[Cheneke et. al., Vol.7 (Iss.10): October 2019] ISSN- 2350-0530(O), ISSN- 2394-3629(P)
Index Copernicus Value (ICV 2018): 86.20
DOI: https://doi.org/10.29121/granthaalayah.v7.i10.2019.543
INTERNATIONAL JOURNAL OF RESEARCH – GRANTHAALAYAH
A knowledge Repository

Science

ASSESSMENT OF LABORATORY COMMODITY SUPPLY CHAIN SYSTEM AT PUBLIC HEALTH FACILITIES OF JIMMA ZONE AND JIMMA TOWN ADMINISTRATION, SOUTH WEST ETHIOPIA

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Abstract

Background: Laboratory commodity management (LCM) is a formidable challenge because of various reasons. Poor LCM could produce wrong laboratory result. However, the status of laboratory commodity supply chain system in Jimma zone is not clearly known. Thus, we aimed to assess the overall supply chain system of laboratory commodity in selected public health facilities of Jimma zone, south west Ethiopia.
Methods: A facility based cross-sectional study within 3 different strata of health facilities: hospitals, A-level health centers, and B-level health centers were conducted. About 40 basic laboratory commodities as well as all pharmacy and laboratory professionals were included for the assessment. Descriptive statistics and analysis of variance with 95% confidence interval using statistical package for social sciences (SPSS) was performed.
Results: A total of 34 facilities having totally 146 professionals were included. Among these 146 professionals only 2 pharmacy professionals took LCM training. In 16(47.1%), 12(35.3%) and 1(2.9%) facilities only 1 pharmacy, 1 laboratory and 0 pharmacy professionals, respectively were available. About 40% of facilities were found to be stocked-out (SO) on the day of visit and the mean day of SO was 51 days. The mean month-of-stock (MOS) on-hand was 5.51. Health centers were more SO than hospitals. Around 31(91.2%), 30(88.2%), 29(85.3%), and 1(2.9%) facilities responded using report and requisition form, internal facility report and requisition form, bin card, and stock card, respectively, however, practically 15(44.1%) had no report on the tools. About 33(97.1%) facilities never received all ordered quantities from their main source, pharmaceuticals fund and supply agency, and 23(67.6%) received products near to their expiry date. Six (17.6%) facilities were resupplied within 2-4 weeks lead time. Sixteen (47.1%) facilities were supervised within last month, 3(8.8%) have never been supervised and in 23(67.6%) the supervision did not include laboratory commodities. About 9(26.5%) facilities were not doing demand forecast. Thirty-three (97.06%) facilities didn`t have separate budget for laboratory commodities.

 ISSN- 2350-0530(O), ISSN- 2394-3629(P)
Index Copernicus Value (ICV 2018): 86.20
DOI: 10.5281/zenodo.3544485

Conclusion: Stocks availability in Jimma zone was found very low. However, MOS on hand showed a better result, though it may not be an indication of good practice. Facilities' storage practice was less than the minimum value.

Keywords: Supply Chain System; Laboratory Commodity; Consumable; Reagent.

Cite This Article: Efrem G/Mariam, Waqtola Cheneke, Awol Jemal, and Henok Assefa. (2019). "ASSESSMENT OF LABORATORY COMMODITY SUPPLY CHAIN SYSTEM AT PUBLIC HEALTH FACILITIES OF JIMMA ZONE AND JIMMA TOWN ADMINISTRATION, SOUTH WEST ETHIOPIA." *International Journal of Research - Granthaalayah*, 7(10), 471-490. https://doi.org/10.29121/granthaalayah.v7.i10.2019.543.

1. Introduction

Medical laboratory is a place that is equipped with various biomedical instruments, equipment, materials, reagents and chemicals for performing different laboratory investigative activities by using biological specimens [1]. Clinical laboratory services are a critical, yet often neglected component of essential health systems in resource-limited countries. However, laboratories play a central role in public health in disease control and surveillance, and in individual patient diagnosis and care in order to forward the necessary results required for further decisions of clinicians on the choice of appropriate treatment options. Yet millions of people still do not have access to reliable and basic diagnostic laboratory services [2], [3].

When diseases are diagnosed incorrectly, not only does the patient suffer, but also valuable medicines are wasted treating a disease for which they are not effective. Therefore, clinical/medical laboratories are situated in health institutions and support the delivery of health services to patients' by screening for different conditions and providing information for differential diagnosis, allowing clinicians to choose appropriate treatment regimens and monitor treatment [4]. Laboratory commodities are products that are used to collect, prepare, test, analyze, store, and dispose of clinical specimens. For logistics purpose they are broadly classified in to three distinct categories of products such as: - reagents, consumables, and durables [5].

Supply chain management (SCM) is a set of approaches utilized to efficiently integrate suppliers, manufacturers, warehouses, and stores:- so that merchandise is produced and distributed at the right quantities to the right locations and at the right time, in order to minimize system wide costs while satisfying service level requirements [6]. Pharmaceutical supply chain management shares the same goal with that of the broader SCM with specific objective of moving pharmaceuticals from the manufacturer to the end user in organized and efficient or optimized ways [7].

Although laboratory services play a significant role in a country's health system and in the delivery of quality health services, managing supply chains in support of laboratory services is a formidable challenge, especially in developing countries [8]. The reason of this challenge includes the following realities; each test performed in a laboratory requires several different commodities, laboratory commodities often come in a variety of preparations-including solid and liquid reagents, laboratory commodities can also be packaged in kits, dry laboratory chemicals and consumable

ISSN- 2350-0530(O), ISSN- 2394-3629(P)
Index Copernicus Value (ICV 2018): 86.20
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liquids are often packaged in bulk, and some laboratory commodities have either short shelf lives or need special storage condition [4].

PFSA is an agency with a prime responsibility of managing the pharmaceutical logistics system of the country. The provision of complete health care necessitates the availability of safe, effective and affordable drugs and related supplies of the required quality, in adequate quantity at all times. Despite this fact, in the past, the pharmaceutical supply chain management system of the country had several problems including non-availability, un-affordability, poor storage and stock management and irrational use [9].

Medical laboratory require suitable laboratory commodities in order to fully provide the required standard services at any time to patients. At the same time different challenges have been encountered to perfectly/fully supply all the necessary commodities at all time in the required quantity. Moreover, the status of the laboratory commodity management in the study area is not clearly known. Therefore, this study is designed to assess the supply chain system of laboratory commodities that are used to give basic diagnostic services in selected public health facilities of Jimma zone and, south west Ethiopia, from March to April 2016.

2. Materials and Methods

2.1. Study Area and Period

This study has conducted in health facilities found in Jimma zone and Jimma town administration, South West of Ethiopia from March to April 2016. Jimma zone is administratively divided in to 17 woredas and Jimma town administration is classified in to 17 kebeles. Both are administratively independent organs having separate health offices.

Jimma town is located at 352km to the South West from Addis Ababa. A total population of Jimma zone and Jimma town is estimated to be 3,173,545 and 189,733 respectively. There are 3 public hospitals, 114 health centers, and 512 health posts found in Jimma zone whereas one general public hospital, one University Specialized hospital, one army hospital, 4 health centers, 8 private whole sales, and one PFSA hub are found in Jimma town administration.

Study Design

A facility based cross-sectional descriptive study method has been applied. Both qualitative and quantitative methods have also employed for data collection.

Study Population

All functional public health facilities found in Jimma zone and Jimma town administration having laboratory services and all health professionals involved in laboratory commodity management have been considered as a source population for the study. Health facilities and health professionals found in the study area that fulfills inclusion criteria have included in the study population.

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Inclusion and Exclusion Criteria

Civil and public health facilities which are giving primary health services to the public and supporting the implementation of the health care system are included. In addition, laboratory head and store manager with a minimum of having 1 year of service in selected facility have been included. Specialized and army hospital found in the study area has been excluded. For store managers having less than 1 year of experience, we used to include the former personnel who were working there.

Sample Size and Sampling Technique

From a total of 122 health facilities (4 primary hospitals, 18 A level health center and 100 B level health center) fulfilling the criteria, 32 facilities have been selected as a study subject. Single population proportion formula with margin of error of 15% [10] [11] and correction by the Finite Population Correction (FPC) is used.

Sampling technique

From a total of 122 public health facilities 32 were selected by disproportionate sampling technique. Accordingly, 4 primary hospitals, 10 A level health centers and 18 B level health centers were selected as a study subject.

Study Variables

The dependent variable of this study is availability, stock status, storage condition of laboratory commodity and quality of logistics data.

The independent variables includes: training of professionals on laboratory commodity management, staff turnover, number of professionals, lead time, selection process, forecasting process, amount of budget, using recording tools, availability of storage guideline, functional refrigerator.

Data Collection Method

A structured questionnaire and observational checklist were used. The questionnaires, from assessment tools for laboratory service and supply chain (ATLAS), logistics indicator assessment tool (LIAT) and logistics system assessment tool (LSAT) [12] [13] [14], which are developed by USAID/DELIVER, were customized and used to collect data from health facility store and laboratory department. In addition, physical counts of laboratory commodities have been conducted to cross check with the data filled on stock recording cards. The questionnaire was planned to collect data such as availability of commodity, stock status, accuracy of logistics data, and storage condition of the facility.

An in-depth interview of key informants (head of laboratory department) from respective health facility has been conducted to assess the management of laboratory commodities using semi-structured interview guidelines with some probing points. This could help us to identify challenges that facilities are facing towards the supply chain systems for laboratory diagnostic commodities.

Data Quality Assurance

Before the actual data collection, the validity of the questionnaire has been pre-tested on health facilities other than sampled facilities by taking 5% of the total sample size of the study and all the

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necessary modifications were made. One day training has been given for the data collectors regarding the objectives and significance of the study and how to collect the data. During data collection process there was a close supervision by the principal investigator to ensure consistency and completeness of the data.

Data Processing and Analysis

Quantitative data were sorted and coded first and then entered into SPSS version 20 for analysis. Descriptive statistics of frequencies, percentages, and averages has also calculated to describe the data and results are tabulated or presented in graph. Student T-test was carried out to test for association between different variables. Furthermore, regression and correlation analysis were carried out to determine associated factors affecting out-come variables. Whereas the qualitative part of the study has transcribed and summarized manually, and the results are presented in the form of narration.

3. Results and Discussion

3.1. Results

Characteristics of The Study Facilities

A total of 34 health facilities which are giving primary health care service are involved in the study. Among these 4 (11.8%), 12 (35.3%), and 18 (52.9%) were primary hospitals, A level, and B level health centers, respectively. Totally 42 pharmacists, 29 druggists, 40 laboratory technologists, and 35 laboratory technicians were working in those 34 health facilities.

In our study area, at a single facility, in real time we found that a maximum of 8 pharmacists, 2 druggists, 5 lab technologists, and 4 lab technicians; on the other hand there were facilities in which we could not find at least one personnel with respect to each of the above professions at a facility level.

From a total of 146 pharmacy and laboratory professionals in study facilities, only two pharmacy professionals have taken laboratory commodity management training. A total of 30 pharmacy professionals and 21 laboratory professionals were left the facilities in the past one year.

When we see the availability of professionals in each facility, 16 (47.1%) and 2 (35.29%) had only 1 pharmacy and laboratory professional respectively. Additionally, 1health center had no pharmacy professional at all.

Inventory Control Practice of Laboratory Commodities in The Study Facilities

From the total health facilities 31 (91.2%), 30 (88.2%), 29 (85.3%), and 1 (2.9%) facilities responded using RRF, IFRR, bin card, and stock card respectively to manage their inventory. Despite their response of high rate use of these inventory recording tools, practically only 5 (14.7%) facilities were completely filled RRF, in 14 (41.2%) facilities complete report were not available and in the other 15 (44.1%) facilities the report was totally not filled for laboratory commodities. In the same fashion only 3 (8.8%) facilities have been fully kept their records on bin card for laboratory commodities but the rest were not using bin cards.

ISSN- 2350-0530(O), ISSN- 2394-3629(P)
Index Copernicus Value (ICV 2018): 86.20
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On the other hand 29 (85.3%) facilities were reported to use both IFRR and RRF to report and reorder pharmaceuticals. But only 19 (55.88%) facilities fill RRF for laboratory commodities and send to higher level. In-order to reorder and resupply internally, 26 (76.5%) facilities laboratory department regularly filled and send IFRR to the main pharmacy store.

During resupply from their main source, PFSA, 33 (97.1%) facilities responded that they had never received all ordered quantities; besides other 23 (67.6%) facilities reported that they received products remaining with short shelf life. Among these; 9 (26.5%) facilities responded that the remaining time for expiry is between 1to 2 month at the time of arrival at their facility while others 11 (32.4%) and 3 (8.8%) replied that they were resupplied with a product remaining 2 to 3 and 3 to 6 months for expiry, respectively. Twenty-eight (82.4%) facilities were resupplied within average lead time of less than two weeks but the other 6 (17.6%) were within two weeks to one month after placing their order.

All facilities had functional refrigerator for laboratory commodities storage that need to be kept within refrigeration temperature. Among these only in 5 (14.7%) facilities the refrigerator were found in main pharmacy store but in others it was found in dispensary or/and other departments. From the total, 32 (94.1%) facilities have had storage guideline.

In majority of the facilities supervision was done in recent time; 16 (47.1%) facilities was supervised within last month and 12 (35.3%) supervised within 1-3 months. But 3 (8.8%) facilities have never been supervised. However, in 23 (67.6%) facilities the supervision did not include laboratory commodities.

Quality of Logistics Data

To compute data quality, we have reviewed recorded data from bin cards and RRF. We wish to compute quality in-terms of accuracy and validity. Practically, it was found difficult to compute accuracy and validity because facilities were not consistently updating and recording on their recording tools.

According to IPLS and LIAT, a discrepancy of less than or equal to 10% was considered to be accurate as well as valid, whereas a discrepancy of more than 10% was considered in-accurate or invalid [11] [27]. Accordingly, when we see the accuracy of RRF in the main pharmacy store of each facility; accuracy of calculated consumption (beginning balance + quantity received – ending balance ± loss & adjustment), maximum stock quantity (CC *2), and quantity ordered (maximum stock quantity – ending balance) of 9 (47.4%) facilities were not being accurate.

Regarding validity; 11 (57.9%), 12 (63.2%), and 16 (84.2%) facilities of beginning balance (ending balance of previous versus beginning balance of the next), quantity received (quantity received on RRF versus on model 19), and ending balance respectively were not valid. Furthermore, loss and adjustment, calculated consumption, and day's out-of-stock of 15 (79%) facilities were not also found to be valid; that means it has not shown consistent value between reviewed documents. This result could also be supported by the finding of qualitative study in which some interviewee responded that their facility could not fill and send RRF to higher level for laboratory commodities consistently, there by the calculated value on recording form may become inconsistent.

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Table1: Percentage of facilities having accurate and valid inventory records on recording tools in Jimma zone and Jimma town 2016.

S.N	Description	Yes	No
1	Check the accuracy of parts within RRF, is it accurate?		
A.	Is Calculated Consumption presented on the RRF to the verified CC (recalculating the CC as beginning balance + Quantity Received – ending balance +/- Loss/Adj.) accurate?	10 (52.6%)	9 (47.4%)
B.	Is Verified Maximum stock quantity, as CC x 2, correct	10 (52.6%)	9 (47.4%)
C.	Is Verified quantity ordered, as Maximum stock quantity-Ending balance, accurate?	10 (52.6%)	9 (47.4%)
2	Are the data reported on the RRF valid?		
D.	Compare the "Beginning balance in the Store" to the "Ending balance in the store" of the previous report.	8 (42.1%)	11 (57.9%)
E.	Compare the "Quantity Received" on the RRF with the "Quantity Received" on PFSA STV or Facility Model 19 within the reporting period.	7 (36.8%)	12 (63.2%)
F.	Compare "Ending balance" indicated on the RRF with Quantity at the end of the reporting period as indicated on the Bin Card.	3 (15.8%)	16 (84.2%)
G.	Compare the "loss and adjustment" indicated on the bin card with RRF loss and adjustment column of the reporting period.	4 (21%)	15 (79%)
H.	Compare "Calculated Consumption" versus the sum of quantities issued on the "Quantity Issued" column of the bin card during the recent reporting period.	4 (21%)	15 (79%)
I.	Comparing the "DOS" on RRF versus "DOS" indicated on the bin card.	4 (21%)	15 (79%)

N=19, CC=calculated consumption, STV=stock transfer voucher, DOS=days out of stock

Selection Process

Among the study facilities, 27 (79.4%) had no national essential drugs list while 24 (70.6%) of them did not develop their own facility drug list. In order to select laboratory commodities 32 (94.1%) facilities used testing algorithm as well as laboratory procedures as a criterion. On the other hand only 2 (5.9%) facilities used ABC analysis to adjust their budget whereas other 21 (61.8%) responded they have not used either ABC or VEN analysis to adjust their budget (funding) because they had no resource problem to procure products.

Turnover of pharmacy professionals could affect selection process, this was computed by statistical analysis and has shown a significant result ($p=0.001$, $B=-0.531$, $t=3.548$). It also affects availability of NEDL and development of facility list. That means turnover of professionals predict development of facility drug list and revealed statistical significant result ($p=0.005$, $B=-1.477$).

Table 2: Percentage facilities follow different type of selection method and processes for laboratory commodities in Jimma zone and town 2016.

Selection methods	Yes	No
Facility has NEDL	7 (20.6%)	27 (79.4%)
NEDL used for selection	5 (14.7%)	29 (85.3%)
All products are available in the list	0	100
Facility has its own list	10 (29.4%)	24 (70.6%)
Facility used ABC analysis to select products (to adjust their budget)	2 (5.9%)	32 (94.1%)
Facility used VEN analysis to select products (to adjust their budget)	11 (32.4%)	23 (67.6%)
Facility has no resource problem for selection	21 (61.8%)	13 (38.2%)

 ISSN- 2350-0530(O), ISSN- 2394-3629(P)
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DOI: 10.5281/zenodo.3544485

STG used for selection	11 (32.4%)	23 (67.6%)
Testing algorithm used for selection	32 (94.1%)	2 (5.9%)
Lab procedure used for selection	32 (94.1%)	2 (5.9%)

NEDL=national essential drug list, VEN=vital essential non-essential, STG=standard treatment guideline, ABC=A products are small portion of products with greatest annual expenditure-B products are almost half portion of products with medium annual expenditure-C products are a large portion of products with lowest annual expenditure.

Steps and Processes of Forecasting

Looking at forecasting in the study facilities, 9 (26.5%) of them were not actually doing demand forecast. But the other 25 (73.5%) undertook demand forecast annually; among these 9(36%) and 7 (28%) facilities accomplished initiated by PFSA and pharmacy head, respectively. Fortunately some in-depth interviewee stated that ``we are not consistently doing demand forecast for our facility`` so that this finding could actually support the above results of quantitative analysis.

Upon conducting demand forecast 33 (97.1%) facilities did not review their goals, strategies, and priorities of forecasting. In the same fashion all of those 33 facilities did not define their scope and purpose. On the other hand 30 (88.2%) facilities have not adjusted for stock-out while calculating quantification. Besides, 24 (70.6%) facilities were not reporting their actual consumption to higher level. After all 21 (61.8%) facilities couldn`t undertake reconciliation of cost of their demand with available fund.

Almost all, 33, facilities didn`t have dedicated and separate budget for laboratory commodities; even though 26 (76.5%) of them responded they had sufficient fund to purchase all needed pharmaceuticals. Eventually all facilities did have functional power to decide on the already allocated budget.

Table 3: Percentage distribution that shows the principal initiator for demand forecast in Jimma zone and town 2016.

Forecast Initiated by	**Frequency**	**Percent**
Store manager	5	14.7
Pharmacy head	7	20.6
DTC	2	5.9
WoHO or ZHD	2	5.9
PFSA	9	26.5
No actual forecasting in the facility	9	26.5

WoHO= woredas health office, ZHD=zone health department, DTC=drug and therapeutics committee.

Availability of Products and Storage Condition

According to the data collected from pharmacy store, the amount of (percentage) facilities with available & updated bin cards, stock-out on the day of visit and in the last 6 months are presented in Table 5. Among those 40 laboratory commodities included in this study, seven were not totally found in any of the studied health facilities. These were Field stain reagents (A and B), Xylene, Glacial acetic acid, Formalin solution, Ether, Indian ink, and Potassium hydroxide reagents. Thus they are omitted from statistical analysis.

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DOI: 10.5281/zenodo.3544485

Sodium hypochlorite was the one in which it had no bin card at all facilities, but 70% alcohol was recorded on bin card in 8 (23.5%) facilities, on the other hand only 6 (17.6%) facilities updated their bin card for immersion oil.

Sodium chloride reagent and weil-felix were stocked out both on the day of visit and in the last 6 months from 33 (97.1%) and 27 (79.4%) facilities respectively. Furthermore, during both periods crystals violate, acetone alcohol, and glucose test strip were also stocked-out from 25 (73.5%) facilities. On the other hand microscope slide and disposable examination glove were stocked-out only from 1 (2.9%) facility either in the last 6 months or on the day of visit. Meanwhile immersion oil was out-of-stock from 4 (11.8%) facilities whereas blood grouping reagents and sputum cup were out-of-stock from 6 (17.6%) facilities in both periods.

When we see the overall averages for each variable in table 5, the finding showed that almost 40% of the facilities were stocked-out on the day of visit and in the last 6 months (from September to February).

In general some statistical analysis was computed to identify associated factors that could affect availability. Availability of laboratory commodity on the day of visit could be affected by; amount of annual budget (fund) for the purchase of pharmaceuticals and number of pharmacy professionals. The predictor `amount of budget` affected availability (SO on the day of visit) of products significantly (p=0.011, B=-0.474, F=7.528). On the other hand the predictor `number of pharmacy professionals` could also affect availability of those products significantly (p=0.001, B=-0.551, F=13.967).

Table 4: Percentage distribution with respect to availability by commodity type and bin cards at facilities in Jimma zone and town, 2016

N=34	% of facilities with available bin card	% of facilities with updated bin card	% of facilities SO on day of visit	% of facilities SO in the last 6 months	Mean SD of stock out
Grams iodine	3(8.8%)	3(8.8%)	17(50%)	17(50%)	0.50
Crystal violate	2(5.9%)	1(2.9%)	25(73.5%)	25(73.5%)	0.447
Acetone alcohol	4(11.8%)	2(5.9%)	25(73.5%)	25(73.5%)	0.447
Safranin	3(8.8%)	3(8.8%)	14(41.2%)	14(41.2%)	0.499
Carbol fuchsine	4(11.7%)	4(11.8%)	12(35.3%)	12(35.3%)	0.495
Acid alcohol	5(14.7%)	4(11.8%)	13(38.2%)	13(38.2%)	0.493
Methylene blue	4(11.8%)	4(11.8%)	10(29.4%)	10(29.4%)	0.462
Sodium chloride reagent	1(2.9%)	1(2.9%)	33(97.1%)	33(97.1%)	0.171
RPR antigen	3(8.8%)	2(5.9%)	12(35.3%)	12(35.3%)	0.485
Immersion oil	6(17.6%)	6(17.6%)	4(11.8%)	4(11.8%)	0.327
Urine dipstick	5(14.7%)	5(14.7%)	9(26.5%)	9(26.5%)	0.447
Methanol	3(8.8%)	2(5.9%)	14(41.2%)	14(41.2%)	0.499

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HIV screening test kit	6(17.6%)	5(14.7%)	17(50%)	17(50%)	0.507
HIV confirmatory test kit	5(14.7%)	3(8.8%)	18(52.9%)	18(52.9%)	0.506
HIV tie-breaker test kit	4(11.8%)	3(8.8%)	25(73.5%)	25(73.5%)	0.447
Blood group anti-A,B,D	3(8.8%)	3(8.8%)	6(17.6%)	6(17.6%)	0.386
Widal O and H	3(8.8%)	3(8.8%)	21(61.8%)	21(61.8%)	0.493
Weil-felix	1(2.9%)	1(2.9%)	27(79.4%)	27(79.4%)	0.410
RF	1(2.9%)	1(2.9%)	21(61.8%)	21(61.8%)	0.493
H.pylori	3(8.8%)	3(8.8%)	20(58.8%)	20(58.8%)	0.499
Pregnancy test kit	5(14.7%)	4(11.8%)	14(41.2%)	14(41.2%)	0.499
Giemsa stain	5(14.7%)	4(11.8%)	9(26.5%)	9(26.5%)	0.447
Glucose test strip	2(5.9%)	2(5.9%)	25(73.5%)	25(73.5%)	0.447
Sputum cup	4(11.8%)	4(11.8%)	6(17.6%)	6(17.6%)	0.386
Microscope slide	6(17.6%)	5(14.7%)	1(2.9%)	1(2.9%)	0.171
Gloves latex disposable	7(20.6%)	6(17.6%)	1(2.9%)	1(2.9%)	0.71
Goggles	2(5.9%)	2(5.9%)	12(35.3%)	12(35.3%)	0.485
Masks	3(8.8%)	3(8.8%)	11(32.4%)	11(32.4%)	0.474
Biohazard bags	2(5.9%)	2(5.9%)	20(58.8%)	20(58.8%)	0.499
Alcohol 70%	8(23.5%)	5(14.7%)	7(20.6%)	8(23.5%)	0.410
Sodium hypochlorite	0(0%)	0(0%)	2(5.9%)	2(5.9%)	0.238
Sharps boxes	3(8.8%)	2(5.9%)	10(29.4%)	10(29.8%)	0.462
Overall average	**4(12.96%)**	**3(9.94%)**	**14(39.87%)**	**14(39.97%)**	**0.418**

Where, SO= stock-out, SD=standard deviation

Mean frequency of SO, number of days products were out-of-stock and the other computed mean frequencies are presented in Table 6.

The minimum mean number of days for which products were out-of-stocked was 0.2 and 0.23 days for disposable examination glove and microscope slide, respectively. Sodium hypochlorite was also stocked-out for a mean of 1.08 days. On the other hand the maximum mean number of days the products were out-of-stock is 171.1 and 129.7 days for sodium chloride reagent and weil-felix, respectively. Glucose test strip, crystal violet and acetone alcohol were stocked-out-for 109.6, 108.7, and 107.8 days, respectively.

The overall average mean number of days in which the commodities were out-of-stock was found to be 50.82 days. Based on student t test for equality of variances equal variances of mean stock-out day was assumed. Accordingly, we found out that health centers experienced stock-out for an average of 31 days more than that of hospitals. This difference of average stock-out was found to be statistically significant (P value=0.002, F=2.487).

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Furthermore, analysis of variance (ANOVA) was also computed between mean stock-out days by facility type (that is hospitals, A-level health centers, and B-level health centers) and the result has showed statistical significance (at P-value=0.003 and F-value=7.063).

The Pearson correlation was computed for mean stock-out days of health facilities versus number of pharmacy professionals and the result showed very weak linear relation (correlation coefficient= -0.117, p-value= 0.510).

A correlation analysis was also computed to evaluate the relation between mean stock-out days and annual budget (funding) for pharmaceuticals. Accordingly, the result showed that there was a large correlation between the two variables (correlation coefficient= -0.513, p-value=0.005).
When we see mean months-of-stock (MOS) on hand between facility levels it was not normally distributed, therefore, it is better to compute and measure MOS on hand in-terms of median for each level of facility so that median MOS on hand for hospitals, A-level health centers, and B-level health centers were found to be 2.5, 1.5, and 1.1, respectively. But these results are somewhat smaller in its value, because a number of variables with zero median MOS on hand were included. By controlling zero values we could get better median MOS on hand for hospitals, A-level health centers, and B-level health centers being 4.2, 6, and 5.9, respectively. But the overall average mean of month in which stock-on hand can possibly be used is 5.51 months.

Fortunately, the above result could be supported by the finding from in-depth interview; respondents raised that `` most of the time we couldn`t find laboratory commodity products from PFSA and the agency is also un-willing to give us a stock out form`` therefore this showed that there was frequent SO of laboratory commodities from PFSA (their main source) and the agency was also un-willing to give them SO form. Without this form nobody would have willingness to take risks by purchasing from private suppliers otherwise they need to follow a longer route of government bidding process. Even with this bidding process they are limited to purchase only by a certain amount of money. Therefore, unless the facilities could be able to purchase all needed commodities in the required quantity at any time otherwise MOS on hand would have been affected.

Table 5: Mean distributions of stock quantity, frequency and days of stock-out within certain period of time, computed by product type, Jimma zone and town 2016.

N=34	Mean balance on bin card	Mean freq. of SO	Mean No. of days SO	Mean Issued in 6 month	Mean Inv. On hand	Mean MOS on hand	Mean No. of exp.	Mean ±SD of stock out
Grams iodine	2333.3	0.5	67.1	676.4	1264.7	7.03	588.2	79.9,
Crystal violate	1750	0.73	108.7	680.8	573.5	1.5	455.8	81.6
Acetone alcohol	125	0.73	107.8	691.1	911.7	1.5	279.4	79.13
Safranin	1500	0.41	69.7	338.2	955.8	2.3	382.3	86.3
Carbol fuchsin	1500	0.35	17.7	2294.1	1205.8	3.1	250	28.5
Acid alcohol	400	0.38	17.7	2632.3	970	2	529.4	29.36

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Methylene blue	2375	0.29	21.6	2176.4	1294.1	4.4	117.6	46.01
Sodium chloride reagent	500	0.97	171.1	176.4	147	0.87	0	36.57
RPR antigen	166.7	0.35	35.6	261.7	172	3.46	73.5	61.6
Immersion oil	308.3	0.11	11.4	125	400	20.2	0	36.19
Urine dipstick	570	0.26	16.4	1060.2	569.1	4.4	191.1	38.4
Methanol	4666.7	0.41	51.2	1102	3161.7	8.4	147	74.33
HIV screening test kit	158.3	0.55	31.9	580.8	116.2	2.2	30.8	47.2
HIV confirmatory test kit	16	0.58	44.1	52.3	24.11	4.3	22.3	56.36
HIV tie-breaker test kit	5	0.73	108	12.3	5.8	1.2	2.3	79.8
Blood group anti-A,B,D	16.7	0.17	13.6	44.1	27.9	5.7	3.8	40.55
Widal O and H	133.3	0.61	101.4	186.7	105.8	2.4	20.5	85.81
Weil-felix	400	0.79	129.7	76.4	44.1	1.2	5.8	76.53
RF	0	0.61	100.7	138.2	167.6	4.9	5.8	85.70
H.pylori	266.7	0.61	96.4	151.4	141.1	5.6	4.4	87.76
Pregnancy test kit	150	0.41	16.3	658.8	125	1.4	54.4	25.94
Giemsa stain	1800	0.26	17.6	1455.8	1250	7.1	441.1	35.51
Glucose test strip	1075	0.73	109.6	226.4	97.7	2	3.7	81.90
Sputum cup	2125	0.17	8.5	909.7	1691.1	10.9		23.75
Microscope slide	4891.6	0.02	0.23	2886.7	3938.2	10.87	0	1.37
Gloves latex disposable	6142.8	0.02	0.20	9494.1	7414.7	6.8	0	1.20
Goggles	3	0.35	50.5	2.02	2.14	4.9		74.69
Masks	2683.3	0.32	54.7	323.8	527	9.7		82.72
Biohazard bags	274	0.58	101.4	135.2	654.6	30.9		89.85
Alcohol 70%	16000	0.23	12.5	13000	10897	5.5	88.2	32.06
Sodium hypochlorite		0.05	1.08	97279.4	24644.1	3.1		5.24
Sharps boxes	191.6	0.29	33.7	52.5	58	7.7		63.00
Overall average		**0.399**	**50.82**			**5.51**		**51.61**

Where, SO=stock-out, MOS=months of stock

Storage practice with in our study facilities has been assessed against standard storage guidelines at the day of visit and results has presented in Table 6. In average a total of 23 (68.3%) facilities

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have compiled their commodities but the remaining 11 (31.7%) have not compiled appropriately. The guideline was taken from standard operating procedures manual for the IPLS of Ethiopia and became customized according to our situation [8].

In 31 (91.2%) facilities fire safety equipment was not available and ready for use and diagnostic products were not also separated from chemicals. Whereas storage area was secured with limited access and products were protected from water and humidity in 33 (97.1%) health facility stores.

Table 6: Percentage of facilities that full fills specific storage practice, Jimma zone and town 2016.

S.N	Storage practice	% Complied	% Not complied
1	Products arranged with clear identification	23(67.6%)	11(32.4%)
2	Products are arranged accessible for FEFO	19(55.9%)	15(44.1%)
3	Cartons and products in good condition	30(88.2%)	4(11.8%)
4	Facility separate unusable from usable	22(64.7%)	12(35.3%)
5	Products protected from direct sunlight	31(91.2%)	3(8.8%)
6	Cartons and products protected from water and humidity	33(97.1%)	1(2.9%)
7	Products protected from harmful animals	27(79.4%)	7(20.6%)
8	Storage area secured and access limited	33(97.1%)	1(2.9%)
9	Products stored at appropriate temperature	30(88.2%)	4(11.8%)
10	Roof maintained in good condition	32(94.1%)	2(5.9%)
11	Storeroom maintained in good condition	18(52.9%)	16(47.1%)
12	Current space sufficient	21(61.8%)	13(38.2%)
13	Fire safety equipment available and accessible	3(8.8%)	31(91.2%)
14	Diagnostic products stored separately from chemicals	3(8.8%)	31(91.2%)
	Overall average	**23(68.3%)**	**11(31.7%)**

N=34

Qualitative Study Result

Questionnaires for qualitative study with probing questions were prepared and in-depth interview with facility laboratory department heads have been conducted by the principal investigator. Twelve facilities were covered by the qualitative study. The findings of the study has categorized in to four themes; these are problems encountered, managerial and financial problem, comparison of quality and availability at the two sources, and possible solutions so that our interviewees opinions are going to be discussed below.

Problems Encountered

Our interviewee raised different types and sources of problems they have encountered while obtaining and managing lab commodities for their facility.

Frequent SO of products while purchasing from PFSA and difficulty of obtaining commodities and spare parts especially for closed system equipment in the market were the main issues in which our interviewees raised frequently. Some other informants were also complaining about PFSA, because the agency has not willing to give SO form to facilities for those products that could have not been available at the time of procurement. These are exemplified by the response of one informant `` when we went to PFSA to procure products it is difficult to get majority of products which are essential to give basic services, for example now days we can`t get EDTA tube``. In

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addition to this there were also laboratory commodities with near expiry date from PFSA, especially for those products supplied by a special agreement between PFSA and Oromia regional health bureau.

On the other hand our informants also revealed their own problem and told us their failure of doing demand forecast and RRF periodically, however, they also rose about their storage problem within their facility; even if they have had a separate storage for pharmaceuticals most rooms were very narrow to become appropriate store.

Managerial Difficulty

In managing allocated budget most facilities had already knowledge gap and there is long bureaucracy on the aspects of financial management, though some have had budget shortage problem. This may be due to lack of communication among professionals on how to manage their allocated resources wisely. On the other hand majority of the informant raised that, pharmacy professionals, managers, and the management of the facility itself didn't give attention for laboratory commodity. They only give attention for the availability of medicines rather than laboratory commodity. This can be exemplified by the expression of one of our interviewee; ``the pharmacists are not providing lab commodities, even sometimes they replied `we don`t know` so that it is better to be purchased by laboratory personnel``.

Comparison of Quality and Availability Between the Two Sources

We have also asked our key informants their opinion about the quality and availability of products with regard to their supplying sources that are PFSA or private suppliers. Some of them have said availability is batter at PFSA but the other said so at private supplier, at the same time regarding quality most said it is better at PFSA but the other said at private supplier, this is exemplified by the response of one interviewee; ``PFSA has supplied good quality products because the agency supplied and managed products according to SOP``. On the other hand some other interviewee said both availability and quality are the same at both separate organizations since they have got products from similar manufacturing companies.

Possible Solutions

Our informants have also raised different types of solutions that could help to alleviate the burden of facilities on managing lab commodities; during supply of near expiry and SO they raised use of FEFO and borrowing products from nearby facilities as a possible solution. On the other hand in order to fill knowledge gap; provision of capacity building trainings or assigning logistician having good knowledge and experience have believed to provide better solution. Besides, some interviewee said that; intensive supportive supervision should also be undertaken consistently.

Despite the fact that majority responded; strengthening PFSA should be given priority attention to enable the agency capable enough to fully supply vital commodities according to request, others also raised purchasing from private suppliers should be facilitated in order to maintain their stock within allowable level. Meanwhile others raised their opinion regarding options on sustainable availability of stock provided to maintain stock within acceptable level, laboratory commodities should have to be purchased by laboratory professionals. The central theme and essence of these responses can be exemplified by the opinion of one of our interviewee; `` in order to get variety of

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products in bulk, PFSA should have to be strengthened since the price in PFSA is very competitive``.

Finally, our interviewee has also raised their opinions that could bring actual solutions for those problems at facility level. These are; request and demand forecast should be done frequently in appropriate time and good communication and commitment among professionals should also be created and maintained.

3.2. Discussion

The ultimate objective of studying or managing the overall supply chain system is to ensure availability of products at service delivery point consistently in the required quantity and quality with affordable price.

In our current study we have found out that the overall percentage of facility that was stocked-out on the day of visit was 39.87%, which means availability of stocks was 60.13%. When we compare this result with a finding from a survey conducted on IPLS implementation in Ethiopia (availability of 89%), it has a very wide difference. This may be due to the fact that the survey on IPLS was conducted only on selected vital medicines and its sample size was also larger [11]. Other study undertaken on distribution and availability of TB diagnostic items in Amhara regional state revealed its findings as; carbol fuchsin, methylene blue and acid alcohol were out of stock from 11%, 11%, and 8.5% of health centers, respectively, on the day of visit [15], whereas our study found that acid alcohol, carbol fuchsin, and methylene blue were stocked out from 38.2%, 35.3%, and 29.4% of facilities, respectively, during the specified time. These distinct findings may come from the difference between the sample sizes of the studies.

Other study conducted in Malawi reported its findings in terms of availability of each product in health centers and hospitals separately [16]. According to the study, availability of AFB and Malaria reagents was in stock at all health centers on the day of visit. But Methanol was stocked out from 60% of hospitals. In our study, however, Acid alcohol, Carbol fuchsine, and Methylene blue was stocked out from 38.2%, 35.3%, and 29.4% facilities, respectively, on the day of visit. Besides these Giemsa stain was also stocked out from 26.5% of our facility. This shows that the supply system in our study area was found ineffective and poor, because even program products like AFB reagents were not supplied in a well manner. This may probably be due to lack of reliable supplier, poor quantification practice, lack of consistent integrated supportive supervision or trainings especially on the management of laboratory commodities. On the other hand the same study reported 17% of health centers had no disinfectants but a situation was better in hospitals (8% were stocked out). Similarly, in our study a comparable result was found: alcohol and sodium hypochlorite were out of stock from 20.6% and 5.9% of facilities, respectively. This similar study result may come from their comparable sample size (40 versus 34 facilities) or similarity of the study area that were on the laboratory commodity.

Moreover, the overall percentage facilities stocked out during the last 6 months were 39.97%, which means stock availability was 60.03%. When we compare this result with similar result of the survey of IPLS, availability of 78.1%, it has showed a wider difference. The difference could be resulting from that the survey of IPLS was conducted country wide in all regions. As all the

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regions in the country were included for the IPLS survey, in which there are remarkable differences in performance, managerial and geographical aspects among regions, therefore, those differences could also potentially contribute to difference in availability across facilities. This quantitative result can also be supported by our findings from qualitative assessment. Some relative finding from qualitative analysis showed that there was a frequent stock-out of laboratory commodities from their main source, PFSA, and simultaneously the agency has attributed by its lack of willingness to give SO form, based on which, facilities were enabled to undertake procurement of those non-available products from private suppliers, thereby it was difficult to undertake procurement from these optional competitive sources. Furthermore, interviewee also rose about lack of knowledge on the management and utilization of financial resources and the longer financial bureaucracy that discourage them to take possible options. Therefore, facilities could become stocked out because of these reasons.

Another study conducted on assessment of laboratory logistics management information system in Addis Ababa reported its findings as; uni-gold test kit, stat-pack test kit, carbol fuchsin and methylene blue were stocked out from 3%, 9%, 11%, and 11% of facilities, respectively, during the last 6 months [17]. But our study result showed SO of the same products from 73.5%, 52.9%, 35.3%, and 29.4% of facilities, respectively. This huge difference may be because of a plan to change testing algorithm for HIV/AIDS by Ministry of health throughout the country so that in most health facilities these testing kits were not been supplied. But concerning TB staining reagents it may be because of the proximity of facilities (in Addis Ababa) to potential supplying sources.

In this current study we found that mean number of days the products were out-of-stock are almost 51 days. The mean number of days the products were out-of-stock versus number of pharmacy professionals showed very weak correlation (correlation coefficient= -0.117, p-value= 0.510) and inverse relation, which means with more number of pharmacy professionals mean number of SO day would not be minimized. This assumption can also be supported by qualitative finding, which is, majority of interviewee replied pharmacy professionals didn`t give attention for laboratory commodities during the time of procurement. Therefore, the actual available number of pharmacy professionals might not influence the number of days in which products were out of the stock.
A minimum and maximum month-of-stock on hand has already established by PFSA so that both hospitals and health centers should have a minimum of 2 months and a maximum of 4 months of stock on hand [9]. In this current study the hospitals, A-level health centers and B-level health centers have median MOS on hand for 2.5, 1.5 and 1.1 months, respectively. Our finding is somewhat lower than the expected standard duration of MOS. This might be due to the presence of large stock out of products on the day of visit. But when we computed median after omitting stocked-out products, we have found 4.2, 6.0, and 5.9 median MOS on hand for hospitals, A-level health centers and B-level health centers, respectively.

According to a finding from a similar study on 582 laboratory commodities to analyze percentage composition of MOS on hand whether it is below, above, or within the allowable set of 2-4 MOS, 12.9% of commodities were below 2, 61.5% were above 4 and only 25.6% were within 2 and 4 MOS. This result of survey on IPLS of Ethiopia revealed a comparable result with our study. It stated that across products, most facilities were not stocked according to the recommended 2-4 months of stock. For most of the assessed products overstocking was more common than under

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stocking [10]. This might be because of the fact that facilities were not conducting demand forecast properly thereby at a time of procurement they were going to purchase any quantity of available commodity arbitrarily. This opinion can also be supported by the finding from the qualitative study that similar opinion was raised during the in-depth interview; while facilities went to PFSA to procure commodities, because of frequent SO from PFSA, they would procure as much as possible any available products.

In this current study to compute accuracy and validity of inventory data recording we have reviewed RRF and bin card and found out that from all the 34 facilities only 19 (55.9%) filled RRF and only 12.96% had a bin card for the majority of laboratory commodities. Accordingly, accuracy of calculated consumption, accuracy of quantity ordered and maximum stock quantity were 10 (52.6%). Only 10 facilities were trying to record laboratory commodities on bin cards, among these only 4 practically recorded majorities (but not all) of our commodity of interest against their bin cards. Among those 10 facilities, one facility recorded only one commodity and another one facility recorded two commodities. The validity of beginning balance, quantity received and ending balance were 8(42.1%), 7(36.8%), and 3(15.8%), respectively. A study conducted in Addis on the assessment of IPLS for HIV/AIDS and TB laboratory commodity reported that facilities had a 68% discrepancy on calculated consumption, 60% on ending balance and 52% on quantity received [18] which is comparable with our study finding.

Moreover, in our current study the storage practice following to comply with the specific storage guideline was 68.3% (the standard of which is ≥80%). A survey conducted on IPLS implementation reported that on average 55% of the facilities met acceptable storage condition (≥80% of storage guideline) [10]. Based on our study finding percentage of facilities that maintain acceptable storage condition was only 9 (26.5%). This could be because of that most stores in the study facilities were managed by nurses, even some facilities didn`t employ pharmacy professionals. On the other hand pharmacy professionals, themselves, were not committed to strictly follow and apply the standard available storage guideline.

Regarding selection process, in this current study, we have found out that only 7 (20.6%) of facilities had the national essential medicine list (NEML). Though it was only available in some facilities, all reported that the list didn`t include all crucial products (especially laboratory commodities) which are assumed to be vital to give the required health care services. On the other hand only 10 facilities have developed their own facility list. To select products only 5.9% and 32.4% of our facilities were using ABC and VEN analysis respectively but the other significant proportion of our facilities, 61.8%, responded they didn`t have actual resource problem(financial resource) that could force them to undertake selection of products for their facility. Whereas, as we all know, resources are always scarce and that is why products were being stocked out, therefore, such kind of responses will never be acceptable especially in health care service delivery setting. The need of developing and applying different methods of selection, however, is indeed used to efficiently and effectively manage all the available scarce resources. Even-though, more than half of facilities responded as they had no resource problem, our finding showed that almost 40% of our facilities were stocked out during the day of visit and products were also experienced being stocked out for overall mean of 51days.

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Actually, in our view, the Ministry of health as well as Food, Medicine, and Health care administration and control Authority (FMHACA) also didn`t give attention for laboratory commodities. We have said this because laboratory commodities were not included in the national essential medicine list [19].

Besides these, when we see the processes of demand forecast, almost all facilities (97.1%) have never had reviewed its goals, strategies, and priorities as well as never defined scope and purpose of forecasting prior to undertake the actual demand forecast. Actually 26.5% of facilities didn`t undertake forecasting and the other 88.2% of facilities didn`t adjust stock out while performing demand forecast. On the other hand 70.6% of facilities were not reporting their actual consumption of laboratory commodities to higher level. A study conducted in Addis Ababa reported, 24 (92.6%) facilities were completing and sending RRF to PFSA every two months [20]. This huge difference might be due to the difference between our study facilities and facilities in Addis Ababa which included specialized hospitals, regional hospitals as well as national referral laboratory and it also assessed only HIV and TB diagnostics commodities.

Therefore, we assumed that, because of all the above reasons forecasting process were not following the right procedure so that procurement was undertaking arbitrarily; that is why stock status of facilities couldn`t show stable, consistent and acceptable value.

Finally, facilities were facing different kinds of challenges up on managing its supply chain system. During our in-depth interview key informants have raised challenges they were facing on the process of obtaining and managing laboratory commodities. The major challenges almost raised by all interviewee was frequent stock out of products from their primary source, PFSA, fail to perform forecasting periodically, fail to fill and send RRF periodically, difficulty to get SO form from PFSA (PFSA is attributed by its unwillingness to give SO form), lack of management for available budget, and long bureaucracy in financial process to purchase products from private suppliers. These are the most existing and unresolved challenges that health facilities have been facing in order-to obtain and manage laboratory commodities.

A study conducted in Addis Ababa reported, on its qualitative part, that the following findings were problems encountered on the implementation of IPLS; frequent stock-outs caused by long distribution channel and lack of standard inventory control practice for reagents remain the main cause of poor product availability, failure of some high volume health facilities to make timely report of complete and accurate RRFs, weak stock keeping practice, weak level of motivation and commitment to properly and timely conduct operations [20]. Therefore, the findings are showing almost a comparative result with our finding.

Eventually most facility key informants have also raised procurement of laboratory commodities by Pharmacy professionals as a major challenge in their facility because they thought Pharmacy professionals have not been giving attention to laboratory commodities at a time of procurement, similarly some informants said that their own facility management didn`t give attention for the supply of laboratory commodities, as a result, SO or delay of initiation of purchase request would be consequently occurred in the facility.

 ISSN- 2350-0530(O), ISSN- 2394-3629(P)
Index Copernicus Value (ICV 2018): 86.20
DOI: 10.5281/zenodo.3544485

4. Conclusion and Recommendations

Our study result showed that availability or/and stock status in Jimma zone was very low; this might be because of frequent stock out of products at their main source, PFSA, or failure to re-supply based on quantity request. In addition to this inappropriate selection process and/or quantification of lab commodities may also be a reason. However, months of stock on hand showed a better result, though, it may not be an indication of good practice; therefore, it might be due to inappropriate quantification of products or failure of using inventory control tools adequately.

Moreover, health centers were found to be stocked out for an average of 31 days more than hospitals. This could be due to the presence of inadequate number of pharmacy and laboratory professionals at the health centers or, on the other hand, could be from lack of commitment or attention towards lab commodity both by professionals and the management of the study facilities. Selection and quantification process and performance were poor so that majority of facilities procure arbitrarily; therefore, this may lead to availability of products more than expected maximum stock level or in the other side unavailability of vital products in the facility. On the other hand storage practice followed by majority of facilities was less than the minimum acceptable value.

We therefore recommend the ministry of health to consider assigning appropriate and skilled professionals in the field of laboratory commodity management in health facilities. Moreover we recommend undertaking a study that could focus on identifying the possible cause and solution for poor laboratory commodity management in health facilities in the country.

Acknowledgements

We would like to acknowledge Jimma University for becoming the source of funding. We would also like to express our gratitude to Jimma Zone Health Bureau, Jimma City Health Bureau, all health facilities who willingly participated in the study, health professionals within the facilities who showed their cooperation during data collection, data collectors, SCMS Ethiopia, Mr. Tesfaye Seifu, Dr. Elias Yusuf, Mr. Biniyam Girma, friends and colleagues without whom this study may not be possible.

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