this, sharing knowledge and experience is also very important. The hospital management should also promote positive team building among all staffs.

Functioning the cold room of the specialized hospital and procuring the medical refrigerators should get attention. This requires additional budget; therefore, the health facility should work with partners to fill the gap. Connecting the backup generator to all medical stores to secure commodities safety and efficacy should also have to get priority.

Arranging off-site and on-site on-job trainings are also another solution. The EPSA has launched IPLS electronic version. Interested person should be registered and secure a certificate of recognition/completion. Implementing IPLS as prescribed as a standard should get emphasis,

C) Customer satisfaction

In most of the hospitals, customers were raising complain on laboratory service. As every patient coming to the hospitals might have possibility for visiting the laboratory, the availability of tests prescribed to the patients matters their satisfaction. One of the laboratory head told me that

"… *patients were almost always complaining for the lab service. Sometimes even stool or urine tests were not being available due to stock out of one or more reagents".*

6. Discussions

The eventual goal of the laboratory commodities inventory management is to ensure laboratory commodities availability at the public health facilities that will leads to higher customer satisfaction (serving customers) at reduced cost. The performance of inventory management of these commodities is one of the key reasons for success of public health facilities (17, 86).

6.1. LMIS performance

Accurate data reporting is one step in ensuring availability of laboratory commodities, on top of this, it reduces or cuts out stock outs, wastages, bull-hip effects. Every piece of information provides a room for sound logistics decision at each level of supply chain(87). Bin cards are an immediate source of information about the stock for store manager and those interested to check or know the stock status of any product. Accuracy of bin card shows the efficiency and commitment of those involved in managing laboratory commodities(88-90). The current study discovered that the reported availability of bin cards, RRFs and IFRRs at studied public hospitals was 100%; and none of the studied hospitals had stock card. But only 225(69.88%) of the laboratory commoditieshad bin cards.And 130(58.07%) of the bin cards were updated. This study is comparable with Lesotho (53%) (75)and Addis Ababa (50%)(45, 50)on bin card updating practice.During the in-depth face to face interview, the reason for poor utilization was explored and found to be the negligence and poor staff commitment. This shows the bin card utilization in the hospitals is not good when compared with the national and International standard value. The variation for deviation from the ideal standard might be due to high workload and the poor commitment of the store managers.

6.2. Inventory management performance

The present study indicated that 51.7% of the studied public hospitals laboratory commodities were ordered by the pharmacy department based on AMC data. This finding was higher than that of Lesothowhich was 33%(75). The current finding does not comply with the IPLS in which AMC data were used for ordering of health commodities in the forced min-max inventory control system(72). The qualitative finding showed that lack of capacity building on ordering and quantifying laboratory commodities was a challenge for store managers. Therefore, the

difference seen on this finding might be due to the absence of continued professional development besides the staff commitment.

Conducting physical inventory for stock verification is important, it supports the store managers and logisticians to check if the inventory records are accurate and complete at any time. The more frequent the stock verification is done the more the accurate data will be generated and used for decision(4, 20). The current study disclosed that about 42.9% of the studied hospitals conducted physical inventory at least quarterly. In contrast to this, according to the nationalguideline on stock verification, physical inventory has to be conducted quarterly in central stores. The result of this study was poor compared to the national guideline(3). This might happen because of low follow-up of the hospital management and poor adherence to the national guideline.

The current study showed that inventory accuracy rate of laboratory commodities was 30.43%, implying the accuracy of inventory records was lower than the standard. The finding of the present study is lower when compared with a study conducted in Zimbabwe which was 60%(47); and slightlylower than that of Addis Ababa public facilities, that is,38.9% (50). The difference may be due to absence of supportive supervision from the management andpoor commitment of the store managers besides data recording errors.

In this study 39.75% of the key laboratory commodities experienced stock out at the time of data collection and higher figure (58.07%) was reported six months prior to data collection with mean stock out duration of 18 days. This indicate a very higher stock our of laboratory commodities, which directly affects the trust the customers have on health care system, i.e. impairs patient satisfaction(4). The finding of the present study is comparable with a study conducted in TikurAnbessa, Addis Ababa where 37% of the commoditiesexperienced stock out(26). The variance in the verdicts might be due to lack of inventory management skill, lack of commitment of hospitalmanagement in the current study. This study also identified the reasons for stock outs inadequate supply from source, lower commitment of the logistics personnel and lower attention given to pharmacy department for arranging transportation.

Concerning the wastage of laboratory commodities, this study indicated that 277,291.31 Ethiopian Birr was lost in the studied hospitals. The wastage rate was 8.73%. This result is lower than the finding of study conducted in Rwanda (27) and Uganda (76), which were 42%

and 23% respectively. But it is four times higher than the nationally set wastage rate(25). This shows that there was a high wastage rate. The difference of the findings could be the type of commodities studied where ARVs laboratory commodities were studied in compared results. In addition to this, poor adherence to the Federal Hospitals Pharmacy directive which dictates exchange commodities before the items expired(91)and lower commitment of the store managers might be the reasons for the higher wastage.

6.3. Storage Conditions

Good storage practice should be ensured at health facilities. Some commodities may have special storage conditions (for example, cold temperature) and has to be stored according to the manufacturers' storage requirements. The storage area has to be dry, well-lit, well-ventilated, out of direct sunlight, equipped with safety equipment (for example, fire extinguisher), clean, of sufficient space, with standard pallets and shelves (92). This study revealed that only 1(14.3%) of the studied public hospitals achieved desirable storage conditions.This finding show that majority of studied hospitalsdoes not fulfilled the desirable storage conditions.This might be associated with poor adherence of the store managers to the storage guidelines and inadequacy of warehouse materials such shelves and pallets. When each criterion was considered, the average storage conditions fulfilled was 70.59% in the current study. The current finding isslightly higher than Lesotho (57.43%)(75) and Addis Ababa (63.64%)(45).

In all studied public hospitals,hazardous and flammable chemicals were stored with other pharmaceuticals. This is against the storage guideline (3). This is associated with a challenge reported during in-depth interview. The emphasis given to Pharmacy department is too low as compared to other departments and the absence of facilities and infrastructure at health facilities was also quoted by respondents.

7. Conclusions and Recommendations

7.1. Conclusions

Based on the results of the study the following conclusions are drawn. The data quality of LMIS was poor and characterized by inaccurate records and poor record updating practice. There was a frequent stock out of laboratory commodities, and the wastage rate was higher than the nationally set rate. The inventory records were inaccurate. Most of the facilities did not fulfill acceptable storage conditions. The challenges associated with inventory management include, stock out at the supplier side, lack of budget at facilities, low administrative support from facility management, absence of facilities/infrastructure, absence of accurate data, lack of staff commitment and absence of continuous professional development.

7.2. Recommendations

The following recommendations are forwarded from the study findings. Accordingly,

To Public hospitals in Jimma City and Jimma Zone

- There should be a continuous improvement plan that addresses the gaps seen on LMIS, stock handling, and in inventory management which should be accompanied by on-job training for store managers and logisticians and management support.
- The public hospitals should conduct stock status analysis on routine basis
- The Public hospitals should adhere to the appropriate storage guideline.
- Managements of public hospitals found in Jimma City and Jimma Zone should supervise and support the pharmacy department.

To researchers

- Further studies should be conducted to explore challenges comprehensively in all health facilities.

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Annexes

Annex A: List of key Laboratory commodities

S/N	List of key commodities	Unit	Remarks
1	Field stain A reagent	1 gram	
2	Field stain B reagent	1 gram	
3	Gram stain reagent	1 gram	
4	ZN stain reagent	1 gram	
5	Sodium chloride reagent	1 gram	
6	Formalin, solution	1 liter	
7	Ether	1 liter	
8	India ink	1 mL	
9	Potassium hydroxide, reagent	1 gram	
10	Pregnancy test kit	1 test	
11	HIV test kit (Determine)	1 test	
12	HIV test kit (Uni-Gold^{TM})	1 test	
13	Viral load reagents	1 kit	
14	CD4 test reagents	1 kit	
15	RPR/VDRL kit	1 test	
16	Hepatitis screening kit	1 test	
17	Chemistry autoanalyser reagent kit, glucose	1 test	
18	Chemistry autoanalyser reagent kit, creatine	1 test	
19	Chemistry autoanalyser reagent kit, GOT (AST)	1 test	
20	Hematology autoanalyser reagent kit	1 test	
21	Gram stain reagent, crystal violet	1 liter	
22	Gram stain reagent, iodine	1 liter	
23	Gram stain reagent, alcohol	1 liter	
24	Gram stain reagent, safranin	1 liter	
25	ZN Kinyoun stain	1 liter	
26	ZN acid-alcohol solution	1 liter	
	Culture media		
27	a. Blood agar	1 bottle	
28	b. McConkey	1 bottle	

S/N	List of key commodities	Unit	Remarks
29	c. Muller Hinton	1 bottle	
30	d. Powder Hb	1 bottle	
31	e. TSI (triple sugar iron agar)	1 bottle	
32	Oxidase reagents	1 gram	
33	Typing antisera	1 mL	
34	Sensitivity antibiotic discs	1 ampoule	
35	Methanol	1 liter	
36	Xylene	1 liter	
37	Immersion oil	1 mL	
38	Disinfectant	1 liter	
39	Hand soap	1 bar of soap	
40	Unused sharps boxes	1 box	
41	Gloves	1 pair	
42	Waste receptacle	1 receptacle	
43	Goggles	1 pair of goggles	
44	Mask	1 mask	
45	Apron (plastic)	1 apron	
46	Laboratory coats	1 coat	

Annex B: List of indicators used to measure Laboratory Commodities Inventory management performance & LMIS

1. $Stock\ out\ rate = \frac{Number\ \ of\ items\ \ that\ experienced\ \ \ stock\ \ out\ \ in\ a\ specific\ \ period}{total\ \ number\ \ \ of\ products\ \ \ exp ected\ \ to\ be\ availed} \times 100$
2. $Stock\ out\ rate\ at\ the\ time\ of\ \ visit\ =$

   $\frac{Number\ \ of\ items\ \ that\ experienced\ \ \ stock\ \ out\ T\ he\ time\ \ of\ assessment}{Total\ \ number\ \ \ of\ commodities\ \ \ assessed} \times 100$
3. $Average\ percentage\ of\ \ time\ that\ products\ are\ out\ of\ \ stock\ =$

   $\frac{sum\ \ of\ \ DAYS\ out\ \ of\ \ stock\ \ wit hin\ the\ last\ \ 100\ days}{Total\ \ number\ \ \ of\ commodities\ \ \ assessed\ \times 100\ days} \times 100$
4. $Bin\ card\ updating\ practice = \frac{total\ \ number\ \ \ of\ items\ \ of\ \ which\ bincard\ \ \ updated}{total\ \ number\ \ \ of\ items\ \ that\ have\ \ bin\ card} \times 100$
5. $Inventory\ accuracy\ rate = \frac{Stock\ \ record\ \ \ count - physical\ \ stock\ \ count}{physical\ \ \ stock\ \ count} \times 100$
6. $Percentage\ of\ \ recorded\ balances\ that\ is\ less\ than\ physical\ counts\ =$

   $\frac{No.of\ \ commodities\ \ \ less\ \ than\ physical\ \ counts}{Total\ \ number\ \ \ of\ commodities\ \ \ assessed} \times 100$
7. $Percentage\ of\ \ recorded\ balances\ that\ is\ less\ greater\ physical\ counts\ =$

   $\frac{No.of\ \ commodities\ \ \ greater\ \ \ than\ physical\ \ counts}{Total\ \ number\ \ \ of\ commodities\ \ \ assessed} \times 100$
8. $Ratio\ of\ \ inventory\ variation\ to\ physical\ \ stock\ \ =$

   $\frac{Difference\ \ \ between\ \ \ recorded\ \ \ and\ physical\ \ values}{Physical\ \ \ quantity\ \ \ (ba sed\ on\ actual\ \ \ count\ )} \times 100$
9. $Percentage\ of\ \ products\ available = \frac{Total\ \ products\ \ \ in\ stock}{Total\ \ no.of\ \ products\ \ \ assessed} \times 100$
10. $Stock\ wastage\ rate = \frac{Unusab\ le\ physical\ \ \ stock}{Total\ \ \ quantity\ \ \ of\ usable\ \ \ and\ \ unusable\ \ \ \ stock} \times 100$
11. $Value\ of\ \ unusable\ stock = \frac{value\ \ \ of\ \ wasted\ \ \ units\ \ per\ \ product}{value\ \ \ of\ \ total\ \ \ unit s\ purc hased\ \ of\ \ same\ \ \ product} \times 100$
12. $Storage\ condition = \frac{number\ \ \ of\ \ storage\ \ \ criteria\ \ \ fulfilled}{total\ \ \ number\ \ \ of\ \ storage\ \ \ criteria} \times 100$

Annex C: Data collection tools

Code of the hospital_____

Region _____

Date: _____

First ask the store manager and then the Head of the pharmacy and/or DSM officer. Then, visit the warehouse and laboratory store.

Part A: General issues

1. Who is the principal person responsible for laboratory commodities at this facility?
   A. Laboratory technologist
   B. Clinical Officer
   C. Druggist
   D. Pharmacist
   E. Other
2. What is your profession?
   A. Nurse
   B. Clinical Officer
   C. Druggist
   D. Pharmacist
   E. Laboratory technologist
3. What is your education level?
   A. Master's Degree
   B. BSC degree
   C. Diploma
   D. Certificate
4. What is your position in this health facility?
   A. Store manager
   B. Pharmacy head
   C. Supply manager
5. How many years you have served in this position? Year _____ Month _____

6. Who determines this facility's resupply quantity?

A. The facility itself

B. Higher-level facility

C. Other

7. How are the facility's resupply quantities determined?

A. Formula

B. Don't know

C. Other means

8. How did you learn to complete the forms/records used at this facility?

A. Never learned

B. During a logistics workshop

C. On-the-job training

D. On-the-job (self-learning)

E. From pears

9. From whom did you receive, your most recent supervision? From _____

10. When did you receive, your most recent supervision visit?

A. Never received

B. Within the last month

C. Within the last 3 months

D. Within the last 6 months

E. More than 6 months ago

11. Did your supervision visit include drug management, such as

A. Stock card checked

B. Reports checked

C. Expired stock removed

D. Storage condition checked

Part B: LMIS related

12. Is there LMIS system in your facility?

A. Yes

B. No

13. If yes to ques. No 12, is it computer based or paper based?

A. Computer

B. Paper

C. Both

14. What LMIS forms does the hospital use? DO NOT READ LIST. PROMPT "ANYTHING ELSE?" (Check all that apply and verify.)
    A. Bin cards
    B. Stockcards
    C. IFRR
    D. RRF
    E. Other (*specify*):…….
    F. None
15. What forms does the hospital use for ordering supplies? DO NOT READ LIST. PROMPT "ANYTHING ELSE?" (Check all that apply and verify.)

    A. Orderbook

    B. RRF

    C. Requisition and Issue voucher

    D. Other (*specify*):…….

16. Do LMIS reports include the following?

    A. Stock on hand

    B. Quantities used

    C. Loss/adjustment

17. How often are these LMIS reports sent to the highest level?

        A. Monthly

        B. Bimonthly

        C. Quarterly

        D. Semiannually

        E. Annually

18. What forms does the hospital use for receiving supplies?
    A. Deliverynote

    B. Requisition and Issue voucher

    C. Other (*specify*):…….

19. Does the hospital laboratory have standard preprinted requests and reporting forms (IFRR)?

A. Yes

B. No

C. Don’t know/not sure

20. If NO to question 18, what supports or forms are used for lab commodities requesting and reporting? (Specify.) _____
_____
_____

Part C: Inventory Management performance

21. Does the hospital have a set minimum stock level for reagents and consumables at which orders need to be placed?

A. Yes

B. No

C. Don’t know/notsure

22. Does the hospital have a set maximum stock level for reagents and consumables above which the inventory level should not go?

A. Yes

B. No

C. Don’t know/notsure

23. Who determines how much to order?

A. Laboratory

B. Pharmacist

C. Higher levelauthorities

D. Other(*specify)* _____

24. Which data elements do you use to calculate how much to order? DO NOT READ LIST. PROMPT “ANYTHING ELSE?” *(Check all that apply.)*

A. Average monthly consumption

B. Number of tests performed

C. Stock remaining in the laboratory

D. Set maximum stock level forreagents

E. Other(*specify*) _____

F. Don’t know/notsure

25. Where does this facility send its order for resupply? *(Check all that apply.)*

A. JimmaEPSA hub

B. Central EPSA

C. FMoH

D. Private supplier/Open market

E. Other (*specify*) _____

26. How often do you place orders?

A. Monthly

B. Quarterly

C. Every 6months

D. Other(*specify)* _____

27. When was the last time you sent an order/report for products from this facility?

A. Within the last month

B. 2 months ago

C. 3 months ago

D. 3 months ago

28. How many emergency orders have you placed in the last 6 months?

A. None

B. 1

C. 2

D. Other (specify) _____

29. On average, approximately how long does it take between ordering and receiving products?

A. Less than 2 weeks

B. Weeks to 1 month

C. Between 1 and 2 months

D. More than 2 months

E. >3

30. Under normal circumstances, how long does it take from the time you place an order to the time the supplies are available for use?

A. _____days

B. _____months

C. Don't know/not sure

31. Are there certain commodities that you always stock out before resupply? If no to 31, go to no. 34.

A. Yes

B. No

32. If yes to question 21, list the commodities you stick out of the most frequently.

1. _____

2. _____

3. _____

33. What are the reasons for stock out?

1._____

2._____

3. _____

34. Do you always have a surplus of certain commodities before resupply? If no to 34, go to 36

A. Yes

B. No

35. If yes to question 25, list the commodities you have a surplus of most frequently.

1._____

2._____

3. _____

36. Is there expired or damaged product?

Yes

No

37. What are the reasons for expiry?

1._____

2._____

3. _____

38. How do you arrange your products?

A. By FIFO

B. By LIFO

39. If you are experienced stock outs in the resent **6** months as of question no. 21 above, Please specify the reasons for the stock outs)

_____

_____

_____

_____

_____

_____

40. How often is a physical inventory of reagents and consumable supplies conducted in the central medical stores? Every _____months

Part D: Observation checklist for Storage condition

SN	Description	Yes	No	Comment
41	Products that are ready for distribution are arranged so that identification labels and expiry dates and/or manufacturing dates are visible.			
42	Products are stored and organized in a manner accessible for first-to-expire, first-out (FEFO) counting and general management.			
43	Cartons and products are in good condition, not crushed due to mishandling. If cartons are open, determine if products are wet or cracked due to heat/radiation (fluorescent lights in the case of condoms, cartons right-side up			
44	The facility makes it a practice to separate damaged and/or expired products from usable products and removes them from inventory.			
45	Products are protected from direct sunlight at all times of the day and during all seasons.			

SN	Description	Yes	No	Comment
46	Cartons and products are protected from water and humidity during all seasons.			
47	Storage area is visually free from harmful insects and rodents. (Check the storage area for traces of rodents [droppings or insects].)			
48	Storage area is secured with a lock and key but is accessible during normal working hours; access is limited to authorized personnel.			
49	Products are stored at the appropriate temperature during all seasons according to product temperature specifications.			
50	Roof is always maintained in good condition to avoid sunlight and water penetration.			
51	Storeroom is maintained in good condition (clean, all trash removed, sturdy shelves, organized boxes).			
52	The current space and organization are sufficient for existing products and reasonable expansion (i.e., receipt of expected product deliveries for foreseeable future).			
53	Products are stacked at least 10 cm off the floor.			
54	Products are stacked at least 30 cm away from the walls and other stacks.			
55	Products are stacked no more than 2.5 meters high.			
56	Fire safety equipment is available and accessible (any item identified as being used to promote fire safety should be considered).			
57	Products are stored separately from insecticides and chemicals.			

Part E: Inventory management assessment tool: Data collection and calculation sheet

A	B	C	D	E	F	G	H
#	Name of product	Unit	# DAYS out of stock within the last 100 days. Starting date / /	Last stock balance recorded on stock cards. *Do not correct errors!*	Physical quantity (based on actual count)	Difference between recorded and physical values *(E-F)*	Absolute value of G |*G*| *(remove minus signs from results in column G)*
1	Field stain A reagent	1 gram					
2	Field stain B reagent	1 gram					
3	Gram stain reagent	1 gram					
4	ZN stain reagent	1 gram					
5	Sodium chloride reagent	1 gram					
6	Formalin, solution	1 liter					
7	Ether	1 liter					
8	India ink	1 mL					
9	Potassium hydroxide, reagent	1 gram					
10	Pregnancy test kit	1 test					
11	HIV test kit (Determine)	1 test					
12	HIV test kit (Uni-Gold^{TM})	1 test					
13	Viral load reagents	1 kit					
14	CD4 test reagents	1 kit					
15	RPR/VDRL kit	1 test					
16	Hepatitis screening kit	1 test					
17	Chemistry autoanalyser reagent kit, glucose	1 test					
18	Chemistry autoanalyser reagent kit, creatine	1 test					

A	B	C	D	E	F	G	H
#	Name of product	Unit	# DAYS out of stock within the last 100 days. Starting date / /	Last stock balance recorded on stock cards. *Do not correct errors!*	Physical quantity (based on actual count)	Difference between recorded and physical values *(E-F)*	Absolute value of G |*G*| *(remove minus signs from results in column G)*
19	Chemistry autoanalyser reagent kit, GOT (AST)	1 test					
20	Hematology autoanalyser reagent kit	1 test					
21	Gram stain reagent, crystal violet	1 liter					
22	Gram stain reagent, iodine	1 liter					
23	Gram stain reagent, alcohol	1 liter					
24	Gram stain reagent, safranin	1 liter					
25	ZN Kinyoun stain	1 liter					
26	ZN acid-alcohol solution	1 liter					
27	Blood agar	1 bottle					
28	McConkey	1 bottle					
29	Muller Hinton	1 bottle					
30	Powder Hb	1 bottle					
31	TSI (triple sugar iron agar)	1 bottle					
32	Oxidase reagents	1 gram					
33	Typing antisera	1 mL					
34	Sensitivity antibiotic discs	1 ampoule					

A	B	C	D	E	F	G	H
#	Name of product	Unit	# DAYS out of stock within the last 100 days. Starting date / /	Last stock balance recorded on stock cards. *Do not correct errors!*	Physical quantity (based on actual count)	Difference between recorded and physical values *(E-F)*	Absolute value of G |*G*| *(remove minus signs from results in column G)*
35	Methanol	1 liter					
36	Xylene	1 liter					
37	Immersion oil	1 mL					
38	Disinfectant	1 liter					
39	Hand soap	1 bar of soap					
40	Unused sharps boxes	1 box					
41	Gloves	1 pair					
42	Waste receptacle	1 receptacle					
43	Goggles	1 pair of goggles					
44	Mask	1 mask					
45	Apron (plastic)	1 apron					
46	Laboratory coats	1 coat					

Part F: LMIS Data Quality: Usable Stock on Hand at Time of Most Recent LMIS Report

Commodity	Usable Stock on Hand (at time of most recent LMIS report)			
	According to most recent LMIS report	From stock ledger or stock cards from time of LMIS report	% Discrepancy (col.3–col.2/col.2) *100	Reasons for discrepancy
1	2	3	4	5
Field stain A reagent				
Field stain B reagent				
Gram stain reagent				
ZN stain reagent				
Sodium chloride reagent				
Formalin, solution				
Ether				
India ink				
Potassium hydroxide, reagent				
Pregnancy test kit				
HIV test kit (Determine)				
HIV test kit (Uni-Gold^{TM})				
Viral load reagents				
CD4 test reagents				
RPR/VDRL kit				
Hepatitis screening kit				

Commodity	Usable Stock on Hand (at time of most recent LMIS report)			
	According to most recent LMIS report	From stock ledger or stock cards from time of LMIS report	% Discrepancy (col.3–col.2/col.2) *100	Reasons for discrepancy
1	2	3	4	5
Chemistry autoanalyser reagent kit, glucose				
Chemistry autoanalyser reagent kit, creatine				
Chemistry autoanalyser reagent kit, GOT (AST)				
Hematology autoanalyser reagent kit				
Gram stain reagent, crystal violet				
Gram stain reagent, iodine				
Gram stain reagent, alcohol				
Gram stain reagent, safranin				
ZN Kinyoun stain				
ZN acid-alcohol solution				
Blood agar				
McConkey				
Muller Hinton				
Powder Hb				
TSI (triple sugar iron agar)				
Oxidase reagents				

Commodity	Usable Stock on Hand (at time of most recent LMIS report)			
	According to most recent LMIS report	From stock ledger or stock cards from time of LMIS report	% Discrepancy (col.3–col.2/col.2) *100	Reasons for discrepancy
1	2	3	4	5
Typing antisera				
Sensitivity antibiotic discs				
Methanol				
Xylene				
Immersion oil				
Disinfectant				
Hand soap				
Unused sharps boxes				
Gloves				
Waste receptacle				
Goggles				
Mask				
Apron (plastic)				
Laboratory coats				

Accurate 0%, Near accurate +- 10% and above not accurate

PART G: Stock Status (Specify a full six-month period prior to the survey; and the day of visit)

Maximum months of stock_____ Minimum months of stock _____ Order interval_____

Note: For any product that experienced a stockout in the last 6 months (including the day of visit), please note reasons (by product).

Are stock cards and reports completed using the smallest unit of count? Y/N

Product	Units of count	Managed at this facility?	Physical inventory—Store room	Stockout today? (Y/N)	Quantity of expired products	Stock card available? (Y/N)	Stock card updated? (Y/N)	Balance on stock card	Stockout most recent 6 months (Y/N)	Number of stockouts	Total number of days stocked out	Total issued (most recent 6 months)	Number of days of data available
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Field stain A reagent													
Field stain B reagent													
Gram stain reagent													
ZN stain reagent													
Sodium chloride reagent													
Formalin, solution													
Ether													
India ink													
Potassium hydroxide, reagent													
Pregnancy test kit													
HIV test kit													

Product	Units of count	Managed at this facility?	Physical inventory—Store room	Stockout today? (Y/N)	Quantity of expired products	Stock card available? (Y/N)	Stock card updated? (Y/N)	Balance on stock card	Stockout most recent 6 months (Y/N)	Number of stockouts	Total number of days stocked out	Total issued (most recent 6 months)	Number of days of data available
1	2	3	4	5	6	7	8	9	10	11	12	13	14
(Determine)													
HIV test kit (Uni-Gold™)													
Viral load reagents													
CD4 test reagents													
RPR/VDRL kit													
Hepatitis screening kit													
Chemistry autoanalyser reagent kit, glucose													
Chemistry autoanalyser reagent kit, creatine													
Chemistry autoanalyser reagent kit, GOT (AST)													
Hematology autoanalyser reagent kit													
Gram stain reagent, crystal violet													

Product	Units of count	Managed at this facility?	Physical inventory—Store room	Stockout today? (Y/N)	Quantity of expired products	Stock card available? (Y/N)	Stock card updated? (Y/N)	Balance on stock card	Stockout most recent 6 months (Y/N)	Number of stockouts	Total number of days stocked out	Total issued (most recent 6 months)	Number of days of data available
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Gram stain reagent, iodine													
Gram stain reagent, alcohol													
Gram stain reagent, safranin													
ZN Kinyoun stain													
ZN acid-alcohol solution													
Blood agar													
McConkey													
Muller Hinton													
Powder Hb													
TSI (triple sugar iron agar)													
Oxidase reagents													
Typing antisera													
Sensitivity antibiotic discs													
Methanol													
Xylene													

Product	Units of count	Managed at this facility?	Physical inventory—Store room	Stockout today? (Y/N)	Quantity of expired products	Stock card available? (Y/N)	Stock card updated? (Y/N)	Balance on stock card	Stockout most recent 6 months (Y/N)	Number of stockouts	Total number of days stocked out	Total issued (most recent 6 months)	Number of days of data available
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Immersion oil													
Disinfectant													
Hand soap													
Unused sharps boxes													
Gloves													
Waste receptacle													
Goggles													
Mask													
Apron (plastic)													
Laboratory coats													

Part G: In-depth interview guide

1. How do you see the inventory management practice of your hospital? What about LMIS condition at your hospital? Are they being practiced? How? _____

_____

_____

_____

_____

2. What are the challenges associated with Inventory management of laboratory commodities? _____

_____

_____

_____

_____

3. **What are the root causes of these challenges? What are the possible solutions?**

_____

_____

_____

_____

_____

4. What measures were taken to alleviate the challenges? _____

_____

_____

_____

5. How did you overcome the problems/challenges? _____

_____

_____

6. How do the customers feel the laboratory service of your hospital? _____

_____

_____

_____

_____

7. What are the opportunities the hospital does not utilized to improve the inventory management of lab commodities**?** _____

_____

_____

_____

_____