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Addis Ababa University
School of Information Science and
School of Public Health
M.Sc. in Health Informatics Programme

Project Title:

**Assessment and Improvement of Quality of Medical Laboratory Commodity Logistics
Management Information Systems in Saint Paul's Hospital Millennium Medical College**

By:-

Muhe Bilal

Addis Ababa, Ethiopia

June, 2015

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Saint Paul's Hospital Millennium Medical College

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Dedication

I bestow my project paper to my mother Hawa Yusuf and relatives. I dedicate this work and give special thanks to my sweet daughters Wildan and Amal Muhe. And also to my wife Medina Nasir which she was not left side me.

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Abbreviations and Acronyms

AAU	Addis Ababa University
AFB	Acid Fast Bacilli
AIDS	Acquired Immunodeficiency Syndrome
ALP	Alkaline Phosphate
ART	Antiretroviral Therapy
BUN	Blood Urea Nitrogen
CD4+	T-lymphocyte Bearing CD4 Receptor
EOP	Emergency Order Point
et.al	And others
FMOH	Federal Ministry of Health
GOT	Glutamate Oxaloacetate Transaminase
GPT	Glutamate pyruvate transaminase
HIV	Human Immunodeficiency Virus
IPLS	Integrated pharmaceutical logistics system
IRB	Institutional Review Board
JSI/DELIVER	John Snow Inc. / Deliver project
LIAT	Logistics Indicator Assessment Tool
LMIS	Logistics Management Information System
LSAT	Logistics System Assessment Tool
MOH	Ministry of Health
MSH	Management Sciences for Health
NGO	Non-Governmental Organization
PATH	Program for Appropriate Technology in Health
PFSA	Pharmaceuticals Fund and Supply Agency
RHB	Regional Health Bureau
SCMS	Supply Chain Management System
SDP	Service Delivery Points
SPSS	Statistical package for social sciences
TB	Tuberculosis
USAID	United States Agency for International Development

Abstract

Background: Laboratory logistics management information system is the management of laboratory commodities in a systematic and standardized way by collecting, processing and utilizing timely logistics data to inform quantification, procurement, storage and distribution of laboratory commodities.

Objectives: to assess and improve the quality of medical laboratory commodities of logistics management information system in St. Paul's Millennium Medical College.

Methodology: facility based cross-sectional descriptive study design was conducted from April, 2015 to June, 2015. The data's were collected using self administered structured questionnaire for quantitative and semi structured interviewee questionnaires was implemented for qualitative findings. Intervention and problem solving mechanism was practiced.

Scope of the project: maintaining LMIS to provide quantity and quality of the laboratory commodities that was served and satisfied the community without interruption of the services through the six basic rights of logistics.

Significance of the project: is to provide reliable, accurate and manageable with specified period that easily monitored and controlled use of laboratory commodities of stock status.

Result: in the selected facility there was a well-functioning logistics management information system for laboratory commodities. Among the total participants 15(83.3%) of the respondents did not have in-service training on LMIS. The frequency of stock out, under stock and over stock of laboratory commodities at the time of assessment were 35.7%, 23.8% and 9.5% respectively.

Conclusion: the majority of study participants have no knowledge about LMIS and monitoring the stock status of laboratory commodity.

Recommendation: In-service training should provide for laboratory professionals and integration of LMIS to laboratory information system should implement to minimize the gaps.

Chapter One

1. Introduction

1.1 Background

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 from point of origin to point of consumption [1]. Laboratory logistics management information system is the management of laboratory commodities in a systematic and standardized way by collecting, processing and utilizing timely logistics data to inform quantification, procurement, storage and distribution of laboratory commodities or reagents [2]. A logistics management information system (LMIS) is the system of records and reports that uses to collect, organize, and present logistics data gathered across all levels of the system [3].

Logistics Management Information System (LMIS) provides the mechanism through which personnel collect, manage, and report such information, which is necessary to support sound and objective logistics decision making. The goal of this decision making is to ensure an uninterrupted supply of commodities and to identify any problems in the supply pipeline. Data provided through the LMIS also help inform policy and product selection decisions [2]. Furthermore, well-functioning LMIS provides decision-makers throughout a supply chain with accurate, timely, and appropriate data, such as stock on hand, losses and adjustments, consumption, demand, issues, shipment status, and information about the cost of commodities managed in the system [4].

An effective logistics system helps provide adequate, appropriate supplies to health providers, increasing their professional satisfaction, motivation, and morale. Motivated staffs are more likely to deliver a higher quality of service. If a logistics system provides a reliable supply of commodities, more people are likely to use health services. Customers feel more confident about the health program when they have a constant supply of commodities—it motivates them to seek and use services [3]. A well implemented LMIS reduces the likely hood of stock outs and overstocks that can waste scarce resources and lead to product expiration [5].

Typically, LMIS should collect the three essential data items needed to make logistics decisions: stock on hand, quantities dispensed to user or used in a given period of time (consumption), and losses and adjustments to stock for purposes other than use (expiry, damage, wastage, theft, etc.). Those data are recorded on stock-keeping records, transaction records, and consumption records. The data are then used at the facility and are reported to higher levels for resupply and management purposes. Information provided to higher levels is processed and reported back to lower-level facilities as feedback reports to encourage and improve the performance of the logistics system [6].

A well-designed logistics system is fundamental in providing a continuous supply of good quality health commodities throughout the health system. In designing a logistics system, the environmental and political context of the country in which the system is to be implemented must be considered, including future plans for computerization or integration of health services and supply chains [7]. Automation of a logistics management information system can greatly facilitate the work of supply chain managers by enabling faster collection, transmission, and aggregation of data; by reducing human error in calculations; and by allowing for visibility of data up and down the supply chain [4].

The desired outcome of a computerized LMIS is a user-friendly system that meets the LMIS requirements and is used by the appropriate people to make informed logistics decisions. The right information needs to flow from the point-of-use to the computerized LMIS in a timely manner, and be converted into information that can be used for decision-making at all levels of the system [8]. Moreover, maintaining a logistics system is an enduring activity that involves a continual process of assessing, designing/redesigning, and implementing [7].

The global health community recognizes that strong health systems are the foundation to effectively deliver health services that produce better health outcomes. Strengthening health systems in developing countries requires improved decision-making capacity at all levels and building capacity in countries with the least resources requires strengthening the management of health systems as a whole [9]. As countries continue to expand health programs and strengthen the supply chains that support them, there is an increased need for simple to use tools and software packages to support the logistics information management to organize and analyze

timely, accurate data that can be used for decision making, as well as for advocacy and resource mobilization [10].

A number of supply chain interventions are needed to ensure that the commodities required to fulfill the standards are available when and where needed. Such interventions include selecting the appropriate products, designing and implementing a logistics system, conducting national quantification, and procuring the necessary commodities [11]. Moreover, the information collected by using the Assessment Tool for Laboratory Services and Supply Chains is analyzed to identify challenges and opportunities for improvement in the laboratory logistics system and to outline next steps, such as supplementary assessment or additional interventions [12].

Well-functioning supply chains will enhance availability of the commodities required to provide the necessary laboratory services. Laboratory services play a significant role in a country's health system and in the delivery of quality health services. Laboratory capacity depends on the availability of the required commodities to perform various tests, with most tests requiring multiple commodities to be available simultaneously [2].

1.2 Statement of the Problem

Implementing a logistics system is a dynamic process that requires ongoing training, monitoring, evaluation, and adjustments to ensure the system is effective and efficient [7]. Without logistics management information system implementation; programs will inevitably waste valuable resources through prolonged and frequent stock outs, over stocks, under stocks and losses [13]. Strong laboratory LMIS accompanied by coordination and harmonization of quantification, procurement, inventory control, distribution and reporting are necessary to ensure continuity of care for the patient and to guarantee efficient use of limited resources [1].

An LMIS provides the mechanism through which personnel collect and manage such information, which is necessary to support sound and objective decision making in managing the supply chain. The goal of this decision making is to ensure uninterrupted supply of commodities and to identify any problems in the supply pipeline. Data provided through the LMIS also help inform policy and product selection decisions [6].

Although managing a logistics system still requires recording, reporting, analysis and use of the three essential data elements (stock on hand, losses and adjustments and rate of consumption), there are a number of additional data elements that are being collected to manage the three commodity categories. Furthermore, although a manual system can still suffice, service providers have an increasing range of responsibilities, and many countries are exploring computerization of LMIS as a way to reduce the burden on service providers at facilities and to provide timely and accurate data for logistics decision-making as well as for advocacy and resource mobilization [14].

The lack of adequate coordination and consistent communication between testing facilities and key entities at the central level are some of the other major constraints that are currently impeding the proper functioning of the logistics system. A gap also exists between the government and donors on information sharing regarding donated equipment, products and consumables. At the service delivery point (SDP), critical logistics records are not well kept and tend to be frequently unavailable at the time of need. Technical staffs are required to send monthly reports on a regular basis. Many of these reports were however found to be unavailable most of the time. It was also noted that distribution remains a key challenge in the existing system and as such, the lead time for the delivery of commodities tends to be exceptionally long, often resulting in stock outs of key testing reagents at the service delivery point [10].

Prior to the logistics system design, the Ethiopian laboratory logistics system was characterized by an inadequate supply of required reagents and supplies, which in turn was affected by the lack of information on these commodities for procurement and resupply decisions. In addition, distribution systems for laboratory commodities were not systematically designed, strengthened nor supported. Patients were requested to wait 2-3 months or longer at hospitals for critical commodities such as CD4 reagents. Laboratory machine failure and Pharmaceutical Fund and Supply Agency (PFSA) limited capacity to deliver reagents were among the major problems that affected the national laboratory logistic system in the country [15].

One of the study which was conducted in Ethiopia shows that about 60.5% health facility were stocked out for at least one antiretroviral treatment (ART) monitoring and tuberculosis(TB)

laboratory reagents and the highest stock out rate was for chemistry reagents. Expired ART monitoring laboratory commodities were found in 25 (73.5%) of facilities. Fifty percent (50%) of the assessed hospitals and 54% of health centres were currently using stock/bin cards for all HIV/AIDS and TB laboratory commodities in main pharmacy store, among these only 25% and 20.8% of them were updated with accurate information matching with the physical count done at the time of visit for hospitals and health centres respectively [1].

Even though no similar study or effort was conducted related to this project, this result was initiated the project conductor to act upon for improvement of the laboratory commodity of logistics management information system of the Saint Paul's Hospital Millennium Medical College. Accordingly, the identified problem was solved through conducting training to laboratory professionals, establishing LMIS team in the hospital with the collaboration of higher officials and developing system management for LMIS.

1.3 Objectives

1.3.1 General Objectives

To assess and improve the quality of medical laboratory commodity of logistics management information system in St. Paul's Hospital Millennium Medical College.

1.3.2 Specific Objectives

- To identify the major gaps for the laboratory commodity stock status (stock out, over stock and under stock)
- To assess the behavior of users towards the medical laboratory commodity of LMIS
- To describe solutions that help for the improvement of quality of medical laboratory commodity LMIS

1.4 Significance of the Project

The outcome of this project would be to improve the management of laboratory commodity logistics system of SPHMMC and then to transfer the system to nation. Moreover, the expected deliverables of this project is to provide reliable, accurate and manageable information that helps for decision making. Consequently, customers can have uninterrupted services regards to laboratory commodity. Furthermore, it aspires to avert resource wastage and reduce supply chain of commodities inconsistency.

Reliable monitoring of the quality of laboratory LMIS of this project will expect to contribute to the optimization of the following services to:

- reduce the frequency of stock out, over stock and lose of laboratory commodities
- detect and organize available commodities on the shelf as early as possible
- apply the principle of first expire first out (FEFO)
- minimize the wastage of laboratory reagents and chemicals or resources

1.5 Scope and Limitation of the project

Generally, to minimize the gap related to laboratory commodities of LMIS. The scope of the project was to assure and sustain the availability of laboratory commodities from delivery point to consumption point and to follow the LMIS principle.

The current logistics commodities of Saint Paul's Hospital Millennium Medical College (SPHMMC) laboratory is based on paper or bin/stock card and it has a deficiency of easily detecting the stock out, over stock, under stock and lack of identifying the commodities that will be expired early. To overcome such gap this project was tried to assess and identify the main causes and action was taken on the identified gaps. So this project was implemented to solve these problems and it was helped for the higher officials to take action for the improvement of LMIS of SPHMMC laboratory commodities.

The project was based on the unique characteristics of laboratory commodities; “recommendations for logistics system design and implementation for laboratory commodities include the following indicators like standardization, product selection, quantification and procurement, inventory management, storage and distribution, quality assurance and quality control, staffing and management” [3]. The activities of the project were acquiring permission for the project from the hospital, developing questionnaire, gap analysis for stock status, implementation of best solution, giving off and on job training for health professionals, compiling, summarizing and dissemination of the result for the concerning body and closing down of the project.

The goal of this project was to manage the laboratory commodities that was served and satisfied the community without interruption of the services through the six basic rights of LMIS, which are “the **right** quantities of the **right** laboratory supplies to the **right** facilities at the **right** time in

the **right** condition at the **right** cost” [10]. Finally, evaluation and report was addressed to all those affected by the project activities and closing down of the project ceremony were preceded by project conductor.

The limitation of the project was inability to assess the whole commodity in SPHMMC laboratory. Another constraint of the project was the budget allocated and shortages of time. Additionally, no similar study was conducted in the selected facility before to make comparison and conclusion of this project.

1.6 The rationale of the project

The main cause to study this project was the interruption of laboratory commodities due to failure of implementing LMIS procedure. So to minimize the gap, this project was designed to identify the root causes for interruption of laboratory commodities and then to provide solution based on the identified causes.

Chapter Two

2. Literature Review

2.1 General Literature Review

2.1.1 An Overview of Laboratory Logistics Management Information System

Information is the motor that drives the logistics cycle. Without information, the logistics system would not be able to run smoothly. Managers gather information about each activity in the system and analyze that information to coordinate future actions. For example, information about inventory levels and consumption must be gathered to ensure that a manager knows how much more of a product to procure. Logisticians added the word logistics to Management Information System (MIS) to create Logistics Management Information System (LMIS). They wanted to make it clear that the collection of data for logistics is a separate activity from the collection of data for other information systems. Logistics is not just a set of operations to move products from one place to another, but rather a key element on helping the people to meet their needs and to achieve the goals of various activities. Logistics refers to activities concerned with selecting, financing, delivering, and distributing supplies [16].

Effective laboratory leadership and management are often lacking many countries still do not have a national laboratory policy, a strategic plan, or a dedicated budget for laboratories. Fundamental weaknesses in the overall management of laboratory services, together with a lack of human and financial resources and poor infrastructure, prevent the efficient operation and delivery of accessible, quality-assured laboratory services to support national public health programs, including malaria and tuberculosis (TB) control and treatment and the delivery of antiretroviral therapy (ART) [17].

If laboratory services are to support health care effectively, they need to provide reliable, valid, and timely results. Functioning, good-quality equipment and uninterrupted supplies of test kits, reagents, and other consumables are mandatory. Yet many countries have given little attention to the particular needs of laboratories and what is required to create an effective commodity management system. Governments and donors responsible for procuring and managing laboratory equipment and other commodities often lack updated standard international guidance. Consequently, stock outs occur when large quantities of materials that are inadequate,

inappropriate or of poor quality are procured and resources are wasted [17].

The inventory control system is a forced ordering maximum/minimum inventory control system. Every SDP in the system is required to report at the end of every other month and order all laboratory commodities back up to the maximum level. If stock on hand for any commodity falls below 2 weeks (0.5 months) of stock before the end of the reporting period, an emergency order should be placed. To maintain adequate stock levels, the maximum months of stock, minimum months of stock and an emergency order point have been established as 4, 2 and 0.5 months respectively for SDPs [18].

2.1.2 Quality of Laboratory Logistics Management Information System

Numerous benefits are associated with the standardization of laboratory services. Standardization is an essential intervention; it is a prerequisite to designing, implementing, and strengthening laboratory logistics systems. Standardization streamlines and reduces the range of commodities that must be procured and distributed from a central place, thereby increasing the effectiveness of the system to deliver the high-quality commodities needed to provide testing services [11].

A computerized LMIS provides several important benefits over a manual LMIS, such as ensuring mathematical accuracy, rapid aggregations, calculations, and productions of reports and graphs. A computerized LMIS also provides functionalities such as alert mechanisms to assist in decision-making [4].

A number of studies conducted through the world to assess the status of logistics management information system (LMIS) and supply chain systems for the implementation of HIV/AIDS and tuberculosis programmes, majority of them showed, logistics management tools didn't capture the three essential logistics data items (stock on hand, consumption and losses and adjustments) and implementation of LMIS is still a serious problem in many areas as shown by presence of inaccurate logistics data and frequent stock outs of key commodities [1].

Laboratory services act as a cornerstone for public health programs by supporting diagnosis, monitoring, screening, and surveillance to control and manage diseases. Consequently, many laboratory tests are needed to provide the comprehensive package of testing required for public health programs. All these tests require commodities, functioning equipment, trained personnel, and infrastructure. Strategies to standardize and streamline the provision of testing services can

help to simplify and fundamentally improve the efficiency, quality, and affordability of testing for both the service provider and the patient [11].

2.1.3 Attributes and Factors of Quality Improvement of Laboratory LMIS

Ensuring continuous availability of health supplies is a challenge for program managers. The vulnerability of financing of supplies can be attributed to several factors that are usually beyond the sphere of influence of the program managers alone. Examples of such factors include change in donor priorities, health sector reforms, implementation of Poverty Reduction Strategies, and or use of sector-wide financing such as basket funding. Program managers can minimize these impacts, especially on availability of financing, by addressing the commodity management from a strategic perspective [19].

The sheer number of commodities has serious implications for most logistics functions and activities, particularly the design and management of the logistics information and inventory control systems, as well as quantification and procurement of laboratory supplies come in a wide range of preparations and packaging. Some laboratory supplies come in kits, others in bottles, and others in packages with pieces of 100, 1,000, or more. Though supply chains should strive to have a minimal number of pack sizes for a particular product, even in the best case multiple pack sizes may exist and can lead to confusion in ordering and managing commodities. To facilitate stock keeping, issuing, and reporting of these commodities, review each product, how it is issued to the bench, how it is used at the bench, and the number of pack sizes to determine which unit is most appropriate to use in recording and reporting commodity information [2].

In a recently developed commodity database that compiled the list of commodities currently being stored, procured and distributed by the Central Medical Stores (CMS) and the National Health Laboratory (NHL) a total of 859 items were identified. These items are for all testing areas which include Chemistry, Hematology, Immunology, Virology, Blood Bank, Microbiology, Molecular Biology, Histology and Cytology. In developing this list of commodities, it was found that on multiple occasions, existing products were found to be obsolete. Many of the similar type chemicals also came in various pack sizes. Some of the reagents found in storage were also found to have expired. The reason for these identified problems can be attributed to the sheer volume of commodities that the CMS and NHL have to manage [10].

The performance of the supply chain depends on staff that is already fully committed to other activities usually do not have adequate logistics training, and whose responsibilities may not formally include logistics tasks. As a result, supply chain break downs, such as stock outs and product wastage are not uncommon or unexpected. In-country supply chains often lack dedicated and skilled human resources that are devoted to routine logistics management tasks, as well as the structural entities through which to organize and manage resources and operations. Logistics management responsibilities at the central level are often dispersed among numerous program staff, offices, or locations, leading to challenges in communication and unclear pathways for resolving problems or making decisions [8].

To increase the range and volume of commodities managed by public sector supply chains, there must be an increase in funding for strengthening staff to manage them. If no established coordinating body or mechanism for managing logistics system activities and the necessary financial resources exists, there is a risk that the funding provided may not be used efficiently. This leads to inefficiencies in the supply chain and, ultimately, will have a negative impact on customer service [8].

2.1.4 Challenges in Laboratory Logistics Management Information Systems

Identified and categorized challenges regarding the information system implementation as issues that were created and also worsen with time. The more specific categorizations of these issues can be viewed as: management process issues, organizational environment issues, leadership issues, technical systems issues, and personnel issues. Management process issues speak of functional operation of an organization such as budgeting, personnel, and general management. Organizational environment issues are identified as factors which are less tangible such as organizational culture, change, and behavior. Leadership issues relate to the areas which involve the interaction and direction of the organization executive. Technical systems issues are mainly those referring to the hardware and software considerations of ITs. Personnel issues are those issues surrounding each individual in the organization. These issues impact the planning, procurement, and deployment of information systems in their organizations [16].

One of the challenges with the current laboratory system is the consistent interruption of testing services resulting from unplanned activities, reagents stock outs and expiration because of poor quantification and inadequate logistics systems to support the flow of these commodities. Prolonged equipment down time as a result of poor service and maintenance, excessive emergency order situations that interrupts the supply plan and lack of documented procedures was also another issue identified with the current laboratory system [10].

Unlike commodities such as tablets or capsules that can be easily counted, many laboratory commodities are liquids or powders that are difficult to count. Only a few drops or a weighed measure of a laboratory commodity may be used at a time. The same commodity may be used for a variety of different tests and by a number of different people in a single laboratory, thereby making actual consumption of the commodity either as its actual use or as a function of the number of tests performed difficult to track and measure. Add to this challenge the number of commodities used in a laboratory, and the task of tracking consumption becomes difficult and unmanageable [6].

In addition to use for actual tests, a percentage of laboratory commodities are used for quality control (QC) purposes. Distinguishing the use of commodities for QC from the use of commodities for testing is difficult and time-consuming. Because of the short shelf life of reconstituted reagents, they may be discarded before being completely consumed, and therefore are wasted. A certain amount of wastage should be expected in laboratory services. This wastage differs from loss caused by damage, expiry, or theft. Loss should be tracked in an LMIS, while it is difficult to separate wastage from consumption [6].

2.1.5 Types of Laboratory Commodities

Before you begin quantifying laboratory commodities, it is important to have a basic knowledge of the different types of commodities found in the laboratory. Laboratory commodities are used to collect, prepare, test, analyze, store, and dispose of clinical specimens. While these activities include a wide range of items; for logistics purposes, they are broadly classified into three distinct categories of products: reagents, consumables, and durables. Each item is a necessary component in any laboratory test. Their classification depends on the commodity's characteristics and use, and also determines how you can track and forecast its usage [20].

2.1.6 Trends of Laboratory Logistics Management Information Systems

In January 2008, the international laboratory community converged for a meeting in Maputo Mozambique was to develop recommendations for clinical laboratory testing harmonization and standardization. Central to the theme of this workshop was the call to promote the standardization of laboratory supplies at each tiered level of the laboratory network. Following the standardization workshop, a laboratory logistics system design workshop was held to develop a logistics system designed to collect and capture essential data for decision making. The decisions that the system would need to inform include the routine resupply to facilities, monitoring and adjusting stock imbalances within the network of facilities as well as accurate national quantification of essential laboratory commodities [11].

In Kenya, the Ministry of Health (MOH) and its partners began to focus on the idea of funding the development of computerized systems for HIV/AIDS commodity management in 2001. The DELIVER project Kenya office was asked to undertake the system design and implementation process and eventually opted for a custom-built Oracle-based computerized inventory control system (ICS) and LMIS. In Uganda, the program has adopted a pre-existing software package, Supply Chain Manager (SCM), and has customized the software to manage HIV tests and ARV drugs through the National AIDS Control Program [14].

The Ministry of Health and Child Welfare (MOHCW)/ Acquired Immune Disease Syndrome (ADIS) & tuberculosis (TB) Unit of the Government of Zimbabwe (GOZ) are committed to strengthening the national TB program. The USAID | DELIVER PROJECT was requested to provide technical assistance to MOHCW staff to design logistics system(s) for the management of TB commodities. This design includes a logistics management information system to collect and report the essential data items to facilitate decision making at the national level to ensure that the products are managed within the desired stock levels [21].

In Zambia, the Logistics Management Unit is based at the Medical Stores Limited (MSL) and plays a pivotal role in the success of the logistics system. Four data specialists receive the LMIS reports and orders from facilities for antiretroviral drugs, HIV tests, prevention of mother to child transmission commodities, laboratory commodities, and essential medicines. The unit receives reports from all facilities and processes them in a computerized LMIS [8]. Some of the strengths

of the Malawi laboratory services and logistics system include the development of national laboratory policies and draft standard operating procedures (SOPs); dedicated staff at central-, intermediate-, and service-levels; adequate storage capacity; and an improving laboratory infrastructure [22].

The supply chain for routine resupply of laboratory commodities in Tanzania varies by the location and the type of laboratory and the type of commodity being resupplied. In most cases, general laboratory supplies are distributed directly from Regional Medical Stores (RMS) to central and district hospitals. Health center laboratories usually receive their supplies monthly from the district hospital laboratory [23].

A cross-sectional facility based-survey was conducted in Zimbabwe. The result showed that, forty seven (34.4%), 46 (31.95) and 23 (28.9%) of facilities reported that, they were stock out for uni-gold, determine and oraquick test kits respectively during six months before the assessment. Two (3.2%), 2 (3.2%) and 16 (38.6%) of facilities were stock out for uni-gold, determine and oraquick test kits respectively on the day of visit. Fifteen (25.9%), 11 (19.7%) and 5 (28.7%) of facilities had less than the minimum stock levels for uni gold, determine and oraquick test kits respectively. Twenty three (38.9%), 18 (30.6%) and 10 (58%) of facilities had higher than the maximum stock levels for uni-gold, determine and oraquick test kits respectively. Seventy five percent of facilities maintained stock/bin cards for rapid test kits from which 80% of them were updated. Sixty percent of 8 facilities recorded stock on hand that differed from the physical inventory on the day of visit. None of the facilities had expired determine and uni-gold test kits. Eighty percent of facilities maintained the ideal storage conditions. Six (9%), 25 (39.5%) and 7 (12%) of facilities had received less, equal and higher quantity than ordered respectively for rapid test kits. Majority of laboratory staffs were not trained in LMIS except PMTCT staffs [1].

The Ethiopian laboratory LMIS was weak, consistently being hampered by several systemic challenges that caused frequent stock outs of critical commodities, thus impeding continuous and quality testing for patients [13]. Currently, the country has designed integrated pharmaceutical logistics systems (IPLS) for all public health commodities including essential drugs, family planning, malaria, laboratory services, nutrition, Tuberculosis-leprosy and HIV/AIDS commodities [24].

Several studies have been conducted through the world to see the status of logistics management information system for health commodities remained poorly implemented in most of developing countries and supply chain systems, moreover, there is limited information in Ethiopia in general and particularly in laboratory logistics management information system [1].

2.2 Related Literature

2.2.1 Activities of logistics management information systems

Logistics activities are the operational component of supply chain management, including quantification, procurement, inventory management, transportation and fleet management, and data collection and reporting. Supply chain management includes the logistics activities plus the coordination and collaboration of staff, levels, and functions. Supply chain includes global manufacturers and supply and demand dynamics, but logistics tends to focus more on specific tasks within a particular program health system [25].

The logistics cycle depicts the activities and supporting systems that must take place to ensure product availability for health services. Those activities occur in various forms at all levels of the logistics system, but the last mile involves a simplified cycle of activities to support resupply to SDPs, including transportation, data collection, quantification, and procurement [26].

2.2.2 Features of laboratory commodities

Some laboratory products are used during outbreaks or epidemics and they require a responsive logistics system that can quickly deliver large quantities to areas of need; other laboratory products are used in large quantities for routine testing and they must be ordered regularly to adjust to fluctuations in demand; and other products are available in large volumes (20L) and only need to be replaced once every few months. If all these products are managed in the same way, either the products with high turnover will stock out, or the products that are slow moving or have short shelf life, will be over-ordered and will result in wastage [27].

2.2.3 Computerization of laboratory commodities of LMIS

Computerization of the LMIS can occur at the site level or at the central level. In many countries, while site-level computerization of the LMIS for laboratory supplies is only at the pilot stage, central-level computerization may be possible and appropriate. Given the large number of commodities that need to be managed, supplied, and reported in support of laboratory services,

the central-level LMIS should be computerized where possible. Manual aggregation of logistics data for laboratory supplies can be cumbersome and time-consuming. A computerized LMIS can rapidly aggregate logistics data, accurately perform calculations, and to produce reports and graphs for analysis in a timely manner. In determining the appropriateness of using a computerized LMIS, consideration should be given to the availability of computer hardware, printers, data backup mechanisms, reliable electricity, and regular support from computer technicians. The software used to manage and analyze the data should be designed with consideration of the types of logistics decisions that will be made to support logistics activities along with knowledge [6].

The benefits of standardization are far-reaching. Clinically, for example, when different facilities use the same standard laboratory equipment and testing procedures, test results are comparable between facilities. Programmatically, having a greater number of the same machine and reagents results in economies of scale, which provide leverage to national laboratory programs in negotiating service and maintenance contracts. Additionally, having a smaller range of equipment and techniques facilitates the training of staff members. Finally, fewer products flowing through the supply chain enhance the agility, efficiency, and manageability of the national laboratory logistics system. For example, when facilities at the same level use the same techniques and equipment to conduct the same menu of tests, the correlated commodities are also the same. Alternatively, if machines break down or if a sudden change in consumption occurs, commodities can be redistributed to other facilities, thereby reducing the risk of expiries and stock outs [10].

2.2.4 Report on various commodities related to logistics management in some countries

Tanzania, in 2002, launched an ambitious plan to improve efficiency by integrating the LMIS and storage and distribution of a number of vertical systems, including essential drugs, contraceptives, STI supplies, malaria control supplies, and laboratory supplies. Intentionally excluded was the Expanded Programme on Immunizations (EPI) and TB programs. DELIVER helped the MOH off to a rational start with a process mapping exercise that specifically identified factors that would complicate the integration. As a result, before the integration took place, the MOH developed a new system design that included improvements and simplifications for ordering, receiving, and issuing; disbursing funds at the central level; managing funds at local

levels; aligning transport schedules; reporting; and special products handling. One special feature of the new design is a mechanism for prioritizing products into essential products that must always be in stock, and additional products that, while important, may be ordered and stocked on a discretionary basis. The new system was pilot tested, evaluated, and revised [28].

In Rwanda DELIVER's work reflected the USAID Mission's desire to directly support one important program—family planning—with the design and implementation of a vertical distribution system. Prior to 2002, contraceptive distribution was plagued by problems that included bad storage conditions and a limited choice of products at SDPs—often only one or none. At higher levels of the system, unfilled logistics positions were associated with stock outs at district levels. A design workshop held in 2002 produced consensus on how to upgrade storage, stock control, minimum/maximum inventory control mechanisms, and the LMIS. Following the workshop, DELIVER assisted with preparing standard operating procedures (SOPs) for district and SDP levels, as well as job aids for staff with logistics responsibilities. DELIVER assisted the MOH in training or orienting 546 staff members at SDP, district, and national levels [28].

2.2.5 Management of laboratory commodity

Logistics data management entails the collection, review, aggregation, analysis, and interpretation of logistics data and the development and dissemination of logistics data reports. The purpose of collecting logistics data is to improve customer service (i.e., commodity availability) by improving the quality of management decisions. To make the collected data useful for decision making, it must be aggregated and analyzed, and then shared with the appropriate decision makers [8].

For any max-min system, it should set the max and min levels high enough to avoid stock outs, yet low enough so you do not increase the risk of expiration or damage. It is possible, and actually likely, that the stock balance will, at times, go below the min; but, ideally, it should never go below the emergency point. To achieve this, you must set a min level high enough to ensure that the facility never completely runs out of stock. At the same time, you must still set the max low enough to ensure that space in the storeroom is adequate and that the stock does not expire before it can be used [3].

Weak management of laboratory commodities (reagents, equipment, and other consumables) has been identified as a key gap in ensuring quality and uninterrupted laboratory testing in many developing countries, including Angola. Inadequate skills, lack of proper tools, and poor infrastructure hamper effective management of commodities in laboratories resulting into recurrent stock outs of testing reagents, equipment breaking down frequently and for long periods and in some instances stoppage of critical laboratory testing services. These glitches in the smooth laboratory operation contribute substantially to suboptimal disease control programs and interventions [29].

2.2.6 Involvement of laboratory professionals

For a laboratory logistics system to work, adequate staff must be in place at all levels to manage it. All personnel need to be trained in system procedures and supported in their jobs by effective and knowledgeable supervisors. As new commodities enter the system, staff members need to be made aware of the products' particular logistics considerations (e.g., storage requirements). When new procedures are put in place, personnel need to be trained to perform those procedures. Because it is important to maintain the highest quality standards, procedures and policies for laboratory practices should be regularly reviewed with staff members. Performance should be routinely monitored and supported with supervision. A schedule for supervisory visits helps make supervision more routine, participatory, and supportive [30].

Currently, laboratory personnel are not widely involved in determining what is used in the laboratories. The limited involvement of laboratory personnel in the sourcing and deployment of laboratory diagnostics leads to having inappropriate diagnostic technologies in the laboratories. Furthermore, customs clearing processes appear to be a bottleneck in the procurement of health commodities, more so with laboratory supplies because some of them have relatively shorter shelf-life and most laboratory reagents require storage at refrigeration temperatures [29].

Chapter Three

3. Methodology

3.1 Project Study Area

The Project was conducted in Addis Ababa, which is the capital city of Ethiopia, in Saint Paulo's Hospital Millennium Medical College particularly in the laboratory department. SPHMMC is teaching and referral hospital located in western part of Addis Ababa in Gulele Sub City. The hospital built by Emperor Haileselassie in 1969 with the help of the German Evangelic church; it aims to serve the under privileged people. A medical college was established in 2000 E.C. This hospital serves on average 700 out clients daily. The hospital has 340 beds. The laboratory gives service on average 300 clients daily including the private wing.

3.2 Study Design and Period

Facility based cross-sectional descriptive study and followed with developing system management (which means from the distribution point to the consumption of the commodity or the whole flow chain of the laboratory commodity system) was conducted from April, 2015 to May, 2015 to assess and improve the gaps and to provide solution for the laboratory LMIS.

3.3 Source of Population/Information

- The source of populations was all commodities that were available in SPHMMC laboratory.
- All laboratory and pharmacy professionals and higher officials of SPHMMC.

3.4 Study Population

- All commodities which were available in the SPHMMC laboratory storage for Clinical Chemistry, Hematology, Serology and Hormone reagents
- All laboratory professionals who were working only in the department of Clinical Chemistry, Hematology, Serology and Hormone
- The heads of Pharmacy, Laboratory and Stores of each department
- The 2 higher officials (Vice Provosts for Medical Services and Business and Development) of SPHMMC

3.5 Inclusion Criteria

All commodities for Clinical Chemistry, Hematology, Serology and Hormonal reagents that were found in the laboratory storage were included during the study period.

All laboratory professionals in the study unit, the heads of pharmacy, laboratory and store, and finally the two vice provosts were included.

3.6 Exclusion Criteria

Except Hematology, Hormone, Serology, and Clinical Chemistry, all laboratory commodities were excluded.

Except the study population unit, the heads of pharmacy, laboratory and store and the two vice provosts, all laboratory professionals were excluded.

3.7 Sample Size

A total of 42 commodities were found in the SPHMMC laboratory store for Hematology, Hormone, Serology, and Clinical Chemistry within the study period. This value was found at time of inventorying the selected commodities in the store of laboratory. This means not the calculated value rather it found by census (counting/surveying directly) sampling method

A total of 18 laboratory professionals were involved in the department of study population plus six (6) personnel's which were the heads of laboratory and pharmacy and store of the departments and also the two vice provosts

3.8 Sampling Technique

Census sampling technique was practiced for collecting the laboratory commodities in the laboratory store and purposive sampling technique was conducted for laboratory professionals during the assessment.

3.9 Study Variables

Dependent variables

- Logistics management information system (LMIS)
- Laboratory commodity stock status

Independent variables

- ✚ Information system
- ✚ Study participants

3.10 Data Collection Tools

A structured and semi-structured questionnaire which was originally developed by ATLAS [12] and locally adapted was used to collect quantitative and qualitative information from selected facility respectively. Self administered structured questionnaire was provided for laboratory professionals after getting their written consent to collect quantitative information about the practice, knowledge and attitude towards LMIS and also used to collect about educational level, work experience, age and sex of the study population.

The quantitative collection instrument was used to provide information on the indicators like the availability of bin/stock card, of laboratory commodities for Hematology, Hormone, Serology, and Clinical Chemistry on the period of assessment and stock out, over stock, under stock of frequency and percentage, percentage of personnel trained in LMIS, percentage of expired commodities, and percentage of stock /bin cards available for each commodity. Additionally, inventorying of the selected commodities was conducted in the laboratory store using the prepared spread sheet. This instrument was used to know the quantity of selected laboratory commodities.

The other data collection tool was qualitative method, which was conducted by interviewing using semi structured questions for the key informant of six (6) personnel's. Those were vice provost for medical services that is responsible for medical aspects, the vice provost for business and development in charges for financial process, the laboratory head for planning and managing the laboratory commodity, the pharmacy head is responsible for ordering and purchasing the laboratory reagents, pharmacy store head is accountable for distributing the laboratory reagents to the laboratory unit and the laboratory store head which is responsible to control and monitor the stock status of laboratory commodity and issuing those commodities to each unit .

3.11 Data Collection Procedure

The data was collected by one trained senior laboratory technologists and principal investigator. The data collector was trained for 1 day about how to use the check list, spread sheets eligibility criteria, and other ethical issues. Data was collected by using the standardized questionnaire, interviewing and inventory. The information present on each commodity was recorded in a spread sheet. Qualitative data was collected using semi structured interviewing by project

investigator and then it was transcribed and recorded by mobile phone at the time of dialogue or conversation.

3.12 Data Management and Quality Assurance

Data collection check list, questionnaire and data collection spread sheet was pre-tested before the actual data collection ongoing in the selected hospital to ensure the validity and reliability of the study tool. The pre-test was conducted at the selected facility on non study population of laboratory professionals. After the pre-test conducted, the appropriate adjustment was made to standardize the data collection tool and training was given to data collector by project investigator. The collected data was checked for completeness and accuracy by project investigator.

3.13 Statistical Analysis

The quantitative data was analyzed using Statistical Package for Social Sciences (SPSS) version 16 software. Descriptive statistics was computed and result was presented using tables and graphs. The qualitative portions of the study were analyzed using qualitative analysis technique (recording and finally writing the report by narrating the finding).

3.14 Intervention and Problem Solving Mechanism

The main idea of this project is to work in the health environment with the assistance of information technology (IT). So that, the major intervention and problem solving mechanism is making LMIS standardization. In this project situation “standardization” means managing the whole flow of laboratory commodity from the point of origin to the point of consumption. This idea is supported by literature “A number of supply chain interventions are needed to ensure that the commodities required to fulfill the standards are available when and where needed. Such interventions are includes selecting the appropriate products, designing and implementing a logistics system, conducting national quantification, and procuring the necessary commodities” [11]. So, this project was able to achieve the objective by developing system management for LMIS, establishing team of LMIS with the collaboration of the hospital management from different departments, conducting training to laboratory professionals and higher officials.

3.14.1 Establishing Team and Conducting Training

The team was established in order to initiate the higher management officials and to make them to be active participants of this project. Their role in this project will be very crucial to solve the gap identified in the quality improvement of LMIS and to provide quality laboratory services to the society. The established team or committee was to coordinate donor and government inputs and to develop a commodity security strategy for laboratory services. In addition, this committee could periodically monitor and review the standards. Training was also conducted for laboratory professionals and higher officials to create awareness and knowledge towards LMIS.

3.14.2 Computerization of the LMIS

The process of undertaking computerization – whether it is selecting and customizing existing solutions or developing new software – can be a daunting task, especially if there is limited understanding of where the process begins and the different steps in that process. While computerization can greatly facilitate the work of supply chain managers, the implementation of software packages can be costly and time consuming, requiring planning and management to achieve optimal outcomes. Adequate time and human, financial, and information technology (IT) resources must be allocated during every step of the software development process to ensure that the most appropriate software package is chosen and maintained [4].

As project investigator proposing that, changing the recording system from manual to electronics and integrating the LMIS with laboratory information system (LIS). This process may achieve its objectives through the mobilization of the hospital management and incorporating the IT professionals. The process may include integration, programming, alerting, and loading of commodity items. Even though there are constraints to implement this system, based on the above statements the project conductor advises the hospital management to adapt and apply this system for LMIS.

3.15 Method of Result Dissemination

The results found from this project will be disseminated to Addis Ababa University School of Information Science and School of Public Health, department of Health Informatics. The method of dissemination will be through hard and soft copy of the project result. The hard copy of the assessment results and proposed solution of the LMIS is given to Saint Paul hospital millennium medical college.

3.16 Ethical Consideration

The project was approved by Ethics and Review Committee of the School of Public Health of Addis Ababa University and then institutional review board (IRB) of Saint Paul's hospital. Protection of the rights of the respondents ensured by giving them due freedom to involve or not involve in the project assessment. Privacy and confidentiality was maintained during data collection process. The purpose, general content and nature of the project explained to each respondent to obtain a written consent before inclusion into the project assessment.

3.17 Operational Definitions

Logistics Management Information System is capable of collecting and reporting timely logistics data to enable quantification, procurement, storage, and distribution.

Reagents: are chemicals and biological agents that are used in laboratory testing for detecting or measuring an analyte (the substance being measured or determined)

Quality Control (QC): The operational techniques and activities that sustain the product or service quality to specified requirements.

Quality Assurance: Planned and systematic action that is necessary to provide adequate confidence that a product or service will satisfy given requirements for quality.

Project: is a temporary, non-repetitive, goal-oriented activity that has measurable outputs and particular set of constraints.

Quality: ability of a service to satisfy the needs and expectations of the customer.

Quality improvement: is a system by which better health outcomes are achieved through analyzing and improving service delivery processes

Overstock: A supply imbalance that occurs when stocks exceed the established maximum.

Stock card: A generic name for an inventory control card.

Stock out: Depleted supply of a given product or products; a zero stock balance.

Under stock: A supply imbalance that occurs when stocks fall below the established minimum.

Chapter Four

4. Results and Discussions

4.1 Results

This project was an assessment of the stock status and expiry date of laboratory commodities, knowledge, attitude and practice of laboratory professionals towards the quality improvement of logistics management information systems in the laboratory department of Saint Paul Hospital and interviewing higher officials. The assessment result of the project is presented as follows.

Part I

4.1.1 Quantitative findings of the project

4.1.1.1 Socio-demographic characteristics of laboratory professionals

A total of 18 laboratory professionals were involved in the quality improvement of LMIS of the study, of which 10(55.6%) were females and 8(44.4%) were males. Regarding age of the study population, 15(83.3%) respondents were between the age group of 20-30 and the rest from 31-40, 41-50 and 51-60 was 1 respondent for each age group. Concerning educational status, the majority of the respondents were 15(83.3%) have first degree and the rest 3(16.7%) of them have diploma. The work experience of the respondents 11(61.1%) have served 0-5 year, 4 (22.2%) of them have served between 6-10 years, 1 respondent has served 11-15 years and the rest 2 have served above 21 years. The above information has presented in table 1 as follows:

Table 1: Socio-demographic characteristics of laboratory professionals

Variables	Category	Frequency	Percent
Sex (n=18)	Male	8	44.4
	Female	10	55.6
	Total	18	100
Age (n=18)	20-30	15	83.3
	31-40	1	5.6
	41-50	1	5.6
	51-60	1	5.5
	Total	18	100
Educational Level (n=18)	1 st Degree	15	83.3
	Diploma	3	16.7
	Total	18	100
Work experience (n=18)	0-5	11	61.1
	6-10	4	22.2
	11-15	1	5.6
	16-20	0	0
	>21	2	11.1
	Total	18	100

Note: n- number of respondents or study participants

Part II

4.1.1.2 Knowledge of laboratory professionals towards LMIS

Among 18 study population only 3 of them had got in-service training which was organized by the hospital and NGO's. But the majority 15 (83.3%) of respondents did not have training on the LMIS. Most of 15(83.3%) respondents have no knowledge about the consumption and inventory system of medical laboratory LMIS. Among those took training, 2(11.1%) of them know about the consumption and inventory system of laboratory commodities, but 1 respondent did not know about inventory mechanism.

Table 2: Knowledge of respondents about quality improvement of medical laboratory LMIS.

Variables	Category	Frequency	Percent
Training on LMIS (n=18)	Yes	3	16.7
	No	15	83.3
	Total	18	100
Way of knowledge acquired (n=3)	Training	2	66.7
	Discussion	0	0
	Workshop	1	33.3
	Total	3	100
Training provider (n=3)	Hospital	2	66.7
	NGO	1	33.1
	RHB	0	0
	Total	3	100
Stock status consumption (n=18)	Yes	3	16.7
	No	15	83.3
	Total	18	100
Monitoring system of usage (n=3)	Per patient	0	0
	Per test done	3	100
	Total	3	100
Commodity inventory system (n=18)	Yes	2	11.1
	No	16	88.9
	Total	18	100
How often inventory conducted (n=3)	Monthly	1	33.3
	Quarterly	2	66.7
	Annually	0	0
	Total	3	100

4.1.1.3 Attitude of laboratory professionals towards quality improvement of LMIS

The following table 3 depicts that response of study participants towards LMIS attitude. Among 18 study population 6(33.3%) of them were agree that, developing system management will improve LMIS. The majority 12(66.7%) of respondents said that strongly agree, developing system management will improve LMIS. 16(88.9%) and 2(11.1%) of the study participants responded that they prefer to work as a team and individual respectively, if LMIS implemented. Response of the study participants for the question causes of successful implementation of LMIS were, 5(27.8%) of them responded that staff interest, 4(22.2%) of them knowledge of the project, again 4(22.2%) of them claimed that team work, 2(11.1%) of them managerial support and 3(16.7%) of them responded that all the above causes make successive.

The importance of LMIS for decision making and controlling of stock status, 10(55.6%) of them replied as moderate and 7(38.9%) of them said most important and 1 study participant replied least helpful. All study participants were believed that improvement of LMIS will improve the quality of laboratory services and they were also interested to take training on medical laboratory LMIS.

Table 3: Attitude of respondents about quality improvement of medical laboratory LMIS

Variables	Category	Frequency	Percent
Contribution of developing system management for improvement of LMIS (n=18)	Strongly agree	6	33.3
	Agree	12	66.7
	Disagree	0	0
	Strongly disagree	0	0
	Total	18	100
How did you prefer to work if LMIS implemented? (n=18)	As individual	2	11.1
	As a team	16	88.9
	Other	0	0
	Total	18	100
Causes for successful implementation of LMIS (n=18)	Staff interest	5	27.8
	Knowledge of the project	4	22.2
	Management support	3	16.7

	Team work	4	22.2
	Other	2	11.1
	Total	18	100
Importance of quality improvement of LMIS for decision making & controlling (n=18)	Most	7	38.9
	Moderate	10	55.6
	Faire	0	0
	least	1	5.5
	Total	18	100
Improving LMIS will improve the service of laboratory and interest of training on LMIS (n=18)	Yes	18	100
	No	0	0
	Total	18	100

Part IV

4.1.1.4 Practice of laboratory professionals towards quality improvement of LMIS in SPHMMC

The following table 4.1 illustrates various practices of laboratory professionals. Among 18 study population only 5(27.8%) of them were participate on quality improvement of LMIS project and also they were participates as a team or individually by evaluating themselves in the project activities as average or moderate participant. But the majority 13(72.2%) of study population didn't have the opportunity to participate in the project activity. The other important issue concerning practices of laboratory professionals was about the integration of LMIS with laboratory information system (LIS), around 11(61.1%) were responded that it is integrated with LIS and the other 7(38.9%) of them respondent asserted that it was not integrated.

Table 4: Practice of respondents about quality improvement of medical laboratory LMIS

Table 4.1 Participation of study participant in project activities

Variables	Category	Frequency	Percent
Opportunity to participate for improvement of LMIS project	Yes	5	27.8
	No	13	72.2
	Total	18	100
How did you participate in the project? (n=5)	As individual	1	20
	As a team	4	80
	Other	0	0
	Total	5	100
How did you evaluate your participation? (n=5)	Highest	3	60
	Average	1	20
	Lowest	1	20
	Total	5	100
Integration of LMIS with LIS (n=18)	Yes	10	55.6
	No	7	38.9
	Don't know	1	5.5
	Total	18	100
Methods of laboratory commodities recorded	Electronic based	7	38.9
	Paper based	7	38.9
	Other (both)	4	22.2
	Total	18	100

Table 4.2 below states that concerning the stock status of the laboratory commodity, the respondents replied depending on their experience. Their response was depending on frequency of stock out 3(16.7%) of them said monthly, 10(55.6%) of them replied quarterly, 1 respondent claimed annually and other 4(22.2%) respondents assumed different time. Coming to under stock frequency responses, high number of them 6(33.3%) replied monthly, 5(27.8%) out of 18 asserted quarterly, 2 of them thought annually and 5(27.8%) of study population replied weakly and other time. Lastly, the response of study population on over stock was 2(11.1%) of them encounter monthly, 3(16.7%) of them quarterly, 5(27.8%) respondents faces annually and the greater part of the participant 8(44.4%) responded that they do not know or not faces at all.

Related to stock balance problem of the study commodities, the respondents placed Clinical Chemistry highest about 8(44.4%) of them responded and followed by Hormone which accounts 7(38.9%) of them replied. The others Hematology and Serology responded by 2(11.1%) and 1(5.6%) participants respectively. Concerning laboratory machines, 9(50%) of respondents states

that Clinical Chemistry machine was repeatedly out of functioning. Each Hormone and Hematology machines were claimed by 3(16.7%) respondents and additionally 3(16.7%) respondents claimed that both Hematology and Clinical Chemistry machines were down. The other 3 of them said Hormone & Clinical Chemistry machines were out of use for repeated time. Finally, the recording of laboratory commodities based on electronic was responded by 7(38.9%) participant and the other about 7(38.9%) replied that manually or paper based and the rest 4(22.2%) of them claimed that other or both recorded.

Table 4.2: Practice of respondents regards to laboratory commodity stock status and functionality of machine

Variables	Category	Frequency	Percent
Commodity stock out	Monthly	3	16.7
	Quarterly	10	55.6
	Annually	1	5.6
	Other	4	22.2
	Total	18	100
Commodity under stock	Monthly	6	33.3
	Quarterly	5	27.8
	Annually	2	11.1
	Other	5	27.8
	Total	18	100
Commodity over stock	Monthly	2	11.1
	Quarterly	3	16.7
	Annually	5	27.8
	Other	8	44.4
	Total	18	100
Commodity mostly face stock imbalance	Hematology	2	11.1
	Clinical Chemistry	8	44.4
	Hormone	7	38.9
	Serology	1	5.6
	Total	18	100
Repeatedly out of functioning laboratory machine	Hematology	3	16.7
	Clinical Chemistry	9	50
	Hormone	3	16.7
	Other	3	16.6
	Total	18	100

4.1.1.5 Assessing availability of bin/stock card, stock status and expiry date of the commodities in the laboratory store of SPHMMC.

As table 5 depicts below, at the time of assessing the laboratory store, a total of 42 commodities item were collected for the analysis of stock card availability, stock out item, under stock item, over stock item and expired product for selected study commodities. Among 42 commodities 16(38.1%) items were belongs to Clinical Chemistry, 8(19.0%) were Hormone, 11(26.2%) of Serology and the rest 7(16.7%) were Hematology.

Table 5: Item and Percentage of selected commodities in SPHMMC laboratory store

Commodities	Frequency	Percent
Clinical Chemistry	16	38.1
Serology	11	26.2
Hormone	8	19.0
Hematology	7	16.7
Total	42	100

4.1.1.6 Stock card/bin Availability by Commodity Item

4.1.1.6a Stock card/bin availability for Clinical Chemistry commodities in SPHMMC laboratory store

A total of 16 items were collected for clinical chemistry tests that were available in the laboratory store. Among 16 items 7(43.8%) of them have stock bin/ card for Total Cholesterol, Triglyceride, Uric acid, Urea, Albumin, Total Protein and Glucose. But the majority of commodities, such as High Density Lipoprotein Cholesterol (HDL-C), Low Density Lipoprotein (LDL-C), Creatinine, Serum Glutamate Oxalooacetate Transaminase (SGOT), Serum Glutamate Piruvate Transaminase (SGPT), Alkalinephosphatase, Total and Direct Bilirubin and Amylase, 9 (56.2%) have no stock bin/card.

4.1.1.6b Stock card/bin availability for Serology commodities in SPHMMC laboratory store

Out of 11 commodities items only 4(36.4%) have stock card/bin for Hepatitis B surface antigen (HBSAg), Hepatitis C virus, Widal-Welfilex (WWF) and Venereal Disease Research Laboratory (VDRL). But most of commodities which accounts 7(63.3%) have no stock cards for the items Helico pylori bacteria antibody (H.Pylori ab), Helico pylori bacteria antigen (H.Pylori.ag), HCG,

Rhamotid factor (RF), Anti streptolysin-O (ASO), C-reactive protein (CRP) and Anti nuclear antigen (ANA).

4.1.1.6c Stock card availability for Hematology commodities in SPHMMC laboratory store

Among 7 items of Hematology commodities all of them, which were 100% have stock bin/cards and the items were CELDYN diluents solution, CELDYN detergent solution and CELDYN lyze. The other types of commodities were blood group reagents which are Anti-A, Anti-B, Anti-AB and lastly anti-D or Rh-factor.

4.1.1.6d Stock card/bin availability for Hormone commodities in SPHMMC laboratory store

7(87.5%) out of 8 Hormone commodities have no stock card/bin. The commodities items were Thyroid Stimulating Hormone (TSH), Thyroxin (T3), Thyroxin (T4), Follicle Stimulating Hormone (FSH), Estradol, Luteinizing Hormone (LH), Prolactin and Testosterone.

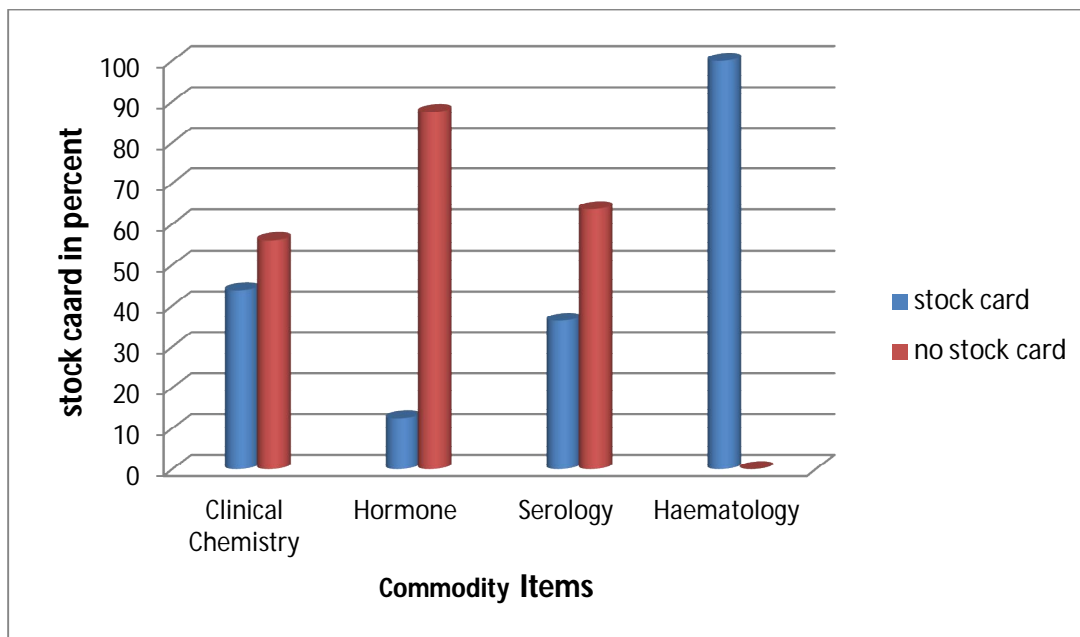


Figure2. The graph shows that the availability of stock card/bin for selected commodity item

4.1.1.7 Stock Status of the Selected Commodity

4.1.1.7a Stock out items for selected commodities in SPHMMC laboratory store

From the total of 42 items 15 (35.7%) of it were out of stock during the assessment period. Out of 15 commodities 7(46.7%) of it were Hormone reagents and followed by Clinical Chemistry which were 6(40%) out of 15 items, namely Urea, Albumin, HDL-C, LDL-C, Alkalinephosphatase and Direct Bilirubin. Next to these commodities Serology about 2(13.3%)

of it stock out and items were HCV and H. pylori.ag. Haematology commodity was not stock out at the time of assessment in the laboratory.

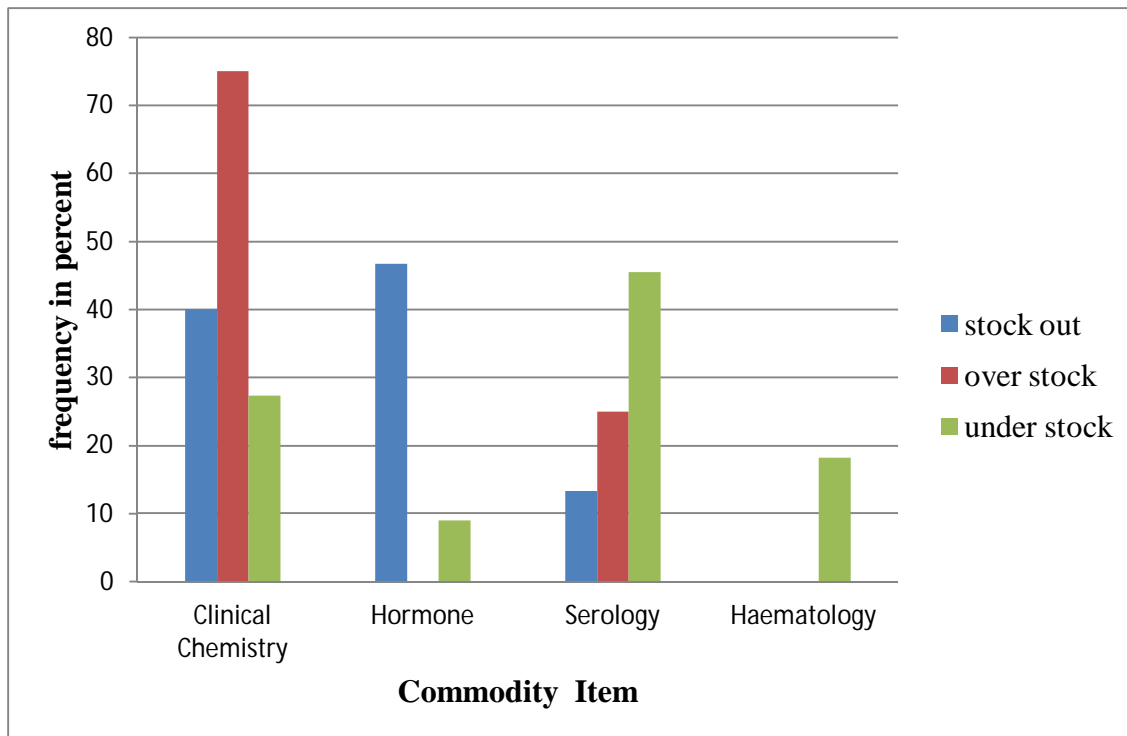
4.1.1.7b Under stock items of selected commodities in SPHMMC laboratory store

Out of 42 items 11 (26.2%) of it were under stock commodities. 3(27.3%) out of 11 were Clinical Chemistry which are Glucose, SGOT and SGPT, 5(45.5%) out of 11 were Serology that includes HBSAg, H.pylori ab, ANA, HCG and CRP, one (9.0%) out of 11 was Hormone commodity and 2(18.2%) out of 11 were Hematology for CELLDYN diluents and detergents were under stock commodities.

4.1.1.7c Over stock items of selected commodities in SPHMMC laboratory store

From the total of 42 items 4(9.5%) of them were found to be over stock commodities. Among over stock items 3 (75%) of them belongs to Clinical Chemistry and the specific items were Creatinine, Amylase and Total Protein. The rest was from Serology commodity that is Ramotid Factor (RF) which accounts 25% of the stock status.

Figure3. The graph shows the result of stock status of laboratory commodities in SPHMMC April, 2015.



4.1.1.8 Assessing expired items of selected commodities in SPHMMC laboratory store

During the assessment the expired items accounts 6(14.3%) from the total of 42 commodities. From the expired products the Clinical Chemistry was the highest which covered about 4 (66.7%) of the expired commodities and following to it the Serology commodities were 2(33.3%) out of 6 identified products in the SPHMMC laboratory store.

Figure 4 below shows that expired commodities in SPHMMC laboratory during the assessment and the result indicate only among expired commodities not the entire commodities.

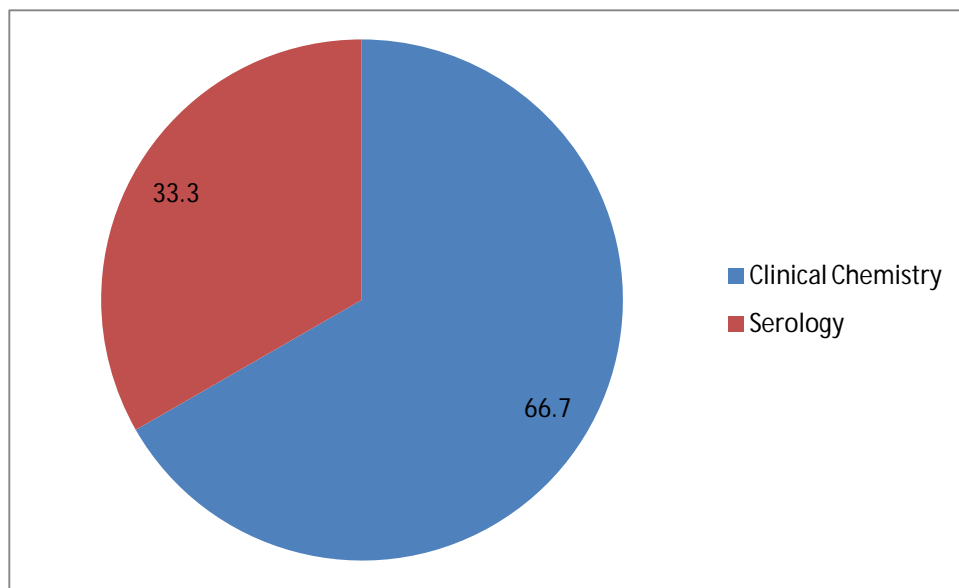


Figure4. Expired Commodities

4.1.1.8 Using the guidelines checking the storing condition of commodities in SPHMMC laboratory store

As indicated in annex VI, the storing conditions of the commodities were almost fulfilling the checklist presented except for the points of storage space and fire safety equipment absence. Products are stored at every facility in the pipeline; almost everyone working in the supply chain is responsible for product storage. Storage ensures the physical integrity and safety of products and their packaging, throughout the various storage facilities, until they are dispensed to clients. An important goal in storage of health products is the correct staging of health products to ensure that orders can be filled and distributed.

4.1.2 Qualitative Findings of Semi-Structured Interview Questionnaires

4.1.2.1 Semi-structured interview questionnaire response of the vice provost for medical services of SPHMMC, Ethiopia, AA, April 2015

The vice provosts for medical services was replied the questions presented about the quality improvement program for laboratory LMIS. The hospital has a program but it is not functioning actively for time being and it will be functioning after six months. The reason not to be active now was the hospital has conducting reforms like balance stock card (BSC) and expanding of the different units of the laboratory department within the hospital. Regarding problems raised related to laboratory LMIS the hospital has assigned permanent team that easily resolves if any issue happened. Concerning laboratory LMIS team the hospital not yet established, but informally the tasks were carrying out by different personnel's.

4.1.2.2 Semi-structured interview questionnaire response of the vice provost for business and development of SPHMMC, Ethiopia, AA, April 2015

The vice-provost for business and development of SPHMMC was reacted to questions raised by project conductor about the policy of LMIS, financial/budget allocation for laboratory department, monitoring consumption and financial reporting system of laboratory commodities, having program of enhancing knowledge of laboratory professionals towards the quality improvement of LMIS and what methods or plan to enhance the staffs of laboratory personnel's. The hospital has policy for the quality improvement of LMIS and the financial system also allocated to the laboratory by its own budgetary approach and the consumption and financial report of laboratory commodities controlled by established system. Regarding enhancing knowledge of laboratory professionals towards LMIS the hospital has a program and the method also through training as needed.

4.1.2.3 Semi-structured interview questionnaire response of the pharmacy department head of SPHMMC, Ethiopia, AA, April 2015

The pharmacy department has playing a significant role by providing all commodities to the laboratory. The entire laboratory commodities were supplied from different supplier and the pharmacy not using standard forms to supplier to receive commodities. There is also a delay of receiving laboratory commodities from supplier due to unavailability of supplier in the country. Related to this interruption the pharmacy department is report the phenomenon to laboratory department to minimize unnecessary disturbance in the working environment. Additionally, the

major challenge to acquire the laboratory commodities was there is no continuous availability of the reagents from supplier.

4.1.2.4 Semi-structured interview questionnaire response of the pharmacy department store head of SPHMMC, Ethiopia, AA, April 2015

The pharmacy store head has a controlling mechanism of laboratory commodities stock status and checked regularly by quarterly to avoid the imbalance of the item in the pharmacy store. The store head was using standard forms to monitor and control the stock balance of laboratory commodities which were stock cards. Moreover, he was applying established distribution system of LMIS and this system was check and balance system of the commodities.

4.1.2.5 Semi-structured interview questionnaire response of the laboratory department head of SPHMMC, Ethiopia, AA, April 2015

The response of laboratory head about how you acquire laboratory commodities was by purchasing with own budget and the department has a permission/mandate to order adequate laboratory commodities to have in stock. According to the laboratory head response, the frequency of reordering of the commodities was quarterly and also using standard LMIS forms for collecting and reporting laboratory commodities. The department has a system of monitoring for the consumption of laboratory commodities and this system is check and balance with test performed. The head had no scheduled supervision of laboratory store but informally supervises and has no using standard check list during informal supervision. The department has no a system of gathering suggestions for quality improvement of medical laboratory logistics management information system and also not yet started for staff satisfaction related to availability of laboratory commodities.

4.1.2.6 Semi-structured interview questionnaire response of the laboratory department store head of SPHMMC, Ethiopia, AA, April 2015

The laboratory store head was also responded to various questions concerning to the commodities as follows. The store head have standard operating procedure for LMIS and applies for his day to day activities. Government distributed note (Model 22) form was applying for ordering and reporting of commodities to pharmacy store department and bin/stock cards were using for some commodities within the laboratory store to keep the records. The stock status of laboratory was reviewed monthly and damaged or expired commodities were separated and removed from stock records. Moreover, the store has a system of managing laboratory

commodities during issuing to each unit of laboratory and using daily register forms to control the study commodities.

4.2 Discussions

4.2.1 Quantitative discussions

The final goal of the medical laboratory logistics management information system is to ensure laboratory commodity availability at the service delivery points; as a result clients will obtain the necessary laboratory investigation. Moreover, the medical field now a day requires the use of computer for information processing, accuracy, record keeping, decision making and for other multipurpose.

4.2.1.1 Knowledge of the respondents towards LMIS

The in progress project result reveals that, related to knowledge, lack of in-service training on LMIS was evidently observed. This means, the majority 11(61.1%) of the laboratory professionals in the department has work experience between 0-5 years. This result considered as one cause by project investigator. Most 15 (83.3%) of them have not got training on LMIS, but 3(16.7%) of them have got training. These results were due to lack of giving continuous in-service training and awareness creation for newly recruited employee. However, the hospital was tried filling the gap by providing training for 2(11.1%) of the study participants and importance of in-service training on LMIS. Accordingly, similar study was not conducted in the selected facility regards to this project, but related study which was conducted by Adino Desale et.al., in Addis Ababa at 43 health facilities shows that only 4 (3.5%) of them have got training from the total of 39 laboratory managers for LMIS [1]. This difference is due to the number of participants and the facility type.

Again the above result supported by literature “Traditional approaches for improving LMS have included workshops and having staff go to training venues. However, health facilities in many developing countries are faced with human resource challenges including inadequate numbers, low skills, low motivation, high turnover, and high attrition. It is simply isn’t feasible for the facility to keep releasing employees for lengthy of didactic trainings” [28].

This project result shows that in relation to the consumption and inventory mechanism of laboratory commodities about 15(83.3%) of respondents have no knowledge and this was found

to be a factor for gap on LMIS. This result in line with the other related study conducted by Adino Desale et.al., the established inventory control procedures were known and utilized by only 2 (25%) out of eight hospital laboratories. The rest 75% of hospital laboratories did not know and utilized the established maximum-minimum stock levels [1]. Again this idea was supported by literature “when designing a logistics system, the type of max-min inventory control system (ICS) that you choose will dictate how and when commodities will be resupplied throughout the system. The ICS and the related max-min stock levels for the commodities will also have a direct impact on the resources needed to implement the system, including what resources will be needed (storage capacity, vehicles, human resources, time), as well as when and where these resources will be needed and how they are used” [3].

4.2.1.2 Attitude of the study population

The result of the present study shows that the majority 12(66.7%) of them were strongly agreed that developing system management will contribute for quality improvement of LMIS. This result is supported by literature, “more training, more resources, more of the same failed approach may not be the answer. The solution lies in an integrated approach that includes identifying the problems, planning strategically, and setting targets, meeting expectations and deadlines, accountability, leadership, active monitoring and evaluation (M&E), and a systematic management approach based on performance monitoring and transparency” [28].

Another result related to this project of the respondents almost all 16 (88.9%) were preferred to work as a team and this result indicates that implementing LMIS will brought effectiveness to succeed the objective of the project. According to study participants response factors that support to implement LMIS were: staff interest, knowledge about the project, team work and managerial support inputs for completed implementing of the present project. This result reveals that identifying the causes and then responding for those causes’ results in implementing or making decision will improve the project objectives.

The result of this study shows that, the importance of LMIS related to decision making and controlling the stock status, the respondents were replied, 10(55.6%) of them said helps as moderately and 7(38.9%) of them considered as most important. These results supported by literature “Using these data, the computerized LMIS calculates essential stock status indicators

and provides information in the form of reports and graphs to decision makers to assist with the monitoring of logistics system performance and the planning of future product and logistics system requirements” [23].

The study result shows that, all (100%) of the study population thought that quality improvement of LMIS will improve the service of laboratory and they were also interested to take training on LMIS. This result agreed with the literature “technologies for key laboratory tests are routinely changing, and programs often want to change standards as technologies both emerge and improve” [31].

4.2.1.3 Practice of study population

The result of this project shows that, 13(72.2%) of study participant have no the opportunity to participate in quality improvement of LMIS. This is due to various reasons, from the result, majority of the participants were fresh in work experience, this type of project was not conducted repeatedly and budget was not allocated specifically for this program.

The result of this project shows that, 11(61.1%) of study participant assumed the LMIS was integrated with currently actively functioning laboratory information system (LIS), but the fact indicates that it was not integrated. This response was due to lack of knowledge and not giving attention for issue. This idea in line with the literature “an LMIS does not operate in a vacuum, but in a dynamic environment, where other computerized systems are already being invested in, planned for, and implemented. In recognition of these linkages, the computerization or automation of the entire supply chain will involves more than just the LMIS” [31].

The study results of stock out frequency reveals by respondents were 10(55.6%), 4(22.2%), 3(16.7%) and 1(5.5%), quarterly, different time, monthly and annually respectively. This result compared to other study but with related study shows as the most frequent stock out reagents were chemistry reagents in hospitals [1]. The difference was due to sample size, methodology and number of facilities conducted. This result also supported by literature” stock outs are the most serious negative outcome in a logistics system. Stock out information is simple to collect and was collected at the facilities visited during the survey” [22].

The result of under stock frequency was 6(33.3%), 5(27.8%), 5(27.8%), and 2(11.1%) of them responded that monthly, quarterly, weakly and annually respectively. This result again related to the study conducted by Adino et. al. showed that, majority of facilities were found under stock. Additionally, these result in agreement with the literature “An inventory control system informs the storekeeper when to order or issue, how much to order or issue, and how to maintain an appropriate stock level of all products to avoid shortages and oversupply” [22].

The finding of this project shows that 8(44.4%) of them do not know the frequency of over stock commodity, but the other 5(27.8%), 3(16.7%) and 2(11.1%) were replied that annually, monthly and quarterly respectively. This result has similar idea with, 12 of facilities had higher stock levels for the last 6 months [1]. This result indicates that, intervention should apply on system management for LMIS and awareness creation for laboratory professionals to enhance management of commodities.

Current study also indicates that 44.4% and 38.9% were a problem of stock imbalance for the item Clinical Chemistry and Hormone commodities respectively. This result in line with the study conducted by Adino et.al most frequent stock out reagents were chemistry reagents, but hormone reagent was not included in their study.

Related to machines, the finding shows that 50% of respondents states Clinical Chemistry was highly out of functioning for repeated time. This result in line with the literature “prolonged instrument down time; lack of advance planning for post-warranty service; inadequate capacity at the central, regional, and facility levels to address instrument breakdowns in a timely manner; and poor adherence to preventive maintenance protocols” [31]. The result and the statement reveal that, LMIS will be enhanced by implementing those identified problems in selected facility.

The other point of this project, regarding the registration of laboratory commodities, the project participants replied that 7 of them said electronically and the other 7 of them paper based and the rest assumed both. In fact the recording system at the time of visiting the laboratory store was using both computer and manually. The above result again shows that the participants have a big gap on the practice of recording the laboratory commodities in the store.

4.2.1.4 Discussion on the assessment of the availability of bin/stock card, stock status and expiry date of the commodities in the laboratory store of SPHMMC

The result of this project shows that, there were about 42 items of study commodities identified at the time of assessing the laboratory store. As indicated in table 5, 16(38.1%) out of 42 items were belongs to Clinical Chemistry, 8(19%) of them Hormone, 11(26.2%) of it to Serology tests and the other 7(16.7%) of it were Hematology. These figure shows that, only the availability of tests which were performing in the laboratory department of the hospital during the assessment conducted in the facility.

The project study result shows that among 16 items of Clinical Chemistry commodities 7 of them have stock card and the majority of commodities have no bin card. This result was comparable with the study conducted by Adino, et.al. 5 (55%) items of Clinical Chemistry commodities has stock cards. This is due to the laboratory has well maintained recording system. The other finding of this study shows that 4(36.4%) out of 11 items of Serology commodities has stock cards. Related to this finding no similar or related study was conducted to compare, but it shows that the initiation was encourage to enhance the existing system.

Related to Hematology finding, all commodities have stock cards. This result indicates, a well recorded data will help for decision making on laboratory commodities of LMIS. But the other finding on Hormone tests shows that almost all of the items have no stock card. This result affects the quality of LMIS for decision making and improvement.

4.2.1.5 Discussion on stock status of the study commodities in SPHMMC laboratory store

The result of this project shows that 15(35.7%) out of 42 items were stock out. From the total stock out reagents 46.7% of it was hormone reagents and followed by Clinical Chemistry which was 40% of it were stock out. These results show that stock out in most health facilities were a common problem and the causes may be estimated due to lack of practicing max-min inventory system, weak quantification/forecasting, shortage of funding and requested quantity not received in the right time [1].

The assessment result shows about under stock commodities 11(26.2%) out of 42 items were identified. Among these 3(27.3%) of them were Clinical Chemistry, the higher number was Serology which were 5(45.5%) items, 2(18.2%) of them were hematology and 1 of it was

Hormone commodities. This condition was observed due to inadequate amount of commodity received. Additionally, lack of updating stock card, wastage and number of tests order increased.

As a result indicates concerning over stock, 4(9.5%) out of 42 items was found. From these items 3(75%) of them belongs to Clinical Chemistry and one (25%) of it was Serology. This result compared with the study conducted by Adino et.al. in 10 (23.2%) of facilities reported to have a surplus of some HIV/AIDS and TB laboratory commodities. The difference is may be due to the commodity type and the number of facilities. Here also lack of applying inventory management and weak quantification of commodities.

The result indicates that among assessed commodities 6(16.7%) items were found expired and from this 4(66.7%) of items were belongs to Clinical Chemistry and the rest 2(33.3%) items were belongs to Serology commodities. This result depicts that more efforts should practice to avoid and minimize the expiration of commodities. The inventory system should reviewed and checking of stock status.

4.2.2 Discussion on the qualitative results

4.2.2.1 Discussion on response of vice provost for medical services

The higher official was responded to the questions that were presented concerning the quality improvement of LMIS. Accordingly, the hospital has a program of quality improvement on LMIS, but this program currently not functioning actively and it may be implemented after 6 months. The reason was the hospital conducting reforms on balance stock card (BSC) and expanding different programs. The hospital has also a permanent team to resolve problems related LMIS. But the official doesn't know the availability of LMIS team unit. The function of this team is to solve problem regarding the laboratory commodities and related issues. Moreover, the absence of formed team was inability of to explain about the commitment and sufficient number of staff.

Establishing a laboratory commodity committee helps to coordinate donor and government inputs and to develop a commodity security strategy for laboratory services. A logistics system can only work if well-trained, efficient staff monitor stock levels, place orders, and provide products to clients. Health programs assign the appropriate resources to staff (for example,

supervision authority and technical knowledge) to complete logistics activities. In fact, some countries have established national logistics management units that analyze logistics data and provide feedback throughout the system [3].

4.2.2.2 Discussion on response of vice provost for business and development services

The officials responded that the hospital has developed a policy concerning logistics management. The hospital also allocated budget to the laboratory commodity through budgetary system and to achieve this goal it needs to work with policymakers to establish a specific budget for laboratory commodities and the logistics system in which they are managed. The other response of the official related to controlling the consumption of laboratory commodities was through established system.

But from literature aspects, “There are two major ways of capturing consumption for laboratory commodities. The first is to use issues from stock at the lowest level—within the laboratory itself, this means issues from the store to the bench—as a proxy for consumption. The second is to track the actual consumption of a test, that is, the amount of product used in the process of conducting a test. To facilitate stock keeping, issuing, and reporting of these commodities, review each product, how it is issued to the bench, how it is used at the bench, and the number of pack sizes to determine which unit is most appropriate to use in recording and reporting commodity information”[30].

Regarding knowledge enhancement on LMIS for laboratory professionals the hospital has a program to conduct through training. Moreover the hospital has an experience by conducting training on quality improvement of LMIS. “Supervising the staffs that works within the logistics system keeps it running smoothly and helps to anticipate needed changes. Routine, effective supervision, coupled with on-the-job training in logistics, helps to both prevent and resolve supply problems and human resource constraints” [28].

4.2.2.3 Discussion on response of pharmacy department head

The entire laboratory commodities are provided through this department and it was using standard forms to order the commodities to the supplier which is Government receiving note (Model 19). Related to providing commodities it has a problem of limited access or it has an impact on the services of laboratory not decide on time. There was also a delay of receiving the commodities from supplier due to the supplier not available in the country. These problems

should be overcome by implementing the LMIS principles, which means by applying Maximum-Minimum stock level or status. The head responded that the delay of commodity was reported to laboratory department. This is important part that helps laboratory department to manage stock status of the commodity. The department was facing the major challenge to acquire the commodities due to lack of continuous availability from the suppliers. This problem may be solved as project investigator view by direct contacting with manufacturers keeping the rule and regulation of the country policy of commodity.

4.2.2.4 Discussion on response of pharmacy department store head

The pharmacy store has a controlling system for laboratory commodities stock status and monitor and checked quarterly. The response of store head concerning the type of using standard forms for controlling stock balance was stock cards. The pharmacy store has also established distribution system of commodities to the laboratory through checking and balancing system. “After an item has been procured & received by the health system or program, it must be transported to the SDP where the client will receive the products. During this process, the products must be stored until they are sent to the next lower level, or until the customer needs them. Almost all businesses store a quantity of stock for future customer needs” [3].

4.2.2.5 Discussion on response of laboratory department head

The department has acquire these selected commodities by allocated budget through the hospital financing system by purchasing and the department has a mandate to determine the amount of commodities to order. The department head also responded that to have adequate amount of stock status the frequency of ordering laboratory commodities was quarterly. The department has standard forms to collect and report LMIS data which helps for planning and decision making. The department has also a system of monitoring and consumption of laboratory commodities and this system was controlled by check and balance with test performed. As the head responded that, no scheduled supervision was conducted for laboratory commodities in the store but informally conducting the visiting. The department has no system for gathering suggestion for improvement of LMIS and also method of measuring staff satisfaction related to this project. This finding also supported by literature “Customers are not the only ones who benefit from the consistent availability of commodities. An effective logistics system helps provide adequate,

appropriate supplies to health providers, increasing their professional satisfaction, motivation, and morale. Motivated staff is more likely to deliver a higher quality of service” [31].

A delivery truck system helps reinforce supervision because the supervisor arrives with the supplies. This requires additional supervision resources, however, because supervisors must be out of the office for extended periods. Forced-ordering also forces routine reporting, which allows supervisors to check math errors and changes in consumption. In a standard system, if no products are needed, a report might be skipped. It is difficult to supervise outlets that are not visited regularly and do not report regularly; absence of information is not a positive sign [3].

4.2.2.6 Discussion on response of laboratory department store head

The store head was responded that he was using standard operating procedure for LMIS and also using for day to day activity. This is the strongest part of department and by following the management that requires criteria for LMIS. For ordering and reporting he was applied government distributed note (Model 22) form to pharmacy store department and using sock card for some commodity items. The stock of laboratory commodity was reviewed monthly and at the time of visit the damaged and expired commodities were separated and removed from stock records. This point is an important for quality improvement of LMIS and helps for managing laboratory commodities. The store has also a system of managing commodities at the time of distributing each item to working units by using daily register forms to check balance stock.

Supported information related to the above laboratory store findings, because most of the product manufacturers are based internationally, the most common in-country distribution system is a system where products flow from central medical stores to districts and regions; and, ultimately, to service delivery points. Similar to storage of health products, distribution plays an essential role in the health logistics system. Distribution consists of moving products down the pipeline from the national central warehouse until they are dispensed to the final customers. However, to maintain a well-functioning distribution system, you must consider several essential points in transportation planning and execution [24].

4.3 Intervention and proposed solution of the Project

This project was aimed to identify gaps and solve the identified gaps through establishment of teams related to LMIS, providing training to all concerned stakeholder and developing system management for LMIS.

4.3.1 Conducting training

The project owner has taken actions based on the result and pre-defined project proposal to overcome the problem or gap identified. Consequently, training was conducted for the laboratory professionals and for some higher officials. The training was provided by project owner for half (½) day on the quality improvement of medical laboratory logistics management information system. After providing training, the feedback was sensible to the principal investigator by making awareness creation and narrowing the gap observed on knowledge of LMIS. Moreover, the participants were feels that knowing about the LMIS is one part of their duty to manage and communicating with laboratory store head.

4.3.2 Developing system management for LMIS

From the above title we infer that there is existing system which is LMIS. So this system has its own procedure to be fully functioning. Hence, there are different activities involved in LMIS, such as Product Selection, Serving Customer, Forecasting and Procurement, Quantification, Distribution and other. Therefore, each activity requires its own procedure and methodology to meet the planned objectives. So based on these features of the LMIS, this project was designed to establish the system. This means each activity should be checked and controlled by formed team from supplier to the service delivery point and this helps for decision making.

4.3.3 Formation of LMIS team

The team was established from various departments and including higher officials. Namely, laboratory head, pharmacy head, pharmacy and laboratory department store head, medical service provost, business and development provost, from the hospital quality management office and nursing directorate. The objective of this team was to make decision regards to laboratory commodity. The main duty of this team is to monitor and control the stock status of laboratory commodity in the laboratory and pharmacy store. Moreover, the team also conducts communication and assessment with specified supplier if there is a change on the outside environment on the condition of commodities to make action before things changes. The team

has scheduled to hold meetings in every two (2) months and if necessary emergency meeting will be called at any time.

4.3.4 Proposing Computerization and Integration of the System

Based on the nature of the project and from the analysis of result, the project conductor is proposing the integration of the LMIS to the laboratory information system. This integration requires programming, alerting, loading items, adequate time; human, financial, resources must be allocated during every step of the system development process. The reason to propose for integration is every laboratory professional using LIS. So, if the whole commodities loaded on this system with above mentioned features, the LMIS can easily accessed and the gap will minimized on the stock and knowledge of professionals will enhanced. Finally, this system provides input for end users and evaluates the process of users at main server.

4.4 Strength and Limitation of the Project

4.4.1 Strengths

The major gaps were identified on LMIS and solution was also provided to the causes. The higher officials did show willingness to participate and make decision on the gaps. There was an improvement among the study participant towards knowledge, attitude and practice after training provided. Performing of both qualitative and quantitative type of study also considered as strength of this project. The findings of this project may initiates or guides to conduct and helps as a base-line for further study.

4.4.2 Limitations

The main limitation of the project was, no similar study conducted related to this project to make comparison for gap identified. The time allocated was not enough to accomplish the project. The sample size also was not enough to draw conclusion.

Chapter Five

5. Conclusion and Recommendation

5.1. Conclusion

The project assessment was conducted on quality improvement of medical laboratory LMIS on the gap of knowledge, attitude, practice of laboratory professionals and on some higher officials. For the identified gaps possible solutions were proposed and some interventions were implemented. From the project assessment result knowledge gap, lack of in-service training on LMIS and the majority of laboratory professionals have less work experience were identified as a cause to meet the objective of LMIS.

The hospital has an experience by providing training on logistics management information system and it is considered as the indicator to continue training and strong part of the finding. Most of the study participants did not know about the commodity inventory and consumption mechanism. There was also well established and organized LMIS in the laboratory store that helps to monitor and evaluate the commodity stock status. Moreover, the laboratory store has been using locally and nationally developed forms to distribute and receive laboratory commodities.

The finding reveals that the LMIS is not integrated with laboratory information system. The result also shows, the study populations have different knowledge on the commodities imbalance (which means the stock out, under stock and over stock) frequency and there was also a machine failure or malfunctioning for repeated time.

The hospital has a program to enhance the laboratory professional's knowledge and policy regards to LMIS. There was also a permanent team that solves problem related to logistics. But the hospital has no established team for LMIS. Additionally, laboratory department was not conducting supervision in the store, using standard check list for stock status and storage condition formally. The result of this project indicates that a major challenge of acquiring laboratory commodity was availability of reagents is not continues from the suppliers. Finally, for the identified gaps, possible intervention and awareness creation was practiced on laboratory professionals. Moreover, proposing that to change the manual to electronic recording system and integrating the LMIS to laboratory information system.

5.2 Recommendation

Based on the findings and conclusions of this project, the following recommendation was provided:

- From the findings most of the respondents didn't got training, so to overcome this gap, continuous training should be provide on LMIS to laboratory professionals and other parties in connection with this system.
- Majority of the study participants have no knowledge on commodity consumption and inventory system, so due to this the laboratory professionals should be involve in commodity management cycle, particularly in the selection, procurement, and distribution
- The LMIS is not computerized, so it should be computerized and also integrate with the laboratory information system, which is now actively functioning system and localized for only laboratory department. So every laboratory professionals can easily accessed about the commodity stock status and enhance knowledge on it
- Should apply standard procedures and principles of logistics to utilize efficiently and effectively
- Supervision of laboratory store was not conducted formally, as a result supervision should be conduct using standard check list and with specified schedule. Because it avoids or minimizes the stock imbalance and expiry date.
- Plan for long and short terms of preventive and maintenance of laboratory machines, consequently, to avoid malfunction and interruption of services and reagent wastage
- There was repeatedly out of functioning of machine and commodity status, due to this plan to have reserve machines, especially for Clinical Chemistry and practice the rule of maximum-minimum commodity level application
- Awareness creation should be provide for higher officials and other concerned body about the importance and impact of logistics management system on the quality of laboratory services
- There was a lack of updating and reviewing of stock card for all commodity items, so it should be updated and reviewed for the purpose of inventory controlling system

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Annex I

Addis Ababa University
School of Information Science and School of Public Health Science,
Department of Health Informatics

Information Sheet

Dear Participant, How are you? My nameI am a post graduate student of Addis Ababa University, School of Information Science and School of Public Health in the department of Health Informatics and going to study and collect data on Medical Laboratory Logistics Management Information System for selected Hematology, Clinical Chemistry Serology and Hormonal commodities in SPHMMC laboratory.

The objective of this project is to improve the quality of laboratory LMIS and to collect current information of the stock status of the selected commodities in the SPHMMC laboratory. The information you provide will be used to improve the quality of laboratory LMIS performances and to implement appropriate interventions and solutions.

If you decide to participate, I will guarantee that there is no any influence related to this project but only request you that to provide all relevant information regarding the project. Any information that is obtained in connection with this project and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law. Your name will not be written on the questionnaire or be kept in any other records. Your participation is voluntary and you are free to withdraw your consent and to discontinue participation at any time without penalty. Your participation or not, do not have any influence for your position or responsibilities in this facility (SPHMMC).

For the successes of my project, you are kindly requested to respond genuinely and voluntary with patience. You are making a decision whether or not to participate in this project. Your signature below indicates that you have read the information above and have decided to participate in the project.

Thank you for your participation

Annex II

**Addis Ababa University
School of Information Science and School of Public Health Science,
Department of Health Informatics**

Consent form

I _____ here by giving my consent for giving accurate information on the project title assessing and improving the quality of medical laboratory logistics management information system (LMIS) in SPHMMC as recommended by the researcher/data collector and to answer those logistics questions. For the accomplishment of this project, you are kindly requested to respond genuinely and voluntary with patience. You are making a decision whether or not to participate in this project. Your signature below indicates that you have read the information above and have decided to participate in the project I understand there is no problem within my position in the health facility by participating in this project at the beginning as well as at the end of the study. I believe that this project will be used and implemented in my health facility and also will provide improved quality of laboratory LMIS services.

Participant Name _____ Signature _____ Date _____

Investigator Name _____ Signature _____ Date _____

Annex III

Addis Ababa University
School of Information Science and School of Public Health Science,
Department of Health Informatics

Questionnaires

This questionnaire is prepared to gather the necessary information to conduct the project as the partial fulfillment of the requirement M. Sc in Health Informatics programme at Addis Ababa University School of Information Science and School of Public Health. On this questionnaire your name will not be written and your answers will be kept completely confidential. Your honest answers will help the project investigator (PI) to understand better to fill the gap on the quality improvement of the medical laboratory LMIS (logistics management information system) and to identify problems related to such a project and finally to bring the possible intervention to the problem. PI would like to greatly welcome your truthful participation in filling the questionnaire.

Part I

Socio-demographic characteristics of St. Paul's hospital laboratory professionals

1. Sex

a. Male

b. Female

2. Age

a. 20-30

b. 31-40

c. 41-50

d. 51-60

3. Educational level

a. Masters

b. Degree

c. Diploma

4. Work experience in year

a. 0-5

b. 6-10

c. 11-15

d. 16-20

e. 20+

Part II

- a. As individual b. As a team c. Other (specify).....
9. In your opinion, what are the causes for the successful implementation of LMIS?
- a. The staff interest c. Managerial support
- b. Knowledge about the project d. Team work e. Other (specify).....
10. How important do you think, improving the quality of medical laboratory LMIS will help for decision making and controlling of stock status?
- a. Most b. Moderate c. Faire d. Least
11. Do you think, improving the quality of LMIS will improve the quality of laboratory services in the hospital? a. Yes b. No c. Do not know
12. If you get the opportunity, are you interested to take training on the improving the quality of medical laboratory LMIS? a. Yes b. No

Part IV

Practice of laboratory professionals towards the improvement of quality of medical laboratory LMIS

13. Have you ever got the opportunity to participate in quality improvement project for medical laboratory LMIS? (If No, skip Q15&16)
- a. Yes b. No
14. If yes for Q14, how did you participate in the project activity?
- a. As individual b. As a team c. Other (specify).....
15. If yes for Q14, how did you evaluate your participation in quality improvement project activities?
- a. Highest b. Average c. Lowest
16. Is the laboratory LMIS integrated with laboratory information system?
- a. Yes b. No c. Don't know
17. How often do you face the laboratory commodity stock out?
- a. Monthly b. Quarterly c. Annually d. Other (specify).....

18. How often do you encounter the laboratory commodity under stock?

- a. Monthly b. Quarterly c. Annually d. Other (specify).....

19. How often do you face the laboratory commodity over stock?

- a. Monthly b. Quarterly c. Annually d. Other (specify).....

20. Which laboratory commodity mostly encounters a problem of stock balance status?

- a. Hematology b. Clinical Chemistry c. Serology d. Hormonal

21. Which laboratory equipment/machine is/are mostly out of functioning?

- a. Hematology b. Clinical Chemistry c. Hormonal d. Other (specify).....

22. How are the commodities of laboratory being recorded?

- a. Electronic based b. Paper based c. Other (specify).....

Annex IV

Addis Ababa University
School of Information Science and School of Public Health Science,
Department of Health Informatics

Using semi-structured questionnaires, interviewing some of the St. Paul's hospital higher officials and laboratory and pharmacy department staffs to gather information about the quality improvement of medical laboratory LMIS from the delivery point to the utilization and how the system is functioning.

Part I

Semi-structured interview questionnaire to the vice provosts for medical services of SPHMMC

1. Does SPHMMC has quality improvement program on laboratory LMIS?

2. If No for Q1, when do you think the program actively implemented?

3. How does SPHMMC resolve quality improvement of laboratory LMIS related problems?

4. Do you have laboratory commodity LMIS team unit?

5. If yes for Q4, do you think that you have sufficient number of staff for this unit?

6. Is yes for Q4, how do you evaluate the staff commitment towards improving quality of laboratory LMIS?

Annex IV

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Part II

Semi-structured interview questionnaire to the vice provosts for business and development services of SPHMMC

1. Has SPHMMC developed quality improvement for medical laboratory LMIS policy?

2. How are financial resources allocated to laboratory commodity?

3. How do you monitor laboratory commodity consumption and financial reporting systems?

4. Is there a program to enhance knowledge of laboratory professionals towards quality improvement of laboratory LMIS?

5. If yes for Q4, in what method do you want to enhance their knowledge?

Annex IV

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Part III Semi-structured interview questionnaire to the laboratory head of SPHMMC

1. How do you acquire laboratory commodity for consumption?

2. Who determines how much laboratory commodity to order?

3. How often do you think you should reorder your commodity to ensure adequate stock status?

5. Are standard laboratory forms available and used to collect and report laboratory LMIS?

6. Is there a system to monitor the consumption of laboratory commodities?

7. What is the system do you use to monitor the consumption of laboratory commodities?

8. Have you scheduled supervision of stock status of laboratory commodity in store?

9. If yes for Q7, how often the supervision being conducted?

10. If yes for Q7, is there a standard supervision checklist or procedure?

11. Do you have a system of gathering suggestions for quality improvement of laboratory commodity of LMIS?

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Part IV

Semi-structured interview questionnaire to the laboratory store head/ keeper

1. Do you have standard operating procedure for LMIS?
2. If yes for Q1, do you apply in your day to day activity?
3. What forms does the laboratory use for ordering & reporting commodities to the pharmacy?
4. What forms does the laboratory use to keep records of commodities in store?
5. How often is the stock status for laboratory commodities reviewed?
6. Are damaged/expired commodities physically separated while inventory and removed from stock records?
7. Do you have system of managing laboratory reagents/commodities during issuing to each unit of the laboratory?
8. Which logistics forms do you use and fill out to manage Hematology, Clinical Chemistry, Serology and Hormonal laboratory commodities?

Annex IV

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Part V

Semi-structured interview questionnaire to the pharmacy head of SPHMMC

1. Do the entire laboratory commodities come from the same supplier?

2. What LMIS forms do you use for ordering laboratory commodity to the supplier?

3. Is there a delay in receiving laboratory commodities from supplier?

4. If yes for Q3, what was the reason/s for the delay in receiving the commodities?

5. If yes for Q3, do you report the reason to the laboratory department?

6. What are the major challenges to acquire the laboratory commodities from the suppliers?

Annex IV

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Using semi-structured questionnaires, interviewing some of the St. Paul's hospital higher officials and laboratory and pharmacy department staffs to gather information about the quality improvement of medical laboratory LMIS from the delivery point to the utilization and how the system is functioning.

Part IV

Semi-structured interview questionnaire to the pharmacy store head/keeper of SPHMMC

1. Do you have controlling mechanism of laboratory commodity stock status?

2. Are stock balances for laboratory commodity monitored regularly?

3. If yes for Q2, how often do you check it?

4. What standard forms do you use to monitor and control the stock balance of laboratory commodity?

5. Is there an established distribution system of laboratory commodity of LMIS?

6. If yes for Q5, what is the system do you use for distribution?

Annex V

Addis Ababa University
School of Information Science and School of Public Health Science,
Department of Health Informatics

In this part the project investigator plan to identify the availability of bin/ stock card, status of stock and expiry date in the laboratory store for the Hematology, Serology, Hormone and Clinical Chemistry commodities. So for this purpose spread sheet for inventory and check list are prepared to collect the necessary information to fill the gap in improving the quality of medical laboratory LMIS in St. Paul's Hospital Millennium Medical College laboratory.

1. Assessing the availability of stock card, expiry date and stock status for **Clinical Chemistry** tests commodity in St. Paul's hospital laboratory storage, April 2015.

Note: Y- yes

N- no

Q- quantity

Item	Stock card			Stock out			Under stock			Over stock			Expired			Remark
	Y	N	Q	Y	N	Q	Y	N	Q	Y	N	Q	Y	N	Q	
Total Cholesterol																
Triglyceride																
HDL-C																
LDL-C																
Uric acid																
Urea																
Creatinine																
SGOT																
SGPT																
Alkaline phosphatase																
Bilirubin Total																
Bilirubin Direct																
Albumin																
Total protein																
Amylase																
Glucose																

2. Assessing the availability of stock/bin card, expiry date and stock status for **Serology** tests commodity in St. Paul's hospital laboratory storage, April 2015.

Item	Stock card			Stock out			Under stock			Over stock			Expired			Remark
	Y	N	Q	Y	N	Q	Y	N	Q	Y	N	Q	Y	N	Q	
HBSAg																
HCV																
H.pylori ab																
H.pylori ag																
WWF																
HCG																
RF																
ASO																
CRP																
ANA																
VDRL																

3. Assessing the availability of stock/bin card, expiry date and stock status for **Hematology** tests commodity in St. Paul's hospital laboratory storage, April 2015.

Item	Stock card			Stock out			Under stock			Over stock			Expired			Remark
	Y	N	Q	Y	N	Q	Y	N	Q	Y	N	Q	Y	N	Q	
Diluents																
Lyze																
Cleaner																
Anti-A																
Anti-B																
Anti-AB																
Rh factor (anti-D)																

4. Assessing the availability of stock/bin card, expiry date and stock status for **Hormone** tests commodity in St. Paul's hospital laboratory storage, April 2015.

Item	Stock card			Stock out			Under stock			Over stock			Expired			Remark
	Y	N	Q	Y	N	Q	Y	N	Q	Y	N	Q	Y	N	Q	
TSH																
T3																
T4																
FSH																
Estradol																
LH																
Prolactien																
Testosterone																

Annex VI

Addis Ababa University
School of Information Science and School of Public Health Science,
Department of Health Informatics

The following check list uses to observe the availability of laboratory commodity in standard storing form in St. Paul's hospital, April 2015.

No.	Questions	Yes	No	Comments
1.	Are products arranged on shelves with arrows pointing up, and with identification labels, expiry dates, and manufacturing dates clearly visible?			
1.	Are commodities stored and organized in FEFO procedures?			
2.	Did outer cartons are in good condition?			
3.	Are damaged and expired products separated from usable products in the storeroom?			
4.	Are all commodities stored in a dry, well-lit, well-ventilated storeroom?			
5.	Are cartons and commodities protected from direct sunlight?			
6.	Is storage area is secured with a lock and key?			
7.	Are reagents or commodities stored at the appropriate temperature according to product temperature specifications?			
8.	Is roof maintained in good condition to avoid sunlight and water penetration?			
9.	Is storeroom clean, with all trash removed, no evidence of food and drinks, products stored on sturdy shelves/bins, and boxes organized neatly?			

10.	Current storage space is sufficient for existing commodities?			
11.	Are all commodities stored separately? (eg. Chemicals, flammables, acids, etc)			
12.	Fire safety equipment is available and accessible?			
13.	Are products stacked at least 30 cm away from the walls and other rows or stacks of products? (to prevent contact with outer walls and allow access to products)			
14.	Products are stacked no more than 2.5 m high.			
15.	Are products stacked at least 10 cm off the floor? (on pallets or other materials that elevate the products off the floor)			