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Inventory Management Practices and Supply Chain Performance of Antiretroviral Medicines in Public Hospitals in Nyamira County, Kenya

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DECLARATION

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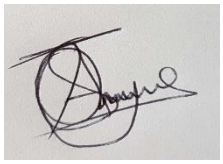
Signature:  Date: 12th October, 2019

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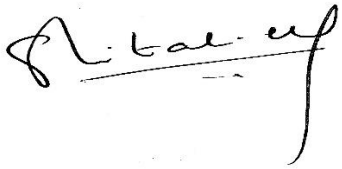

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ABBREVIATIONS AND ACRONYMS

AIDS	Acquired Immune deficiency Syndrome
APHIA	AIDS, Population and Health Integrated Assistance
ART	Antiretroviral Therapy
ARV	Antiretroviral
CD4	Cluster of Differentiation 4
CSCMP	Council for Supply Chain Management Professionals
ERB	Ethical Review Board
DHIS	District Health Information System
FHI	Family Health International
FP	Family Planning
HAART	Highly Active Antiretroviral Therapy
HIV	Human Immunodeficiency Virus
IT	Information Technology
KAIS	Kenya AIDS Indicator Survey
KNH	Kenyatta National Hospital
LMIS	Logistics Management Information System
HIV	Human Immunodeficiency Virus
MoH	Ministry of Health
MSH	Management Sciences for Health
NASCOP	National AIDS and STI Control Programme
SOP	Standard Operating Procedure
STI	Sexually Transmitted Infection
UON	University of Nairobi
USAID	United States Agency for International Development
WHO	World Health Organization

ABSTRACT

Availability of essential medicines at all times in sufficient amounts is crucial to the success of any functioning health system. Unreliable supply systems have however plagued the provision of uninterrupted supply of these life-saving medicines in many developing countries, with antiretroviral medicines used in managing HIV having the worst repercussions. This study sought to: identify the inventory management practices used, evaluate the supply chain performance and determine the challenges affecting inventory management of ARV medicines in public hospitals.

The study used a descriptive cross-sectional design and targeted eight public hospitals in Nyamira County, Kenya. Census method was used to sample officers involved in ARV medicines management namely: hospital pharmacists, facility in charges, sub-county pharmacists, antiretroviral therapy nurses, county pharmacist and hospital administrators. Primary data was collected using semi-structured questionnaires, key informant interviews and checklists whereas secondary data was retrieved from the DHIS2. Data collected was analyzed using descriptive statistics. Descriptive statistics was used to provide percentages, frequencies and measures of central tendencies.

The study found that the prevailing inventory management practices in Nyamira County public hospitals included: use of scheduled inventory control model (80.95%), forecasting demand using previous consumption data (100%), keeping accurate and updated stock records for each commodity (92.31%), including essential logistical data in reports (100%), including safety stock (61.54%) and keeping ARV medicines in dedicated stores (75%). With the exception of order lead time (17.98 days), the other supply chain performance metrics namely stock out rate (52.12%), stock wastage rate (43.2%) and reporting rates (70.84%) were found to be deficient. The challenges mostly affecting inventory management unearthed were: inadequate staff, inadequate training, lack of proper storage and unreliable supply of medicines.

The study recommends regular training, adoption of electronic inventory system, use of data for decision making, dedicated storage of ARV medicines and inclusion of buffer stock as some strategies to improve the inventory management and consequently supply chain performance of ARV medicines.

Key words: Inventory Management Practices, Supply chain performance, stock availability, order lead time, safety stock

CHAPTER ONE: INTRODUCTION

1.1 Background Information

Inventory management is considered to be the nucleus of every viable pharmaceutical supply system(1). It refers to the activities involved in ordering, receiving, storing, issuing and replenishing of a finite list of commodities. The primary goal of an ideal inventory management system is to maintain an uninterrupted supply of commodities to facilities and ultimately clients while keeping inventory holding costs at a minimum. A key objective in WHO's essential medicines strategy is "to expand access to essential medicines by improving financing and supply systems"(2). However, unreliable supply systems have been identified as a major hindrance to sustainable provision of essential medicines across many developing countries.

Hausman(3) defines Supply chain performance as "the extended supply chain's activities in meeting end-customer requirements, including product availability, on-time delivery, and all the necessary inventory and capacity in the supply chain to deliver that performance in a responsive manner." It is one of the critical factors that determine health outcomes. The importance of having essential medicines available at all times is fundamental. This is determined by the performance of the supply chain.

Anteretrovirals are drugs used in the treatment of retroviruses, primarily HIV. While HIV/AIDS prevention, care and treatment programmes have made great strides in reducing the HIV pandemic in Kenya, former Nyanza province has consistently maintained a high prevalence of the infection(4). Though the root cause of this sustained high prevalence could be multifactorial, ensuring availability and uninterrupted access to ARV medication is a key intervention being used to contain the spread of the disease.

In a bid to establish whether the supply system of ARV medicines is effective, this research attempted to investigate the inventory management practices being done in public hospitals in one of the counties of Nyanza region called Nyamira County. The challenges in inventory management were also identified as well as an evaluation of the supply chain performance.

1.2 Problem statement

According to the latest Kenya HIV estimates report of 2018, the ART coverage in Nyamira County is estimated to be 77% and 93% among adults and children respectively(5). This is a significant improvement from the estimates done in 2014 which indicated an ART coverage of 58% and 38% among adults and children respectively(6). This improvement is attributed to the increased number of ART sites. An increased number of ART coverage means an increased need of uninterrupted access to ARV medicines. Additionally, demand for ARV medicines has gone up due to change of treatment guidelines which now requires all persons tested positive for HIV to be initiated on HAART irrespective of CD4 count(5).

Conversely, a quick review of the stock status of ARV commodities in Nyamira County through the DHIS2 tool indicates varying degrees of commodity security among the 8 hospitals of interest, with some experiencing stock outs, others being understocked while some facilities having more than the maximum months of stock at different points during the reviewed period of 2018. According to the County HIV and AIDS strategic plan 2014/15-2018/19, "erratic and inadequate supply of HIV/STI-related commodities"(7) was listed as a capacity gap that was hindering the availability and access to ARV medicines. A key mitigation strategy prescribed by the strategic plan was to conduct regular supervision as well as routine monitoring of ARV commodities.

The main consequence of stock outs of ARV medicines is poor adherence to treatment. Schaecher(8) associates poor adherence to treatment with ineffective viral suppression, resistance to medication, increased morbidity and low survival rates.

An assessment of the inventory management practices and supply chain performance of ARV medicines therefore needed to be conducted to give a true picture of where the problems in managing ARV medicines is and provide recommendations based on the findings.

1.3 Purpose of the study

The main goal of this study was to optimize a best practice model for inventory management and supply chain of ARV medicines in Nyamira County by assessing the current practices of inventory management and making recommendations on what needed to be done better or differently.

1.4 Research questions

I. What are the inventory management practices currently in use for managing ARV medicines in public hospitals in Nyamira County, Kenya?
II. How is the supply chain of ARV medicines in public hospitals in Nyamira County performing?
III. What challenges affect inventory management of ARV medicines in public hospitals in Nyamira County, Kenya?

1.5 Objectives

1.5.1 Main objective

The main objective of this study was to investigate the inventory management practices and evaluate the supply chain performance of ARV medicines in public hospitals in Nyamira County. Kenya.

1.5.2 Specific objectives

I. To identify the inventory management practices used for ARV medicines in public hospitals in Nyamira County, Kenya
II. To evaluate the supply chain performance of ARV medicines in public hospitals in Nyamira County, Kenya
III. To determine the challenges affecting inventory management of ARV medicines in public hospitals in Nyamira County, Kenya

1.6 Significance and anticipated output

The biggest beneficiaries from this study will be the stakeholders of HIV/AIDS management. They include: NASCOP, Ministry of Health, Kenya, donors like USAID, implementing partners like APHIA plus and the Health Department of Nyamira County Government. The survey unearthed the current practices being conducted in inventory management and isolate the challenges. This information will be useful to the stakeholders in identifying the areas that need resource mobilization and capacity building so as to promote commodity security of ARV medicines.

The survey in this study will also likely add value to the existing body of knowledge in inventory management and supply chain performance from the perspective of a public health system for future researchers.

The anticipated output of the study is to isolate the deficiencies of the current inventory management practices and supply chain performance of ARV medicines in public hospitals of Nyamira County and consequently provide recommendations for policy and best practice.

1.7 Delimitations

The inventory management practices in focus were: how order quantities are determined, the triggers for replenishing stock, availability, accuracy and up to datedness of stock keeping records and safety stock policy.

The supply chain performance indicators that were evaluated were: stock out rates, order lead time, stock wastage rate and the rate of reporting.

The target population of the study was: facility in charges, pharmacists, hospital administrators and ART nurses in all the eight public hospitals in Nyamira County namely: Nyamira County Referral Hospital, Manga Sub-County hospital, Kijauri Sub-County hospital, Masaba Sub-County hospital, Ekerenyo Sub-County hospital, Nyangena Sub-County hospital, Nyamusi Sub-County hospital and Esani Sub-County hospital. The study focused on the inventory management practices and supply chain performance of ARV medicines within Nyamira county, Kenya.

1.8 Limitations

Firstly, since the study was only limited to public hospitals in Nyamira County due to cost and time constraints, the findings may not give a general picture of the inventory practices in the entire County of Nyamira since majority of the public health facilities offering ARV medicines are of lower levels, namely dispensaries and health centers.

Secondly, this study focused only on ARV medicines and therefore the findings may not be generalized to the inventory practices and supply chain performance of other health commodities such as reproductive health commodities, other essential medicines, laboratory commodities, vaccines and medical supplies.

Finally, the filling of questionnaires was the discretion of the study participants. There was a possibility therefore that some questionnaires would not have complete data and potentially affect the findings of the survey. Furthermore, the targeted population involved middle to top level management of the facilities they worked in and therefore their availability may have been unpredictable.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

The topics covered in this chapter include inventory management practices, supply chain performance and empirical literature review on inventory management practices and supply chain performance that includes the gaps in research. A conceptual framework is provided at the end to outline the parameters under investigation and show the relationship between the independent and dependent variables.

2.2 Inventory Management Practices

The main areas of interest of this research when evaluating inventory management practices in an operating unit were: inventory control model, how order quantities are determined, availability, accuracy and up to datedness of stock keeping records and safety stock policy(9).

For Pharmaceutical supply systems, the trigger for reordering determines which model is being used. The maximum-minimum inventory control system is the popular one for managing health commodities. This system is developed to make sure stock levels lie within a set range with the upper limit called the maximum stock and the lower limit called the minimum stock. According to USAID|DELIVER(10), the max-min inventory control system has 3 types: forced order system, continuous review system and the standard system.

In the forced order system, the prompt for ordering is the conclusion of a review period. All stocks are evaluated at the end of the review period and the quantity to be ordered is given by the deficit required to bring up the stock levels to the maximum stock. One advantage of this system is that it is simple since the inventory manager simply has to order every item at conclusion of a review period. Secondly, due to its predictable nature, transport can easily be arranged for. Third, constant stock assessment is not necessary since all commodities are ordered for at every review. A disadvantage of this model is that all items have to be ordered for even those with stock levels slightly below the maximum level. A variation of the forced order model is called Vendor Managed Inventory whereby the supplier transports supplies to a facility at the conclusion of a review period, assesses stock and tops them up to the maximum level.

In a continuous review system, the prompt for placing an order is when the minimum stock quantity is reached. The main advantage of this model is the elimination of small orders. The main

disadvantage is that transport is harder to arrange for since orders are placed at any time as long as an item has reached minimum stock levels. A variation of the continuous review is called the two-bin system where two equal sized bins are filled with a particular product. The minimum is reached when the first bin is exhausted and the maximum is reached when both bins are full.

In the standard system, the prompt for placing an order is the conclusion of the period of review for commodities that hit minimum stock quantity. Since it combines the decision rules for both the forced and continuous review system, it enjoys both their advantages. The main disadvantage is that it has a higher minimum stock level thus increasing inventory holding costs and likelihood of commodities expiring(10).

In order to accurately determine what quantity to order, an inventory manager needs to forecast future demand. According to MSH(1) , there exists four methods of forecasting demand: projective, causal, judgmental and morbidity based method.

The projective methods relies on previous consumption data to envisage demand. Consumption data refers to the actual numbers of a product that were issued to clients during a given period. This method is ideal for mature programs that have accurate data and complete supply of commodities(11).

The causal method of forecasting is used when demand is correlated with some known measurable factor like epidemics, seasonality, market conditions and changes in health system structure and size. This is preferred when the set of variables causing the demand are available, causal relationships are anticipated and the course of the relationship is identified(12).

The judgmental method relies on individual estimates which are largely subjective. Experienced staff are consulted and their opinion on future demand is considered. According to Armstrong(12), this method is ideal when the experts possess privileged demand intelligence, are unbiased and significant changes in demand are unlikely.

Morbidity based method requires data on incidences of health problems and expected number of attendances together with the standard treatment for a given health condition to project demand. This method is most suitable for new programs or those that are scaling up. Data requirements include population demographics, prevalence of the health condition and treatment protocols(13).

Stock keeping records are the primary source of data in inventory management and can either be manual or electronic. Whether stock record is manual or electronic, data recorded in them must be accurate and up-to-date. There are a number of reasons that may lead to a stock record not having correct data, most of which are preventable. They include: theft, infrequent physical counts, poor training of inventory management staff, expired or damaged commodities being withdrawn but not struck off the stock records and storing stocks of one item in different locations as a result of poor warehousing practices(1).

The stock card or ledger is the most crucial record according to MSH(1). An ideal stock card should at the minimum contain: product description, unit of issue, date of expiry, columns and rows to indicate date, issues, receipts and balance. Other commonly used stock records include: vertical file cards and kardexes. According to the USAID|DELIVER project (10), stock keeping records must contain stock on hand, losses and adjustments for each product. Consumption data which is the third essential data for decision making is not recorded on the stock keeping record because seldom does a product move from the store directly to a client.

In logistics management, reports are tools used to move information upstream or downstream in order to avail information to decision makers. Stock records are of no use if the information is not available to managers for decision making. For the purposes of improving inventory management, MSH(1) recommends that the following needs to be reported on: stock on hand, inventory holding costs, inventory value at the start and end of the review period, consumption patterns, service levels and medicines at risk of expiring.

The CSCMP defines safety stock as “the inventory a company holds above normal needs as a buffer against delays in receipt of supply or changes in customer demand.” (14). Commercial companies set safety stock using formulas that factor in demand patterns, cost of stock outs and cost of holding inventory. On the other hand, in the public health supply chain, the inventory holding cost of extra stock is weighed against health and political implications.

MSH(1) gives the standard formula for calculating safety stock to be the product of average lead time and average monthly consumption adjusted for stock outs. Radasanu(15) describes a variation to this standard formula which includes a multiplier to the formula called the safety factor. The safety factor does not have any scientific derivation but rather relies on the experience of the stock manager. It serves the purpose of compensating for varying consumption patterns and supply

delays. Whichever the criteria used, safety stock is an important aspect that needs to be considered when designing an inventory management system.

2.3 Supply chain performance

Keebler et al(16) explain that supply chain performance can only be improved with the prior knowledge of how it is currently performing and that the only way of doing so is by measuring it so as to explicate its strengths and weaknesses and thereby isolate the problem areas.

In measuring performance, Frazelle(17) recommends indicators that consider quality, productivity, response time and financial status. Quality indicators give a measure of how satisfactory you are in doing a given task. It is a measure of accuracy. Response time indictors show how time-efficient the supply chain is. Financial indictors on the other hand portray the financial situation of an organization and helps identify the drivers of cost whereas productivity indicators illustrate resource utilization and whether or not it is efficient(18).

For this study, stock out rates, order lead time, stock wastage rate and facility reporting rates were measured as the quality, response time, financial and productivity performance indictors respectively.

Stock out rate looks at the availability or absence of products during a given time frame. It is a measure of a program or health facility's ability to meet the customer's demand. Sources of data that can be used to determine stock out rate include: physical inventories during site visits, records of supervision and LMIS records. It can either be for a single product across a number of selected facilities or for commodities expected to be available in a given type of facility(19). Wangu and Onyango(20) in a study done in public hospitals, Nakuru, Kenya concluded that the leading causes of stock outs were: poor distribution (91%), inadequate funding (58%), inappropriate selection (58%) and irrational drug use(56%).

Aronovich et al(19) defines order lead time as an indicator that measures the mean time it takes from when an order is requisitioned to when it is collected by a given facility. This indicator measures the efficiency of both the central store and the distribution system. To be able to calculate order lead time, data can be obtained from order and requisition forms. The formula used to calculate order lead time is as follows: Total sum of days between placing an order and receiving it divided by total number of orders placed.

A case study done in a Mexican company looking at how order lead time can be improved drew the conclusion that decentralization of inventory from a central warehouse to strategic stores closer to the consumers and improving space utilization for every shipment were viable strategies of reducing order lead time(21).

Unusable to usable stock gives the ratio of the stock which is unusable due to damage or expiry to the stock which is usable. Measuring the unusable to usable ratio can be an indicator of poor storage and inventory practices such as poor stock rotation, overstocking and deplorable storage conditions(19).

Reporting rate refers to the proportion of facilities under investigation that fill and send reports as per the agreed reporting time frames. Timeliness, accuracy and completeness of reporting is also measured. Timely information is necessary for managers to make effective decisions such as resupplying, redistribution or identifying facilities that require resource mobilization such as increasing staff and supervision. In order to calculate reporting rates, Aronovic et al(19) recommend knowing the total number of facilities, the reporting schedule and actual dates that reports were submitted in the recent period.

2.4 Inventory management practices and supply chain performance

A study by Wagura(22) in Kenya showed the relationship between inventory management systems and supply chain performance. The perpetual inventory system was found to be the most widely used system in the surveyed hospitals. This system yielded a high supply chain performance which was measured by the quality and cost of service delivery. The gap with this study is that it did not show how the different inventory models varied in terms of performance. Additionally, the determination of performance was purely from the responses gathered from questionnaires. It would be interesting to identify the inventory practices by observation also and evaluate the supply chain performance using quantifiable performance indicators such as stock out rates.

Another study done in Uganda by Okiria(23) assessed the relationship between inventory management practices and supply chain effectiveness of essential medicines. It adopted a descriptive and analytical survey across 6 selected public hospitals in Uganda. The inventory management practices investigated were: use of essential lists in medicines selection, use of safety stock, budget allocation, inventory monitoring and use of average monthly consumption to order. The supply chain performance indicator measured was stock outs. The study found a significant

correlation between supply chain practices and the supply chain performance indicator of stock outs. It recommended ordering practices that factored lead time and buffer stock, use of essential lists in selection, proper planning of procurement and use of average consumption adjusted for stock outs. The research gap with this study is geographical location since the supply chain system in Uganda varies with the Kenyan one as the latter operates a devolved system of healthcare. Additionally, the study focusses on government funded essential medicines. Other health commodities such as medical supplies and program funded commodities such as vaccines, ARVs and FP commodities offer opportunities for investigation.

A similar study done by Onyango(24) focusing on fast moving consumer products in Nairobi, Kenya identified just in time, economic order quantity, enterprise resource planning, vendor managed inventory and material requirement planning as the inventory practices in use. The results showed that these inventory practices had impacted positively on supply performance whose indicators were inventory holding cost, stock outs, cost of ordering and obsolescence. The study recommended all manufacturers to use just in time method more in order to achieve leanness, adopt vendor managed inventory to monitor stock automatically and design a reorder level to ensure no stock outs. The research gap in this study is that it focused primarily on the dependent demand inventory system popular in the manufacturing sector as it is suitable for managing supplies and raw materials. The pharmaceutical supply chain uses the independent demand system since it majorly deals with finished goods(1).

Awle(25) in her study on the relationship between effective drug inventory control management and stock outs in Kenya's public hospitals found no significant correlation between the determinants of drug inventory management and stock outs. The study was a descriptive survey that utilized questionnaires. The determinants of drug inventory management under investigation were systems of information technology and distribution, staff capacity and policies governing the efficiency of drug supplies. The study recommended that other determinants of effective inventory control management such as financing of public institutions need to be considered for further research. The gap in this research is that it had a small sample size of only two public hospitals therefore the findings may not give a clear picture of the relationship between the investigated variables in public hospitals of Nairobi or Kenya.

Barasa et al(26) reported on a study in Bungoma, Kenya, which investigated the influence of inventory management practices on availability of medicines in public health facilities. The study used a cross-sectional design and targeted sub county pharmacists, medical superintendents, procurement officers and health administrative officers in all the 9 sub-county hospitals of Bungoma County. Four main inventory management challenges emerged namely: lack of a dedicated county central store, inefficient inventory management system, staff shortage and unavailability of guidelines for inventory management that are up to date. From the results, inventory management practices were shown to impact directly on medicines availability. The research recommended the need for a health supply chain expert to improve medicines management. The research gap identified is that the study focused only on government-procured essential medicines. The findings would therefore be difficult to generalize for other medical supplies and donor-funded commodities like ARVs. Additionally, due to the autonomous nature of the counties in Kenya, the situation in other counties may not be the same therefore similar surveys ought to be conducted in other regions.

2.5 Summary of research gap

Firstly, many studies done on this topic have focused only on the dependent demand inventory system which is predominantly used in the manufacturing industries such as the one done by Onyango(24) . The pharmaceutical supply chain in a public health system uses an independent demand system which is applicable for finished goods like medicines. There exists a gap in research on the dependent inventory system practices. Studies done on the dependent inventory system practices have majorly looked on stock control models such as the one done by Wagura(22) leaving other inventory practices such as determination of order quantities, safety stock policy, stock keeping records and reporting as potential gaps in research. Thirdly, majority of the studies done on this topic in public hospitals such as those done by Barasa(26) and Okiria(23) have focused on essential medicines which are procured by government. There exist a gap in this topic on how donor funded commodities which are usually supported by vertical programs such as ARVs commodities, FP commodities and vaccines manage their inventory and how their supply chain is performing. Finally, many studies have adopted the model of using opinions of respondents singly to evaluate supply chain performance. This study would like to exploit this gap by using both respondent feedback and measurable performance indicators like stock out rates, unusable to

usable ratio, order lead time and reporting rates. These areas have yet to be researched on especially in the geographical context of the study location.

2.6 Conceptual framework

The figure in the next page illustrates the conceptual model of the study. Supply chain performance indicators are a function of inventory management practices enlisted. This study postulated that the inventory management practices under investigation, namely: inventory control models, determination of order quantities, stock keeping records, reporting and safety stock policies significantly affect the supply chain performance which will be measured as stock out rates, order lead time, unusable to usable stock ratio and reporting rates. In other words, improving inventory management practices will improve supply chain performance by reducing stock out rates, order lead time, stock wastage rate and increasing reporting rates.

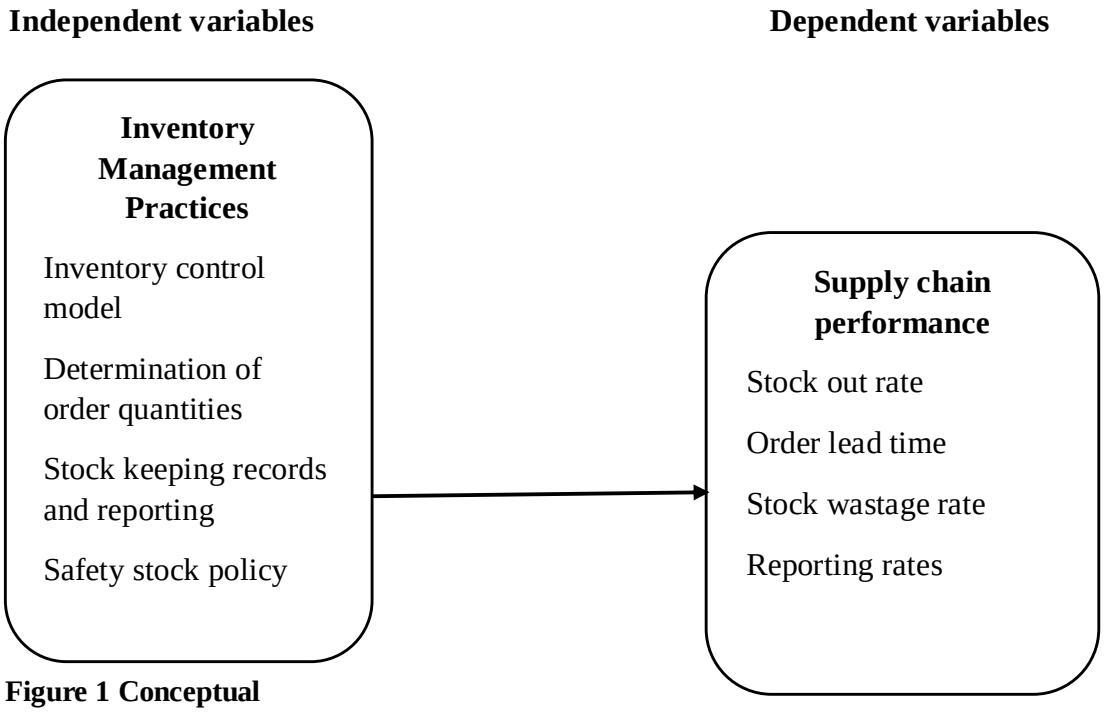

Figure 1 Conceptual Framework (Author, 2019)

CHAPTER THREE: METHODOLOGY

3.1 Research design

This study adopted a descriptive cross-sectional design while using mixed research methods. The research was cross-sectional since it gathered snapshot data on the inventory management practices happening in public hospitals across Nyamira County. This was advantageous since it is not expensive to conduct, can contain multiple variables at the time of the data snapshot and can be used to prove and/or disapprove assumptions. It is descriptive because assessed the inventory management practices in the target population which is one of the features of a descriptive study as described by Kothari(27).

The independent variable of the study was inventory management practices whose parameters were: inventory control model, determination of order quantities, stock keeping records and reporting and safety stock policy. The dependent variable was supply chain performance which was measured with the following indicators: stock out rate, order lead time, stock wastage rate and reporting rates.

3.2 Location of the study

The study was conducted in Nyamira County, Kenya in all its 8 public hospitals namely: Nyamira county referral hospital, Ekerenyo sub-county hospital, Nyamusi sub-county hospital, Kijauri sub-county hospital, Masaba sub-county hospital, Esani sub-county hospital, Manga sub-county hospital and Nyangena sub-county hospital. Since the focus of the study was on ARV medicines, Nyamira County provided an ideal research ground as it is in Nyanza region which has the highest prevalence of HIV in Kenya.

The location also offered a convenient sample for the researcher in terms of getting clearance and ease of access since it is his work location. Kothari(27) describes a convenience sample as one which is selected for inclusion in the sample based on easy accessibility by the researcher. This method offers fast and easy access to a sample needed for a given study.

3.3 Target and study population

The target population of the study were health workers involved in ARV medicine management namely: pharmacists in charge, sub county pharmacists, county pharmacist, facility in-charges and ART nurses who were 38 in number.

Due to the small target population, all the above health workers across all the 8 public hospitals of Nyamira County were the study population. The total study population recruited was as follows:

Table 1 Health workers recruited into the study

Cadre	**Total number**
Pharmacist In charges	8
Facility in charges	8
ART nurses	8
Sub-county pharmacists	5
County pharmacist	1
Hospital administrators	8
TOTAL	**38**

3.4 Inclusion/Exclusion criteria

3.4.1 Inclusion criteria

In this study, health workers in Nyamira County public hospitals involved in ARV medicines management who voluntarily gave informed consent and signed the consent declaration form were included.

3.4.2 Exclusion criteria

Health workers in Nyamira County public hospitals who were not involved in the management of ARV medicines were not involved in this study.

3.5 Samples

The census method of sampling was used for this study. This was due to the small study population of those officers involved in medicine management in public hospitals within Nyamira Coutny. This method used the entire study population as the sample. Therefore all the 38 officers listed above as the study population were used as the sample. Kothari(27) explains that when this method is used for sampling, it provides the highest level of accuracy as it leaves no element of chance. This method was preferred for this study since the universe of the study was small. Consequently, the facility in charges, pharmacist in charges, sub county pharmacists, ART nurses and hospital administrators were visited at their work station and the relevant data collection tools used to obtain data from them.

3.6 Data collection instruments

The primary data collection instruments that were used for this study were structured questionnaires, key informant interview and checklists. Secondary data was collected from the DHIS2.

Questionnaires offered the advantage of low cost, freedom from interviewer's bias and the ability to afford the respondents sufficient time to give informed answers. Close ended questions were used. Checklists were used to record the available ARV medicines on the day of visit. Key informant interviews were used to provide in-depth information on the subject matter. The DHIS2 was used to extract historical logistical data usually reported monthly by facilities to calculate the indicators of supply chain performance such as lead time and reporting rates. As recommended by Kothari(27), the reliability, suitability and adequacy of the secondary data was first checked before being used.

3.7 Validity

Kothari(26p73) defines validity as "degree to which an instrument measures what it is supposed to measure." For this study, validity was checked in 3 ways. Firstly, the data collection tools were peer reviewed by the researcher's classmates to check if the instructions were clear, the language was easily understood and the tools were user friendly. Secondly, the content of the tools were reviewed by the researcher's supervisor to ascertain that the data collection tools captured sufficient content to meet the study's objectives and were free from bias. Finally, from literature review, the tools used in similar published studies were compared to the one proposed in this study and necessary adjustments and improvements made.

3.8 Reliability

This refers to the ability of a measuring tool to give reproducible results. It is a measure of accuracy and precision(27). To ascertain the reliability of the proposed data collection tools, the pre-test was done twice in Kisii County, a neighboring county to the study population with a similar disease burden of HIV and a similar medicine management system of health commodities(28). The results from the two pre-tests were compared to check if the results showed a reproducible pattern.

3.9 Data collection techniques

The first phase of data collection involved the use of questionnaires which were distributed to the identified participants using the "drop and pick later" technique. A sample of the questionnaire to be used can be found in appendix 1. This was to allow the respondents adequate time to complete them. This distribution of questionnaires was done by the principal investigator.

The second phase involved going to collect the questionnaires which also doubled up as a site visit to collect additional data on medicines availability and stock wastage rate using the checklist provided in appendix 2 together with stock records. This was done by the principal investigator.

The third phase involved conducting a key informant interview with the county and sub county pharmacists of Nyamira County to provide in-depth information on the inventory management practices and supply chain performance of ARV medicines in Nyamira County.

Finally, secondary data on reporting rates and order lead time was retrieved from the DHIS2. This was done by the principal investigator with the permission of the County Health Records and Information Officer.

3.10 Data management and analysis

Quantitative data generated from the questionnaires was validated to check for completeness, coded and fed into a computer statistical package such as Statistical Package for Social Sciences (SPSS) version 22. The entered data was then analyzed using descriptive statistics to generate frequency distribution, percentages, averages and standard deviations.

To identify the inventory management practices used for ARV medicines in the public hospitals of Nyamira County, the descriptive statistic method of frequency was used to demonstrate which practices are mostly used and which ones are least used from the feedback of the respondents. Each parameter under question was then rated as a percentage from all the respondents.

Challenges affecting inventory management practices were ranked by getting the challenge with the highest frequency that the respondents strongly agreed to as the leading challenge and the rest were listed in descending order. The data was then be presented in a table.

To determine the stock out rate, the total number of ARV medicines not available on the day of visit was divided by the total number of ARV medicines expected to be available. An average was

done to get the average stock out rate of all the 8 public hospitals and this data was presented in a table.

In stock wastage rate, the total number of unusable stock due to damage and expiry was compared to the total stock present on the day of visit and given as a percentage. An average for all the facilities was then obtained.

Order lead time was given as an average of the lead time for each order placed in the last 3 months. An average lead time for all the facilities was then obtained.

Reporting rate and reports on time for each facility were obtained from the DHIS2 for the past 12months and an average determined. The average reporting rate for all the facilities was also determined.

3.11 Logistical and ethical considerations

Ethical clearance to conduct the research was sought from KNH/UON ERC before commencement of the study. The ethical clearance letter was protocol number P223/03/2019 (see appendix 12).

CHAPTER FOUR: RESULTS

4.1 Introduction

This chapter summarizes the key findings of the research based on primary data collected using questionnaires. In addition, key informant interviews and secondary data extracted from hospital records and DHIS are also included. The results are presented in form of graphs, charts, and tables.

4.2 Sociodemographic characteristics

Out of 37 questionnaires distributed, 36 were filled and retrieved representing a response rate of 97.3%. Additionally, all of the six key informant interviewees recruited agreed to participate. The participants comprised of 13 (36.11%) pharmacists, 8 (22.22%) ART nurses and 15 (41.67%) administrators **(Table 2)**. Nineteen (52.78%) participants had worked for between 1-5 years.

Table 2 Sociodemographic characteristics of respondents (n=36)

Variable	Category	Frequency n (%)
Cadre	Pharmacist	13 (36.11%)
	ART nurse	8 (22.22%)
	Administrators and In-charges	15 (41.67%)
Work experience (years)	Below 1	3 (8.33%)
	1– 5	19 (52.78%)
	5 – 10	12 (33.33%)
	Above 10	2 (5.56%)

4.3 Inventory Management Practices

This section summarizes the inventory management practices including the inventory control models, order determination, stock keeping, reporting, safety stock policy, storage, selection and staffing.

4.3.1 Inventory control models

Inventory control models are mathematical models which help a business or facility dealing with commodities in deciding the optimum level of stock that should be held. The purpose of an

inventory model is to inform the supply chain manager when and what quantity to requisition or issue in order to maintain an appropriate stock level so as to prevent stock outs or overstocking(10).

The most predominantly used inventory control model was the forced order system (80.95%) while the continuous review system was the least preferred (23.1%) as depicted in **figure 2** below.

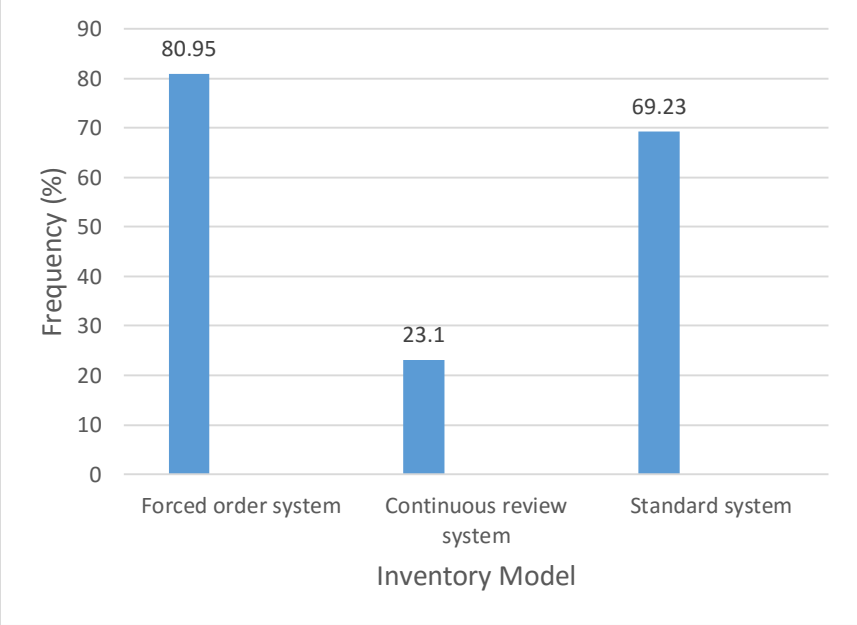

Figure 2 Inventory control models (n=21)

4.3.2 Determination of order quantities

When determining order quantities, several factors have to be considered. The least predictable of the variables used in the formula for calculating reorder quantity is forecasting the needs of the future. The methods used for forecasting demand include the projective method which relies on previous consumption, causal method which relies on external factors like epidemics and market structure, judgmental method which relies on estimates from experienced staff and morbidity method which uses data on diseases incidence and standard treatment guidelines.

All respondents used the projective method. The morbidity method was also largely used (17, 80.95%) in forecasting as shown in **figure 3.**

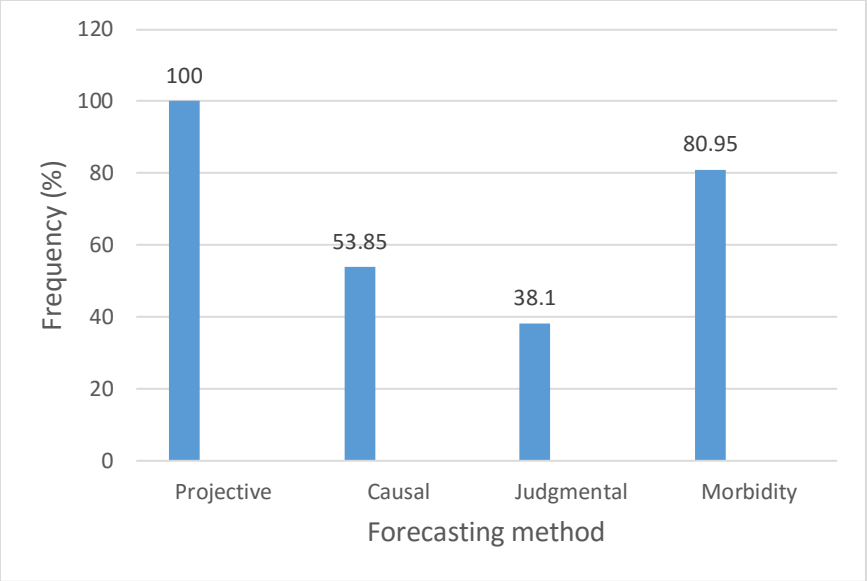

Figure 3 Forecasting methods used in determining order quantities (n=21)

4.3.3 Stock keeping records and reporting practices

Use of stock keeping records for each ARV medicine, conducting regular stock counts by using the full inventory counting method and using stock records as the source data for procurement and distribution decisions was being practiced by all the Pharmacist participants. A majority (12, 92.31%) had stock records which were accurate and updated (**Table 3**). Consumption, stock on

Table 3 Stock keeping records and reporting practices (n=13)

Category	Variable	Frequency
Stock keeping	Present for all ARV medicines	13 (100%)
	Accurate and up to date	12 (92.31%)
	Regular stock counts done	13 (100.00%)
	Full inventory counting method	13 (100%)
	Cyclical inventory counting method	1 (7.69%)
	Source data for procurement and distribution decisions	13(100%)
Reporting	Reports are compiled at the end of each review period	13(100%)

	Consumption data included in each report	13 (100%)
	Stock on hand data included in each report	13 (100%)
	Losses and adjustments data included in each report	13 (100%)
	Commodities near expiry data included in each report	11 (84.62%)
	Requisition reports reviewed and approved by administration prior to submission	11 (73.33%)

hand and loses as well as adjustments were the most essential logistical data that was reported (100%).

4.3.4 Safety stock policy

Majority (8, 61.54%) of the Pharmacists when asked about their safety stock policy indicated that they included a buffer stock .Out of these, 10 (76.92%) reported to be using a formula in arriving at the safety stock.

4.3.5 Storage, selection and staffing

As custodians of non-pharmaceutical supplies, majority of ART nurses (6, 75%) affirmed that their facilities had stores dedicated for storage of ARV medicines (**figure 5)**.

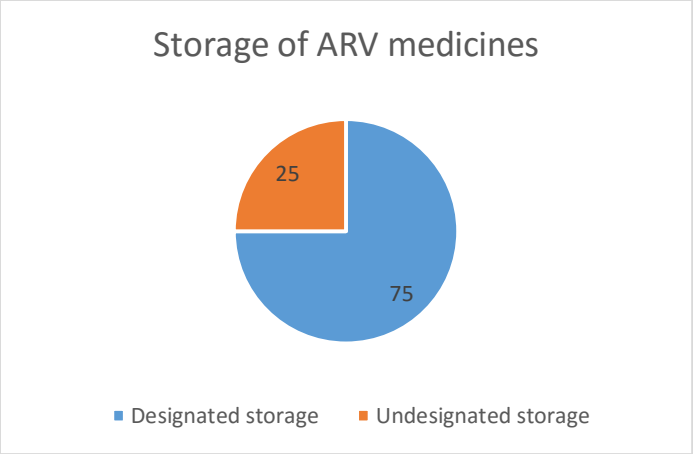

Figure 4 Storage of ARV medicines (n=8)

Meanwhile, the facility in charges and administrators all (15, 100%) unanimously confirmed that the requisition method was in use for the selection and ordering of ARV medicines and they had adequate personnel responsible for managing ARV inventory in their respective facilities.

4.4 Supply Chain Performance

4.4.1 Supply chain performance according to respondents

Nurses, hospital administrators and facility in-charges when asked on how their respective facilities' ARV medicines supply chain was performing in terms of stock outs, stock wastage, order lead time and reporting rates responded as summarized in **figure 7.**

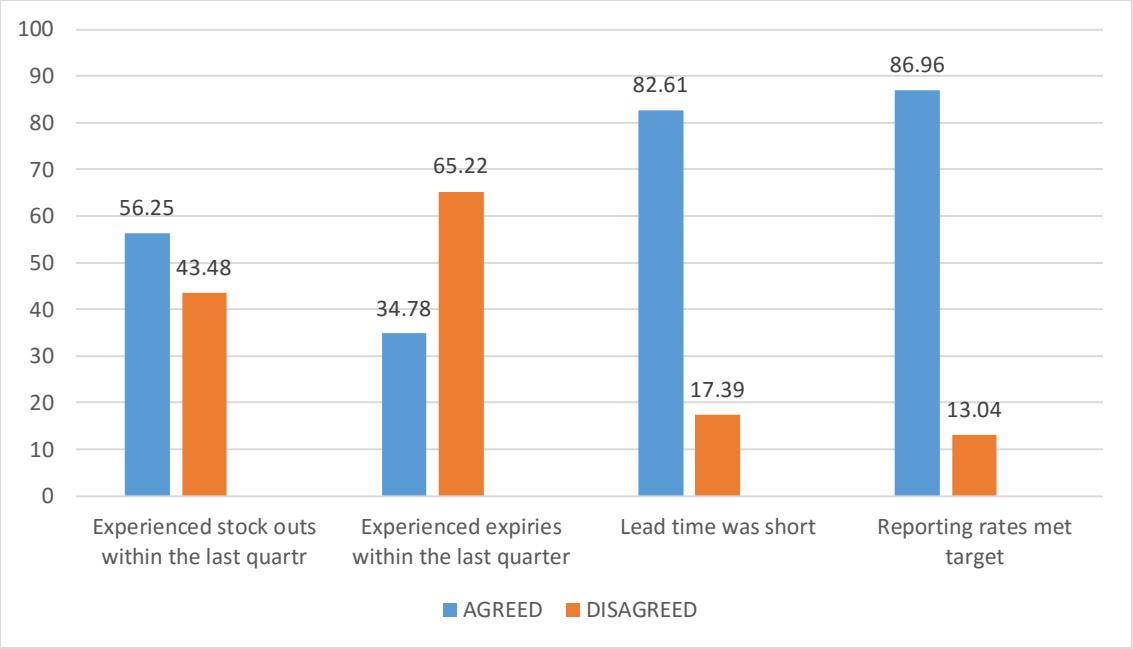

Figure 5 Supply chain performance according to respondents (n=23)

Slightly more than half (13, 56.52%) of the respondents had experienced stock outs in their respective facilities within the last quarter. Majority (15, 65.22%) had not had expiries within the last quarter. Order lead time was perceived to be short by many (82.61%) respondents while reporting rates were predominantly (86.96%) believed to be meeting the set targets.

4.4.2 Supply chain performance evaluation

Stock availability was evaluated in all the eight public hospitals of Nyamira County by comparing the ARV medicines in stock on the day of visit to those expected to be in stock as per the Kenya Essential Medicines List, 2016**.** The total number of ARV medicines expected to be in stock was 41. The stock availability across the facilities ranged from a lowest (16, 39.02%) in Hospital F and G to a highest (24, 58.54%) in Hospital H and the overall average across all facilities was 47.88%. The stock availability rates for Hospital A and E were 19(46.3%) and for Hospital B was 21(51.2%) while Hospital C and D had 22(53.7%). Order lead time for the three most recent months to the day of visit is shown in **table 7**:

Table 4 Order lead time of ARV medicines supply

Hospital	March order lead time (days)	April order lead time	May (order lead time)	Average order lead time (days)
Hospital A	26	18	27	23.67
Hospital B	12	11	11	11.33
Hospital C	28	20	16	21.33
Hospital D	28	20	16	21.33
Hospital E	12	14	9	11.67
Hospital F	12	14	9	11.67
Hospital G	28	18	18	21.33
Hospital H	28	18	18	21.33
			Average	**17.98**

The order lead time ranged from the shortest of 11.33 days in Hospital B to the longest of 23.67 in Hospital A with and overall average of 17.98 days.

Stock wastage rate was evaluated for all the eight participating hospitals by comparing the unusable stock of ARV medicines per regimen to the total stock on hand (usable and unusable) of that regimen as summarized in **table 8** below:

Table 5 Stock wastage rate of ARV medicines

Hospital	ARV drugs expired	Dosage	Unusable stock	Total stock	Stock wastage rate (%)
Hospital A	Atazanavir/Ritonavir tablets	300/100mg	5	163	3.07
	Lopinavir/ritonavir tablets	200/50mg	2	6	33.33
	Efavirenz tablets	600mg	12	12	100
	Tenofovir/Lamivudine tablets	300/300mg	32	81	39.51

	Abacavir/Lamivudine tablets	120/60mg	5	120	4.17
	Zidovudine/Lamivudine/Nevirapine tablets	300/150/200 mg	3	3	100
	Zidovudine/Lamivudine tablets	60/30mg	10	11	90.91
				Average	53
Hospital B	Abacavir	300mg	4	4	100
				Average	100
Hospital C	Zidovudine/Lamivudine	60/30mg	112	176	63.64
	Tenofovir/Lamivudine	300/300mg	10	210	4.76
	Zidovudine/Lamivudine/Nevirapine tablets	30/50/60mg	214	414	51.70
	Dolutegravir tablets	50mg	10	10	100
				Average	55.03
Hospital D	Emtricitabine/Tenofovir	200/300mg	1	6	16.67
	Dolutegravir	50mg	3	11	27.27
	Efavirenz	600mg	4	4	100
				Average	47.98
Hospital E	None		0	508	0
				Average	0
Hospital F	Zidovudine/Lamivudine tablets	30/60mg	28	73	38.36
	Zidovudine/Lamivudine/Nevirapine	300/150/200 mg	55	174	31.61
				Average	34.99
Hospital G	None		0	361	0
				Average	0
Hospital H	Zidovudine/Lamivudine/Nevirapine tablets	300/150/200 mg	100	987	10.13
	Lopinavir/Ritonavir	50/200mg	400	404	99.00
				Average	54.57
				Overall average	**43.2**

It ranged from a lowest of 0% in Hospital E and G to a highest of 100% in Hospital B, with an overall average of 43.2%.

The reporting rates for the eight hospitals were extracted from the DHIS for the period of 12 months from January 2018 to December 2018. **Table 9** outlines the findings below:

Table 6 Facility reporting rates for the period Jan 2018 - Dec 2018

Hospital	**Actual Reports**	**Expected Reports**	**Percentage (%)**	**Reports on Time**	**Percentage on Time (%)**
Hospital A	9	12	75	9	75
Hospital B	9	12	75	9	75
Hospital C	9	12	75	8	66.7
Hospital D	8	12	66.7	8	66.7
Hospital E	9	12	75	8	66.7
Hospital F	9	12	75	9	75
Hospital G	7	12	58.3	7	58.3
Hospital H	8	12	66.7	8	66.7
Average	**8.5**	**12**	**70.84**	**8.25**	**68.8**

The reporting rates ranged from a lowest of 58.3% in Hospital G to joint highest of 75% in Hospitals A, B, C, E and F with an overall average reporting rate for all the hospitals at 70.84%. The percentage reports on time ranged from a lowest of 58.3% in Hospital G to a joint highest of 75% in Hospitals A, B and F with an overall average percentage on time for all the hospitals at 68.8%.

4.5 Challenges affecting inventory management of ARV medicines in public hospitals in Nyamira County, Kenya

A number of challenges were identified by the participants **(Figure 8).** The most common ones

Figure 6 Challenges affecting Inventory Management (n=36)

were inadequate staff (26, 72.22%), inadequate training (16, 44.45%) unreliable supply of medicines (16, 44.44%) and lack of proper storage (16, 44.44%).The least significant challenges were: incompetent staff (29, 80.56%), poor record keeping (26, 72.22%) and poor reporting (25, 69.44%).

4.6 Effect of Inventory Management practices on supply chain performance

The effects of inventory management on the supply chain performance (SCP) as described by Pharmacists are summarized in **Table 4**. The most effective approaches in reducing stock out rates and order lead time were accurate use of stock keeping records and use of formula in determination of order quantities at 92.31% and 76.92% respectively. Reduction in stock wastage was better achieved by stock keeping and use of a formula in determining re-order quantities(13, 100%) followed by reports (12, 12.31%).

Table 7 Effect of Inventory Management on Supply Chain Performance (n=13)

Inventory management Practice	Effect on SCP	Frequency n (%)
Inventory control model	Reduction in stock out rates	10(76.92%)
	Reduction in order lead time	10 (76.92%)
	Reduction in stock wastage rate	9 (69.23%)
	Increase in reporting rates	12(92.31%)
Use of formula in determination of order quantities	Reduction in stock out rates	12(92.31%)
	Reduction in order lead time	10(76.92%)
	Reduction in stock wastage	13(100%)
	Increase in reporting rates	11(84.62%)
Stock keeping	Reduction in stock out rates	12 (92.31%)
	Reduction in order lead time	8 (61.54%)
	Reduction in stock wastage	13 (100.00%)
	Increase in reporting rates	11 (84.62%)
Reports	Reduction in stock out rates	11(84.62%)
	Reduction in order lead time	8(61.54%)
	Reduction in stock wastage	12(92.31%)
	Increase in reporting rates	13(100%)
Safety stock policy	Reduction in stock out rates	11(84.62%)
	Reduction in order lead time	6(46.15%)
	Reduction in stock wastage	10(76.92%)
	Increase in reporting rates	9(69.23%)

CHAPTER FIVE: DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The following chapter reviews key findings of the study within the framework of current literature. Conclusions and recommendations have been underscored for policy, practice and further research based on the research findings.

5.2 Discussion

The most predominant inventory control model used in managing ARV medicines in Nyamira County was the scheduled (forced order) system (80.95%). Information from the key informants on why this model was preferred revealed that it helped prevent stock outs and was logistically viable since orders were placed only once at the end of the review period. These benefits are consistent with those of published literature. However, one downside it may elicit is that orders for requisitions may be of small quantities since every item is ordered. Nepal's MoH adopted the forced order system due to difficulty of accessing facilities and order timing unpredictability thereby rendering the continuous review model impractical(10). Contrary, a similar study done in Nairobi County found the perpetual (continuous-review) inventory model was more operational across public health facilities in Nairobi County(22).

It emerged that the predominant forecasting methods in use in determining order quantities were the projective(100%) and morbidity methods (80.95%) which is in line with MSH(1) recommendations for quantifying health commodities that have reliable data on consumption and number of expected patient attendances.

Bin cards and the electronic inventory management tools were present, regularly updated and served as the source data for procurement and distribution decisions across all the hospitals. A similar study done in Uganda unveiled that having accurate stock cards available for each stock keeping unit was crucial in determining stock levels and status(23). Quantity dispensed, stock on hand and losses and adjustments emerged as the most essential logistical data reported on as recommended by USAID|DELIVER(10). Safety stock was factored in the facility ARV orders using a formula. However, literature suggests that more complex advanced methods used to determine safety stock possibly offer little or no significant benefits over simpler techniques(1).

ARV medicines in majority of the facilities were stored in dedicated stores separate from other essential medicines or medical supplies. This finding contrast those of a similar study done in Bungoma where nearly half of the surveyed facilities lacked dedicated stores for keeping essential medicines(26).

Selection and ordering of medicines was exclusively done using the requisition method which involves the recipient determining for themselves the type and quantity of commodities they order from a supplier. This system according to USAID|DELIVER benefits from the users having the latest updated information necessary for decision making and developing a sense of ownership of decisions pertaining to orders. It may not be ideal however if the users are not skilled in quantification and even if they do, their orders may still require verification from the suppliers. Another undoing of the requisition system is that time meant for serving clients or patients has to be sacrificed whenever the responsible staff are crunching the numbers(10).

The common causes of inaccurate stock records unveiled were: inadequate training, inadequate staff, oversight and staff turnover. Literature isolates other causes of inaccurate data such as: manual data entry, theft and speed which data is updated. A study conducted in the United States discovered that inaccuracy at one level of the supply chain has an adverse impact on the performance of inventory at other levels(29).

It was the unanimous opinion of administrators that their respective facilities were adequately staffed with personnel responsible for managing ARV medicine inventory contrary to the findings of Barasa et al(26) in Bungoma County. The prevalent methods used in preventing stock outs were: use of buffer stock, conducting regular stock counts, regularly updating stock keeping records and using consumption data to forecast demand. These findings were complementary to the recommendations of a study done in Tanzania on stock-outs of antiretroviral drugs and coping strategies used to prevent changes in treatment regimens in Kinondoni District, which advocated for reliable forecasting and proper inventory management as strategies to prevent supply interruption of ARV medicines(30).

The main challenges affecting inventory management of ARV medicines in public hospitals in Nyamira County were: inadequate staff, inadequate training, lack of proper storage and unreliable supply of medicines. These challenges were comparable to those found in other studies(26)(31). To overcome these challenges, the key informants notably recommended: facilitating more

training, recruiting more pharmaceutical personnel and continuous mentorship and supervision which are in line with recommendations from other similar studies(32)(26)(31).

Stock outs of ARV medicines were reported to be experienced in the public hospitals of Nyamira County within the last quarter amongst more than half (56.52%) of the respondents. The overall stock out rate in Nyamira County public hospitals was found to be high at 52.12%. In Tanzania, a study conducted discovered 16 out of 20 clinics surveyed had experienced stock outs of ARV medicines citing short duration of expiry, inaccurate quantification and poor supply systems as the main causes resulting in supply interruption. Change of regimen, likely increase in patient-carried costs to access medicines in alternative health facilities and increased treatment failure were the hypothesized impacts of stock outs(30).

In this study, expiries were used as a measure of stock wastage. 34.78% of respondents reported to have experienced expiries within the last quarter which is comparative to the calculated overall stock wastage rate on the day of site visits that was discovered to be 43.2%. WHO recommends accurately determining stock wastage rate as a means of optimizing inventory levels and evaluating the infrastructure of a supply chain(33). It is however important to note that the moderately high stock wastage was attributed to the change of treatment guidelines since majority of the expired ARV medicines such as Zidovudine/Lamivudine/Nevirapine discovered on day of site visit were no longer preferred in HIV/AIDS treatment.

The evaluated average order lead time in the past three months to the day of site visit was found to be 17.98 days across the surveyed hospitals which was perceived to be reasonable by a large majority (82.61%) of the respondents. Treville et al recommend prioritizing lead time reduction in order to improve the performance of the demand chain(34).

Reporting rates for the F-CDRR of ARV medicines over 12 complete months averaged at 70.84% while the percentage on time averaged at 68.8% across all surveyed public hospitals of Nyamira County, which was unsatisfactory against the county target of 100%. This unsatisfactory reporting rates is consistent with an assessment of health commodities supply chains in Kenya done in 2001 by JSI that unearthed poor reporting particularly on consumption patterns and levels of stock(35). However, majority of the respondents perceived their individual facilities to be meeting reporting rate targets. It is important to note that the key informants attributed this unsatisfactory performance of reporting rates to a major health workers strike that happened in the year 2018 in

Nyamira County. USAID|DELIVER recommends that for supply chain managers to make good use of data, just like the products, the right data of the right quality, must be in the right quantity, at the right time, in the right place and at the right cost(10).

5.3 Conclusion

Inventory management practices were according to the recommended best approaches despite various challenges. The supply chain performance metrics evaluated, with the exception of order lead time, were all found to be unsatisfactory owing to the high stock out rates, below par reporting rates and high stock wastage rate due to expiries discovered. The relatively short order lead time which was also perceived to be reasonable by the respondents seems to suggest that the central store and distribution system for ARV medicines was efficient.

5.4 Recommendations

5.4.1 Recommendations for policy and practice

Based on findings uncovered from the study, the researcher gives the following recommendations:

1. Decision making on reorder quantities should fully be guided by data if it is available and reliable
2. Electronic dispensing and inventory tracking tool should be adopted in all public health hospitals to promote data visibility
3. Regular training on inventory management should be planned for and facilitated to improve capacity of new and existing staff
4. Provisions for dedicated storage of ARV medicines should made in public hospitals
5. Up to date tools for reporting and inventory management should be made available to all reporting facilities
6. Buffer stock should always be factored during medicines requisition
7. Suppliers should stock sufficient quantities of ARV medicines and distribute to facilities based on their demand and consumption

5.4.2 Recommendations for further research

Based on areas not exhaustively explored by the study, the researcher gives the following recommendations:

1. Further studies are necessary to determine the inventory management practices and supply chain performance of lower level facilities like health centers and dispensaries
2. Further studies are needed to check how the investigated inventory management practices and supply chain performance metrics differ with those in mission and private hospitals

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APPENDICES

Appendix 1: Questionnaire for Pharmacists

Introduction

This questionnaire has been designed for the sole purpose of collecting data on the effect of inventory management practices and supply chain performance of ARV medicines in public hospitals in Nyamira County. The data collected will be treated with a very high degree of confidentiality and it is meant for academic purposes only.

Section A: General Information

Please mark with a TICK (✓) in the applicable box

1. Gender

   [1] Male [0] Female

2. Please indicate the age bracket you belong to

   [1] Below 25 years [2] Between 25 and 35 years

   [3] Between 36 and 45 years [4] Above 45 years

3. For how long have you been working in your organization?

   [1] Below 1 year [2] Between 1 and 5years

   [3] Between 5 and 10 years [4] Above 10 years

Section B: Inventory management practices Used in ARV Medicines

4. Provided below are some statements about inventory management. State whether they are in use (**YES**) or not (**NO**) in your facility Please mark with a TICK (✓) in the applicable box.

Statements on inventory management practices	**YES**	**NO**
Inventory control models		

Trigger for ordering ARVs is the end of the reporting period *(Forced order system)*		
Trigger for ordering ARVs is when minimum stock is reached *(Continous review system)*		
Trigger for ordering ARVs is the end of reporting period for ARVs that have reached minimum stock level *(Standard system)*		
Determination of order quantities		
Previous consumption data is used to forecast demand of ARVs (*Projective method)*		
Forecasts are based on external factors like epidemics, change in health system structure and size (*Causal method)*		
Forecasts are based on individual judgment of experienced staff (*Judgment method)*		
Forecasts are based on HIV prevalence, incidences and expected number of attendances (*Morbidity method)*		
Stock keeping record and reporting		
All ARV medicines have stock records		
Stock records for ARVs are accurate and up to date		
Regular stock counts are done minimum once every reporting period for ARVs		
Entire inventory of ARV medicine is counted at one go in each stock take (*Full count)*		
Inventory of ARVs is divided into counting groups, with each group being counted per stock taking session (*Cyclical count)*		
Reports for ARV medicines are compiled at the end of each reporting period		
Data on consumption is included in every report		

Data on stock on hand is included in every report		
Data on losses and adjustments is included in every report		
Data on commodities near expiry is included in every report		
Safety stock policy		
A safety/buffer stock is kept for every ARV product		
A standard formula is used in calculating safety stock		
A rough estimate is used as safety stock		

Section C: Supply chain performance

Please indicate based on your experience working in this facility whether you agree (YES) or disagree (NO) with the following statements. Please mark with a TICK (✓) in the applicable box.

Statement on supply chain performance	**YES**	**NO**
There have been no shortages of ARV medicines in this facility in the last quarter		
There have been no expiries of ARV medicines in this facility in the last quarter		
The order lead time for ARV medicines is reasonable		
The reporting rate and reporting on time of ARV reports submitted by this facility meets the required target		

Section D: Inventory management practices and supply chain performance

5. Using the below Likert scale, state the extent to which you agree with the following statements on the influence of inventory management practices on measures of supply chain performance (**disagree, neutral, agree)** Please mark with a TICK (✓) in the applicable box

Statements on Supply chain performance,	**Disagree**	**Neutral**	**Agree**
Use of an inventory control system has: Reduced stock out rates			
Reduced order lead time			
Reduced unusable to usable stock ratio			
Increased reporting rates			
Use of a formula in determining reorder quantities has: Reduced stock out rates			
Reduced order lead time			
Reduced unusable to usable stock ratio			
Increased reporting rates			
Use of stock keeping records has: Reduced stock out rates			
Reduced order lead time			
Reduced unusable to usable stock ratio			
Increased reporting rates			
Use of reports has: Reduced stock out rates			
Reduced order lead time			
Reduced unusable to usable stock ratio			
Increased reporting rates			
Having a safety stock has: Reduced stock out rates			
Reduced order lead time			
Reduced unusable to usable stock ratio			

Increased reporting rates			

Section E: Challenges affecting inventory management of ARV medicines in public hospitals in Nyamira County, Kenya

6. Please indicate or rate the challenges that your health facility faces in Inventory management of ARV medicines using the likert scale given (**disagree, neutral, agree).** Please mark with a TICK (✓) in the applicable box.

Challenges affecting Inventory Management	**Disagree**	**Neutral**	**Agree**
Lack of proper storage			
Lack of a good inventory control system			
Inadequate staff			
Poor record keeping			
Poor reporting			
Incompetent staff			
Unreliable supply of medicines			
Inadequate training on inventory management			
Lack of commitment by top management			
Poor inventory infrastructure			
List and rate any other Inventory management challenges in the spaces provided below	**Disagree**	**Neutral**	**Agree**

Appendix 2: Key Informant interview guide for Sub-county Pharmacists and County Pharmacist

1. How do supply chain managers of ARV medicines determine which items should be held in stock and which ones should be ordered as needed?
2. How frequently are ARV medicines ordered by the public health facilities in Nyamira County?
3. Do the public health facilities in Nyamira County have dedicated stores for keeping ARV medicines?
4. Explain the various inventory control models that have been used in managing ARV medicines?
5. Which inventory control model has been most effective and why?
6. Which stock keeping records are mostly used in managing inventory of ARV medicines?
7. Are stock keeping records of ARV medicines accurate and current in the public health facilities of Nyamira County?
8. If not, what are some factors that from your experience contribute to inaccurate stock records?
9. What data from ARV reports do you use for decision making?
10. What measures do you incorporate in managing ARV inventory to prevent stock outs?
11. How do you think inventory management affects:
    a) Stock availability
    b) Order lead time
    c) Ratio of usable to unusable stock
    d) Reporting rates

12. From your experience, what are some challenges that affect inventory management of ARV medicines in public health facilities in Nyamira County?

Appendix 3: Questionnaire for Hospital administrators and facility in charges

Introduction

This questionnaire has been designed for the sole purpose of collecting data on the effect of inventory management practices and supply chain performance of ARV medicines in public hospitals in Nyamira County. The data collected will be treated with a very high degree of confidentiality and it is meant for academic purposes only.

Section A: General Information

Please mark with a TICK (✓) in the applicable box

1. Gender

   [ ] Male [ ] Female

2. Please indicate the age bracket you belong to

   [ ] Below 25 years [ ] Between 25 and 35 years

   [ ] Between 36 and 45 years [ ] Above 45 years

3. For how long have you been working in your organization?

   [ ] Below 1 year [ ] Between 1 and 5 years

   [ ] Between 5 and 10 years [ ] Above 10 years

Section B: Inventory Management Practices and Supply Chain Performance

1. The facility determines for itself the type and quantities of ARV medicines that it orders according to its needs

   ☐ Yes

   ☐ No

2. The facility has stock keeping records for ARV medicines available and staff are trained on how to use them

   ☐ Yes

   ☐ No

3. The facility compiles reports on the stock position of ARV medicines routinely.

   ☐ Yes

☐ No

4. The facility has staff dedicated to managing inventory of ARV medicines
   ☐ Yes

5. The facility has a dedicated store for keeping ARV medicnes
   ☐ Yes
   ☐ No

6. Orders made for ARV commodities are reviewed and approved by the administration before being submitted
   ☐ Yes
   ☐ No

7. There have been no shortages of ARV medicines in the hospital in the last quarter
   ☐ Yes
   ☐ No

8. The time from when orders are placed and received is reasonable
   ☐ Yes
   ☐ No

9. There were no expiries of ARV medicines realized within the last quarter
   ☐ Yes
   ☐ No

10. Reporting rates and reporting on time for this facility in the last quarter has met the targets
    ☐ Yes
    ☐ No

Section C: Challenges affecting inventory management of ARV medicines in public hospitals in Nyamira County, Kenya

Please indicate or rate the challenges that your health facility faces in Inventory management of ARV medicines using the likert scale given (**disagree, neutral, agree).** Please mark with a TICK (✓) in the applicable box.

Challenges affecting Inventory Management	**Disagree**	**Neutral**	**Agree**
Lack of proper storage			
Lack of a good inventory control system			
Inadequate staff			
Poor record keeping			
Poor reporting			
Incompetent staff			
Unreliable supply of medicines			
Inadequate training on inventory management			
Lack of commitment by top management			
Poor inventory infrastructure			
List and rate any other Inventory management challenges in the spaces provided below			
1.			
2.			
3.			
4.			
5.			

Appendix 4: Questionnaire for ART nurses

Introduction

This questionnaire has been designed for the sole purpose of collecting data on the effect of inventory management practices and supply chain performance of ARV medicines in public hospitals in Nyamira County. The data collected will be treated with a very high degree of confidentiality and it is meant for academic purposes only.

Section A: General Information

Please mark with a TICK (✓) in the applicable box

1. Gender

   [ ] Male [ ] Female

2. Please indicate the age bracket you belong to

   [ ] Below 25 years [ ] Between 25 and 35 years

   [ ] Between 36 and 45 years [ ] Above 45 years

3. For how long have you been working in your organization?

   [ ] Below 1 year [ ] Between 1 and 5 years

   [ ] Between 5 and 10 years [ ] Above 10 years

Section B: Inventory management practices and Supply Chain performance of ARV Medicines

1. Orders are placed at the end of every reporting period
   - ☐ Yes
   - ☐ No
2. Previous consumption data is used to predict demand of ARVs
   - ☐ Yes
   - ☐ No
3. Individual judgment of experienced staff is used to predict demand of ARVs
   - ☐ Yes
   - ☐ No

4. Number of expected attendances or incidences are used to predict demand for ARV medicines

   ☐ Yes

   ☐ No

5. There are stock records for managing inventory of ARV medicines

   ☐ Yes

   ☐ No

6. ARV medicines in this facility are kept in a designated store

   ☐ Yes

   ☐ No

7. There have been no shortages of ARV medicines in this facility in the last quarter

   ☐ Yes

   ☐ No

8. There have been no expiries of ARV medicines in this facility in the last quarter

   ☐ Yes

   ☐ No

9. The time from when ARV orders are place to when they are received (lead time) is reasonable

   ☐ Yes

   ☐ No

11. Reporting rates and reports on time for this facility in the last quarter have met the targets

   ☐ Yes

   ☐ No

Section C: Challenges affecting inventory management of ARV medicines in public hospitals in Nyamira County, Kenya

Please indicate or rate the challenges that your health facility faces in Inventory management of ARV medicines using the likert scale given (**disagree, neutral, agree).** Please mark with a TICK (✓) in the applicable box.

Challenges affecting Inventory Management	**Disagree**	**Neutral**	**Agree**
Lack of proper storage			
Lack of a good inventory control system			
Inadequate staff			
Poor record keeping			
Poor reporting			
Incompetent staff			
Unreliable supply of medicines			
Inadequate training on inventory management			
Lack of commitment by top management			
Poor inventory infrastructure			
List and rate any other Inventory management challenges in the spaces provided below			
1.			
2.			
3.			
4.			
5.			

Appendix 5: Checklist to be filled by the researcher

1. Stock availability

ARV medicine	Dose-form	Dosage	Available	
			YES	NO
Abacavir	Tablet	300mg		
Lamivudine	Oral liquid	50mg/5ml		
	Tablet	300mg		
Zidovudine	Oral liquid	50mg/5ml		
	Tablet	300mg		
Efavirenz	Tablet	200mg		
		400mg		
		600mg		
Nevirapine	Tablet	200mg		
Atazanavir/ritonavir	Tablet	300/100mg		
Darunavir	Tablet	600mg		
Lopinavir/ritonavir	Oral liquid	400mg + 100mg/5mL		
	Tablet	200mg + 50mg		
Ritonavir	Oral liquid	400mg/5ml		
	Tablet	100mg		
Raltegravir	Tablet	25mg		
		100mg		
Abacavir+Lamivudine	Tablet	60mg+30mg		
		120mg+60mg		
		600mg+60mg		
Efavirenz+Lamivudine+Tenofovir (EFV+3TC+TDF)	Tablet	400mg+300mg+300mg		
		600mg+300mg+300mg		
Emtricitabine+Tenofovir	Tablet	200mg+300mg		
Lamivudine+Tenofovir (3TC+TDF)	Tablet	300mg+300mg		
Lamivudine+Zidovudine (3TC+ZDV)	Tablet	30mg+60mg		
		150mg+300mg		
Lamivudine+Nevirapine+Zidovudine (3TC+NVP+ZDV)	Tablet	30mg+50mg+60mg		
		150mg+200mg+300mg		
		TOTAL		
		Stock out rate		

2. Stock wastage rate

Category	Amount
Total unusable stock	
Total usable stock	

Grand total	
Stock wastage rate (%)	
3. Order Lead time	
Total order lead time	
Number of months	
Average order lead time	
4. Reporting rate	
Actual reports submitted (on time)	
Total reports expected	
Reporting rate (%)	

Appendix 6: Budget

Budget item	**Cost per item (USD)**	**Number of items (USD)**	**Total**
Ethical review fee	30	1	30
Transport to submit proposal for ethics review	15	2	30
Printing questionnaires and checklist	0.5	50	25
Pretest transport	10	4	40
Questionnaire distribution	5	16	80
Site visit to collect checklist data	10	8	80
Internet subscription	20	1	20
		TOTAL (USD)	**305**

Appendix 7: Work plan

Task	**Scheduled date**	**Complete (✓)**
Submit Draft zero of proposal	By 03rd March	
Review and make final submission of proposal	By 1st April	
Print and submit proposal to ERB	By 1st April	
Review feedback from ERB and resubmit	By 8th May	
Seek clearance to conduct survey in the sampled hospitals	17th-21st June	
Distribute survey questionnaires	24th-28th June	
Site visit to collect filled questionnaires and collect more data using checklist	By 12th July	
Extract secondary data from DHIS2 and NASCOP commodity dashboard	By 15th July	
Data analysis	15th-29th July	

Chapter 4 draft and review	13th-24th May	
Chapter 5 draft and review	29th-11th August	
Review of 1st draft of thesis by supervisor	26th August – 1st September	
Edit and review of 2nd draft	2nd-13th September	
Final dissertation ready	By 15th September	
Thesis defense	16th-30th September	

Appendix 8: Informed consent

PARTICIPANT INFORMATION AND CONSENT FORM FOR ENROLLMENT IN THE STUDY

Title of Study: Inventory Management Practices and Supply Chain Performance of Antiretroviral Medicines in Public Hospitals in Nyamira County, Kenya

Principal Investigator and institutional affiliation:

JOHNSON OMAE ANYONA

University of Rwanda

Vaccines, Immunization and Health Supply Chain Management

Kigali, Gikondo - Street, KK 737

P.O. Box 4285, Kigali

Rwanda.

Tel.no: +254720781664

Email: omaejohnson89@gmail.com

Introduction

I would like to tell you about a study being conducted by the above listed researcher. The purpose of this consent form is to give you the information you will need to help you decide whether or not to be a participant in the study. Feel free to ask any questions about the purpose of the research, what happens if you participate in the study, the possible risks and benefits, your rights as a volunteer, and anything else about the research or this form that is not clear. When we have answered all your questions to your satisfaction, you may decide to be in the study or not. This process is called 'informed consent'. Once you understand and agree to be in the study, I will request you to sign your name on this form. You should understand the general principles which apply to all participants in a medical research: i) Your decision to participate is entirely voluntary ii) You may withdraw from the study at any time without necessarily giving a reason for your withdrawal iii) Refusal to participate in the research will not affect the services you are entitled to in this health facility or other facilities. We will give you a copy of this form for your records.

May I continue? [ ] YES [ ] NO

This study has approval by The Kenyatta National Hospital-University of Nairobi Ethics and Research Committee protocol No. _____

WHAT IS THIS STUDY ABOUT?

The researcher listed above is collecting responses in a questionnaire from individuals who are involved in the inventory management and supply chain of antiretroviral medicines in public hospitals in Nyamira County. The purpose of the study is to optimize a best practice model for inventory management and supply chain of ARV medicines in Nyamira County by assessing the current practices of inventory management and making recommendations on what needs to be done better or differently. Participants in this research study will be asked questions about their general background information, inventory management practices they use in managing antiretroviral medicines and the impact of some inventory management practices on supply chain performance. There will be approximately 38 participants in this study randomly chosen. I am asking for your consent to consider participating in this study.

WHAT WILL HAPPEN IF YOU DECIDE TO BE IN THIS RESEARCH STUDY?

If you agree to participate in this study, you will be requested to fill the administered questionnaire which will be issued to you using the "drop and pick later" technique. You are free to fill the questionnaire at your convenience which will then be collected after one week.

ARE THERE ANY RISKS, HARMS DISCOMFORTS ASSOCIATED WITH THIS STUDY?

Medical research has the potential to introduce psychological, social, emotional and physical risks. Effort should always be put in place to minimize the risks. One potential risk of being in the study is loss of privacy. We will keep everything you tell us as confidential as possible. We will use a code number to identify you in a password-protected computer database and will keep all of our paper records in a locked file cabinet. However, no system of protecting your confidentiality can be absolutely secure, so it is still possible that someone could find out you were in this study and could find out information about you.

Also, answering questions in the interview may be uncomfortable for you. If there are any questions you do not want to answer, you can skip them. You have the right to refuse the interview or any questions asked during the interview.

ARE THERE ANY BENEFITS BEING IN THIS STUDY?

Although there will be no direct benefit to you for participating in this research, it is our hope that the data collected from this study will provide valuable information on the gaps in inventory management and supply chain performance of ARV medicines in the public health system and make evidence-based recommendations on improving commodity security of ARV medicines.

WILL BEING IN THIS STUDY COST YOU ANYTHING?

Your participation in this study is free of charge.

WHAT IF YOU HAVE QUESTIONS IN FUTURE?

If you have further questions or concerns about participating in this study, please call or send a text message to the study staff at the number provided at the bottom of this page.

For more information about your rights as a research participant you may contact the Secretary/Chairperson, Kenyatta National Hospital-University of Nairobi Ethics and Research Committee Telephone No. 2726300 Ext. 44102 email uonknh_erc@uonbi.ac.ke.

The study staff will pay you back for your charges to these numbers if the call is for study-related communication.

WHAT ARE YOUR OTHER CHOICES?

Your decision to participate in research is voluntary. You are free to decline participation in the study and you can withdraw from the study at any time without injustice or loss of any benefits.

CONSENT FORM (STATEMENT OF CONSENT)

Participant's statement

I have read this consent form or had the information read to me. I have had the chance to discuss this research study with a study counselor. I have had my questions answered in a language that I understand. The risks and benefits have been explained to me. I understand that my participation in this study is voluntary and that I may choose to withdraw any time. I freely agree to participate in this research study.

I understand that all efforts will be made to keep information regarding my personal identity confidential.

By signing this consent form, I have not given up any of the legal rights that I have as a participant in a research study.

I agree to participate in this research study: [ ]Yes [ ]No

Participant printed name: _____

Participant signature / Thumb stamp_____Date: _____

Researcher's statement

I, the undersigned, have fully explained the relevant details of this research study to the participant named above and believe that the participant has understood and has willingly and freely given his/her consent.

Researcher's Name:_____

Date: _____

Signature: _____

Role in the study:_____*[i.e. study staff who explained informed consent form.]*

For more information contact JOHNSON ANYONA at +254720781664 from 8am to 5pm on weekdays or email at: omaejohnson89@gmail.com

Research supervisors:

1. Dr. Peter Karimi, PhD.
   Senior lecturer
   University of Rwanda & University of Nairobi
   Email: ndirang15@gmail.com
   Tel. no: +254722436019

2. Dr. Shital Maru, PhD.
   Senior Lecturer
   University of Nairobi
   Email: smaruspecial@gmail.com
   Tel.no: +254720939659

Appendix 9: Curriculum vitae of Principal Investigator

CURRICULUM VITAE

JOHNSON OMAE ANYONA

Nyamira, Kenya.

Email: omaejohnson89@gmail.com

Cell phone number: 0720781664

0731516680

PROFILE	A self – motivated, assertive and self - driven individual with a good work ethic. I have strong communication and organisational skills and I have an ability to remain calm in stressful and unexpected circumstances. I am emotionally mature with a composed temperament. I am detail oriented, flexible and willing to learn as well as trustworthy, honest and reliable. Registered as a Pharmacist with the Pharmacy and Poisons Board, Kenya.
EDUCATION	**2017 – 2019: Master of Health Supply Chain Management** (ongoing*) *University of Rwanda* **2009 – 2013: Bachelor of Pharmacy** *University of Nairobi* **2004 - 2007: Kenya Certificate of Secondary Education** *Maseno School* **1996 - 2003: Kenya Certificate of Primary Education**

Bhayani Primary School, Kisumu

ORGANIZATIONAL SKILLS

Supervisory: Served as Pharmacist in charge of four Pharmacists, seven Pharmaceutical technologists, two Pharmacist interns and one support staff in a department that comprises of four pharmacies. Together with the staff, I ensured provision of efficient pharmaceutical care to our patients.

Team player: Established and maintained collaborative relationships with other health care professionals in our facility. I was a key member of the Hospital Therapeutic Drug Committee, whereby I liaised with other health care providers in the development and adoption of the hospital's first ever Formulary. I also provide drug information in the facility upon request.

Leadership and management: Prioritized tasks and utilized my supportive personnel in an effective manner to ensure efficient running of the department.

Decision making and problem solving: Able to quickly assess a situation and make well thought-out decisions. When necessary, I seek counsel and directives from my superiors.

Quick learner: Able to quickly adapt to new concepts and apply them.

WORK EXPERIENCE

December 2016 to date: Nyamira County Referral Hospital

Served as Pharmacist in Charge from April 2017- April 2018.

- Interpreting prescriptions, intervening and consulting prescribers in case of incompatible drug therapies, preparing medication, dispensing and counselling patients on the rational use of drugs to ensure optimal therapeutic outcomes.
- Good commodity management of all pharmaceutical in our facility. This includes: preparing essential medicine lists, procurement, proper drug storage including cold chain management and stock inventory.
- Organizing and participating in Continuous Medical Education (CMEs), mentoring and supervising Pharmacist interns and students on attachment.
- Developing and promoting collaborative relationships with all health care professionals in our facility by providing drug information to promote and ensure rational drug use.
- Supervising and verifying the accuracy of duties performed by pharmacy personnel to ensure efficient running of the department.
- Compiling routine reports for tracer commodities such as reproductive health, malaria, antiretroviral and tuberculosis.
- Served as a key member of the Hospital Management Team responsible for planning, budgeting and implementing the facility's work plan.
- Attending and participating in professional advancement programs and workshops such as Malaria case management, logistics management Information System.

June 2015 – November 2016: Nyamusi Sub-County Hospital

Served as Pharmacist In-Charge where my duties included:

- Primary duties of a Hospital Pharmacist.
- Championed and implemented good commodity management by setting up separate stores for pharmaceuticals and non-pharmaceuticals and introduced inventory control in the facility. This created order and reduced the drug retrieval response rate, reduced stock outs, minimized expiries and wastages significantly.

September 2014 – April 2015: Pharmacy Internship

Completed twelve months of pharmacy internship which included industrial, community and hospital rotations at Cooper-K Brands Ltd, Pentapharm Chemist, Nairobi and Jaramogi Oginga Odinga Teaching and Referral Hospital respectively. During my internship tenure, I participated in providing pharmaceutical care and gained immense practical knowledge in drug manufacturing thereby acquiring useful skills and always working at peak performance.

RESEARCH

2016 – 2017: Sanisphere Ltd

Worked as a research analyst where my duties included:

- Conducting a Pharmacies Observation Post survey in selected retail and hospital pharmacies in selected towns on brand penetration.

VOLUNTEER WORK

Participated in several medical camps at Dandora (2014), Mt. Suswa (2013), Kariobangi (2012), Baringo (2011) with an aim of providing primary health care and promoting preventative care.

ADDITIONAL TRAINING

June 2017: District Health Information System-Logistics Management Information System (DHIS-LMIS) Integration Training.

July 2015: Case management training for the diagnosis, treatment and prevention of Malaria (Training of Trainers)

May 2015: Federation of East African Pharmaceutical Manufacturers (Pre-incubation internship training on Industrial Pharmacy)

	April 2015: Merck African Supply Chain Forum
COMPUTER SKILLS	Proficient in MS Office programs including Word, Excel, PowerPoint and Access. Also proficient in using Community Health Information Systems used at our facility for dispensing prescriptions, billing and keeping inventory records for commodities.
HOBBIES	Outdoor activities such as: Running, camping, hiking and swimming. Playing board games i.e. Chess, Monopoly and Scrabble. Writing and directing plays.
REFERENCES	1. Dr. Samuel Ombati, Medical Superintendent, Nyamira County Referral Hospital P. O. Box 3 – 40500 Nyamira, Kenya. Telephone: +254 727 058 488. 2. Dr. Nancy Mucogo Njeru, Division of Health Care Financing Department of Policy, Planning & Healthcare Financing (DPP&HCF) Ministry of Health, Kenya Email: nnjerum@gmail.com Telephone: +254 718 543 384.

3. Dr. George Otieno,

County Pharmacist,

Nyamira County.

Email: ottygus@gmail.com

Telephone: +254 722 899 858.

Appendix 10: Recommendation letter

UNIVERSITY of RWANDA

COLLEGE OF MEDICINE & HEALTH SCIENCES

EAC REGIONAL CENTRE OF EXCELLENCE FOR VACCINES, IMMUNIZATION & HEALTH SUPPLY CHAIN MANAGEMENT

RECOMMENDATION LETTER FOR APPLICATION FOR ETHICAL APPROVAL AND FOR DATA COLLECTION

Project title:	**INVENTORY MANAGEMENT PRACTICES AND SUPPLY CHAIN PERFORMANCE OF ANTIRETROVIRAL MEDICINES IN PUBLIC HOSPITALS IN NYAMIRA COUNTY, KENYA.**
Student ID.	**218014682**

Supervisor/s:

1. **Dr. Peter Karimi (PhD)**
2. **Dr. Shital Maru (PhD)**
3.

Degree enrolled in	**Master of Health Supply Chain Management**
Project location:	**Nyamira County**
Project Period:	**1st June-September 30th 2019**

RECOMMENDATION

This is to certify that Mr./Ms. **JOHNSON OMAE ANYONA** Is an MSc health Supply Chain Management, University of Rwanda, College of Medicine and Health Sciences, School of Public Health, EAC RCE-VIHSCM since October, 29017. The candidate has developed the Thesis Project as titled above and presented to the Supervisors' Workshop, held from 27-129 May, 2019 in Kigali, as part of Quality Assurance and scientific panel approval.

The candidate is recommended to the relevant ethical bodies for IRB approval and permission for data collection where applicable, latest middle August 2019. The research does not involve any human subjects and is has been cleared with the University of Rwanda.

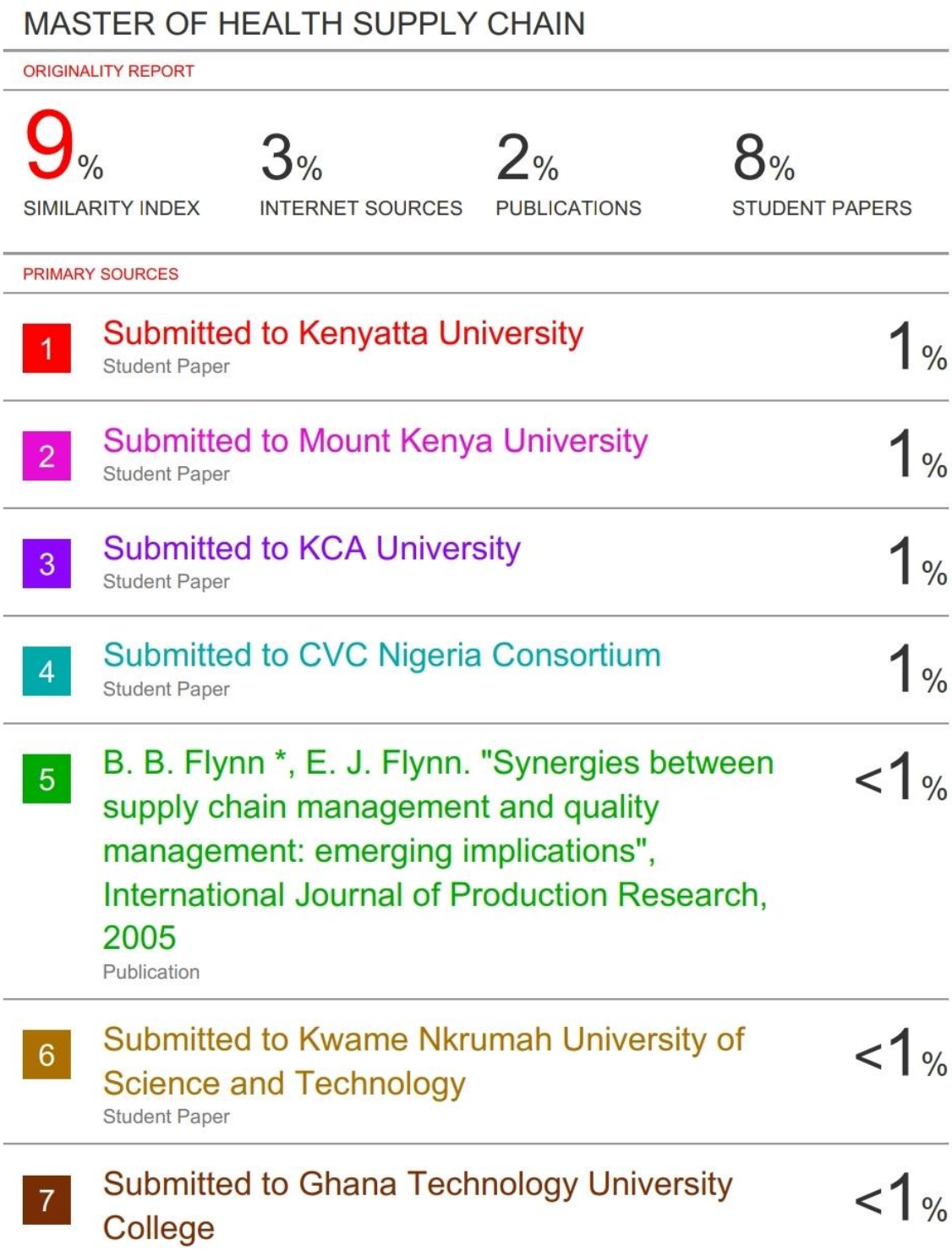
In case of any questions, please do not hastate to contact **Dr Regis Himana**, the Research Coordinator, E: regis.hitimana@gmail.com, T: +250 788 528 533

Any support rendered to the candidate will be highly appreciated.

06/06/19

Stephen KARENGERA
RCE-Director

Appendix 11: Originality report



MASTER OF HEALTH SUPPLY CHAIN

ORIGINALITY REPORT

9%	3%	2%	8%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Kenyatta University Student Paper	1%
2	Submitted to Mount Kenya University Student Paper	1%
3	Submitted to KCA University Student Paper	1%
4	Submitted to CVC Nigeria Consortium Student Paper	1%
5	B. B. Flynn *, E. J. Flynn. "Synergies between supply chain management and quality management: emerging implications", International Journal of Production Research, 2005 Publication	<1%
6	Submitted to Kwame Nkrumah University of Science and Technology Student Paper	<1%
7	Submitted to Ghana Technology University College	<1%

Appendix 12: Ethical clearance letter

UNIVERSITY OF NAIROBI
COLLEGE OF HEALTH SCIENCES
P O BOX 19676 Code 00202
Telegrams: varsity
Tel:(254-020) 2726300 Ext 44355

KNH-UON ERC
Email: uonknh_erc@uonbi.ac.ke
Website: http://www.erc.uonbi.ac.ke
Facebook: https://www.facebook.com/uonknh.erc
Twitter: @UONKNH_ERC https://twitter.com/UONKNH_ERC

KENYATTA NATIONAL HOSPITAL
P O BOX 20723 Code 00202
Tel: 726300-9
Fax: 725272
Telegrams: MEDSUP, Nairobi

Ref: KNH-ERC/A/233

18 June 2019

Johnson Omae Anyona
Reg. No. 218014682
School of Public Health
University of Rwanda
Email.omaejohnson89@gmail.com

KENYATTA NATIONAL HOSPITAL APPROVED 18 JUN 2019 KNH/UoN-ERC P. O. BOX 20723

Dear Johnson

RESEARCH PROPOSAL: INVENTORY MANAGEMENT PRACTICES AND SUPPLY CHAIN PERFORMANCE OF ANTIRETROVIRAL MEDICINES IN PUBLIC HOSPITALS IN NYAMIRA COUNTY, KENYA (P223/03/2019)

This is to inform you that the KNH- UoN Ethics & Research Committee (KNH- UoN ERC) has reviewed and approved your above research proposal. The approval period is 18th June 2019 – 17th June 2020.

This approval is subject to compliance with the following requirements:

a. Only approved documents (informed consents, study instruments, advertising materials etc) will be used.
b. All changes (amendments, deviations, violations etc.) are submitted for review and approval by KNH-UoN ERC before implementation.
c. Death and life threatening problems and serious adverse events (SAEs) or unexpected adverse events whether related or unrelated to the study must be reported to the KNH-UoN ERC within 72 hours of notification.
d. Any changes, anticipated or otherwise that may increase the risks or affect safety or welfare of study participants and others or affect the integrity of the research must be reported to KNH- UoN ERC within 72 hours.
e. Clearance for export of biological specimens must be obtained from KNH- UoN ERC for each batch of shipment.
f. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. (*Attach a comprehensive progress report to support the renewal*).
g. Submission of an *executive summary* report within 90 days upon completion of the study. This information will form part of the data base that will be consulted in future when processing related research studies so as to minimize chances of study duplication and/ or plagiarism.

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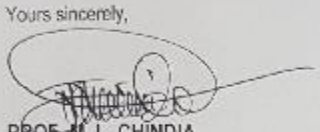
For more details consult the KNH- UoN ERC website http://www.erc.uonbi.ac.ke

Yours sincerely,



PROF. M. L. CHINDIA
SECRETARY, KNH-UoN ERC

c.c. The Principal, College of Health Sciences, UoN
The Director, CS, KNH
The Chairperson, KNH- UoN ERC
The Assistant Director, Health Information, KNH
Supervisors: Dr. Peter Karimi(University of Rwanda& UoN), Dr.Shital M. Maru

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