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Analysis of medicines expenditure for fiscal year 2014/2015 at Lodwar County Referral Hospital

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ANALYSIS OF MEDICINES EXPENDITURE FOR FISCAL YEAR 2014/2015 AT LODWAR COUNTY REFERRAL HOSPITAL

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DECLARATION AND RECOMMENDATION

Declaration

I declare that this work has not been previously submitted and approved for the award of a degree by this or any other University. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made in the thesis itself.

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Approval

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Name of supervisor_____

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ABSTRACT

Major causes of stock outs in public hospital are inadequate fund to purchase the medicines and inefficiencies in the pharmaceutical supply chain. Good pharmaceutical management can result in efficient use of funds for purchasing medicines and improvement of the pharmaceutical supply chain. The objective of this study was to analyse pharmaceutical supply chain costs at Lodwar County Referral Hospital in order to get insight of how the funds were used and use this information to improve pharmaceutical management. This study was conducted using the retrospective case study methodology. A total cost analysis of pharmaceutical supply chain costs was done (pharmaceutical acquisition cost, Inventory holding cost, purchasing cost and shortage cost) for fiscal year 2014/2015 was conducted to identify key cost areas. Pharmaceutical acquisition costs were then subjected to ABC and VEN analysis to narrow down on groups requiring greater fiscal and managerial control The study showed that the total pharmaceutical supply chain cost of Lodwar County Referral Hospital for fiscal year 2014/2015 was KES 53,228,625. Pharmaceutical acquisition costs accounted for 92.3%; inventory holding cost 6.3%; purchasing cost 1% and shortage cost 0.4 % of the total costs. ABC– VEN analysis resulted in identification of three groups requiring different level of managerial control. Class I drugs comprising of 74 of the 200 products (37%) accounted for 82% of the total cost. This group was identified for stringent fiscal and managerial control. In conclusion the total cost analysis aided in identification of pharmaceutical supply chain costs that should be controlled. And the ABC – VEN analysis aided in identifying a comprehensive group of drugs among the essential medicines list that may require higher managerial control.

ACKNOWLEDGEMENT

I take this opportunity to express my gratitude to the pharmacy staff of Lodwar County Referral Hospital and in particular the Stores Pharmacist and the Procurement Officer for their support in collecting and accessing data.

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LIST OF ABREVIATIONS

ABC	An analysis method for determining and comparing medicine cost within a formulary or essential medicines list
ADE	Annual drugs expenditure
EMMS	Essential medicines and medical supplies
EQC	Economic order quantity
KEMSA	Kenya medical supplies authority
LCRH	Lodwar County Referral Hospital
LMIS	Logistics management information system
MEDs	Mission for essential drugs supplies
SARAM	Service availability and readiness report
TCA	Total cost analysis
THE	Total health expenditure
TPE	Total Pharmaceutical expenditure
VEN	An analysis system which sorts out medicines according to their health impact into vital, essential, and nonessential categories and is very useful in setting priorities for purchasing medicines and keeping stock
LMIC	Low and medium income countries
MOH	Ministry of Health

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VT OMNES
VNVM SINT

CHAPTER 1 INTRODUCTION

1.1 Background

WHO (2011) identifies equitable access to essential medicines and medical technologies as one of the six building blocks of health system. Essential medicines – medicines that satisfy needs of the majority of the population – can save life, reduce suffering and improve health, they should therefore be available at all times, in adequate amounts, appropriate doses and at cost that people can afford. Lack of essential medicines negatively affects access to healthcare.

In many developing countries lack of essential medicines is usually experienced leading to increased mortality and morbidity. Commonly cited reasons for lack of essential medicines are poor financing and inefficient pharmaceutical supply chains (Management Science for Health, 2012). Therefore, to improve access to essential medicine there has to be not only adequate funding but also improve of the pharmaceutical supply chain.

The key objective of a hospital pharmaceutical supply system is to ensure essential medicines are available at all times when needed. To meet this objective, the pharmaceutical supply chain has to have enough resources and these resources have to be used efficiently. Analysis of the total pharmaceutical supply chain cost can identify opportunities for saving cost by identifying inefficiencies in the supply chain. The analysis of the cost of the inventory can be done to segment medicines in distinctive groups. Each of the groups can be managed according to is characteristics to improve efficiency.

According to the Kenyan constitution, health is a right. Therefore, Kenyan citizen also have the right to access essential medicines. Also in the constitution, health is a fully devolved function. Therefore, the county government has a responsibility of providing essential medicines to its citizen.

The Turkana County government operates over 152 health facilities to provide healthcare to its residents. One of facilities is The Lodwar County Referral Hospital which is also a referral centre for all the other facilities in Turkana County. Every year the county government directly allocates fixed amount funds to the pharmacy

department of the referral hospital. The pharmacy department has a responsibility of ensuring these funds are used efficiently so that essential medicines are available at all times.

Analysis of how the funds were used can help in improving efficiency. Analysis the hospital pharmaceutical supply chain cost can identify opportunities for cost savings and identify inefficiencies in the system. This information can then help in decision making and policy formulation in the future.

1.2 **Hospital pharmaceutical supply chain costs**

In supply chain management the total cost of ownership is the sum associated with every activity in the supply chain. Three types of costs are associated with medicines in a health care system: direct, indirect, and intangible (Management Science for Health, 2012). When considered collectively, they give the most comprehensive assessment of actual medicine cost. Because of the challenges in quantifying indirect and intangible costs, only the direct costs are considered in this study.

The total cost of operating a pharmaceutical supply chain system is the sum of pharmaceutical acquisition costs, inventory holding costs, purchasing costs and shortage costs (Management Science for Health, 2012). These costs are either be incremental or predictable. If the cost increases with the increase in the number of transactions or quantity of supplies, then it is incremental. If the cost remains the same irrespective of the number of transactions or the quantity of supplies, then it is predictable or fixed. This is significant in decision making because incremental cost can be controlled by reducing number of transactions or the quantities of supplies while predictable cost cannot.

Pharmaceutical acquisition cost is the net cost of pharmaceutical purchases (MSH, 2007). These cost are mostly incremental. They increase with the volume and the price of purchases. Therefore, they can be reduced by either decreasing the volume of purchases or by getting a lower price.

Herist, Rollins and Perri (2011) define inventory holding costs as the price of storing unsold item. The main components of inventory holding costs include losses from inventory; the operational costs of inventory management and the financial

opportunity costs. Inventory holding costs are both incremental and predictable. According to the Management Science for Health, (2012) most operation costs of inventory management are predictable while losses from inventory and financial opportunity costs are incremental. The larger the inventory the higher the inventory holding cost. This because large inventory would be associated with higher opportunity cost, higher risk of losses through inventory and higher operational costs.

Herist, Rollins and Perri (2011) define purchasing costs are associated with managing tenders, placing purchase orders and receiving goods purchasing cost can be both incremental and predictable. Incremental purchasing costs can be increased by increasing purchasing activity such as increasing the frequency of making purchases.

According to the Management Science for Health (2012). Shortage costs include excess cost of emergency purchases; loss of revenue when clients buy outside the system; increased morbidity and mortality due to stock outs, and loss of goodwill caused by erosion of confidence in the system. For purposes of quantifying shortage cost of a pharmaceutical supply chain system, only the extra cost of emergency purchases and loss of revenue when client buy outside the system can be realistically estimated. Keeping excess stocks reduces risk of stock outs hence reduces shortage cost.

Some of the supply chain costs vary directly to each other while others vary inversely. An increases in total pharmaceutical acquisition cost due to buying in larger volumes is likely to increase the inventory - therefore the inventory holding cost – but decrease risk of shortage and therefore decrease shortage costs. Reducing inventory holding costs by making smaller more frequent purchases would likely increase the purchasing costs. One has to find a balance that provides net reduction of total cost. Economic order quantity (EOQ) is used to calculate the order quantity that strikes a balance between holding and purchasing costs.

1.3 Analysing of the pharmaceutical supply chain costs

Total cost analysis (TCA) can be used to analyse the cost of operating a hospital supply chain system. TCA can identify pharmaceutical acquisition costs, inventory holding costs, purchasing cost and shortage costs and how they relate to each other. The total

cost of operating a pharmaceutical supply chain system is the sum of pharmaceutical acquisition costs, inventory holding costs, purchasing costs and shortage costs. According to the Management Science for Health (2012), applications of TCA include finding opportunities for cost reduction and modelling the cost impact of potential changes in the supply system.

1.4 Analysis of inventory based on purchasing value

ABC analysis is a useful tool that can be used to analyse inventory based on purchase value. It categorises medicines into three group: class A, B, and C. based on the share of budget they consume. A being the most valuable items "important few" (few items that consume the biggest percentage of the budget) while C being the list valuable items "trivial many" (many items that consume the smallest percentage of the budget). (Edx, 2016).

This method is used to draw the managers' attention to the "important few" A items. The important few class A items require the most managerial attention and therefore they must be actively managed throughout the pharmaceutical supply chain. The moderate impact class B items need lesser managerial attention than class A items, therefore their management can be automated or they can be managed by exception – only significant deviation from the norm should be brought to the attention of the management. For the minor impact class C items should be passively managed to avoid distracting the management from class A and B.

ABC analysis has important application in pharmaceutical supply chain. In selection class A can targeted for replacement with cheaper alternatives, negotiation for cheaper prices, strict inventory control and strict use to reduce costs. Class C items can be targeted for periodic obsolesce review. Class B items can be monitored for evolution either towards class A or class C items.

1.5 Analysis of inventory based on criticality

VEN analysis is used to analyse how medicines expenditure has been made in terms of criticality of the medicines. VEN system sets priorities for selection, procurement and use according to potential health impact of individual medicines (Management

Science for Health, 2012). Essential medicines in the formulary are assigned the following categories:

V: vital medicines are potentially lifesaving or crucial to providing basic health services. Regular supply is mandatory.

E: Essential, not absolutely vital to provision of basic services.

N: Non-essential, used in minor or self-limiting illness, questionable efficacy or comparable high cost for marginal therapeutic advantage.

Table 1.1-1 Criteria for VEN Classification

Characteristic of medicine or target condition	Vital	Essential	Non-essential
Occurrence of targeted population			
Persons affected (% of the population)	Over 5	up to 5	less than 1
Persons treated (NO per day at average health centre)	Over 5	up to 5	less than 1
Severity of target condition			
Life-threatening	Yes	occasionally	rarely
Disabling	Yes	occasionally	rarely
Therapeutic effect of medicine			
Prevent serious disease	Yes	no	No
Cures serious disease	Yes	yes	No
Treats minor, self-limiting symptoms and conditions	No	possibly	Yes
Has proven efficacy	Always	usually	May or may not
Has unproven efficacy	ever	rarely	May or may not

Source MSH mds- 3

VEN analysis can be used to show how efficiently funds for purchase of medicines have been used. Vital medicines should be given priority in selection and use of funds. Spending high percentage of resources on non-essential medicines may indicate inefficient use or misuse of resources. In procurement orders for vital items should be monitored closely. In inventory management, the safety stocks of vital items should be kept higher to minimize risks of stock outs and the safety stock of non-essential medicines should be kept at lower level to minimize increase of inventory holding

costs. Special attention should be paid to the stock levels of vital medicines and where possible store staff should be assigned to monitor them.

1.6 Analysis based on both criticality and purchasing cost

In the ABC analysis only cost is considered in the management of the inventory. In hospital setting there are low ADE drugs (either because they are cheap or because they are rarely prescribed) that are vital to the functioning of the hospital. Also there are expensive high ADE drugs that are non-essential. Coupling of ABC – VEN analysis makes sure the analysis can create a system gives priority to both cost reduction and availability of Vital medicines.

1.7 Lodwar County Referral Hospital

Lodwar County Referral Hospital is the largest and only public referral hospital for Turkana County. It serves as a referral centre for over 152 other public health facilities, together serving a population of 1.3 million people in Turkana County. It is a general specialized referral hospital with an inpatient bed capacity of 200 and serves more than 500 out patients daily. The pharmacy department is staffed by 8 pharmacists, 8 pharmaceutical technologists, 1 casual staff and 1 procurement staff.

The hospital has a functional medicines and therapeutic committee that selects which medicines should be on the hospital essential medicines list. The essential medicines list was formed with reference to the Kenya Essential Medicines List 2010, the WHO essential medicines list, and ministry of health treatment guidelines and is updated annually. The Lodwar County Referral hospital essential medicines list has 201 drugs. 66 are classified as Vital, 115 are classified as Essential and 20 are classifies as Non-essential

The hospital is mandated to do direct procurement from KEMSA. For the items that have not been supplied by KEMSA, the hospital is allowed to procure directly from MEDs. All other suppliers must pass through a tendering process. the hospital operates a scheduled purchasing model where medicines are procured after every three months and comprehensive stock take is done after every three months.

For Pharmaceutical expenditure, a fixed amount of funds is allocated from the hospital budget based on the previous year's consumption data at the beginning of the financial year.

Medicine are sourced through direct procurement from KEMSA and MEDs which are the suppliers approved for direct buying (without a tendering process) by national government. However emergency supplies in case of shortages are sourced from local suppliers by the pharmacist in charge upon determining that there is a shortage. The pharmacy operates a scheduled purchasing model; medicines are ordered after every three months. The order quantity is set at 4 months of stocks to account for the quarterly purchasing and the lead time which is set at one month. A pharmacist, a procurement officer and 2 casual staff work fulltime at the pharmacy store. The pharmacy issues some medicines for free, while others are dispensed on a cost sharing basis

1.8 Problem Statement

The resources allocated for purchasing and managing pharmaceutical supplies rarely enough to cover the needs of the pharmacy department. In most cases these resources are not used efficiently. This inadequacy and inefficient use of resources results in stock outs which may have grave consequences for the patients.

In case of stock out patients may have to travel to other facilities which may be expensive, the may go without the medication they need, they may seek an alternative which may be appropriate or not and they may also lose confidence in the public health system for failing to cater for their needs. This will negatively affect access and quality of healthcare.

The analysis of pharmaceutical supply chain costs can identify inefficiency and therefore reduce wastage. The analysis of the cost of inventory in terms of both cost and criticality can inform the setting of a priority system that improves efficiency by ensuring the most critical supplies are always available.

1.9 Significance of the study

The hospital pharmacy is expected to make sure patients prescriptions are filled whenever needed despite ever increasing demand and limited resources. Hence the need for efficient and effective pharmaceutical management. The result of this study may be used to improvise the hospital pharmaceutical management system to make it more effective.

The improvement of knowledge on hospital pharmaceutical supply system expenditures can identify where cost savings can be made hence improving efficiency and resources available for purchasing of medicines. The improvement of knowledge on categorization in terms of both costs and criticality may create a priority system that not only improves pharmaceutical supply system but also improves availability of essential medicines and limits negative effects of shortages and stock outs. These will contribute to the mission of the hospital which is to improve quality and access to healthcare.

1.10 Research Objectives

1.10.1 Broad Objective

To analyse the current pharmaceutical costs and find opportunities for cost reduction and improvement of efficiency in the supply chain.

1.10.2 Specific Objectives

1. To identify and quantify pharmaceutical supply chain costs.
2. To segment medicines in terms of their cost of purchases.
3. To quantify the cost of purchases of classes of medicines that are segmented due to their criticality.
4. To create a priority system in the hospital pharmaceutical supply chain based on both criticality and cost of purchases.
5. To identify opportunities for cost saving and improvement of the hospital supply chain system efficiency.

1.11 Research Questions

1. How was the annual drugs budget spent in the fiscal year 2014/2015?
2. When the ADE is segmented by ABC analysis, how are the essential medicines grouped?
3. When the ADE is segment as per classes essential medicines based on criticality VEN analysis, how much funds do each class consume in relation to the ADE?
4. How can cost saving be made in the hospital pharmaceutical supply chain?
5. How can efficiency be improved in the hospital pharmaceutical supply chain?

1.12 Scope of the study

The study is limited to essential medicines that are financed by the county government of Turkana. It excludes tuberculosis and HIV AIDs program essential medicines that have a different supply chain system and are fully financed by donors. Of the supply chain costs, the study only considers pharmaceutical acquisition cost, inventory holding cost, purchasing cost and shortage cost. It excludes the cost associated with the use (for example dispensing cost) process in the supply chain system.

CHAPTER 2: LITERATURE REVIEW

2.1 Access to essential medicines

Poor availability of medicines in public sector facilities is a key barrier to access of essential medicines according to the WHO (2010). Public sector facilities as opposed to private sector, usually provide medicines free or at low cost hence their importance in fostering access to essential medicines. In a survey of 27 developing countries, on average, only 34.9% of public health facilities were found to have satisfactory availability of essential medicines (UN, 2007).

Kenya as a developing country also faces challenges to access of essential medicines. In the assessment of county health system in Kenya, Barker, Mulaki, Mwai, & Dutta, (2014) found only 34 to 60% had maternal health tracer drugs and only 18 to 39 % had child health tracer drugs. Diabetes drugs had the lowest availability ranging from 2% to 25%. First line treatment for malaria had the greatest availability ranging from 44% to 97%. In the MOH (2013) SARAM survey report, mean availability of general medicines was at 44%; medicines for NCD was at 32%; malaria medicines were at 65%; lifesaving products was at 60%; maternal health products were at 29% and children essential medicines at 49%. In the same report, Turkana County Hospitals did not fare any better with mean availability of tracer drugs at 54%, maternal health product at 29%; malaria products at 82% and NCD products at 9%. This showed a high likelihood of patients missing a critical medicine when needed. These reports show that there may be a gap in the funding and use of funds for buying medicines.

Many factors affect availability of essential medicines in the public sector. According to the World Medicines Report, two of the reasons include under budgeting due to inadequate funds to meet needs and inefficiencies in the supply chain (Kaplan & Mathers, 2011). In the assessment of availability of essential medicines in public hospitals, Mwathi and Onyango (2014) reported that stock out was caused by poor distribution (91.2%), issues of funding (58%), inappropriate selection (58%) and irrational use (56%). Therefore, to improve availability of essential medicines issues of funding and supply chain should be addressed.

2.2 Medicines expenditure

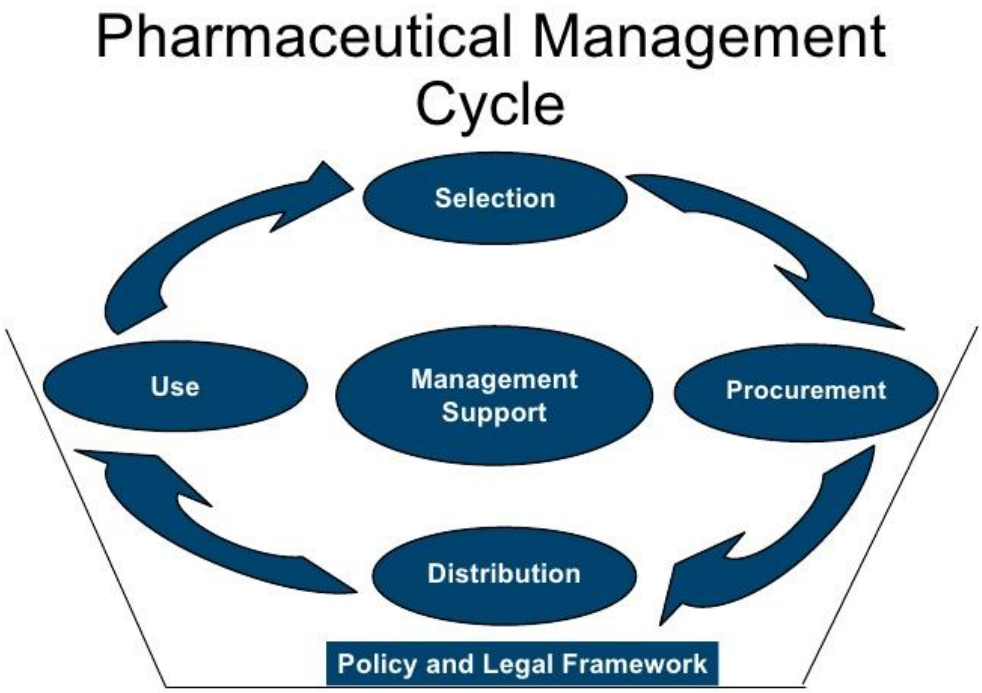
Low medicines expenditure in developing countries may affect availability of medicines in public health facilities. According to Management Science for Health, (2012) The low per capita expenditure on medicines has been shown to be correlated poor availability of medicines. A report by Kaplan & Mathers (2011), show that there is generally low per capita expenditure on medicines in low income countries like Kenya. The report shows that in the year 2006 the per capita consumption of medicines ranged from USD 7.61 in low income countries to USD 431.6 in high income countries. This low expenditure in pharmaceuticals in the developing countries can affect access to medicines

From the Kenya National Health Accounts for the year 2012/2013, the total health expenditure (THE) for Kenya was KSH 234 billion (about KSH 5680 per capita) which accounted for only 6.8% of the GDP. Expenditure for health as a total of all government expenditure was only 6.1% (MOH Kenya, 2015). This is less than the 15% recommended by the Abuja Declaration. The Kaplan & Mathers, (2011) report shows total pharmaceutical expenditure (TPE) has been found to be closely related to THE. The low expenditure on health in general is likely to have negative impact on the money spent on medicines since medicines are directly funded from the health budget. This constraint in funding necessitates an efficient supply chain system and priority setting to reduce the negative impact of stock outs.

2.3 Hospital pharmaceutical supply chains

Pharmaceutical supply chain is made up of four basic functions namely selection, procurement, distribution and use (Management Science for Health, 2012). How well these function are conducted may determine availability of essential commodities. (figure 2-1)

Figure 0-1 Pharmaceutical management cycle



Source MSH mds -3

Selection is the choice that has to be made on which medicines to stock. According to WHO (2010) key factors that should be considered when selecting include; the pattern and prevalence of disease, proven efficacy and safety of the drug, and the cost benefit ratio. Poor selection can increase pharmaceutical acquisition costs and reduction in the quality of care. Analysis of medicines expenditure can improve selection by ensuring the chosen medicines have a favourable cost benefit ratio.

Procurement involves quantification and the tendering process. according to Kaplan & Mathers (2011) the procurement process seeks to ensure availability of right medicines in right quantities at reasonable prices. Quantification involves forecasting the health institution's pharmaceutical needs usually for a year. Over quantification may result in excess buying while under quantification may result in insufficient buying. This may result in excesses or shortages which may increase inventory holding and shortage costs respectively. Procurement also involves different purchasing models – annual purchasing, scheduled purchasing or

perpetual purchasing. Choice of one or combination of these purchasing models affects purchasing and holding costs.

Distribution involves storage and transportation. Storage mainly involves inventory management. According to Management Science for Health (2012 the main purpose of this process is to keep medicines in good condition and avoid losses through spoilage, expiration, obsolescence and pilferage which may result in increase of inventory holding costs.

The use process is an important component of the supply chain. WHO (2010) states that the use of medicines must be rational to ensure that patients receive medication appropriate for their clinical needs, in doses that meet individual requirement for adequate period of time at the lowest cost to them and their community. Irrational use occurs with use of wrong or ineffective medicines or underuse or overuse of effective medicines. Apart from affecting the quality of care this may also increase healthcare costs by increasing pharmaceutical acquisition cost and in some cases holding cost.

One of the reason commonly cited as affecting availability of medicines in developing countries is inefficient supply chains. In a comparative analysis of medical supply chains in developed between developing countries, Dowling, (2011) noted that, in developed countries there is a high degree of automation especially in logistics management information system (LMIS). This permits real-time visibility of supply and demand data resulting in a high level of coordination between different players. Minimum and maximum stocks and distribution are measured in days not months and forecasting is done by the suppliers. In the low and middle income countries (LMIC) it was noted that absence of or limited automation results in inefficient supply chains. There is poor supply chain visibility and data quality is often poor. Maximum and minimum stocks are measured in months resulting in significant amount of funds being tied up in the inventory. Also noted was that LMIC have limited storage capacity and poor storage conditions

In an analysis of challenges of medical supply chain in sub-Sahara Africa, Schöpperle (2013) the following challenges were identified: poor information, inadequate storage, lack of management procedures, human resource capacity and process

management These challenges can negatively influence the pharmaceutical supply chain. Poor information affects the quantification process of the pharmaceutical supply chain. To quantify you need to forecast and to forecast accurately one needs good data. Inadequate storage affects the inventory management process and can therefore affect both inventory holding costs and shortage costs. Low human resource capacity substandard implementation of the supply chain functions therefore affecting availability of essential medicines.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Research Design

Sekaran and Bougie (2009) define study design as the planning of a research in such a way that the requisite data can be collected and analysed to arrive at a solution. Study design include purpose of the study, location, extent at which it is manipulated by the researcher, temporal aspects, and level at which data will be analysed

The purpose of this study was a case study – it analysed pharmaceutical expenditure within the context of a public hospital that is financed by a county government in Kenya. The organisation to be studies was Lodwar County Referral Hospital located in Lodwar.

3.2 Data collection and analysis

Quantitative data was collected by Archival method. Key administrative pharmaceutical supply chain documents were analysed to obtain data.

Study tools were Total cost analysis, ABC analysis and VEN analysis. Quantitative data analysis was done using MS excel spreadsheets. Descriptive statistics – frequency tables, percentages, cumulative percentages and ratios were used to analyse the data.

3.2.1 Total cost analysis

Four components of the pharmacy supply chain cost were compiled. These costs include: Pharmaceutical acquisition cost, Inventory holding cost; purchasing costs and shortage cost.

Pharmaceutical acquisition costs were obtained from delivery notes, supplies invoices and store bin cards.

After compiling the cost, the total cost was calculated as:

Total cost = Pharmaceutical acquisition cost + inventory holding cost + purchasing cost + shortage cost

For inventory holding costs, an average of the beginning inventory and closing inventory balance was taken as the average inventory. The product of the average inventory and the interest paid by the money markets was used to calculate the financial opportunity costs. Loss from inventory amounts was collected from bin card and voluntary surrender forms. The operating costs for storage and stock management were collected from utility bills, receipts, financial records and budget books. Total inventory holding cost was calculated by summing the financial opportunity costs; the loss from inventory and the operating costs for storage and Inventory management.

Purchasing costs were obtained from utility bills, receipts, minutes of acceptance committee proceedings and documents of payment schedules. The shortage costs were obtained by comparing the prices of emergency purchase and that of the regular purchases. The difference was then multiplied by the quantity of emergency purchase.

For data analysis ratios of the above costs were calculated to determine operational efficiency in the supply chain. The ratios calculated are holding cost as a percentage of average inventory; purchasing cost as a percentage of pharmaceutical acquisition cost, average inventory turnover, and the total inventory holding cost as a percentage of total value of medicines bought.

3.2.2 ABC analysis

The ADE of each drug in the essential drugs list was calculated from the medical stores records. The list of drugs was then arranged in descending order from the ones with the highest ADE to the ones with the lowest ADE. Cumulative costs were then calculated – cumulative total being 100% of the total pharmacy ADE. The data was then plotted and the A, B and C classes derived (figure 3). The classes were categorised as follows: Class A – those products consuming up to 70% of the total cost. Class B – those products consuming up to 20% (from 70% to 90%) of the total cost and Class C – those products consuming the remaining 10% (90% to 100%) of the total cost. The results were then presented in tables showing proportions of drugs in each class and proportion of ADE utilized (table 5).

The classes were grouped into class A, B, and C so as to distinguish in terms of their cost. A being the expensive “important few”, B being the middle share and C being the cheap “trivial many”. This has implications on how they will be managed in the pharmaceutical supply chain

3.2.3 VEN analysis

For VEN analysis the research used the hospital essential medicines list in which the VEN status of each drug had been pre-determined by the hospital medicines and therapeutic committee. ADE of each drug was calculated from the store records. The drugs were the grouped to their respected VEN status and the proportion of items and total ADE of each group was calculated and presented in tables.

3.2.4 ABC - VEN matrix analysis

Cross tabulation was done to produce 9 categories (table 3-1). These were further reduced to 3 main categories as shown in (table 3-2). Category I grouped all drugs that were vital and all the class A items. Category II grouped essential and class B drugs items that are not part of category I drugs. Category III items grouped Non-essential and class C items that are not part of either category I or II. Category I were the item that were either expensive or vital or both therefore they needed greater managerial control. Category II were the item that were either essential or moderate cost that were not part of category I these require moderate management. Category III were items that were Cheap and Non-essential that were not part of the first two categories these require passive management.

Figure 3-1 ABC - VEN matrix classification

Category	V	E	N
A	AV	AE	AN
B	BV	BE	BN
C	CV	CE	CN

Figure 3-2 ABC VEN analysis groups

Category	Groups				
I	AV	AE	AN	BV	CV
II	BE	CE	BN		
III	CN				

3.3 Research quality

Internal validity was addressed through data triangulation – use of multiple data sources and data collection techniques. Quantitative data was collected and confirmed by different types of documents containing the same information.

For external validity the research was done in real life setting of the functioning of pharmacy department at LCRH. Literature review was carried out to identify patterns and similarity in findings and conclusions.

3.4 Ethical considerations

Clearance to conduct the study was sought from the Strathmore University research ethical review board and permission was granted.

CHAPTER 4 FINDINGS

4.1 Total cost analysis

The total cost of the LCRH pharmaceutical supply chain for the fiscal year 2014/2015 was KES 53,872,625. Incremental costs, the costs that increases with increase in quantity of supplies bought or increase in the number of transactions, accounted for 95% of the costs while predictable costs, the costs that remain the same irrespective of the increase in quantity bought or number of transactions accounted for 5% of the total costs (table 4-1).

The share of cost component as a percentage of total costs was as per (figure 4-1). Pharmaceutical acquisition costs accounted for the largest share of the total costs at 95% (KES 49,110,625) (appendix I). Followed by Inventory holding costs at 7.45% (KES 4,017,000) (appendix II), Purchasing costs at 0.93% (KES 500,000) (appendix III) and lastly shortage cost at 0.45% (KES 245,000) (appendix IV).

Holding cost as a percentage of average inventory was 38% and purchasing cost as a percentage of pharmaceutical inventory was at 1% (table 4). The average inventory turnover (pharmaceutical acquisition cost divided by pharmacy store average inventory value) was approximately 4 times a year.

Figure 4-1 Pharmaceutical supply chain groups

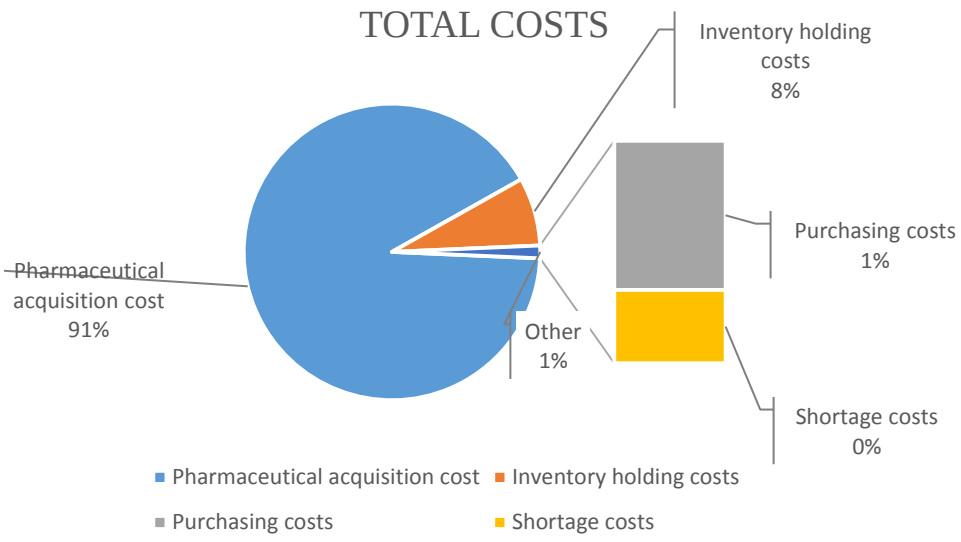


Table 4-1 Summary of the Total cost analysis

Cost Category	Incremental Cost (Est)	Predictable Cost (Est)	Total Cost	% of Total Cost
PHARMACEUTICALS ACQUISITION COST	**49,110,625**		**49,110,625**	**91.16**
INVENTORY HOLDING COSTS	**1,745,000**	**2,272,000**	**4,017,000**	**7.46**
Pharmacy store average inventory value *(PSAIV) (year start value + year end value)/2*	10,500,000.00		10,500,000	
Financial opportunity cost (*PSAIV * 0.08)*	**840,000.00**		**840,000**	
Losses from inventory cost	**905,000**		**905,000**	
Expiry	435,000		435,000	
Unexplained Losses	470,000		470,000	
Pharmacy store operation cost		**2,272,000**	**2,272,000**	
Salaries for pharmacy store staff		2,088,000	2,088,000	
Space and utilities		66,000	66,000	
Communication		48,000	48,000	
Repair and maintenance		40,000	40,000	
Supplies		30,000	30,000	
Holding cost as % of average inventory	17%	22%	38%	
PURCHASING COSTS		**500,000**	**500,000**	**0.93**
Salaries for Purchasing staff		164,000	164,000	
Space and utilities		0	0	
Communication		16,000	16,000	
Administrative overheads		70,000	70,000	
Total additional cost of annual tender		250,000	250,000	
Purchasing costs as % of pharm. acquisition cost		**1%**	**1%**	
SHORTAGE COSTS	**245,000**		**245,000**	**0.45**
TOTAL COST	**51,100,625**	**2,772,000**	**53,872,625**	**100.00**
Percentage incremental and predictable costs	**95%**	**5%**	**100**	

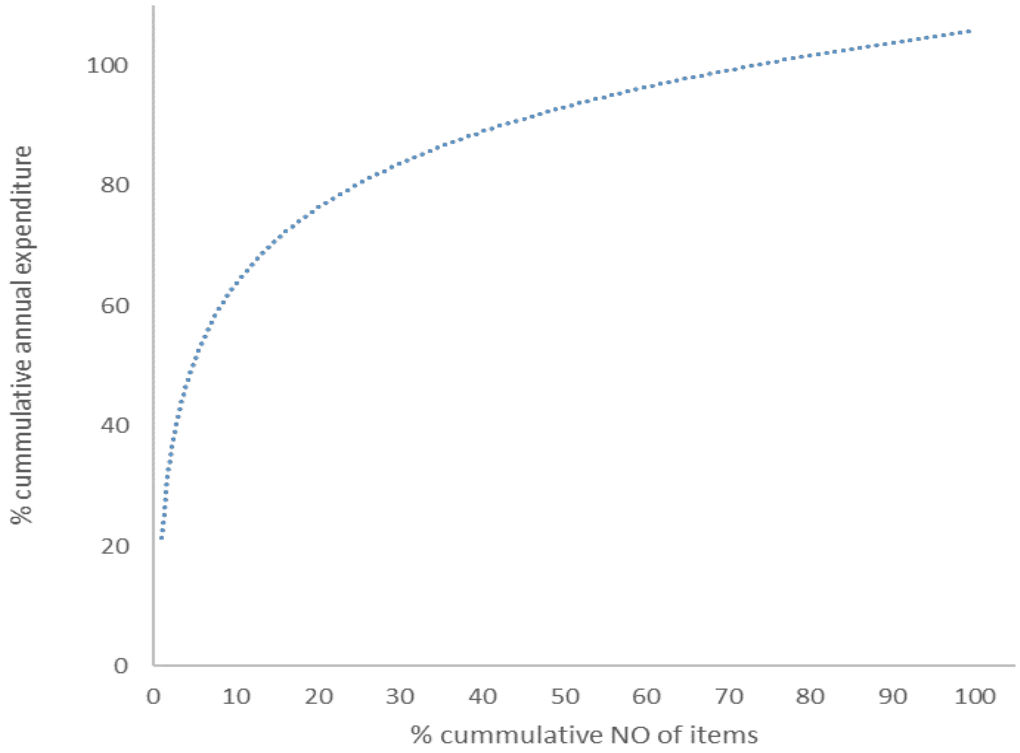
4.2 ABC analysis

The findings of ABC analysis are shown in (table 4-2) and (figure 4-2). Class A items accounted for 12% (24) number of items but consumed 70% (KES 34,401,615) of the ADE. Class B Items accounted for 18% of the number of items but consumed only 20% (KES 9,842,365) of the ADE. Class C accounted for 70% of the number of items but only 10% (4,867,645).

Table 4-2 ABC analysis of ADE

Category	NO. of items	% NO of items	ADE(KES)	% of pharmacy ADE
A	24	12%	34,401,615	70%
B	36	18%	9,841,365	20%
C	141	70%	4,847,645	10%
TOTAL	201	100%	49,090,625	100%

Figure 4-2 ABC analysis curve



4.3 VEN analysis

The finding of the VEN analysis are show in table 6. 33% (66), 57% (115) and 10% (20) of the number of items were found to be in the V, E and N categories respectively. Accounting for 64% (KES 31,274,375), 33% (KES 16,129,080) and 3% (KES 1,707,170) of the ADE of the pharmacy department.

Table 4-3 VEN analysis of the ADE

Category	NO. of items	% NO of items	ADE(KES)	% of pharmacy ADE
V	66	33%	31,274,375	64%
E	115	57%	16,129,080	33%
N	20	10%	1,707,170	3%
TOTAL	201	100%	49,110,625	100%

4.4 ABC-VEN matrix analysis

Table 7 shows the result of ABC VEN matrix analysis. Nine subcategories are created (VA, VB, VN, AB, AN, BE, BN, CE, CN) by cross tabulation of ABC and VEN categories. The nine subcategories are then grouped into category I, II, III (Table 8). Category I contains all class A and vital drugs. Category II contains the essential and class B drugs that are not captured in category I. Category III contains non-essential and class C drugs not captured in category I and II.

Table 4-4 ABC VEN matrix analysis

Category	A			B			C			TOTAL		
	Actual expenditure (KES)	%	NO. of items	Actual expenditure (KES)	%	NO. of items	Actual expenditure (KES)	%	NO. of items	Actual expenditure (KES)	%	NO. of items
V	25,536,990	52	16	4,187,200	9	14	1,550,185	3	36	31,274,375	64	66
E	8,109,905	17	7	5,310,415	11	20	2,708,760	6	88	16,129,080	33	115
N	754,720	2	1	343,750	1	2	608,700	1	17	1,707,170	3	20
Total	34,401,615	70	24	9,841,365	20	36	4,867,645	10	141	49,110,625	100	201

Table 4-5 ABC VEN matrix analysis groups

Category	Groups in the category	NO. of items	% NO of items	ADE(KES)	% of pharmacy ADE
I	AV,VB,VC,AE,AN	74	37	40,139,000	82
II	BE,CE,BN	110	55	8,362,925	17
III	CN	17	8	608,700	1
TOTAL		201	100	49,110,625	100

There were 74 (37%) items in category I, 110 (55%) items in category II and 17 (8%) items in category III, amounting for 82% (KES 40,139,000), 17% (KES 8,362,925) and 1% (608,700) of ADE of the pharmacy, respectively

CHAPTER 5 DISCUSSION

5.1 Total cost analysis

Pharmaceutical acquisition cost and inventory holding costs accounted for almost all of the total costs. Purchasing cost and shortage cost were less than 2% of the total costs.

5.1.1 Purchasing costs

The low level of purchasing cost may indicate an efficient purchasing system or underfunded purchasing office. In this study it may be because there was no dedicated purchasing office – most purchasing functions were performed by staff working full time in other pharmacy offices. This reduced salary, space and utilities, supplies and administrative overhead costs associated with purchasing office. There was no reporting on the procurement performance so it is not possible to determine the reason for low purchasing costs

The low level of purchasing costs may be explained by the procurement model adapted. The national government through the commission for implementation of the constitution mandated the county governments to direct purchase all medical supplies from KEMSA as the first choice then MEDs as the second choice. This direct purchasing reduced cost associated with the tendering process. Though this direct purchasing from KEMSA and MEDs may reduce purchasing cost it may also increase hidden costs. Hidden costs are costs associated with poor supplier performance and are not obvious in the invoice price (Management Science for Health, 2012). The hidden costs may be in form of cost of late delivery, cost of delivery errors, and replacement cost of unusable medicines.

5.1.2 Shortage costs

The low shortage costs of less than 1% of the total costs imply that there were minimal stock outs and therefor good pharmaceutical supply chain management. But the

method used to calculate the shortage cost be unsuitable in this case and therefore inconclusive.

Management Science for Health, (2012) lists four potential stock out costs as: excess cost of emergency purchases, loss of revenue when a client purchases outside the system, increased morbidity and mortality due to stock outs and erosion of confidence in the system due to stock outs. It is only the excess costs of emergency purchases and loss of revenue due clients buying outside the system that can be realistically quantified for a pharmaceutical supply chain system. Of these two only excess cost of emergency purchases could be calculated. Loss of revenue due to client buying outside the system could not be calculated because all the essential medicines are either given for free or on cost sharing basis.

In this study the excess cost of emergency purchases only quantified the medicines that were recorded to have been bought by the hospital due to stock outs. There may have been stock outs that the hospital decided not to make emergency purchases due to lack of funds or other reasons. Therefore, the shortage cost in this case may be inconclusive. A better method may be to record all the un filled prescription medicines and calculate their excess cost if they were to be bought on emergency basis.

5.1.3 Inventory holding costs

Inventory holding cost were approximately 8% of the total costs. The holding cost as a percentage of average inventory, which is an efficiency indicator in supply chain system was at 38%. In commercial firms the inventory holding costs is usually between 28% and 35% of the average inventory (Management Science for Health, 2012). Therefore, the holding cost as a percentage of inventory was higher than normal and this may indicate inefficient inventory management system. Average inventory holding cost in public hospital in other developing countries such as El Salvador, Suriname, Ecuador and Costa Rica are 65%, 26%, 63% and 30% respectively (Management Science for Health, 2012). The study was not able to find local data on Inventory holding costs in public hospital in Kenya to compare with. Average inventory holding costs.

The expiry cost as percentage of pharmaceutical inventory are usually 3-5 % in public health system (Management Science for Health, 2012). In this study the expiry rate was slightly less than 1% of pharmaceutical inventory this may imply that losses through inventory were minimal and hence there was good inventory management. Though this data was limited to the extent that data was available. The low losses from inventory implies most inefficiencies could have been through operational costs. Of the operational costs salaries were the main components. Ways to reduce wage bill without affecting the service level should be explored.

Pharmaceutical acquisition costs were approximately 92% of all the total cost. This means to significantly reduce total cost most intervention should be targeted at the acquisition cost but other supply chain costs should not be ignored because they can affect pharmaceutical acquisition cost. For example, an inefficient purchasing office because of being under funded may fail to effectively seek for cheapest prices in the market thereby increasing the pharmaceutical acquisition costs. Also an ineffective inventory management office may lead to losses through inventory, these may have to be replaced by more purchases thereby driving up pharmaceutical acquisition cost and Total cost.

5.1.4 Controlling the total cost

The main objectives of Total cost analysis are to find opportunities for cost reductions and model the cost impact of potential changes in the supply chain (Management Science for Health, 2012). As per the results of this study opportunities for cost saving can be found mainly in pharmaceutical acquisition costs and inventory management costs.

Pharmaceutical acquisitions cost can be reduced by reducing the unit cost of purchases and reducing the quantity purchased. Reducing the unit cost of purchases means obtaining the lowest prices for commodities which will require good procurement practises to be adhered to. Reducing the quantity of purchases will require strictly limiting purchases to the essential drugs list, good inventory management to prevent losses and rational use of the medications (Management Science for Health, 2012). Current practises of mandatory direct procurement from KEMSA and MEDs may limit efforts to get the lowest price for all the medicines.

Reducing the inventory holding cost may involve: reducing average inventory (increasing frequency of making purchases while reducing the quantity purchased), improving inventory management to reduce losses through inventory, and reducing operational cost by choosing the number and cadre of staff to operate the store. Reducing holding cost may affect the purchasing cost and shortage cost. Increasing frequency of purchases can increase purchasing cost though in this research all purchasing costs are fixed and may stay constant up to a certain level. Reducing the quantity of purchases may risk increase of shortage cost. To balance the inventory holding cost and purchasing cost EOQ - an order level that minimizes holding and purchasing cost – should be calculated for each item in the essential medicines list.

5.2 ABC analysis

The class A items consisting of only 12% of the items consumed 70% of the ADE while class C consisting of 70% of the items consumed only 10% of the ADE. Class A medicines are the "important few" while class C items are the "trivial many". Therefore, class A items should be actively managed while class C items should be passively managed if supply chain resources are to be used efficiently. Class B consisting of 18% of the number of items consumed 20% of the ADE these should be managed by exception

In the analysis of medicine expenditure at Muhimbili National Hospital in Tanzania by Tumaini (2013) produced similar results. In the study class A items consisting 10.5% of the number of items consumed 69.5% ADE. Class B items consisting of 18% of the number of items consumed 20.7% of the ADE and class C items consisting of 71.3% of the items consumed 10% of the ADE. The study recommended that class A items being few and expensive require close day to day control. While class B and C need regular and infrequent reviews respectively. Devnani, Gupta and Nigar also found similar results. In their ABC analysis classes, A, B, and C consisting of 14%, 22% and 64% respectively consumed 70%, 20% and 10% of the ADE respectively. Abate (2012) in analysis of medicines inventory at Black Lion hospital in Ethiopia got different results. In his study Class A items were found to only represent 1.3 % of the items but 79% of the budget.

ABC analysis helps us to use supply chain management resources efficiently. In this case by controlling only 12% of the items one is able to effectively manage 70% of the budget. But one major limitation of ABC analysis is that it only gives importance to cost and demand attributes of the items during grouping. In hospital setting there may be low budget essential medicines that are either cheap in price or used rarely but are lifesaving. When using ABC analysis these items may fall in class B or C items hence they will not be effectively managed. In this study there are 9 vital items are in the B category and 36 vital items in the C category which translate to 18% of the items. Therefore, ABC analysis is not enough for medicines management in hospital setting and there is need for additional methods to be considered.

5.3 VEN analysis

In the VEN analysis study 33% of the items in the essential medicines list were vital accounting for 64% of the ADE. Essential items were 57% and Non-essential items were 10% of the items consuming 33% and 10% of the ADE respectively.

Comparison with similar studies show high variation in the percentages of vital essential and Non-essential items. Tumaini (2012) study at Muhimbili National Hospital showed only 50% of items were Vital. While 62% and 3% were essential and Non-essential respectively. Devnani, Gupta, and Nigar (2010) in their study of a tertiary care teaching, research and referral institute in India showed only 12% of their medicines were Vital, 59% were essential and 29% were Non-essential. This is because the VEN classification are subjective and different institution have different service profiles.

The main purpose of VEN analysis is to make sure critical items are available at all times. The Vital items are absolute necessity for the proper functioning of the institution. Therefore, they are prioritized in in the pharmaceutical supply chain.

In this study if VEN analysis is considered alone it would effectively manage all Vital items - 66% of the items accounting for 64% of the budget. This would be better in management in terms of criticality factor as it manages all vital items. But in the cost factor it would effectively manage 64% of the budget compared to ABC analysis

which would effectively manage 70% of the budget. A combination of methods that take into account both criticality and the cost factor would be better.

5.4 ABC-VEN matrix analysis

In combination of both ABC and VEN analysis both cost and criticality factor are taken into account. In a combination of ABC and VED analysis, the resultant matrix makes it possible to actively manage 74 (37%) items belonging to category I because they are either expensive or vital. The annual expenditure of these items was 82% of ADE of the pharmacy.

AV, AE and BV subgroups of category I consist of 32 items (16%) that are expensive (77% of ADE), and their being out of stock is unacceptable as they are either vital or essential. To prevent locking up of capital due to these items, low buffer stock needs to be maintained while keeping a strict vigil on the consumption level and the stock in hand. From the total cost analysis purchasing costs are mostly fixed costs, low buffer stocks can be maintained by increasing frequency of ordering from the current quarterly to bimonthly or monthly but with consideration of the lead times. A two-bin method of ordering needs to be followed for these as this will reduce risk of stock outs.

CV items are drugs of low cost but high criticality and take up 3% of ADE of the pharmacy. Because this amount is small, these items can be procured once or twice a year as opposed to current quarterly procurement. This is because they have relatively low holding cost so they will not increase the inventory holding costs total.

AN items of category I, are both expensive and Non-essential. In the analysis AN consist of only one item that consume 2% of the ADE. This item should be considered for removal from the essential medicines list to save costs. If it is not removed, it should be carefully monitored for rational use to prevent wastage.

Category II items consist of 110 (55%) of items consuming 17% budget. These items can be ordered once or twice a year, thereby saving on purchasing costs. But since purchasing costs are mostly fixed cost, no saving will be done. the quarterly ordering method should be maintained.

Category III consist of 17 (8%) of items consume 1% of the ADE. Though they have low holding cost from the TCA analysis the purchasing cost are fixed, so reducing the frequency of purchases will not reduce total pharmaceutical cost but increasing the frequency of ordering will reduce holding costs. For these items the current quarterly ordering should be maintained.

Similar studies showed comparable results. in the Devnani, Gupta, and Nigar (2010) study category I consisted of 54.63% of items consuming 74.21% of the budget. Category II consisted 23.38% of items consuming 23.23% of the budget while category III consisted of 23.38% of the items consuming 3.56% of the budget.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion and Recommendations

Pharmaceutical supply chain decision should be informed by analysis of expenditures and inventory to increase efficiency. These analyses should factor both the cost and criticality of the items. The analyses should be performed periodically because of the dynamic nature of the medical sector

The key objectives of the study were to find opportunities for cost savings and improve efficiency. From the total cost analysis key areas of the pharmaceutical supply chain consuming almost all the costs were Pharmaceutical acquisitions and inventory holding. Therefore, measures should be put in place to reduce costs in these areas.

For Pharmaceutical acquisition cost, measures should be put in place to reduce consumption (especially of the high demand or expensive medicines) and to reduce unit price of the medicines. Segmentation strategies should be used to identify expensive or high demand items that utilize high percentage of the budget so that these groups can be targeted for consumption and unit price reduction.

Consumption should be reduced by instituting extra control measures and encouraging rational use of medicines for the expensive or high demand medicines. this may include strictly dispensing according to the treatment guidelines. Also the pharmacy department should restrict purchases to the list of essential medicines.

Unit prices of the medicines should be reduced by competitive tendering. Lack of competition may result to increase in total costs through increase in pharmaceutical acquisition costs and hidden costs. Currently public hospitals are limited to KEMSA as first choice and MEDs as the second choice. Other supplies only come in when these two supplies fail supply all items needed. This direct procurement has advantages of reducing procurement time but may result to higher prices. Therefore, a mixture of procurement systems both direct and competitive should be considered during procurement to take advantage of both systems. None of these procurement system should be given preference over the other.

Regular suppliers' performance evaluation should be implemented. Regular supplier performance evaluation may offer the reason for either maintaining the current system or changing it and help in choice of suppliers. This evaluation should also include hidden costs analysis and price comparison analysis.

The pharmacy procurement office should do regular reports on procurement performance to determine the efficiency of the procurement system. In the study the reason for low purchasing cost was not clear, though the low purchasing costs may indicate saving on Total cost, it may also indicate a poorly funded purchasing office which may be impaired to perform its functions.

Human resource needs assessment should be done for supply chain staff to reduce inefficiencies. Having excess or high wage workers increases inefficiencies by increasing the wage level. Having inadequate or less qualified workers may reduce the wage bill but introduce inefficiencies that increase net total costs. In LCRH there should be an assessment on whether there is need for a full time pharmacist and a procurement officer in the store or if they should can be replaced by low wage cadre like pharmaceutical technologist and storeman who may be able to perform the same function efficiently.

A mixture of purchasing model should be used to cater for different groups of items in the supply chain. Currently the system scheduled purchasing model where purchases are made every three months. This may not be suitable for the high cost items because it might increase holding costs. Also it might not be suitable for the low cost items because it may be not necessary to buy low cost items according to the current schedule. For the high cost critical items (category I), because they have high inventory holding and shortage cost perpetual purchasing model – where the medicines are ordered any time they are needed should be adapted. This will help in reducing both inventory holding cost and negative consequences of shortages. For the low item in all categories annual purchasing model should. This because while may be critical they have minimal effect on the inventory holding costs annual purchasing will result in reduction of risk of shortages. In the same way a customised Inventory control model should be adapted with frequent reviews for category and regular and infrequent reviews for other categories. (figure 6-1)

Non-essential items should be considered for removal from the Essential medicines list especially the expensive category I Non-essential medicines because they are expensive. If not removed they should be given last priority in the when making purchases. There should be periodic obsolesce review for the low cost class C items because of their low demand. (table 6-2)

Table 6-1 Summary of Recommendations: Total cost analysis

Supply chain cost	**characteristic**	**Intervention**
Pharmaceutical acquisition cost	Incremental	Further analysis to segment the inventory and identify where cost savings can be made
Inventory holding cost	Marginally high	Increase frequency of purchase (while reducing quantity of each purchase)
	Both predictable and incremental	Explore ways to reduce losses through inventory Explore ways to reduce operational cost
Purchasing cost	Within acceptable range All predictable	No intervention
Shortage Cost	Within acceptable range	Do an EOQ for all medicines.

Table: 6-2 Summary of Recommendation ABC VEN matrix analysis

Category	**characteristics**	**Intervention**
Class I (AV, AE, BV)	Expensive and critical	Low buffer stock with increased frequency of purchases
	High holding costs	Active monitoring of inventory
	High shortage costs	Strict monitoring for rational use
Class I (CV)	Low cost,	Reduce frequency of purchases
	High criticality, Low holding costs	Increase buffer stock

	High shortage costs	
Class I (AN)	Expensive	Remove from the essential medicines list to save costs
	Low criticality High holding costs	Strict monitoring for rational use
Class II (BE, CE, BN)	Moderate criticality and cost	Should be managed by exception
Class III (CN)	Low cost and low criticality	Passively managed Consider removal from the essential medicines list

6.2 Limitations of the study

For this study there were few comparable studies to compare with especially the Total cost analysis part. This resulted in some results being inconclusive.

The study was limited to the extent that data was available. In the study of shortage cost no proper data on shortage cost were available so the analysis of shortage costs produced inconclusive results.

The accuracy of the study was dependent on accuracy of documentation system. Inventory management in Lodwar county Referral hospital is manual system putting into question the accuracy of the inventory data.

6.3 Further research

To complement ABC analysis, therapeutic category analysis which reviews the volume and use of various therapeutic categories should be done. This will help in finding cheaper substitutes for the class A commodity in ABC analysis.

Hidden cost analysis – cost due to poor supplier performance should be done to help in making procurement decisions.

Price comparison analysis study should also be conducted between various supplies to help in making purchasing decisions.

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APPENDIX I Pharmaceutical acquisition cost/ABC VEN analysis

MEDICINES PURCHASES							
	Total cost	% of ADE	% CM of ADE	VEN	ABC	ABC VEN	ABC VEN
Artemether/lumefantrine tablets	3900000	7.94	7.94	V	A	VA	I
Sodium stibogluconate inj 100mg/ml, 100ml amp	3250000	6.62	14.56	V	A	VA	I
Anti-Snake Venom (African - Tropicalized), Vial	3081000	6.27	20.83	V	A	VA	I
Amoxicillin/clavulanic acid oral Susp 312.5mg/5mL	2716000	5.53	26.36	V	A	VA	I
Amoxicillin cap 250mg 1000s	1914250	3.90	30.26	V	A	VA	I
Amoxicillin /Clavulanic Acid Tablets 500mg/125mg	1859000	3.79	34.05	V	A	VA	I
Rabies Vaccine, purified verocell/human diploid	1575000	3.21	37.25	V	A	VA	I
Ceftriaxone 1g inj	1307500	2.66	39.92	V	A	VA	I
Artesunate IV Injection, 60mg, Vial	955000	1.94	41.86	V	A	VA	I
Sodium Chloride (Normal Saline) 0.9%, 500ml	919400	1.87	43.73	V	A	VA	I
Paracetamol syrup	814340	1.66	45.39	V	A	VA	I
Erythromycin Tablets 250mg	812000	1.65	47.04	V	A	VA	I
Erythromycin ethyl succ. Susp 125mg/5mL (pfr)	796000	1.62	48.66	V	A	VA	I
Metronidazole Suspension 200mg/5ml	785000	1.60	50.26	V	A	VA	I
Ant D (Rho) immunoglobulin	432500	0.88	51.14	V	A	VA	I
Ceftazidime Injection, 1g Vial	420000	0.86	52.00	V	A	VA	I
Paracetamol Tablets 500mg, 1,000 Pack	405850	0.83	52.83	V	B	VB	I
Amoxicillin oral Susp 125mg/5mL	394850	0.80	53.63	V	B	VB	I
Co-Trimoxazole syrup	379000	0.77	54.40	V	B	VB	I
Phenobarbitone Inj 200mg/ml, 1ml amp	363750	0.74	55.14	V	B	VB	I
Diclofenac Injection, 25mg/ml, 3ml, Ampoule	350000	0.71	55.85	V	B	VB	I
Dextrose Solution 10%, 500ml	338700	0.69	56.54	V	B	VB	I
Benzyl Penicillin Injection, 1MU Vial	316000	0.64	57.19	V	B	VB	I

Dextrose Solution 5%, 500ml	311750	0.63	57.82	V	B	VB	I
Metronidazole Tablets 400mg, 1,000 Pack	304500	0.62	58.44	V	B	VB	I
Hydrocortisone Inj 100mg vial	280000	0.57	59.01	V	B	VB	I
Doxycycline Capsules 100mg, 1,000 Pack	211650	0.43	59.44	V	B	VB	I
Oxytocin Inj	196600	0.40	59.84	V	B	VB	I
Gentamicin sulphate Inj	174000	0.35	60.20	V	B	VB	I
Hydralazine Inj 20mg amp pfr(Apresoline)	160550	0.33	60.52	V	B	VB	I
Metronidazole Inj 5mg/mL, 100mlvial	144500	0.29	60.82	V	C	VC	I
Co-Trimoxazole Tablets 400mg/80mg, 1,000 Pack	137800	0.28	61.10	V	C	VC	I
Metformin Tablets 500mg	124000	0.25	61.35	V	C	VC	I
Dextrose Injection 50%, 100ml	122000	0.25	61.60	V	C	VC	I
Insulin biphasic 30/70 100 IU/ml. 10ml vial	96000	0.20	61.80	V	C	VC	I
Oral Rehydration Salt + Zinc Tablets 500ml/20mg, 4sachets/10 tablets	92000	0.19	61.98	V	C	VC	I
Thiopentone inj 500mg vial (pfr)	78600	0.16	62.14	V	C	VC	I
Bupivacaine Hcl in dextrose Inj 5mg amp (Marcaine heavy)	69900	0.14	62.29	V	C	VC	I
Naloxone Injection 0.4mg/ml, pack of 10 Ampoules	57500	0.12	62.40	V	C	VC	I
Insulin (Mixtard) injection 30/70 100i.u/ml, 10ml Vial	55450	0.11	62.52	V	C	VC	I
Chlorpheniramine Inj 10mg/1ml amp	50000	0.10	62.62	V	C	VC	I
Salbutamol Sulphate respirator(nebulizing) solution,5mg/ml, 10ml bottle	46400	0.09	62.71	V	C	VC	I
Morphine Injection 10mg/ml, pack of 10 Ampoules	39900	0.08	62.79	V	C	VC	I
Water for injection, 10ml vial	38000	0.08	62.87	V	C	VC	I
Fluconazole Injection, 2mg/5ml, 100ml Bottle	36500	0.07	62.95	V	C	VC	I
Phenytoin Sodium Injection 250mg, 5 pack	36375	0.07	63.02	V	C	VC	I
Adrenaline Injection, 1mg/ml, Ampoule	34000	0.07	63.09	V	C	VC	I
Potassium Chloride Injection 15%, 10ml, Ampoule	29250	0.06	63.15	V	C	VC	I
Heparin Injection, 5,000iu/ml, 5ml, Vial	28910	0.06	63.21	V	C	VC	I

Suxamethonium Injection 50mg/5ml, Ampoule	26780	0.05	63.26	V	C	VC	I
Salbutamol Inhaler 100mcg/Actuation	26645	0.05	63.32	V	C	VC	I
Amphotericin B Injection, 50mg, Vial	24600	0.05	63.37	V	C	VC	I
Ketamine Injection 50mg/ml, 10ml	22100	0.05	63.41	V	C	VC	I
Hyoscine Butylbromide Inj 20mg/mL amp	21800	0.04	63.46	V	C	VC	I
Halothane, 100% v/v,	20550	0.04	63.50	V	C	VC	I
Atropine sulphate Inj 1mg/mL, 1mL amp	19000	0.04	63.54	V	C	VC	I
Frusemide Inj	18700	0.04	63.57	V	C	VC	I
Neostigmine Inj. 2.5mg/mL, 1ml amp	16500	0.03	63.61	V	C	VC	I
Dexamethasone Injection, 4mg/ml, Ampoule	10000	0.02	63.63	V	C	VC	I
Sodium Valproate Tablets 200mg, 100 Pack	9630	0.02	63.65	V	C	VC	I
Enalapril Tablets 5mg	4900	0.01	63.66	V	C	VC	I
Misoprostol 200mcg Tablets, 30 Pack	4760	0.01	63.67	V	C	VC	I
Digoxin tablets	4545	0.01	63.68	V	C	VC	I
Sodium bicarbonate 8.4%, 10ml amp	1600	0.00	63.68	V	C	VC	I
Glibenclamide Tablets 5mg, 28 Pack	880	0.00	63.68	V	C	VC	I
Nifedipine Tablets	110	0.00	63.68	V	C	VC	I
Cefuroxime 250mg Tablets	2142800	4.36	68.04	E	A	EA	I
Povidone Iodine Aqueous Solution 10%, 5 Litres	1913900	3.90	71.94	E	A	EA	I
Flucloxacilin Capsules 500mg, 30 Pack	1396840	2.84	74.79	E	A	EA	I
Albendazole Tablets 200mg, 100 Pack	910345	1.85	76.64	E	A	EA	I
H. Pylori Kit 500mg, 14 tablets, Kit	731200	1.49	78.13	E	A	EA	I
Ibuprofen Tablets 400mg, 500 Pack	583800	1.19	79.32	E	A	EA	I
Chlohexidine Solution 4%, 5 ltr	431020	0.88	80.20	E	A	EA	I
Haematinic Syrup, 200ml	754720	1.54	81.73	N	A	NA	I
Ciprofloxacin Tablets 250mg	399300	0.81	82.54	E	B	EB	II
Tranexamic Acid Capsules 250mg, 20 Pack	394670	0.80	83.35	E	B	EB	II
Flucloxacillin Inj 250mg (pfr)	361800	0.74	84.09	E	B	EB	II
Salbutamol Syrup 2mg/5mL	359000	0.73	84.82	E	B	EB	II

Clarithromycin Tablets 500mg, 10 Pack	352500	0.72	85.53	E	B	EB	II
Cefuroxime Suspension 125mg/5ml, 50ml	350000	0.71	86.25	E	B	EB	II
Ampicillin/Cloxacillin Capsules 500mg, 100 Pack	345000	0.70	86.95	E	B	EB	II
Cefuroxime Injection, 750mg, Vial	341000	0.69	87.64	E	B	EB	II
Dihydroartemisinin/Piperaquine Tablets 20mg/160mg, 9 Pack	252000	0.51	88.16	E	B	EB	II
Ibuprofen Suspension 100mg/5ml	224000	0.46	88.61	E	B	EB	II
Aminosidine Tablets 250mg, 24 Pack	221500	0.45	89.06	E	B	EB	II
Diclofenac Sodium Tablets 50mg, 1,000 Pack	218200	0.44	89.51	E	B	EB	II
lignocaine/adrenaline dental cartridge	210000	0.43	89.94	E	B	EB	II
Sodium Hypochlorite 3.5%, 5 Litres	200505	0.41	90.34	E	B	EB	II
Sodium Chromoglycate Eye Drops 2%, 10ml	194000	0.40	90.74	E	B	EB	II
Cyclopentolate 1% drops	192600	0.39	91.13	E	B	EB	II
Mydriacil drops	187500	0.38	91.51	E	B	EB	II
Methylated Spirit 70%, 1 Litre	181000	0.37	91.88	E	B	EB	II
Prednisolone Tablets - 5mg	168440	0.34	92.22	E	B	EB	II
Phytomenad. (Vit K) Inj 2mg/ml, 0.2ml amp	157400	0.32	92.54	E	B	EB	II
Hydrocortisone Cream, 1%, 15g	140400	0.29	92.83	E	C	EC	II
Ferrous sulph. /folic acid Tablets 200mg/400mcg	128500	0.26	93.09	E	C	EC	II
Amikacin Injection, 500mg Ampoule, 10 Pack	119892	0.24	93.34	E	C	EC	II
Cetirizine Syrup 5mg/5ml, 30ml	112500	0.23	93.57	E	C	EC	II
Vitamin B complex (B1, B6 and B12)	111900	0.23	93.79	E	C	EC	II
Benzathine penicillin Inj 2.4 MU vial pfr	110000	0.22	94.02	E	C	EC	II
Cephalexin Capsules 500mg, 100 Pack	107500	0.22	94.24	E	C	EC	II
Omeprazole Capsules 20mg, 30 Pack	94000	0.19	94.43	E	C	EC	II
Lysol Solution 12%, 5 Litres	92250	0.19	94.62	E	C	EC	II
Ampicillin/Cloxacillin Oral Drops	86000	0.18	94.79	E	C	EC	II
Acyclovir Tablets	84000	0.17	94.96	E	C	EC	II
Paracetamol Inj 10mg/ml, 100ml vial	81440	0.17	95.13	E	C	EC	II

Betamethasone/neomycin eye drops	75000	0.15	95.28	E	C	EC	II
Cetirizine Tablets 10mg, 100 Pack	70000	0.14	95.42	E	C	EC	II
Silver sulphadiazine cream 1% 250g	61500	0.13	95.55	E	C	EC	II
Levofloxacin Tablets 500mg, 10 Pack	60000	0.12	95.67	E	C	EC	II
Calcium Gluconate Injection, 10%, 10ml Ampoule	53000	0.11	95.78	E	C	EC	II
Propofol Injection 10mg/ml, 5 pack	51640	0.11	95.88	E	C	EC	II
Ephedrine Injection, 50mg/ml, 10ml Ampoule	48900	0.10	95.98	E	C	EC	II
Etamysylate Injection, 250mg, Vial	48400	0.10	96.08	E	C	EC	II
Ampicillin / Cloxacillin Syrup 250mg / 5ml	46000	0.09	96.18	E	C	EC	II
Dextrose in Normal Saline 5%, 1000ml	40000	0.08	96.26	E	C	EC	II
Chlorpheniramine Tablets 4mg, 1,000 Pack	37000	0.08	96.33	E	C	EC	II
Tramadol Injection 100mg Ampoule, 5 pack	36400	0.07	96.41	E	C	EC	II
Clotrimazole cream 1% 20g	35000	0.07	96.48	E	C	EC	II
Frusemide Tablets 40mg, 1,000 Pack	34810	0.07	96.55	E	C	EC	II
Salbutamol Tablets 4mg, 1,000 Pack	34050	0.07	96.62	E	C	EC	II
Clotrimazole Pessaries, 200mg, 3 Pack	34000	0.07	96.69	E	C	EC	II
Flucloxacillin Suspension 125mg/5ml, 100ml	33600	0.07	96.76	E	C	EC	II
Prednisolone Eye Drops 1%, 10ml	30000	0.06	96.82	E	C	EC	II
Clarithromycin Suspension 125mg/5ml, 70ml	29100	0.06	96.88	E	C	EC	II
Penicillin Triple Injection 6:3:3, Vial	28000	0.06	96.93	E	C	EC	II
Mannitol Solution 20%, 500ml	26600	0.05	96.99	E	C	EC	II
Darrows Half strength	26500	0.05	97.04	E	C	EC	II
Chloramphenicol Injection, 1g, Vial	25900	0.05	97.09	E	C	EC	II
procaine penicillin	25000	0.05	97.14	E	C	EC	II
Metoclopramide Injection 10mg/2ml, Ampoule	24000	0.05	97.19	E	C	EC	II
lignocaine adrenaline injection	22500	0.05	97.24	E	C	EC	II
Hydrogen Peroxide 6% (20Vol), 200ml	21500	0.04	97.28	E	C	EC	II

Benzyl benz. emulsion 25% w/v application 50ml	21020	0.04	97.33	E	C	EC	II
Lidocaine (lignocaine) Inj 1%, 1mg/1mL 30ml vial	20000	0.04	97.37	E	C	EC	II
Tinidazole Tablets 500mg, 500 Pack	19400	0.04	97.41	E	C	EC	II
Glutaraldehyde 2% Solution	18200	0.04	97.44	E	C	EC	II
Chlorpheniramine Syrup 2mg/5ml, 5 Litres	17000	0.03	97.48	E	C	EC	II
Gabapentin capsules 300mg	16000	0.03	97.51	E	C	EC	II
Aminosidine Syrup 125mg/5ml, 60ml	15450	0.03	97.54	E	C	EC	II
Acetylsalicylic acid Tablets 75mg-enteric coated	15300	0.03	97.57	E	C	EC	II
Gentamicin sulphate solution 0.3% w/v (eye/ear drops) 5ml	15000	0.03	97.60	E	C	EC	II
Timolol Eye Drops 0.25%, 5ml	13800	0.03	97.63	E	C	EC	II
Ampicillin Injection, 250mg, Vial	13000	0.03	97.66	E	C	EC	II
Tramadol Capsules 50mg, 20 Pack	12750	0.03	97.68	E	C	EC	II
Diazepam Inj 5mg/ml, 2ml amp	12000	0.02	97.71	E	C	EC	II
Fluphenazine Decanoate Injection, 25mg/ml, 1ml, Ampoule	12000	0.02	97.73	E	C	EC	II
Isosorbide Dinitrate Tablets 10mg, 100 Pack	11500	0.02	97.76	E	C	EC	II
Heparin Low Molecular Injection, 40mg/0.4ml, Pre-filled Syringe	10800	0.02	97.78	E	C	EC	II
Bisacodyl 5mg Tablets	10525	0.02	97.80	E	C	EC	II
Ranitidine Injection 50mg/2ml, 5 pack	9135	0.02	97.82	E	C	EC	II
Carbamazepine Tablets 200mg	8100	0.02	97.83	E	C	EC	II
Phenytoin Sodium Capsules 100mg, 84 Pack	7895	0.02	97.85	E	C	EC	II
Metoclopramide Tablets 10mg	7870	0.02	97.87	E	C	EC	II
Spironolactone Tablets 25mg, 1,000 Pack	7360	0.01	97.88	E	C	EC	II
Ketoconazole Tablets 200mg	6460	0.01	97.89	E	C	EC	II
Aminophylline Inj 25mg/mL, 10mL amp	6000	0.01	97.91	E	C	EC	II
Dexamethasone/Gentamycin Eye Drops, 0.1%/0.3%, 5ml	6000	0.01	97.92	E	C	EC	II
Promethazine Syrup 5mg/ml, 60ml	6000	0.01	97.93	E	C	EC	II
Ferrous sulphate Tablets200mg	5700	0.01	97.94	E	C	EC	II

Fluconazole Tablets 50mg, 50 Pack	5700	0.01	97.95	E	C	EC	II
Chlorpromazine Tablets 100mg	5600	0.01	97.97	E	C	EC	II
Phenobarbitone Tablets 30mg	5570	0.01	97.98	E	C	EC	II
Meloxicam Tablets 7.5mg, 20 Pack	5000	0.01	97.99	E	C	EC	II
Mebendazole Tablets 500mg, 1 Pack	4330	0.01	98.00	E	C	EC	II
Fluconazole Suspension 50mg/5ml, 35ml	4100	0.01	98.00	E	C	EC	II
Acyclovir Tablets	3800	0.01	98.01	E	C	EC	II
Dihydrocodeine phosphate Tablets 30mg	3600	0.01	98.02	E	C	EC	II
Benzhexol Tablets 5mg, 100 Pack	3500	0.01	98.03	E	C	EC	II
Losartan Tablets 50mg, 28 Pack	3400	0.01	98.03	E	C	EC	II
Promethazine Injection 25mg/ml, 2ml, Ampoule	2340	0.00	98.04	E	C	EC	II
Nystatin oral Susp 100,000 IU/mL	2100	0.00	98.04	E	C	EC	II
Chlorpromazine inj 25mg/ml, 2ml amp	1800	0.00	98.05	E	C	EC	II
Promethazine Tablets 25mg, 1,000 Pack	1560	0.00	98.05	E	C	EC	II
Amlodipine Tablets 5mg	1150	0.00	98.05	E	C	EC	II
Amitriptyline Tablets 25mg	1140	0.00	98.05	E	C	EC	II
Atenolol Tablets 50mg	1080	0.00	98.06	E	C	EC	II
Losartan/Hydrochlorthiazide 50mg/125mg Tablets, 28 Pack	790	0.00	98.06	E	C	EC	II
Diloxanide furoate Tablets 500mg	620	0.00	98.06	E	C	EC	II
Diazepam Tablets 5mg	306	0.00	98.06	E	C	EC	II
Griseofulvin Tablets 125mg	140	0.00	98.06	E	C	EC	II
Levothyroxine sodium Tablets 100mcg	87	0.00	98.06	E	C	EC	II
Quinine sulphate Tablets 300mg (f/c, scored)	188750	0.38	98.44	N	B	NB	II
Artificial tears 10ml	155000	0.32	98.76	N	B	NB	II
Antiasthmatic Syrup, 100ml,	122000	0.25	99.01	N	C	NC	III
Quinine Drops (Dihydrochloride) 20%w/v, 15ml	112000	0.23	99.24	N	C	NC	III
Acyclovir cream	96000	0.20	99.43	N	C	NC	III
Lactulose Solution 3.4mg/ml, 200ml	72000	0.15	99.58	N	C	NC	III
Hyoscine Butylbromide Tablets 10mg, 50 Pack	49500	0.10	99.68	N	C	NC	III
Calamine lotion 15% 50ml	36400	0.07	99.75	N	C	NC	III

Sulfadoxine/Pyrimethamine Tablets 500mg/25mg, 60 Pack	21000	0.04	99.80	N	C	NC	III
Compound Magnesium trisilicate Tablets 370mg	17500	0.04	99.83	N	C	NC	III
Antacid Gel	16000	0.03	99.86	N	C	NC	III
Multi-Vitamin Syrup, 5 Litres	14700	0.03	99.89	N	C	NC	III
Ky jelly	13100	0.03	99.92	N	C	NC	III
Diclofenac Gel, 1% w/w, 15g	10500	0.02	99.94	N	C	NC	III
Multivitamin Syrup	9000	0.02	99.96	N	C	NC	III
Carvedilol Tablets 12.5mg, 28 Pack	8000	0.02	99.98	N	C	NC	III
Atorvastatin Tablets 10mg, 28 Pack	7800	0.02	99.99	N	C	NC	III
Benzoic/salicylic Acid Ointment, 6%/3%, 20g	1900	0.00	100.00	N	C	NC	III
Loperamide Capsules 2mg, 100 Pack	1300	0.00	100.00	N	C	NC	III
	49110625	100	100.00				

APPENDIX II Inventory holding cost

Inventory holding costs		
Financial opportunity costs	8% average interest rates on average inventory of KES 10,500,000	840000
Operational cost storage and stock management		
Store staff salaries	1 pharmacist @ KES 114,000 pm, 1 procurement officer @ KES 50,000 pm 1 casual @ KES 10,000 pm	2088000
Space and Utilities	Share or electricity bill est KES 5000 pm, Share of water bill KES 500 pm	66000
Communication	Airtime @ KES 3000 pm Data bundles KES 1000 pm	48000
Supplies	Stationeries (including computer and printer supplies) @ est KES 25000 pa, Cleaning supplies @ est KES 5000 pa	30000
Repair and maintenance of the store	Est KES 20,000 for repair of the air conditioners, Est KES 20,000 for repair of the roof	40000
Loss from inventory		
Expiry	Data from list of expired items 2014/2015	435,000
unexplained losses	Discrepancies in quantity issued from the pharmacy store and quantity dispensed at the dispensing window. Discrepancies in the quantity indicated in the bin cards and actual stock count	470,000
Transport cost		
Transport cost	Transport costs from suppliers are factored in the price of the drugs, the store is the same building as the pharmacy.	0
Total inventory holding costs		4,017,000

APPENDIX III Purchasing cost

Calculation of purchasing costs

Salaries for purchasing staff	No full time dedicated procurement office. 1 pharmacist and 1 procurement officer spend 1 week per quarter performing the purchasing function. 1 pharmacist @ KES 114,000 pm and 1 procurement officer @ KES 50,000 pm for 1 month	164,000
Utilities and space	No dedicated space hence no utility bills	0
Communication	Airtime @ KES 3000 quarterly, Data bundles @ KES 1000 quarterly	16,000
Administrative Overheads	Allowances for the acceptance committee - 5 members @1500 per member per sitting, 4 sittings per year Offloading est KES 10000 per quarter	70,000
Tendering costs	Advertisement of annual tenders in national newspapers @ est KES 200,000, allowances for officers through various tender processes est KES 50,000	250,000
Total purchasing costs		500,000

APPENDIX IV Shortage cost

	Quantity	unit price	Total (KES)	KEMSA/MEDs unit price	Total	Shortage (cost KES)
Oxytocin Inj 5 IU/ml ampoule (Syntocinon)	1,500	100	150,000	11.00	16,500	133,500
Hydralazine Inj 20mg amp pfr(Apresoline)	200	460	92,000	23	10580	81,420
Ceftriaxone Inj 250mg vial (pfr)	5000	38	190,000	32	160000	30,000
			Total shortage costs			244,920

APPENDIX V Ethical review

Strathmore UNIVERSITY

REF: SU-IRB 0035/2016

28th April 2016

Daniel Masiga Kokonya
P.O Box 18-30500
Lodwar, Kenya.

Email: daniel.masiga@gmail.com

Dear **Daniel,**

REF: SU-IRB 0035/16 (AMENDMENT) PROPOSAL" ANALYSIS OF MEDICINES EXPENDITURE AT LODWAR COUNTY REFERRAL HOSPITAL"

I make reference to your application dated 21st April 2016, requesting for the approval of the proposed amendment.

We acknowledge receipt of the amended proposal version dated 21st April 2016.

The committee noted the following amendment:

- Narrowing down the topic to only include analysis of pharmaceutical expenditure at Lodwar County referral hospital and leaving out analysis of supply chain challenges.

The committee concluded that the suggested amendment is justified and will not result in increased risk to the participant. The proposed change has therefore been granted **approval** for implementation. You may continue with your study.

You are required to submit any further changes to this version of the protocol to the Strathmore University IRB for review and approval prior to implementing any additional changes.

Sincerely,

Amina Salim
Regulatory Affairs Fellow

STRATHMORE UNIVERSITY INSTITUTIONAL REVIEW BOARD APPROVED

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