DRUG CONSUMPTION PATTERNS WITH CLINICAL AND FINANCIAL IMPLICATIONS AT KENYATTA NATIONAL HOSPITAL

BY

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(Master of Pharmacy in Pharmacoepidemiology and Pharmacovigilance)

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DECLARATION

I declare that this thesis is my original work and to the best of my knowledge has not been submitted elsewhere for examination, award of a degree or publication.

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DECLARATION

1. I understand what Plagiarism is and I am aware of the University's policy in this regard
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DEDICATION

I dedicate this work to my beloved wife Margaret for her encouragement as I worked through this thesis research, my two beautiful children Diana and Simon for always reminding me it is possible and to my late Father who was always an inspiration in my life.

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I will forever be indebted to the Almighty God for his favor throughout my studies.

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COLLABORATING INSTITUTION

In preparing this thesis collaboration was sought from the Management Sciences for Health (MSH). MSH is a non-governmental, non-profit International organization working in the public health realm and dedicated to closing the gap between what is known and what is done about public health problems. MSH works to save lives and improve health by helping public and private organizations throughout the world to effectively manage people, medicines, money and information.

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The research was partly funded by the Kenyatta National Hospital, Human resource department in charge of Training and Research.

ABBREVIATIONS

WHO - World Health Organization

ABC - Always, Better Control analysis

VEN - Vital, Essential and Non-Essential categories

DTC -Drug and Therapeutic Committee

KNH -Kenyatta National Hospital

ATC -Anatomical, Therapeutic Chemical

DDD -Defined daily dose

ADR -Adverse drug reaction

BOS -Board of Survey

DUR -Drug utilization research

EML -Essential Medicine List

STG - Standard treatment guidelines

MSH - Management Sciences for Health

TC -Therapeutic category

DUE -Drug use evaluation.

KEML- Kenya essential medicine list

ICD -International Classification of Diseases.

NF -Non-formulary

OPERATIONAL DEFINITIONS

ABC analysis-(Always Better Control), this is an inventory analysis technique that assigns stock items (inventory) to different levels of significance and thus should be handled or controlled differently. Items are grouped into 3 categories, A, B and C in order of their estimated importance and cost, with category A being the most costly and C being the least costly.

VEN analysis–(Vital, Essential and Non-essential), this is inventory categorization method where drugs are classified according to their health impact into vital, essential and non-essential categories.

Drug use evaluation (DUE)-also known as drug use review, is an ongoing systematic criteria based program of drug evaluation that helps ensure that appropriate drug use is provided. If therapy is determined to be inappropriate, interventions with providers or patients are undertaken to optimize drug therapy.

Process indicators- This refers to indicators being considered in DUE. These include appropriate initiation dose for the indication, lack of contraindications, Laboratory monitoring carried out where indicated, Patient review done, lack of side effects or side effects managed, No drug-drug interactions, appropriate patient education and counseling given.

Outcome indicators- refers to clinical improvement noted on the patient for the different indication or conditions for which the studied drug is being used.

Threshold- Minimum acceptable performance standard or maximum allowable limit

Criteria- Criteria in this study refers to the key areas for consideration in Drug use evaluation, which include, Justification for medicine being prescribed, process indicators and outcome indicators

Non-formulary- Items which are not included in the Hospital formulary and are therefore not classified as either Vital, Essential or Non-essential

ABSTRACT

Background: Medicines costs constitute 20% to 40% of health budgets in many developing countries. This study sought to conduct an analysis of drug use in Kenyatta National hospital using various tools namely ABC and VEN analyses and drug use evaluation (DUE). The overall goal of the study was to contribute to improved and cost effective drug therapy in the hospital by identifying, documenting and analyzing problems in drug utilization and thus contributing towards the rational use of medicines in the institution. .

Objective: The main objective of the study was to investigate the drug consumption patterns, their cost and clinical implication at Kenyatta National Hospital over a period of 3 years (2013-2015).

Method: For the ABC analysis, annual consumption and expenditure data for each year from 2013 to 2015, was extracted from the records at Kenyatta National hospital (KNH) Pharmaceutical stores. This was followed by classification of each of the drugs into the three ABC categories based on their individual annual expenditure. The drugs were also classified into the three VEN categories (Vital, Essential & Non-Essential) based on their public health importance. The VEN classification for drugs in this study was based on the KNH formulary and the Kenya Essential Medicine List 2010 (KEML) VEN categories. Therapeutic categories were identified based on the KNH formulary and the International Classification of Diseases (ICD) and expenditure for each category calculated. Morbidity data was extracted from the Health information records and compared with the annual expenditures for each therapeutic category. From the ABC analysis, one drug suspected to be used irrationally and which had high annual usage expenditure and which was also critical in the hospital was identified for further evaluation. For this purpose Meropenem injection was selected and with the approval of the hospital Drug and therapeutic committee (DTC) a drug use evaluation (DUE) on Meropenem was conducted. The DUE was a retrospective observational study which reviewed medical records of admitted patients based on criteria which were developed before conducting the DUE.

Results: For the ABC analysis, the study analyzed expenditure on an average of 811 drugs for each year (2013-2015). After analysis, the study showed that 13.2% (107), 13.6% (110) and 14.2% (115) of the drugs belonged to Class A for the three years respectively. These drugs consumed 79.9% of the drug budget for 2013 and 2014 and 79.8% for 2015. Class C drugs represented the

highest number of drugs at 576 (70.9%), 566 (69.8%) and 558 (68.8%) for the three years (2013-2015) but these drugs consumed only an average of 5% of the total expenditure on medicines. VEN categorization of the drugs showed that vital and essential medicines consumed the highest percentage of the total expenditure on medicines. ABC-VEN matrix analysis showed that an average of 31% (252) drugs belonged to category I and these drugs consumed an average of 85% of the total expenditure on drugs. Therapeutic category and morbidity patterns showed that out of the 14 categories considered for this study, there was a mismatch between morbidity (% number of cases) and overall expenditure for 12 categories and only two categories matched their percentage expenditures to the percentage number of cases. The DUE revealed that only three out of the eleven criteria met the pre-set threshold of 95%. Most of the Meropenem prescriptions were empirical at (61.3%) and the most common diagnoses were sepsis, pneumonia and meningitis at 26.1%, 17.1% and 15.3% respectively.

Discussion and Conclusion: The study helped to evaluate expenditure on medicines (ABC analysis) against their therapeutic importance (VEN analysis) and disease patterns in the hospital hence identifying probable drug use problems. Overall, there were differences between disease patterns/clinical need and expenditure on the various categories of medicines which should be addressed by the hospital. Moreover, having identified drugs with the highest expenditures (Category A of the ABC analysis), recommendations will be made to the hospital for institution of stricter controls in their use and inventory management including data driven quantification and tighter control on stocking levels in order to control and rationalize drug inventory costs. In addition, the study recommends that the lion share of the hospital budget should be directed to the procurement of Vital and essential drugs as these drugs address the majority and key public healthcare needs and morbidity patterns. The categorization of drugs in ABC-VEN matrix helped to identify the category I drugs which are Vital and expensive and these require efficient management as they will aid in improving patient care and the use of the limited resources

The DUE revealed failure in the use of Meropenem to meet of most of the established criteria as per the pre-set thresholds. The results highlights the need to promote adherence to drug use protocols which would ultimately improve the rational use of medicines including the need for culture and sensitivity testing for selected antibiotics where recommended, despite the financial

burden of such tests on patients. However, empirical use of antibiotics such as Meropenem may be justified in the initial treatment of serious infections where early initiation of therapy is recommended. In this study, the most common diagnosis where Meropenem was used were sepsis, pneumonia and meningitis, and since these are serious infections, the high empirical use of Meropenem at 65.3% may have been justified.

The Therapeutic category and Morbidity pattern analysis showed that there were differences between percentage of drug expenditure and percentage number of cases.

CHAPTER 1:

INTRODUCTION

Drugs have been used for a long time to alleviate patient suffering and improve lives but increasingly pharmacovigilance is showing that drugs can also be 'lethal weapons' if not used appropriately. Drugs are one of the most cost-effective ways of saving lives and improving health. They constitutes 20 to 40 percent of health budgets in many developing countries and their inappropriate use may lead to wastage of resources, and seriously undermine the quality of care provided to patients (1).

The World Health Organization (WHO) in 1977 defined drug utilization research (DUR) as the study of the "marketing, distribution, prescription and use of drugs in a society with special emphasis on the resulting medical, social and economic consequences" (2). Drug utilization research helps in describing the patterns of drug use in specific population, defines the likely problems, analyzes the problems, establishes decisions on how to solve the problems and assesses the impact of the interventions (3).

Drug utilization research is a crucial part of the rational drug use cycle, it assists in diagnosing the problem with the use of medicine by applying both qualitative and quantitative methods (1). The rational use of medicines was defined by the WHO at a conference in Nairobi in 1985 as: "patients should receive medications appropriate to their clinical needs, in doses that meet their own individual requirements for an adequate period of time and at the lowest cost to them and their community" (4). There are many methods established to assess the type and degree of irrational use of medicine such as the aggregate medicine consumption data methods and drug utilization studies (4).

Aggregate data methods such as Always, Better, Control (ABC) analysis, Therapeutic category (TC) analysis and Vital Essential and Non-essential (VEN) analysis have been used by Drug and Therapeutic Committees (DTC) in managing formulary lists and identifying gaps in medicine use

(1). The Anatomical Therapeutic Chemical/ Defined Daily Dose (ATC/DDD) methodologies have also been used to compare drug consumption among institutions, regions and countries. Drug utilization studies are part of the drug-use chain, including the systems and structures surrounding drug use as well as the processes and the outcomes (3).

Drug utilization studies are increasingly becoming an important part of the healthcare system because of the introduction of new drugs in the market, the large differences in the patterns of drug prescribing, the differences in drug consumption in different countries, the concerns about delayed adverse drug reactions (ADR) and the increasing cost of pharmaceutical care (3).

The need for drug utilization studies to assess effectiveness and efficiency of drug use is more urgent in developing countries than developed countries. The methods used in such studies are often developed and tested in industrialized countries and although a few drug utilization studies have been conducted in developing countries, they are few and mainly descriptive (5). Although the effectiveness of drug use evaluation (DUE) programs is yet to be established, DUE studies are still being used to identify variability in drug use as well as to support interventions that will improve patient outcomes (6).

1.1: Problem statement

In September 2013 KNH launched its formulary with the assistance of Management Sciences for Health (MSH). A workshop by the WHO (2006) outlined the difficulties of the drug supply of African countries. This workshop listed challenges in selection and quantification, procurement, storage facilities, inadequate budget allocation, quality assurance and rational use of medicines(7). Inappropriate use of drugs waste resources and seriously undermines the quality of patient care (1). Kenyatta National Hospital being a national referral hospital is quite likely to experience the above problems. Despite the launch of the formulary list there are a number of challenges facing the pharmaceutical supply chain at KNH. These include drug shortages which often lead to purchase of more expensive alternatives, expiration, poor order management, warehouse management challenges and low uptake of information technology. There have been no previous studies done to measure the problem of the supply chain, analyze it and understand the underlying causes at KNH.

1.2: Study Justification

In Kenyatta National Hospital (KNH) the procurement of pharmaceuticals commodities is allocated the highest amount of money among the medical expenses, with 36% of the total expenditure in 2013/14 and 30.1% in the 2014/15 financial years allocated to the procurement of medicines. A Report by the Board of Survey (BOS) for 2013 showed that the value of expired medicines was Kshs. 3,057,741.28. Another report for 2014 showed the value of expired medicines to be Kshs. 3,225,151.21 and the latest report for 2015-2016 shows that Kshs. 1,781,832.50 worth of medicines expired at the institution.

To ensure constant availability of required drugs and medical supplies at KNH, it is of utmost importance that the pharmaceutical store is managed efficiently using appropriate inventory management techniques. The most commonly used methods are the Always Better, Control (ABC) and Vital, Essential and Non-essential (VEN) categorization methods. These methods will be used in this study.

Inventory control in a hospital Pharmacy is important in a resource poor setting as resources are scarce and proper utilization of the resources can enable more patients to receive services. Proper selection and prioritization of medicines and good inventory management would therefore ensure proper allocation of resources to ensure continuous supply of medicines for treatment of the different conditions referred to KNH and avoid expiration of drugs.

ABC-VEN, Therapeutic category (TC) analysis and DUE results are expected to inform the Hospital management on areas of irrational use and on how to improve services. There has been no previous studies done at the Hospital using the inventory management techniques and this study will form a baseline for future studies.

1.3: Research question

What are the drug consumption patterns, their cost and clinical implications at the Kenyatta National Hospital for the period 2013 to 2015?

1.4: Objectives.

1.4.1: Main objective

To investigate the drug consumption patterns, their cost and clinical implications at the Kenyatta National Hospital for the period 2013 to 2015.

1.4.2: Specific objectives

(i) To determine drug consumption and expenditure patterns at Kenyatta National Hospital for the periods 2013-2015 through ABC, VEN and Therapeutic category analysis.

(ii) To describe the morbidity patterns at the Kenyatta National Hospital and relate them to the drug consumption pattern and their cost.

(iii) To identify Meropenem use problems in the hospital by conducting a Meropenem use evaluation at Kenyatta National Hospital.

CHAPTER 2:

LITERATURE REVIEW

2.0: DRUG USE PROCESS.

2.1: Drug selection and procurement

Procurement of medicines needs to be evidence based, guided by an essential drug list or hospital formulary (8). The Ministry of Health in Kenya through the National Medicine and Therapeutic Committee (NMTC) launched its Kenya Essential Medicine list (KEML) in 2010 with the support of World Health Organization (WHO). The document provides a tool to assist in improving health services provision in the health sector, rendered by public, private and Faith based providers (9). KNH also launched its hospital formulary in September 2013 which aims at promoting safe efficacious, rational and cost- effective supply and use of pharmaceuticals (10).

A limited list of drugs for procurement based on a formulary or EML helps in defining which medicines will be regularly procured and is one of the most effective ways to control drug expenditure. Moreover, accurate quantification of selected medicines avoids stock outs and overstock of the same. Past consumption data aids in quantification but is only accurate if there been no stock outs and record keeping is accurate (11).

Whenever a health institution lacks funds to purchase all drugs in quantities which are needed, it is necessary to prioritize the procurement list to match available resources. Various techniques such as ABC analysis, VEN analysis and therapeutic category (TC) analysis are used to set priorities and reduce the quantities of less cost effective drugs (8).

2.2: Drug use problems

Quantitative methods of data collection using aggregate data, health facility indicators or drug use evaluation can identify if there is a drug use problem, the nature of the problem and its magnitude (12). It is important to know why prescribers and patients act as they do and which factors are influencing them. This helps in designing interventions to change behavior and correct the problem. Figure 2 .1 shows some of the factors that influence drug use(1).

Figure 2.1 : Factors that influence drug use.

Source: INRUD materials from the WHO/INRUD Promoting Rational Drug Use Course.

It is however possible to change the use of medicines to ensure that medicines are used in the most effective way. A number of strategies can be employed, which include educational strategies that aim to inform prescribers, managerial strategies that aim to guide the decisions of prescribers and regulatory strategies that aim to restrict the decisions of prescribers(1). A combination of

interventions is more effective than a single intervention in changing a medicine use problem. Figure 2.2 shows the process of changing a medicine use problem (1)

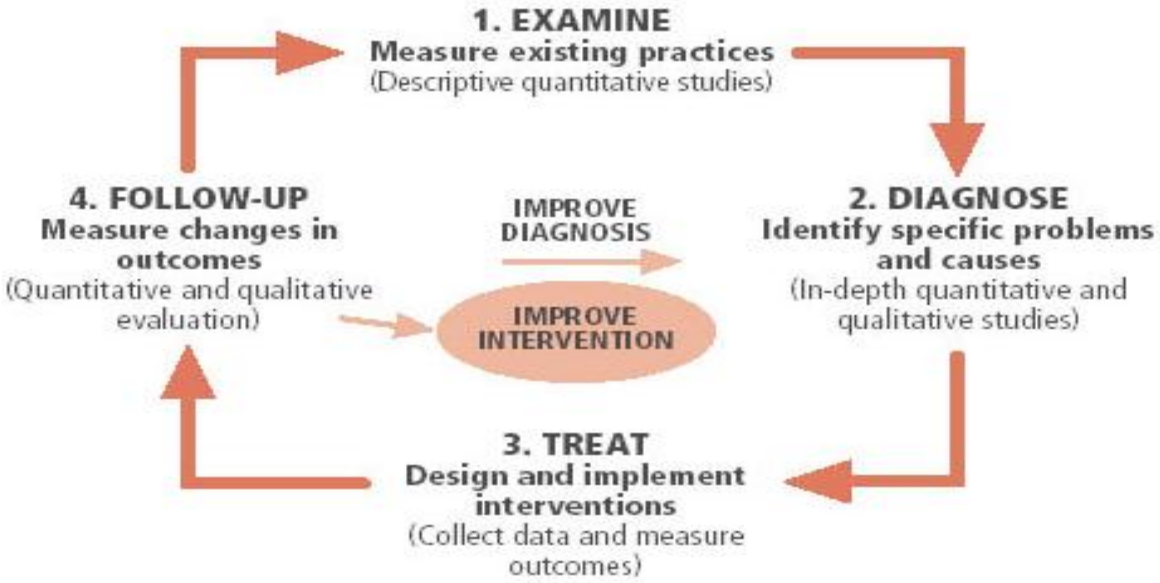

Figure 2.2: Summary of process for changing a medicine use problem.

Source: INRUD materials from the WHO/INRUD Promoting Rational Drug Use Course.

2.2.1: Irrational use of drugs

Irrational use of drugs is the inappropriate, ineffective and economically inefficient use of drugs in healthcare(4). Irrational use of drugs can lead to a number of problems including, reduced access to essential drugs, reduced patient attendance rates due to drug stock-outs and loss of patient confidence in the health care system (4). Methods used to identify irrational use of drugs include aggregate data methods these are used to identify expensive medicines of lower efficacy or to compare actual consumption versus morbidity data. Other methods of identifying irrational use of medicines are the ATC/DDD methodologies, DUE's and qualitative methods (1). Qualitative methods which include, focused group discussions, in-depth interviews, structured observations and structured questionnaires are used to investigate the motives underlying irrational use of medicines (4).

The initial step in handling problems with irrational use of medicines is to measure the problem, analyze it and understand the underlying cause (13). A study conducted by Mulwa (2013) at Makueni Country referral hospital in Kenya concluded that some of the prescribing indicators showed deviation from the standard values recommended by WHO. The study reported irrational/inappropriate prescribing in the hospital, particularly poly pharmacy at (83.7%) for inpatients and (41.7%) for outpatients, underuse of international non-proprietary names (generic names) at (45.5%), over prescription of antibiotics at (72.9%) and incomplete prescription writing at (41.7%) for outpatients (14). Another study conducted at KNH by Chege (2009) showed that Clinical Pharmacist interventions had led to improvement in the rational use of drugs in the targeted wards. This study showed that there was irrational use of drugs before the interventions (15).

The rational drug use cycle assists in addressing the factors that contribute to irrational use of medicine. The WHO rational drug use is presented in Figure 2.3 below.

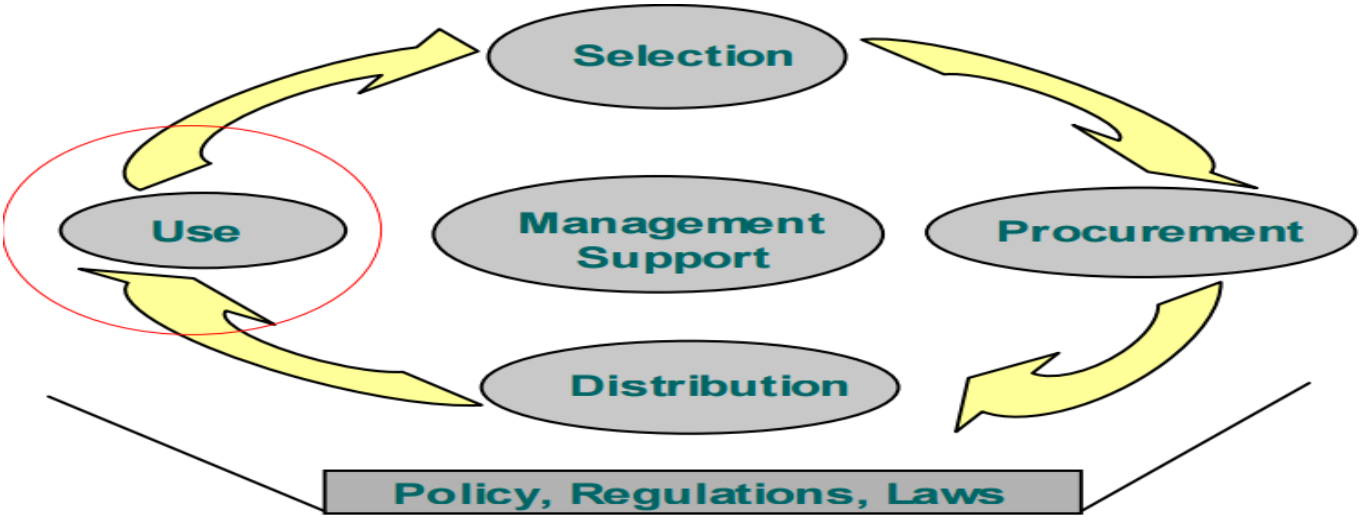

Figure 2.3: Rational drug use cycle. Source: Management Sciences for Health

2.3: Investigating drug use

2.3.1: Drug utilization research

In 1977 the WHO defined Drug utilization research (DUR) as the study of the "marketing distribution, prescription and use of drugs in a society with special emphasis on the resulting medical, social and economic consequences" (3). Drug utilization studies can be either descriptive or analytical. Descriptive studies describe patterns of drug utilization and identify problems deserving more detailed studies, whereas analytical studies link drug utilization to morbidity patterns, treatment outcomes and quality of care to promote the rational use of drugs (2).

Drug utilization research provides information on the patterns of use, quality of use, determinants of use and outcomes of use (3). Patterns of use encompasses profiles of drug use, trends and costs over time. Quality of use entails using audits to compare actual use to national and local formularies. Determinants of use covers the user, prescriber and drug characteristics, and whereas outcomes of use are the health outcomes and their economic consequences (3). Drug utilization research provides early signals of irrational use of drugs, which allows interventions to be put in place to improve drug use. In a DUR, a quality control cycle is essential as it offers a systematic framework for continuous quality improvement and it can be applied both nationally and internationally to allow for benchmarking (3).

2.3.2: Drug utilization studies.

Health institutions should aim at stocking a small range of medicines as this helps to ensure better medicine supply, appropriate prescribing and lower costs of medicines. Essential medicines were defined by the WHO in 1999 as "those drugs that satisfy the health care needs of the majority of the population; they should therefore be available at all times in adequate amounts and in appropriate dosage forms and at a price that individuals and the community can afford" (16). Selecting essential medicines begins with defining a list of common diseases for each level of healthcare. In most healthcare systems, the treatment of first choice for each health problem forms the basis for the Essential medicine list (EML) and Standard treatment guideline (STG). The essential medicines should be made available at all times (17).

A study conducted in India revealed that not only does the quantity of medicines fall short of the requirements but also supply is often erratic. Common medicines are out of stock and remain so for a considerable period. The explanation for this type of scenario in most developing countries is attributed to inventory management (18). Another study done by Pillans et al in a 1500 bed capacity state hospital reported that better inventory control techniques brought about 20% saving in hospital expenditure (19). Studies done by Management Sciences for Health (MSH) in Rwanda in 2011 showed that improving rational medicine use in Nyamata hospital reduced procurement budget by 12% in six months (20). It is therefore evident that ensuring rational use of medicines and improving inventory management procedures can reduce medicine costs and treatment outcomes overall.

Drugs consume a substantial amount of hospital budgets in any healthcare system. In KNH the procurement of drugs for the last five years was allocated over 300million shillings. Figure 2.4 shows the pharmacy budget allocation for five consecutive financial years (2010-2015) at the Kenyatta National Hospital. The supply of drugs and effective management of the healthcare system should be ensured. Availability of drugs improves the confidence of patients in the healthcare system and using proper systems to prioritize drugs avoids lack of vital drugs, which leads to more expensive emergency procurement (2).

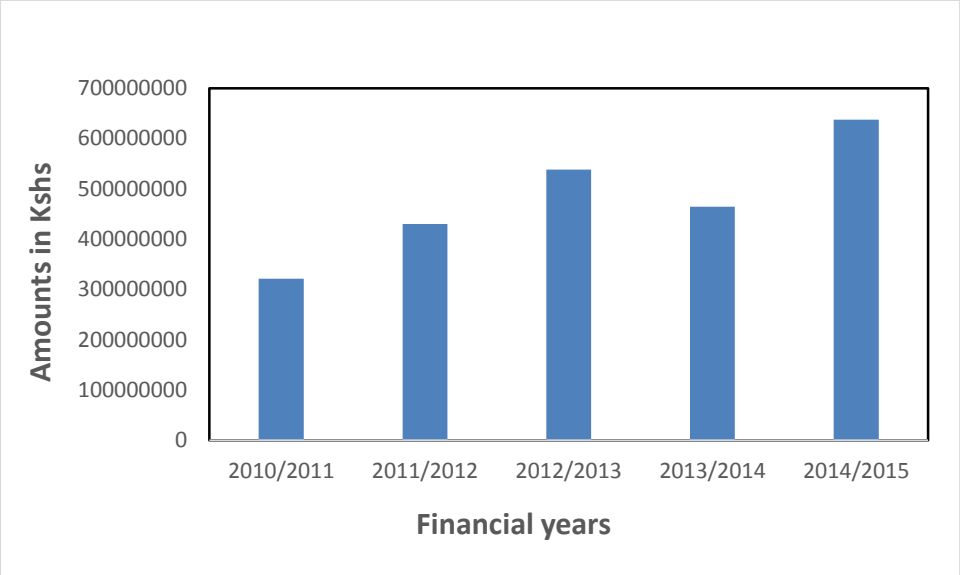

Figure 2.4 Pharmacy budget allocation for Kenyatta national hospital from 2010-2015.

Source: KNH Finance Department database.

Pharmaceutical stores need to be planned, designed, organized and maintained in a manner that results in efficient clinical and administrative services (21). Continuous better inventory control leads to improved medicine availability, improves patient outcomes and reduces morbidity and mortality (19). Lack of proper and reliable past consumption data often leads to poor quantification of drug procurement requirements. Poor quantification leads to over procurement of slowly moving items, or procurement without considering changing patterns of disease, resulting in expiry of medicines (8).

Over procurement often leads to overstocking, and may make hospitals unable to procure vital items when required to do so, due to lack of funds. No Institution has adequate funds to procure all the items in the formulary list, this therefore requires prudent selection to set priorities that will ensure the institution improves its efficiency and effectiveness (11).

Proper selection and prioritization of medicines and good inventory management ensures proper allocation of resources, ensuring continuous supply of medicines. To ensure constant availability of medicines and medical supplies, the pharmaceutical store should be organized efficiently using appropriate inventory management techniques. Information from descriptive studies such ABC-

VEN analysis assists hospitals in putting strict control for the prevention of pilferage of expensive medicines (2).

2.3.3: Drug utilization research methods

Aggregate data methods which involve data not related to any patient have been used to address the problem of irrational use of medicines. Methods such as ABC analysis, VEN analysis and DDD methodology are used to identify broad areas of medicine use. Drug indicator studies involve collecting data at the individual patient level while qualitative methods such as focus group discussions, in-depth interviews, structured observation and structured questionnaires, identify why the drug use problems are occurring (13).

2.3.3.1: ABC analysis method

ABC analysis groups items based on their cumulative cost percentage. Class A items are items that constitute 10-20% of the medicines but consume 70-80% of the budget. Class B items take up the next 10-20% of the items but consume 15-20% of the budget, with the remaining 60-80% of the items which consume 5-10% of the budget being in Class C (1).

Several Hospitals in India have performed ABC analysis of their medical stores with the aim of identifying medicines that require more focused attention. One study at a tertiary care hospital showed that out of the 1536 medicines analyzed 6.77% (104), 19.27% (296) and 79.95% (1136) of the items were found to be in the A, B and C categories respectively (22). Another study by Devnani et al produced comparable results with 58 (13.8%), 92 (21.9%) and 271(64.4%) belonging to Class A, B and C respectively (23).

The drug and therapeutic committee (DTC) at Aga Khan University Hospital in Kenya established a multidisciplinary antimicrobial sub-committee to focus on interventions to contain antimicrobial resistance in 2005. The DTC performed an ABC analysis of 793 drugs and found that the top four drugs were antimicrobials accounting for almost 10% of the medicine budget. In their finding, Meropenem, an expensive broad spectrum Carbapenem had the highest consumption by value (13). Interventions were instituted which included restricting the use of Meropenem and six other

antibiotics, involving a Microbiologist during clinical rounds in the Intensive Care Unit and providing guidelines on correct use of Meropenem and other antibiotics. A repeat ABC analysis in 2006 reported a 62% decrease in Meropenem consumption compared to 2005 (24).

2.3.3.2: VEN analysis method

Vital drugs (V) are potentially life-saving, have significant withdrawal side-effect or have major public health importance. Essential drugs (E) are effective against less severe but significant forms of disease, but are not absolutely vital to providing basic healthcare. Non-essential drugs (N) are used for minor or self-limited illnesses, are of questionable efficacy and have a high cost for marginal therapeutic advantage (1). A VEN analysis done at Nagpur by Thawani et al in 2003 showed that out of 223 drugs analyzed 53 drugs were vital but spend 40.4% of the total expenditure, 85 drugs were essential but consumed 39.9% of the total expenditure and the remaining 85 drugs which were non-essential consumed only 19.7 of the hospital budget on drugs (25).

2.3.3.3: ABC-VEN matrix analysis method

ABC-VEN matrix categorize drugs into three categories (Category I, II and III). Category I comprise of drugs in the AV, AE, AN, BV and CV categories. Category II comprise of drugs in the BE, BN and CE categories and Category III comprise of the remaining CN category. The first letter is from the ABC analysis and the second letter from the VEN analysis.

A combined ABC-VEN matrix analysis at the tertiary care hospital in India identified that only 322(21%) of the 1536 items required maximum attention by the Hospital management (22). Similar results were obtained from a study conducted at the Government medical college hospital in Nagpur (25). These studies show that an ABC-VEN analysis can be applied routinely for the efficient management of medical stores.

2.3.3.4: Anatomical therapeutic chemical (ATC)/Defined daily dose (DDD)

ATC/DDD methodologies are used to compare drug consumption among institutions, regions and countries. DDD's provide a unit of measurement that is independent of price and formulation. This makes it possible to assess trends in consumption of medicines and to perform comparison between population groups and healthcare systems. The WHO has not yet

established DDD's for topical medicines, vaccines, general/local anesthetics, contrast media and allergen extracts (1).

2.3.3.5: Drug use evaluation

Drug use evaluations are used in hospitals to identify problems concerning specific medicines or treatment of specific diseases. Drug use evaluation (DUE) also known as drug utilization review is an ongoing criteria based evaluation of drug use that helps to ensure appropriate use of medicines at the individual patient level by analyzing individual patient data and has been widely used (3). A DUE can be structured to assess the actual process of drug administration or dispensing of a drug. Some of these processes include appropriate indications, dose, and drug interactions or can be structured to assess treatment outcomes for example cured infections or decreased lipid levels. A DUE can be established in a short period once it to is known what the actual drug use problems are.

A DUE conducted in United States on the use of Ceftriaxone for the prophylaxis of abdominal surgery infection, reported that most of the thresholds that the DTC chose were not met until the final fourth quarter after interventions (1). Boruett et al (2006) conducted a drug utilization evaluation (DUE) on the use of antibiotics for prophylaxis in women who were to undergo caesarean section at the Mater hospital in Kenya. In the study they set a threshold of 90% on the four criteria that they investigated. The results showed that none of the criteria's met the threshold with two criteria's scoring as low as 5%. The results of this study points to urgent need for increased managerial and educational strategies to improve drug use. These strategies would result in the reduction of antibiotic resistance, reduce adverse drug reaction, but also costs in healthcare. The strategies would also reduce the cost of drugs and increase adherence to Standard Treatment Guidelines (STG) (26). It is evident that medicine use problems occur not only in developing countries but also in developed countries making it a universal problem (1). Conducting studies to identify medicine use problems and effective implementation of recommendations can assist to address identified problems.

The steps of conducting a DUE can be summarized as shown in Figure 2.5.(26)

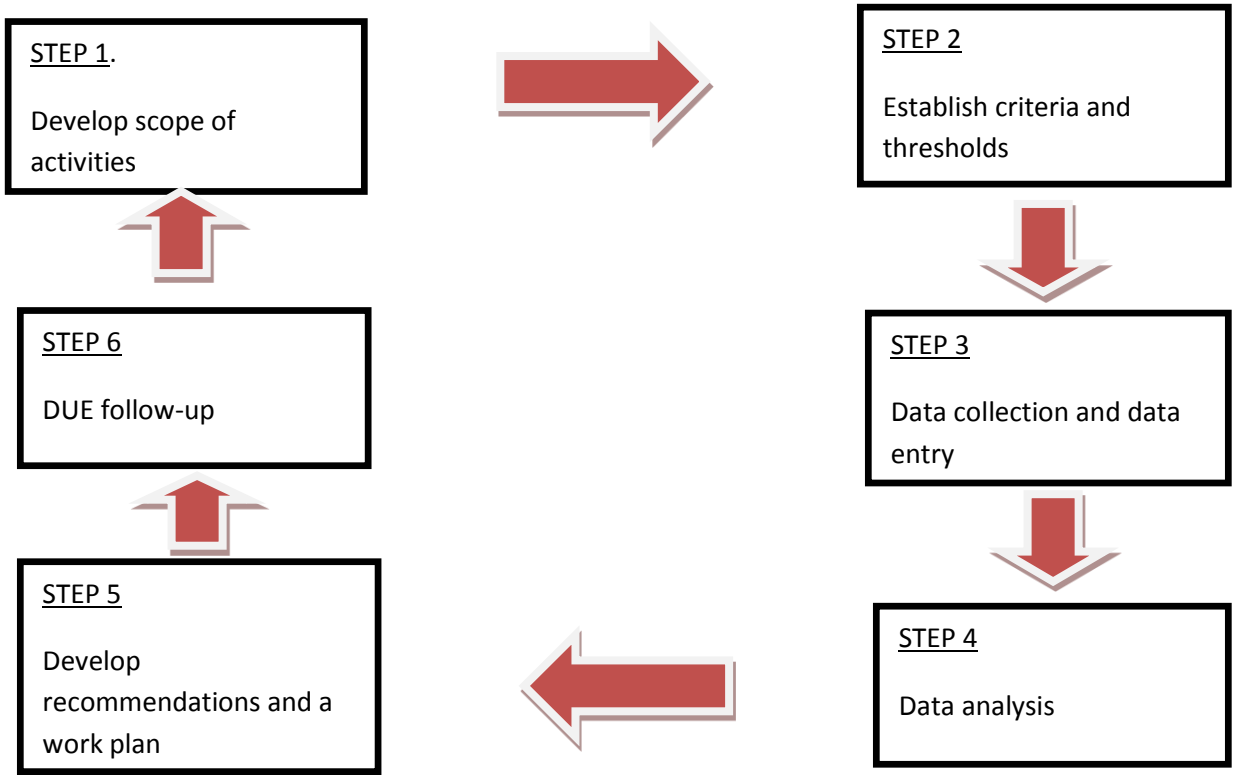

Figure 2.5: Steps for conducting a drug use evaluation.

2.3.3.6: Conceptual Framework of Drug Use Evaluation

Drug use evaluation can be viewed as an evolving management system applied to an underlying healthcare system. Each system consists of inputs, process and output components. The process begins with defining the desired and realistic outputs (for example a specified percentage of decreased costs, hospitalizations or drugs per patient). Then the process looks at the available inputs (the healthcare system and data structure) and finally the process itself. The process involves establishing the criteria for evaluation and applying these criteria. Interventions are then put in place to address the gaps identified and finally evaluation is done to find out the impacts of the intervention. There should be ongoing feedbacks and modification during the process in order to improve the outcomes. Due to continuing changes in healthcare and therapeutic environment, it is

important to repeat DUE's on a regular basis (27). This process of drug use evaluation is illustrated in Figure 2.5.

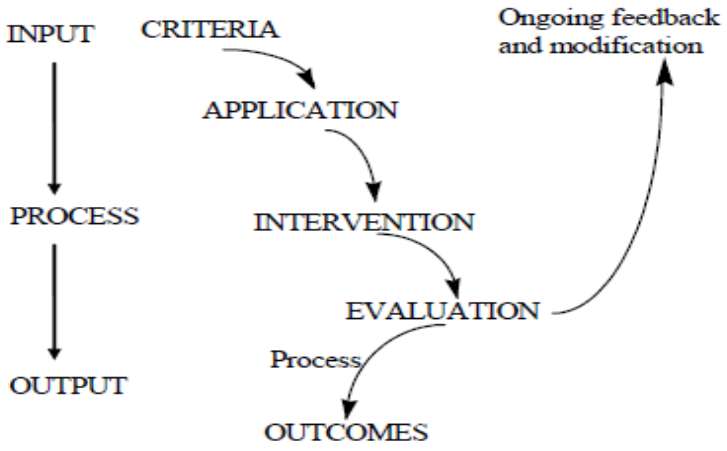

Figure 2.6: Conceptual framework for a drug use evaluation.

Source: Jordan Journal of Pharmaceutical Sciences Vol.1 No.2 2008.

2.3.3.7: Morbidity Methods

The morbidity method estimates the need for specific medicines based on the expected number of attendances, the incidences of common disease considered and standard treatment patterns for the diseases considered (24). The international classification of diseases (ICD) system developed by World Health Organization (WHO) is used to report the major health problems encountered.

The morbidity method requires reliable data on morbidity and patient attendances, and uses standard treatment guidelines to project drug needs. The method is often useful and may be the most convincing approach for justifying a budget request (24). Morbidity data is important in showing the frequency of common health problems and comparing this to the expenditure for that therapeutic category of drugs may reveal if there is irrational use of drugs.

CHAPTER 3:

DETERMINATION OF DRUG CONSUMPTION PATTERNS AT KENYATTA NATIONAL HOSPITAL

3.1 INTRODUCTION

The study was done in two parts, first an ABC-VEN analysis was conducted. Secondly a therapeutic category analysis was performed, and compared to the morbidity patterns seen in the hospital over the three year period.

3.2: MAIN OBJECTIVE.

To determine drug consumption and expenditure patterns at KNH for the periods 2013-2015 through ABC, VEN and Therapeutic category analysis.

3.2.1: Specific objectives

i) To determined drug consumption through ABC analysis at the KNH drug store

ii) To perform a VEN analysis of the drugs at the KNH drug store

iii) To perform a therapeutic category analysis and compare it to the morbidity patterns seen in the hospital over the three year period 2013-2015

3.3: METHODOLOGY

3.3.1: Study site.

The study was conducted at KNH which is a 2000 bed national teaching and referral hospital in Kenya and attends to an annual average of 70,000 inpatients and 500,000 outpatients. It is a public referral hospital in the region and offers quality specialized healthcare to patients from Kenya, Great lakes region, Southern and Central Africa (28). KNH also offers most of the medical specialty and related services including specialized surgeries such as open heart surgery, neurosurgery, critical care services, oncology, burns management and renal services (including kidney transplantation). The hospital also launched its formulary in September 2013 with the support of MSH (10).

KNH has a department known as the Supply Chain which is responsible for purchase, storage of drugs and other medical supplies across the hospital. There are also a number of donor funded programs that are handled also by the Supply Chain department including HIV/AIDS and Malaria programs. Most of the records in Supply Chain are manual but as from 2014 a Health Management information System was launched but it is not fully operational. Procurement of medicines follows the government system of tendering and the lowest bidder wins the tender.

3.3.2: Study design

The ABC analysis was conducted as a retrospective cross –sectional record review. For each year covered in the study (2013-2015), annual consumption data of the drugs from the Pharmaceutical stores along with the related expenditure incurred on each item was retrieved. Data was then transferred into the ABC Analyzer 5, 80/20 Analytics (a software under development and license number granted 8579574233285627). The ABC analyzer grouped the list into three categories A, B and C based on the cumulative cost percentage of 80%, 15% and 5% respectively.

The VEN analysis was a descriptive retrospective study. VEN categorization of all the drugs was performed by classifying the drugs identified from ABC analysis into Vital (V), Essential (E), and Non-Essential (N) categories. The VEN status of each drug was obtained from the KNH formulary and the Kenya Essential Medicines List (KEML), both of which were developed by a multidisciplinary team of Specialist doctors (Physicians, Surgeons, Pediatricians, and Pharmacists etc.) (9),17).

The TC and morbidity pattern study was a descriptive retrospective study. After performing the ABC analysis, the drugs were assigned to a therapeutic category (Appendix 4). This was based on the KNH formulary, World Health Organization(WHO) model list of Essential medicines, the ATC codes and the International Classification of Diseases (ICD-10) developed by the WHO (Appendix 5) (30). Annual morbidity data for the years 2013-2015 was extracted from the Health information database and entered into Microsoft Excel spreadsheet for analysis.

3.3.3: Sources of data

The source of data included S3 cards (Stores Ledger and Stock Control card - indicates prices and stock balances), S5 cards (Bin cards - records stock movement), S13 cards (Counter receipt voucher cards - filled after every purchase or donation), S11 (Issue voucher - issues drugs to users), Security receiving book (records all drugs entering the stores) as well as the Health Management Information System (HMIS) and any other relevant record that could provide relevant consumption data, prices and annual morbidity. The data collection was done at the Pharmaceutical Store, which is located on the ground floor of KNH and is managed by the Supplies Department and Pharmacy and Nutrition Division. The Pharmaceutical Store serves all the Pharmacies at KNH excluding the Private wing Pharmacy. Morbidity data was obtained from the Health information statistics department.

Annual morbidity data was retrieved from the Health Information department the data is entered into the Health Information System (HIS) by the Medical Record staff at the Health Information Department using the ICD-10 system developed by the WHO. The data is entered on a daily basis is aggregated annually to give the number of cases of each disease encountered for the whole year

3.3.4: Inclusion and Exclusion criteria

The study included the drug procurement records for the years 2013-2015. Records for medicines procured directly under the Pharmacy budget were included. The study also included records of any medicines borrowed, donated or returned to the store. S11 were used for medicines borrowed and S13 for medicines donated.

The study excluded medical gases, dialysis solutions and some dressing for burns that were not procured under the pharmacy budget. The study also excluded records of drugs kept at the Private Wing Store which are procured independently of the Main Hospital.

For the TC and morbidity data, the study excluded ICD-10 classes whose annual morbidity data were missing. ICD-10 classes which did not have identifiable medicines were also excluded from the study.

3.3.5: Sample size and Sampling method.

Universal sampling technique was used where every record with relevant information to the study included.

Sample size determination was not conducted for the ABC, VEN and TC analysis; since it was an annual expenditure study, and every record was included in the analysis to obtain as most accurate consumption data as possible.

3.3.6: Data collection procedures

A Research assistant was trained on the use of the data extraction forms. The ABC and TC analysis the data was collected using the adapted data collection form from the WHO studies (Appendix 1&4) (13), the relevant information included the drug code, drug name, pharmaceutical formulation, unit of issue, quantity and unit price. Data was extracted retrospectively from S3, S11, S5, S13, Health management information system (HMIS) and the Security drug receiving book. VEN categorization, were obtained from the KNH formulary and the KEML(9)(10) The data was extracted using a pre-designed form (Appendix 3). The morbidity data was extracted and entered into a predesigned data collection form (Appendix 5) as per WHO- ICD-10 system.

3.3.7: Study Variables and Definitions

For the ABC analysis the outcome variables of interest were the number of drugs belonging to the A, B and C classes and their percentage annual expenditure. Class A drugs are drugs that constitute 10-20% of the drugs but consume 70-80% of the budget. Class B drugs make up the next 10-20% of the drugs but consume 15-20% of the budget, with the remaining 60-80% of the drugs which consume 5-10% of the budget being in Class C (1). For the VEN analysis, the main outcome of interest was the number of drugs belonging to the V, E and N categories and their annual expenditure. Vital drugs (V) are potentially life-saving, have significant withdrawal side-effect or have major public health importance. Essential drugs (E) are effective against less severe but significant forms of disease, but are not absolutely vital to providing basic healthcare.

Non-essential drugs (N) are used for minor or self-limited illnesses, are of questionable efficacy and have a high cost for marginal therapeutic advantage (1).

An ABC-VEN matrix also categorize drugs into three categories of interest (Category I, II and III). Category I comprise of drugs in the AV, AE, AN, BV and CV categories. Category II comprise of drugs in the BE, BN and CE categories and Category III comprise of the remaining CN category. The first letter is from the ABC analysis and the second letter from the VEN analysis.

For the TC analysis the main outcome variable was the total expenditure for each category. For morbidity analysis the outcome variable were the number of disease cases for each ICD-10 class.

3.3.8: Quality assurance and Data management

A Research assistant was trained on the data extraction document. Cross verification was done to ensure the collected and recorded data was correct by randomly sampling the entries and cross checking with the source documents.

The data collected was cleaned by cross checking what had been input into the Microsoft excel worksheet for errors such as double entries and misplaced information. Daily backup was done using a flash disk which was password protected. All the backups were stored under lock and key with only the researcher having access to the keys.

The researcher verified all the information entered in the Microsoft Excel worksheet on a daily basis to ensure correct entries. A pilot was done to ensure the data collection forms captures all the information required. The pilot involved using the data collection forms to collect data on 10 randomly selected drugs. The data collected was included in the study

3.3.9: Data analysis.

ABC analysis was conducted using ABC analyzer which classified the drugs into Class A, B and C using the cumulative cost percentage of 80%, 15% and 5% respectively. The data was then transcribed to an MS Excel spreadsheet for quantitative analysis. The statistical analysis was carried out using MS Excel statistical functions. The annual expenditure of individual items was calculated by multiplying the annual drug consumption by the unit price (Consumption X Cost).

The annual expenditure of individual items was arranged in descending order. The percentage of annual drug expenditure and cumulative drug expenditure percentage were then calculated.

The VEN classification of the medicines was based on the KNH formulary and the KEML. The medicines were classified using a pre-designed form (Appendix 3) and the total percentage of expenditure for each category calculated.

For the ABC-VEN matrix analysis a comparison of the ABC analysis with the VEN classification was done to come up with an ABC-VEN matrix comprising of three categories. Category I consisting of items belonging to AV, AE, AN, BV and CV categories

Category II consisted of items belonging to BE, CE, and BN categories, and the remaining items CN consisted of Category III. The first letter is from the ABC analysis and the second is from the VEN analysis.

For TC analysis annual expenditure on drugs based on the ICD-10 classification was computed from the ABC analysis data. The morbidity data for each ICD-10 class was tabulated from the HMIS data. The number and percentage annual number of cases and annual drug consumption expenditure and percentage were calculated.

The data was analyzed using MS Excel statistical functions. Each ICD-10 class was matched with the expenditure on drugs for that class.

Cost per DDD and DDD/1000 inhabitants was calculated. In calculating the DDD/1000 inhabitants the population of Nairobi was estimated at 4,000,000 (31).

3.3.10: Ethical consideration

Ethical approval was sought from the KNH-UoN Ethics and Research Committee to conduct the ABC, VEN, TC analysis and approval was received in February 2016, approval number P668/10/2015. The study involved only records which were not patients related, however the study was registered at the KNH Research department and approval to access information was granted.

3.4: RESULTS

3.4.1: Annual consumption and expenditure on drugs at KNH.

A total of 812 drugs were analyzed in 2013 and 811 in 2014 and 2015 of which 652(80%) were in the formulary and 159(20%) were non-formulary. The Non-formulary drugs were allocated into VEN categories based on WHO guidelines. The total drugs consumption and expenditure for the period 2013-2015 is shown in Table 3.1.

Table 3.1: Annual expenditures on drugs at KNH drug store for 2013-2015.

Year	Total number of drugs	Drug expenditure in (Kshs)	% of Total annual expenditure
2013	812	400,625,444.17	33%
2014	811	406,391,886.87	33%
2015	811	452,064,244.35	34%
Total		1,259,081,575.39	

3.4.2: ABC analysis

ABC analysis conducted for the KNH drug store for the three years 2013, 2014 and 2015 analyzed 812, 811 and 811 drugs for the three years respectively. The total expenditure on drugs, 2013, 2014 and 2015 were Kshs. 400,625,444.17, 406,391,886.90 and 452,062,244.35 respectively. Class A drugs represented 107(13.2%), 110(13.6%) and 115(14.2%) of the total drugs analyzed for the years 2013, 2014 and 2015 respectively. Class A drugs consumed the largest proportion of the total budget at 79.9% for 2013 and 2014 and 79.8% for 2015. Class C drugs represented the highest number of drugs at 576(70.9%), 566(69.8%) and 558(68.8%) for2013, 2014 and 2015 respectively. These class C drugs consumed only an average of 5% of the total budget. The trend for three years was similar as shown in Table 3.2 and Figure 3.7. Appendix 8, 9 and 10 shows the top 20 drugs identified through ABC analysis for years 2013, 2014 and 2015 respectively. Results for the ABC analysis for drugs at the KNH drug store are shown in Table 3.2

Table 3.2 ABC Analysis of drugs at the KNH drug store for the period 2013-2015

Analysis Parameter	n(%)			% Annual expenditure on drugs		
	2013	2014	2015	2013	2014	2015
A	107(13.2)	110(13.6)	115(14.2)	79.9	79.9	79.8
B	129(15.9)	135(16.6)	138(17)	15.1	15	15.1
C	576(70.9)	566(69.8)	558(68.8)	5	5.1	5.1
Total	812	811	811	100	100	100

The annual percentage of expenditure on drugs was based on the annual expenditures shown in Table 3.1. Figure 3.7 represents the cumulative percentage of the total drugs compared with the cumulative percentage of drug expenditure for the three years of study 2013-2015. The separate categories ABC are indicated.

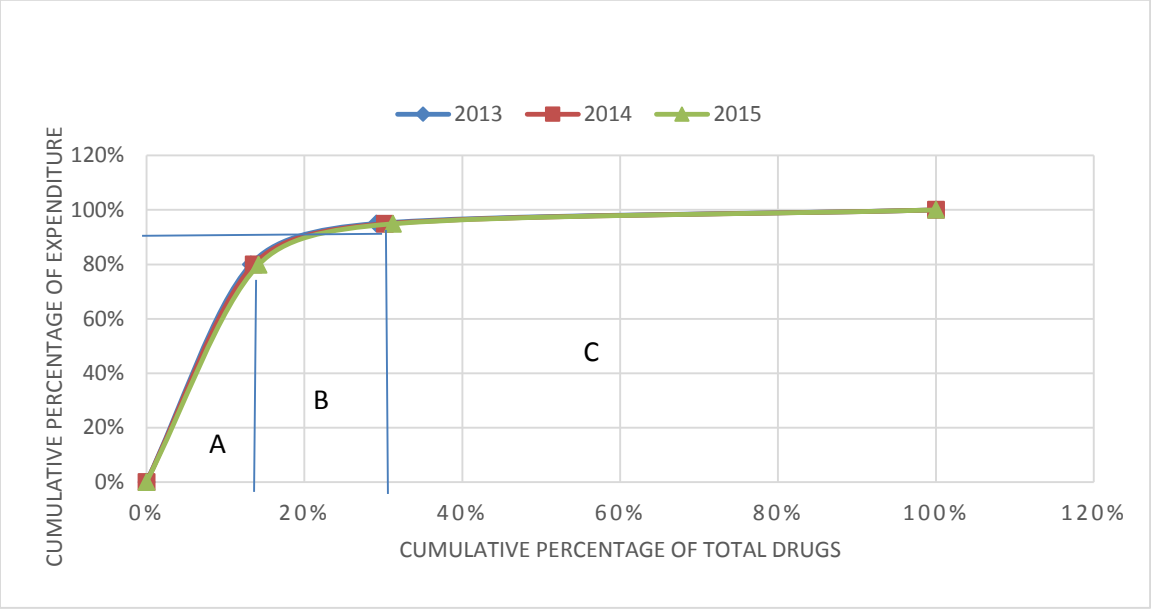

Figure 3.7: ABC analysis of drugs at the KNH drug store for 2013-2015.

From the ABC analysis the top ten drugs for each year 2013-2015 were identified. These are presented in Table 3.3 below and a detailed list attached in Appendix 8, 9 and 10.

Table 3.3: Top ten drugs from ABC analysis and their expenditure for KNH drug store 2013-2015

Item code	Item description	Unit of Issue	Total drug expenditure and % of Annual drug expenditure			VEN Category
			2013	2014	2015	
SS001	Human Albumin -20% Solution	100ml Bottle	17272000 (4.3%)	14332500(3.5%)	10011750(2.2%)	E
SG001A	Inj Acyclovir 250mg	Amp	15637050 (3.9%)	2005327(4.9%)	27024360(6.0%)	V
SE053	InJHeparin sodium 5000IU/ml	5ml Vial	14871114 (3.7%)	13197235(3.2%)	6615000(1.5%)	V
SS025	Inj Na chloride 0.9% solution	500ml Bottl	12774258 (3.2%)	13053166(3.2%)	6362160(1.4%)	V
SC044	Inj Phenytoin Na, 50mg/ml	5ml Amp	9892356 (2.5%)	7961067(2.0%)	8159695(1.8%)	V
SE051	Inj Enoxaparin 100mg/ml	0.4ml syringe		10475432(2.6%)	1794880(4.0%)	E
SA027A	Inj Cisatracurium 2mg/ml	10ml Amp	8023120 (2.0%)	7084701(1.7%)	7407059(1.6%)	E
SS035	injectable three chamber bag	1000 ml Bag	7839000 (2.0%)	8247670(2.0%)		E
SF059	Inj Meropenem 1gm	Vial	7559088 (1.9%)	11295405(2.8%)	14902866(3.3%)	E
SH033	Inj GCSF , 30 miu	prefilled syr	7134000 (1.8%)			V
SS049	Triple chamber parenteral nutrition	2000ml bag			6852480(1.5%)	E
SF027A	Inj Ceftazidime 2g	Vial		7084702(1.7%)		E
SA028	Isoflurane -Liquid for inhalation	250ml Bottle	6619800 (1.7%)		17649647(3.9%)	E
	Total Annual expenditure		400,625,444.17	406,391,886.90	452,064,244.35	

The results shows that there is a decrease in expenditure for Sodium chloride infusion, Heparin injection and Recombinant granulocyte colony stimulating factor for the three years. There is also an increase in the expenditure of Injection Meropenem, Injection Acyclovir and Isoflurane from 2013 to 2015. The expenditure for three chamber bag decreased in 2015 while the expenditure for Injection Triple Chamber parenteral nutrition increased drastically in 2015. The Expenditure for GSCF reduced from 2013 and was not among top 10 drugs in expenditure for next years. There was also a high use of injection ceftazidime in 2014.

3.4.3: VEN analysis

VEN analysis reported that Vital drugs (V) accounted for an average for the 3 years 2013-2015 of 22.8% (185) drugs, Essential drugs (E) accounted for 53.3%(432) of the total drugs consumed at the KNH hospital. Non-essential drugs accounted for 23.9% (194) drugs. The study revealed

that there were a number of non-formulary (NF) drugs that are procured and consumed in the hospital these accounted for an average of 17.4% (141). The results of the VEN analysis are shown in Table 3.4 and Figure 3.8 respectively. There was a similar trend for the three years of study as illustrated in Figure 3.8. Appendix 8, 9 and 10 the last column shows the VEN classification for the top 20 drugs.

Table 3.4: VEN analysis of drugs at KNH drug store for the period 2013-2015

Analysis Parameter	**n(%)**			**% Annual expenditure on drugs**		
	2013	2014	2015	2013	2014	2015
V	177(21.8)	201(24.8%)	178(21.9)	37.7	36.3	27.3
E	433(53.3)	433(53.4)	431(53.1)	56.8	57.6	61
N	202(24.9)	177(21.8)	202(24.9)	5.5	6.1	11.8
Total	812(100)	811(100)	811(100)	100	100	100

The percentage annual expenditure on drugs is based on the annual drug expenditure shown in Table 3.1. Figure 3.8 represents cumulative percentage of the total drugs versus the cumulative percentage of the total expenditure for each VEN category. The VEN categories are included.

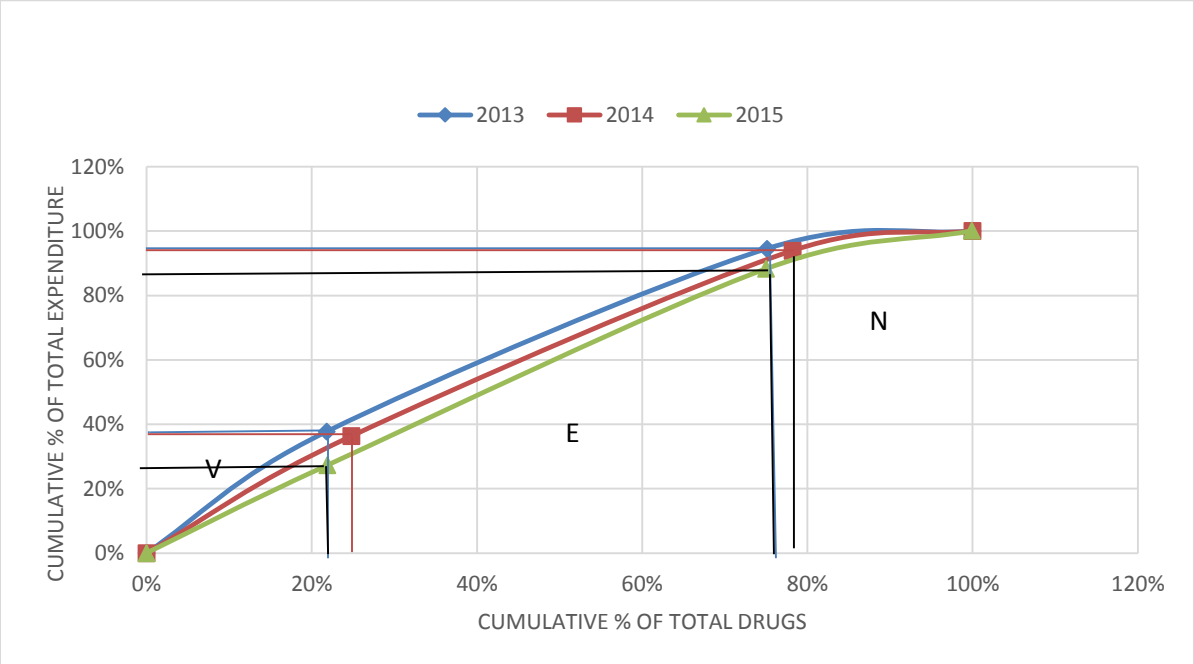

Figure 3.8: VEN analysis of drugs at the KNH drug store for the period 2013-2015.

3.4.4: ABC-VEN matrix analysis

Results of the ABC-VEN matrix analysis for the KNH drug store for years 2013-2015 are shown in Table 3.5. The Results revealed that, the most expensive drugs and which are also vital and essential consumed the highest amount of the expenditure on drugs. On average AV drugs accounting for 36(4.5%) of drugs consumed 28.7% of the expenditure on drugs, while AE drugs accounting for 67(8.2%) consumed 46.8% of the total expenditure on drugs. The cheaper and Non-essential drugs CN class consumed only average of 1% of the total expenditure on drugs. Appendix 11, 12 and 13 shows the top 30 drugs in the ABC-VEN matrix classification for the three years respectively at KNH.

Table 3.5: ABC-VEN matrix analysis of drugs at KNH drug store for 2013-2015.

Analysis Parameter	**n(%)**			**% Annual expenditure on drugs**		
	2013	2014	2015	2013	2014	2015
AV	37(4.6)	38(4.7)	34(4.2)	32.6	31.5	22.1
AE	64(7.9)	66(8.0)	70(8.6)	44.7	45.9	49.9
AN	6(0.7)	6(0.7)	11(1.4)	2.6	2.5	7.9
BV	34(4.2)	33(4.1)	35(4.3)	4.0	3.7	3.9
BE	81(10)	81(10)	75(9.3)	9.2	9.1	8.3
BN	15(1.8)	21(2.6)	28(3.5)	2.0	2.3	2.9
CV	106(13.1)	106(13.1)	109(13.4)	1.1	1.1	1.3
CE	288(35.5)	286(35.3)	286(35.3)	2.9	2.6	2.8
CN	181(22.3)	174(21.5)	163(20.1)	0.9	1.3	1.0
Total	812(100)	811(100)	811(100)	100	100	100

The percentage annual expenditure on drugs is based on the annual expenditures shown in Table 3.1. ABC-VEN Categorization revealed that 247(30.4%), 249 (30.7%) and 259(31.9%) belonged to Category I for 2013, 2014 and 2015 respectively and consumed approximately 85% of the total expenditure. Category II drugs were 384(47.4%), 388(47.8%) and 389(48%) for 2013, 2014 and 2015 respectively and these items consumed approximately 14% of the total drug expenditure. Category III items consumed only an average of 1% of the total expenditure on drugs. The results are shown in Table 3.6.

Table 3.6: ABC-VEN Matrix categorization for drugs at the KNH drug store for 2013-2015.

Analysis Parameter	n(%)			% Annual expenditure on drugs		
	2013	2014	2015	2013	2014	2015
Category I	247(30.4)	249(30.7)	259(31.9)	85.0	84.7	85.0
Category II	384(47.3)	388(47.8)	389(48.0)	14.1	14.0	14.0
Category III	181(22.3)	174(21.5)	163(20.1)	0.9	1.3	1.0
Total	812(100)	811(100)	811(100)	100	100	100

3.4.5: Therapeutic category and morbidity pattern analysis.

3.4.5.1: Morbidity pattern analysis

Analysis of the Annual morbidity data at KNH showed that there was no significant increase in the number of cases between 2014 and 2015. The data for 2013 was partial and hence could not be used for comparison. ICD-10 class S00-T99 (Injuries, poisoning and certain other consequences of external cause, Burns) had the highest number of cases and ICD-10 class H00-H59 (Diseases of the eye and Adnexa) had the least number of cases. The result are presented in Table 3.7 below.

Table 3.7: Morbidity pattern at KNH for 2013-2015

ICD-10 Code	Disease	n(%)		
		2013	2014	2015
A00-B99	Certain infectious and parasitic diseases	2074(11.4)	4815(9.9)	5018(10.4)
C00-D48	Neoplasms	1915(10.5)	4800(9.9)	5253(10.9)
D50-D59	Diseases of the blood and blood forming organs and certain disorders involving the immune system	155(0.9)	492(1.0)	503(1.0)
E00-E89	Endocrine, Nutritional and metabolic disorders	1091(6.0)	2818(5.8)	2840(5.9)
F00-F99	Mental, Behavioral disorders	125(0.7)	368(0.8)	362(0.8)
G00-G99	Diseases of the Nervous system	903(5.0)	1269(2.6)	1324(2.8)
H00-H59	Disease of the Eye and Adnexa	166(0.9)	314(0.7)	354(0.7)
I00-I99	Diseases of the Circulatory system	2299(12.6)	5306(11.0)	5305(11.0)
J00-J99	Diseases of the Respiratory system	1632(9.0)	4774(9.9)	4818(10.0)
K00-K95	Diseases of the Digestive system	1113(6.1)	2988(6.2)	2920(6.1)
L00-L99	Diseases of the Skin and subcutaneous tissue	285(1.6)	711(1.5)	690(1.4)
M00-M99	Diseases of the Musculoskeletal system and connective tissue	363(2.0)	754(1.6)	844(1.8)
N00-N99	Diseases of the Genitourinary system	1336(7.3)	3533(7.3)	3831(8.0)
S00-T99	Injuries, poisoning and certain other consequences of external causes, Burns	2862(15.7)	7274(15)	6958(14.5)
Total		18254(100)	48484(100)	48137(100)

3.4.5.2 Therapeutic category analysis

The drugs at the drug store were categorized according to ICD-10 classification for the three years 2013 to 2015. The results showed that there was an increase in drug expenditure for ICD-10 class A00-B99 (Certain infectious and parasitic diseases) and D50-D59 (Neoplasms) and a decrease in expenditure in ICD-10 class N00-N99 (Diseases of the genitourinary system). In 2014 expenditure in the ICD-10 class F00-F99 (Mental and Behavioral disorders doubled that of the other two years 2013 and 2015. Certain infectious and parasitic diseases (ICD-10 class A00-B99) had the highest average annual drug expenditure (26.3%) and Diseases of the Skin and subcutaneous tissue (ICD-10 class L00-L99) had the lowest average annual drug expenditure (0.3%) for the three years. The results are presented in Appendix 14

Analysis of the expenditure on drugs based on the KNH Formulary categorization showed an increase in expenditure in 2015 for Anesthetic and theatre agents, other anti-infective medicines and Immunologicals, and decrease in drug expenditure in Plasma substitutes and Oxytocic's. The results are shown in Table 3.8

Table 3.8: Expenditure on drugs as per the KNH formulary therapeutic categories for 2013-2015.

NO	Therapeutic category	Total Expenditure		
		2013	2014	2015
1	Anaesthetic and theatre agents	31,847,419.50	29,882,455.25	44,372,410.89
2	Analgesics and Antiinflamatory drugs	21,328,188.30	25,550,924.38	23,234,426.60
3	CNS drugs	30,746,197.68	23421524.62	30,264,897.30
4	Gastrointestinal medicines	4,525,398.72	5,598,815.09	5,183,502.69
5	Cardiovascular drugs	42,455,458.59	46,506,328.51	47,242,380.52
6	Anti-infective medicines , Antibacterials	50,513,836.84	68,207,175.34	77,644,113.59
7	Other Anti-infective medicines	18,321,053.66	23,951,291.04	36,383,120.25
8	Antineoplastic and immunosuppresive drugs	72,602,978.04	65,927,817.10	72,392,977.51
9	Antidotes and Endocrine drugs	16,926,707.86	15,209,988.91	19,039,929.92
10	Topical dermatological preparations	2,994,599.83	1,971,844.96	2,673,963.50
11	ENT preparations	2,208,031.00	2,456,214.04	2,000,968.50
12	Respiratory tract drugs	10,476,915.40	6,661,613.78	10,381,563.32
13	Vitamins and Minerals	6,880,499.45	5,115,727.65	6,054,840.00
14	Disinifectants and Antiseptics	9,865,037.60	8,891,550.25	9,871,303.56
15	Plasma substitutes and Parenteral Nutrition	52,725,902.00	55,633,309.13	38,653,487.20
16	Miscellaneous	14,598,700.00	9,549,277.32	5,873,793.00
17	Immunologicals	5,265,959.70	6,948,920.00	17,840,256.00
18	Oxytocics and Antioxytocics	6,342,560.00	4,907,109.50	2,956,310.00
	Total	400,625,444.17	406,391,886.87	452,064,244.35

Using the ATC codes to categorize all the drugs at the KNH drug store showed that Anti-infective drugs, Antineoplastic and Immunosuppressive drugs consumed the highest amounts of

the Pharmacy allocation on drugs for the three years 2013 to 2015. The results are presented in Table 3.9. Appendix 15 shows some of the ATC codes. There was a decrease in expenditure for cardiovascular drugs in 2015 and an increase in drugs expenditure for Anti-infective drugs and Respiratory system drugs in 2015. A number of drugs have not been allocated ATC codes by the WHO.

Table 3.9: Expenditure for drugs at KNH drug store as per the ATC classification for 2013-2015.

ATC Classification	Drug expenditure (Kshs)		
	2013	2014	2015
A-Alimentary tract and metabolism	30,818,598.73	24,325,785.83	30,235,823.59
B-Blood and blood forming organs	84,766,959.10	87,222,671.21	71,035,640.35
C-Cardiovascular system	16,342,525.69	17,718,202.24	16,503,597.37
D-Dermatologicals	20,680,300.69	15,601,290.37	15,961,404.26
G-Genitourinary system and sex hormones	3,652,879.96	4,557,993.28	5,826,748.40
H-Systemic hormonal preparation, excl. sex hormones and insulins	8,442,609.00	7,888,148.07	7,061,042.82
J-Antiinfectives for systemic use	71,779,540.34	97,975,870.06	129,822,454.59
L-Antineoplastic and immunomodulating agents	72,731,612.64	62,935,383.69	67,324,367.51
M-Musculo-skeletal system	21,528,040.20	19,765,555.69	25,599,514.60
N-Nervous system	50,808,481.38	51,091,653.69	59,560,432.47
P-Antiparasitic products, insecticides and repellants	1,709,699.00	1,174,429.40	1,684,670.25
R-Respiratory system	9,552,815.40	6,054,038.78	10,225,153.32
S-Sensory organs	1,738,231.00	1,674,297.97	1,736,428.50
V-Various	4,583,190.00	5,907,277.86	8,794,780.00
No specific ATC codes	1,489,961.04	2,499,288.73	691,616.32
Total	400,625,444.17	406,391,886.87	452,063,674.35

3.4.5.3 Comparison between expenditure based on ICD-10 classification and Morbidity patterns

Two ICD-10 classes showed almost a similar annual percentage of number of cases and annual percentage of drug expenditure, this was seen in ICD-10 class F00-F99 (Mental, behavioral

disorders) and H00-H59 (Disease of the eye and Adnexa) at 0.7% and 0.6% respectively. 35% of the ICD-10 classes analyzed had higher average percentage of annual expenditure compared to the average annual percentage number of cases and 50% of the ICD-10 classes were the opposite. The results are presented in Table 3.10 and Figure 3.9.

Table 3.10: Morbidity patterns and drug expenditure data for the years 2013-2015 at the KNH.

ICD-10 Code	Disease	n(%)	% Average Annual drugs expenditure
A00-B99	Certain infectious and parasitic diseases	3969(10.4)	26.3
C00-D48	Neoplasms	3989(10.4)	19
D50-D59	Diseases of the blood and blood forming organs and certain disorders involving the immune system	383(1.0)	9.1
E00-E89	Endocrine, Nutritional and metabolic disorders	2250(5.9)	11.8
F00-F99	Mental, Behavioral disorders	285(0.7)	0.6
G00-G99	Diseases of the Nervous system	1165(3.0)	8.5
H00-H59	Disease of the Eye and Adnexa	278(0.7)	0.6
I00-I99	Diseases of the Circulatory system	4303(11.2)	6.0
J00-J99	Diseases of the Respiratory system	3741(9.8)	2.9
K00-K95	Diseases of the Digestive system	2340(6.1)	1.8
L00-L99	Diseases of the Skin and subcutaneous tissue	562(1.5)	0.3
M00-M99	Diseases of the Musculoskeletal system and connective tissue	654(1.7)	6.2
N00-N99	Diseases of the Genitourinary system	2900(7.6)	3.7
S00-T99	Injuries, poisoning and certain other consequences of external causes, Burns	5698(14.9)	3.1
Total		38292	100

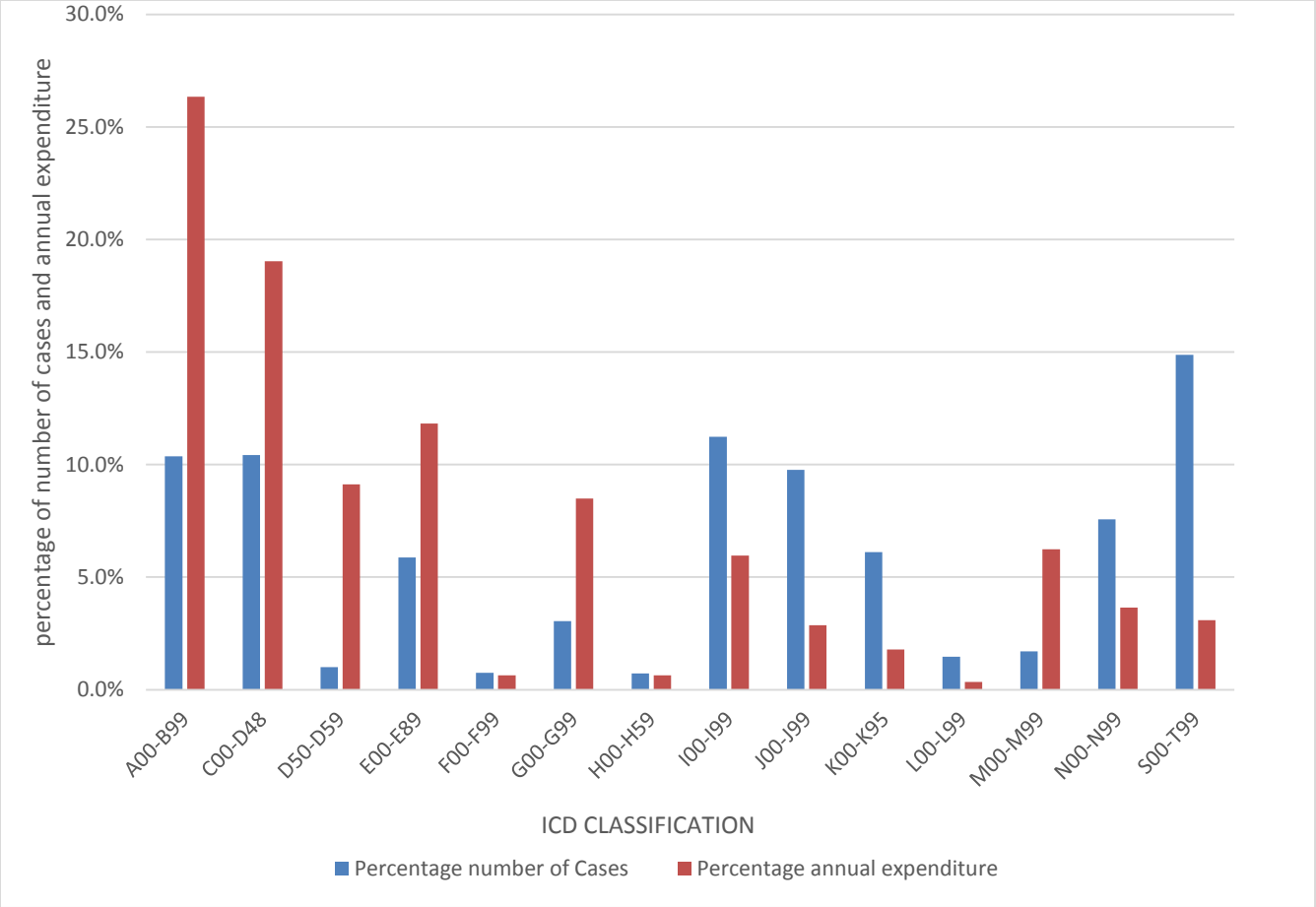

Figure 3.9: Comparison between expenditure and morbidity at KNH for 2013-2015

3.4.6: Cost per DDD and DDD/1000 inhabitants

From the cost per DDD and DDD/1000 inhabitants' analysis the top ten drugs in expenditure with established DDD's for each year were identified. The results are presented in Table 3.11 below and a detailed list attached in Appendix 15, 16 and 17 for the three years respectively

Table 3.11: Top ten drugs from the cost per DDD and DDD/1000 inhabitants for KNH drug store 2013-2015

No	ATC code	Item description	Unit of issue	DDDS	COST/DDD Kshs			DDD/1000 Inhabitants		
					2013	2014	2015	2013	2014	2015
1	J05AB01	Inj Aciclovir Na 250mg	Amp	4g	25272	23670.4	22208	0.15	0.21	0.3
2	B01AB01	Inj Heparin Na 5000IU/ml	5ml Vial	10TU	122.4	116.01	60	30.38	28.44	27.56
3	N03AB02	Inj Phenytoin Na 50mg/ml	5ml Amp	0.3g	286.32	294.26	294.36	8.64	6.76	6.93
4	J01DH02	Inj Meropenem 1gm	Vial	2g	1095.52	1272.22	1782	1.73	2.22	2.09
5	L03AA02	GCSF Injection, 30 miu / 0.5 ml	syringe	0.35mg	10150			0.18		
6	A04AA02	Granisetron -1mg per ml, 3ml	Amp, 3ml	3mg	1495			1.07		
7	A10AE01	Premixed Insulin 70%/30% 100i	10ml Vial	40U	13.12			118.75		
8	L04AA06	Mycophenolate Na 360mg	Tablet	2g	828.67	819.94		1.78	1.7	
9	L04AD01	Ciclosporin -Capsule 100mg	Caps	0.25g	674.95			2.10		
10	H01BB02	Oxytocin -Injection, 5IU	1ml Amp	15u	201.6			6.25		
11	B01AB05	Inj Enoxaparin prefilled 100mg	0.4ml syr	2TU	391.4	533.78	568	2.85	4.91	7.9
12	J01DD04	Inj Ceftriaxone Na 1g	Vial	2g	67.04		67.04	15.57		16.91
13	N02BE01	Tab Paracetamol 500mg, score	Tablet	3g	12			80.83		
14	J01DD02	Inj Ceftazidime 2gm	Vial	4g	3900	3900	3900	0.24	0.41	0.35
15	N02BE01	Inj Paracetamol I.V 10mg/ml	Vial	3G		765			1.87	
16	J01XD01	Inj Metronidazole 500mg	100ml Vial	1.5G		247.83			5.05	
17	J01CR02	Inj Co-Amoxiclav 1.2gm	Vial	3G		242.5	350		4.84	4.71
18	V03AF03	Inj Calcium Folinate 50mg	Vial	60mg			720			1.6
19	J02AX04	Inj Caspofungin 70mg	Vial	50mg			2860			0.35

Note: Drugs with no assigned DDD's are not included in this table.

The cost per DDD for injections Acyclovir, Ceftazidime, Caspofungin, Meropenem and GCSF, and Mycophenolate tablets are higher than for the rest of the top drugs in expenditure for the three years respectively

3.5: DISCUSSION

3.5.1: ABC-VEN.

Class A drugs are few yet they consume the highest amount of the drug expenditure for the 3 years 2013-2015. The Class A drugs consumed (79.9%) in 2013, 2014 and (79.8%) in 2015. Class A and B drugs which were an average of 245 drugs for the three years consumed 95% of the total drug expenditure. The remaining Class C drugs though being the majority drugs only consumed 5% of the total drug expenditure.

The drugs belonging to Class A require stricter managerial control, accurate data driven forecasting of demand, close check on budgetary control, tighter controls on stocking levels, regular purchase orders, frequent stock taking and judicious purchasing, stocking, issuing and inspection. It is in Class A that the hospital can make maximum saving of its budget on drugs(1). Class B drugs require moderate control by the middle level managers, whereas Class C require minimum control measures for order and purchase and such functions can be delegated to lower level managers. Class C drugs account for only 5% of the total hospital budget and will not contribute to significant savings.

There is an increase in the use of Meropenem from 2013 to 2015 and this warranted a Drug use evaluation. The increase in the use of Acyclovir can be attributed to the lack of cheaper alternatives and the high doses needed to treat Viral Meningitis. The decrease in the expenditure of Heparin could be attributed to the increased use of Enoxaparin which is an alternative. The decrease in expenditure for GCSF and Human albumin could be attributed to the introduction of cheaper brands.

ABC-VEN matrix identified drugs in Category I, These drugs are expensive and vital or essential and these are the drugs that require more selective and closer control.

Similar study conducted at the Armed Forces Medical College Hospital in India in 201 reported that, 6.77%(104) drugs consumed 70.03% of annual drug expenditure comprising the A group

while the group C constituted 73.95%(1136) drugs which consumed only 5% of annual drug expenditure of the hospital(22). Another study done by Abate et al at the Tikur Anbesssa specialized hospital in Ethiopia reported that analysis of expenditures for the years 2008, 2009 and 2010, Class A drugs consumed 79%, 77% and 80% of the total budget for the three years respectively. Conversely Class drugs representing 82%, 88% and 81% of the drugs, consumed about 5% of the budget in each year (32). A study done by Junita et al in a Thailand hospital reported that from 336 drugs, 26 drugs(7.74%) consumed 70.84% of the annual value and were classified as Class A, 37 drugs (11.01%) which consumed 19.23% of annual value were classified into class B and majority of items 273 drugs (81.25%) consumed only 9.93% forming Class C (33).

VEN analysis of the KNH drugs store revealed that a majority of the drugs belonged to the Vital (V) and Essential (E) categories indicating that expenditure in the hospital is aimed at serving the health care needs of the majority of the population. There were a number of drugs (141) which were non formulary and were classified into the V,E and N categories based on WHO classification (1).

A VEN study conducted at the Armed Forces Medical College Hospital in India in 2014 reported a similar trend with Vital drugs accounting for 13.14% (201), Essential drugs (E) accounted for 56.37%(866) items and Non-essential drugs accounted for 30.49% (866) of the 1536 drugs considered for the study (22). Another study by Devnani et al 2010 revealed comparable results (23). Abate et al reported that the lion share of the budget was spent on Vital and Essential drugs (32). A study done at the Sasoon Indian hospital which analyzed a smaller number of drugs showed that Vital drugs represented 148(50.9%), Essential drugs 117 (40.2%) and Non-essential drugs were 26(8.9%) (34). Drugs belonging to vital category require continuous availability and reasonable safety stock with no stock out options. Essential drugs require reduced stock levels, the non-essential drugs require minimum managerial control over their availability and stock decisions. The non-formulary drugs should be considered by the Hospital DTC for inclusion into the Hospital formulary as the expenditure of these drugs for the three years was 2.4% of the total hospital expenditure on drugs.

This study produced comparable results to the Armed Forces Medical College Hospital study of 2014 which showed that 21%, 51.17% and 27.83% of the drugs belonged to category I,II and III respectively (22). Devnani et al 2010 also reported that 22.09%, 54.63% and 23.28% of the drugs were found to belong to category I,II and III respectively, accounting for 74.21%, 22.23% and 3.56% respectively of the annual drug expenditure (23). Drugs belonging to Category I require consistent attention on their consumption and stocks. Majority of the drugs belong to category II (47.7%) of the total drugs and are of intermediate value (14%) and are essential towards patient care and hence will require control and close supervision by middle level managers in the hospital.

Drugs belonging (CE) category which are cheap and essential averaged (35.4 %) of the total drugs but consumed an average of 2.8% of the total drug expenditure. These (CE) drugs can be availed at all times as they are essential but cheap. Category III (CN) consisted of an average of 21.3% (173) items but they consumed only an average of 1.1% of the total hospital budget. These Category III items can be ordered in bulk to save on ordering cost, these drugs also require minimum supervision.

Antineoplastic and Antibiotics drugs consumed the highest amount of money of the Pharmacy drug procurement allocation. Most of the Antineoplastic are expensive and KNH is the only referral hospital that handle most of the Cancer cases in the country. Antibiotic are often highly prescribed and KNH being a referral hospital stocks most of the expensive antibiotics including third line Carbapenems.

The Cost/DDD analysis identified Acyclovir, Meropenem, Piperacillin and Tazobactam, Vancomycin, Mycophenolate, Ciclosporin and Ceftazidime has having cost per DDD which are ten times higher than the rest of the drugs. The estimation of cost per DDD allows identification of problematic drugs in the hospital such Acyclovir in which prescriptions must be checked carefully

3.5.2: Therapeutic category and morbidity patterns.

The mismatch between the percentage number of cases and the percentage drug expenditure in ICD-10 classes A00-B99, C00-D48, D50-D59, G00-G99 and M00-M99 and this could be attributed to irrational use of medicines for the management of the cases or the medicines used to

manage the cases could be expensive. The mismatch in percentage annual number of cases and the percentage drug expenditure in ICD-10 classes I00-I99 (Diseases of the circulatory system), J00-J99 (Diseases of the respiratory system),K00-K95 (Diseases of the digestive system), D50-D59, E00-E89,L00-L99 and S00-T99 could be attributed to the use of cheaper medicines to manage the cases or there is lack of enough medicines in the formulary to manage these cases and as such the hospital could be losing revenue. There is need for further studies on the reasons for the variability in expenditure and morbidity. Morbidity methods are not very accurate as the morbidity data are at times incomplete and may underestimate the drugs required (1).

Majority of the drugs used to treat the most common cases as per morbidity patterns are in Class A, these include injectable such as Acyclovir, Meropenem, Heparin, Enoxaparin and Sodium chloride infusion. These drugs are either vital or essential and should be availed at all times. Neoplasms drugs spend an average of 19% of the annual drug budget for the three years and had a majority of the drugs in Class A. Most of the drugs are expensive and essential and this may require the Pharmacy Department to be allocated more funds so as to avail them at all times.

Theatre drugs consumed a high amount of money for the three years, however data on the number of cases operated was not available. The increase in expenditure for Anti-infective and Respiratory tract drugs could be attributed to an increase in the number of cases for the two diseases

3.6: RECOMMENDATIONS.

The Hospital administration should focus more on Class A drugs as these are expensive and consume high amount of total expenditure on drugs. Constant monitoring and regular stock taking of the Class A drugs is recommended. ABC-VEN analysis identified drugs in Category I, an average of 31% (252) drugs which consumed an average of 84.9% of the total drug budget and these are recommended to the hospital management as requiring strict managerial control. Secondly the study identified a high number of non-formulary drugs which are recommended to the Hospital DTC for consideration for inclusion into the Hospital formulary. There is need to develop a standard operating procedure in the hospital for converting non-formulary drugs into formulary drugs.

Categorization of drugs by the ABC-VEN matrix helps to identify Category I drugs which are expensive and vital and this small number of drugs should be given priority in procurement. ABC-VEN analysis need to be applied routinely for efficient management of the drug store as it will help to improve the use of limited resources and aid in improving patient care.

Drugs for the treatment of Infections and Neoplasms are also recommended as requiring more strict control to avoid out of stock situation as they may lead to more expensive emergency procurement. There is need to conduct further studies on the expenditure on theatre agents as the finding will help linking the drug expenditure to the number of cases.

Where drugs used to treat certain cases are expensive, there is need to seek for cheaper alternatives. Further studies comparing morbidity and drug expenditure are recommended.

3.7: STUDY LIMITATIONS

While the results of this study are recommended the study had some limitation which included, during the ABC, VEN and TC analysis included incomplete and partial consumption data. Some prices for some medicines were missing. For the morbidity pattern data study limitations included incorrect entries, lost data in the Health information system for year 2013 (data was partial). Some medicines are used to treat more than one disease and the comparison may not give an accurate picture of morbidity and expenditure. Every effort was made to get all data that was available.

3.8: CONCLUSION.

ABC value analysis showed that although Class A drugs represented an average of only (13.7%) of the total drugs they consumed an average of approximately (80%) of the total drug expenditure for the three years of study 2013, 2014 and 2015. Class C drugs though being the majority of the drugs, an average of (567) drugs consumed only 5% of the total drug expenditure for the 3 years 2013, 2014 and 2015. ABC value analysis identified items that will need greater attention for control and will assist the KNH management in putting intervention that will bring major cost reduction by focusing on Class A items where savings will be more noticeable.

VEN analysis showed that Vital and essential drugs consumed approximately (95%) of the total drugs expenditure, the remaining Non-essential drugs consumed only 5% of the drug expenditure. However 20% of the drugs included in the study were non-formulary. The VEN

analysis identified the items where expenditure will reflect the public health needs and morbidity patterns. The VEN analysis will assist the Hospital management to set interventions focused on the Vital and Essential items to ensure that major share of the budget is spent on these vital and essential medicines.

From the ABC-VEN matrix, items in Category I averaging 252 drugs consumed 85% of the total expenditure on drugs. The ABC-VEN analysis identified the Category I drugs, these are drugs which are expensive and vital. The results of this study will help in the judicious use of the limited resources in order to improve patient care. The ABC-VEN techniques need to be adopted by the Hospital Management as routine practice to ensure optimal use of resources and eliminate out of stock situations in the hospital.

TC and morbidity pattern revealed a mismatch between the drug expenditure and the number of cases seen in the hospital. In the various ICD-10 classes, ICD-10 class S00-T99 (injuries, poisoning and certain other consequences of external causes, Burns) had the highest number of cases for the 3 years of study 2013, 2014 and 2015. The highest expenditure was in ICD-10 class A00-B99, in which the average drug expenditure was (26.3%), Neoplasms (ICD-10 class C00-D48) were second at (19%). The two ICD classes (A00-B99 and C00-D48) showed similar high expenditure when the data was analyzed as per the KNH formulary and the ATC classification. The therapeutic category and morbidity pattern analysis will help the hospital management to address the gaps between expenditure and the number of cases. Further studies in the mismatch between expenditure and morbidity are recommended

The DTC should focus on the expenditures in Antibiotics and Antineoplastic medicines as these have been shown to spend a high amount of the hospital budget from all the classifications done.

CHAPTER 4.0

MEROPENEM USE EVALUATION AT KENYATTA NATIONAL HOSPITAL.

4.1: INTRODUCTION

Following the ABC analysis for medicine consumption data for the years 2013-2015, a number of medicines which consumed the highest percentage of the Hospital budget were identified. Inappropriate use of antibiotics remains the primary factor in antimicrobial drug resistance (35). Antimicrobial and injectable drugs are amongst the most expensive of all drugs, often consuming most of a hospitals drugs budget (1). There is a growing concerns of antibiotic resistance and the lack of new antibiotics emerging in the market (4). There is need in the hospital to improve patient outcomes and minimize the cost of treatment. Meropenem is a third line antibiotic, which is also expensive and showed a consistent trend of increasing expenditure for the three years from 2013 to 2015. There was therefore need to conduct a drug use evaluation on Meropenem. With the finding of this DUE the DTC will have evidence to develop and implement appropriate interventions to address the identified Meropenem use problems.

4.2: MAIN OBJECTIVE.

To identify Meropenem use problems in the hospital by conducting Meropenem use evaluation at Kenyatta National Hospital.

4.2.1: Specific objectives.

i) To determine the proportion of the Meropenem use criteria that meet the pre-set threshold.
ii) To describe the most common disease conditions for which Meropenem is prescribed
iii) To analyze the number of Meropenem prescription that were supported by culture and sensitivity laboratory reports
iv) To identify the different factors that are associated with Meropenem prescribing patterns.

4.3: METHODOLOGY.

4.3.1: Study design

A retrospective review of medical records of patients who had been treated with Meropenem.

4.3.2: Study site

The study was conducted at KNH which is a 2000 bed national teaching and referral hospital in Kenya. Refer to Section 3.3.1 for details

4.3.3: Study population

The study population consisted of all inpatients who had been treated with Meropenem in the months of February to May 2016.

4.3.4: Inclusion and Exclusion criteria

The study included all in patients who had been treated with Meropenem and whose records could be traced during the study period.

4.3.5: Sample size determination

The WHO recommends that a minimum of 50-75 records should be reviewed at each health facility, but can be increased depending on the number of Doctors and number of patients (36). The Mater study used a sample size of 110 (26), the Namibia study used a sample size of 100 (37) and a study done at a US hospital used a sample size of 120 (1). Based on these three studies an average sample size of 110 was chosen. The study reviewed a total of 111 patient records.

4.3.6: Sampling procedure

The study used convenience sampling to choose patients who had been treated with Meropenem. To identify the patients, the Pharmacy drug order book was used. Patients treated with Meropenem for the months of February to May 2016 were identified and their medical records retrieved from Medical records. Patient records which were availed by Medical Records department were included in the study until the sample size required was achieved.

4.3.7: Data collection

Data was collected using data collection form adapted from the Namibia Study (Appendix 2 and 6) which was validated via a pilot study after ethics approval (38). A pilot study was done to ensure the data collection forms captured all the information required. Relevant data on justification for the medicine being prescribed, process and outcome indicators was collected. Other information included the patients' demographic information (Appendix 6). The criteria for Meropenem DUE are shown in (Appendix 7). Data was extracted from patient's medical records .The data from the paper based data collection forms was transferred to Epi-info version 7.0.

4.3.8. Study variables and definitions

The study aimed at accessing how many of the criteria chosen will meet the pre-set threshold of 95%. The main criteria of interest were, Justification for Meropenem use, adverse drug reactions, Culture and sensitivity results, Contraindications, initiation and maintenance doses. The criteria are defined in detail in Appendix 8.

4.3.9: Data Management

The data collected was cleaned by cross checking entries into the Epi-info version 7.0 worksheet for errors such as double entries and misplaced information. Data was backed up daily and password protected to avoid loss or inappropriate access of information. All the backups were stored under lock and key. Verification of all the information entered in the Epi-info software was done on a daily basis to ensure data was entered correctly.

4.3.10: Criteria for Meropenem use evaluation.

The criteria for the Meropenem DUE was developed before commencing the study. Threshold for each criteria was set at 95% for the DUE. The criteria was based on studies done in Namibia, Kenya and the WHO(26).The criteria covered the following aspects, Indication, initiation dose, Maintenance dose, contraindications for use, Laboratory monitoring, Patient review by Doctors, Side effects. Drug-drug interactions, Culture and sensitivity results and clinical improvement of the patient.

4.3.11: Data Analysis

The frequencies of each of the criteria's was obtained and transferred to a Microsoft Excel spreadsheet and Statistical Package for the Social Sciences (SPSS) version 22 for the DUE data analysis . The baseline characteristics of the patients on Meropenem was analyzed from the data collection forms. The type of condition for which Meropenem was indicated was also captured from the data collection form and tabulated.

Using the data collection form the data was tabulated and the number of yes or no responses analyze. The percentage of yes responses was calculated based on of the total number of yes responses divided by the overall total number of responses. Based on the earlier set threshold, the proportion of criteria that meet the preset threshold was calculated.

Lastly a chi-square test was performed and a P-value of <0.05 was considered statistically significant. The criteria covered are indicated in Appendix 8.

4.3.12: Ethical consideration

Ethical approval was granted by the KNH-UoN Ethics and Research Committee. Approval was received in February 2016, approval number P668/10/2015. Since the study was retrospective and used records of discharged patients, informed consent was not sought.

However the study was registered at the KNH Research department and approval to access patient records granted and all the relevant fees paid. Only records were used in this study and there were no invasive procedures, therefore the safety of participants was guaranteed. The finding will be communicated to the hospital DTC to assist in improving patient care and outcomes. All data collection forms were stored under lock and key. All electronic data were stored in password protected computer files. Patient identifiers were replaced with codes

4.4: RESULTS

4.4.1: Baseline characteristics of patients on Meropenem

Table 4.12: Socio-demographic and clinical characteristics of patients treated with Meropenem at KNH.

VARIABLE	n%
Gender (n=111)	
Males	59(53.2%)
Females	52(46.8%)
Age (n=111)	
0-18years	43(38.7%)
18-30years	22(19.8%)
over 30years	46(41.5%)
Employment (n=111)	
Employed	10(9%)
Unemployed	86(77.5%)
Unspecified	15(13.5%)
Education level (n=111)	
Primary and below	83(74.7%)
Secondary and above	20(18%)
Unspecified	8(7.3%)
Diagnosis (n=111)	
Sepsis	29(26.1%)
Meningitis	19(17.1%)
Pneumonia	17(15.3%)
Urinary tract infection	6(5.4%)
Cancers	6(5.4%)
Peritonitis	5(4.5%)
Other conditions < 5 cases	29(26.2%)

Most of the study participants were unemployed (86%).Majority of the study participant had only primary education or below (74.7%). The study included almost an equal number of males and females at (53.2%) and (46.8%) respectively.

4.4.2: Type of disease conditions treated with Meropenem

Out of the 111 patients files reviewed most patients had different forms of sepsis comprising (26.1%) of the total cases, followed by Meningitis (17.1%) and Pneumonia at (15.3%) of cases. The least common cases had one case each (0.9%) as shown in Table 4.13.

Table 4.13: Types of diseases treated with Meropenem at KNH in 2016.

DISEASE	n	%
Cellulitis	2	1.8%
Abscess	1	0.9%
Septicemia	2	1.8%
Exfoliative skin disorder. ? SJS	2	1.8%
Obstructive Jaundice	1	0.9%
Pneumonia	17	15.3%
Urinary tract infection	6	5.4%
Leukocytosis	3	2.7%
Sepsis	29	26.1%
Peritonitis	5	4.5%
Meningitis	19	17.1%
Spiking fevers	4	3.6%
Surgical site infection	2	1.8%
Bacterial infection	2	1.8%
Pulmonary Tuberculosis	2	1.8%
Acute kidney infection	2	1.8%
Cancer	6	5.4%
Preeclampsia with HEELP syndrome	1	0.9%
Febrile neutropenia	1	0.9%
Pharyngitis? Chronic Heart disease	1	0.9%
RVD, chronic gastroenteritis	2	1.8%
Gangrenous caecum	1	0.9%
Total	111	100

HEELP- Hemolysis, elevated liver enzymes and low platelet count
RVD- Retroviral disease
SJS- Stevens Johnson Syndrome

4.4.3: Meropenem use evaluation criteria

During the Meropenem use evaluation only 3 criteria met the pre-set threshold of 95%, these were right prescriber initiating or reviewing treatment at (98.2%), Patient review by a Doctor at (98.2%) and the lack of adverse reactions in the treatment course at (99.10%). Some of criteria

performed very dismally, culture and sensitivity results recorded in patient's files at (38.74%), drug- drugs interactions at (47.75%), and lack of clinical improvement at (41.44%) as presented in Table 4.14, Figure 4.10 and Appendix 7

Table 4.14: Results of Meropenem use evaluation at KNH in 2016.

Criteria and Indication	Threshold	Observed %	Yes		No		Comments
			n(%)		**n(%)**		
1.Justification for the medicine being prescribed	95%	82.9	93	82.9	18	17.1	Threshold not met
2.Prescription of the medicine	95%	98.2	109	98.2	2	1.8	Threshold met
3.Appropriate initiation dose for indication	95%	70.3	78	70.3	33	29.7	Threshold not met
4.Appropriate maintenance dose for indication	95%	70.3	78	70.3	33	29.7	Threshold not met
5.No contraindication for use of Meropenem	95%	70.3	103	92.8	8	7.2	Threshold not met
6.Patient reviewed by a specialist	95%	98.2	109	98.2	2	1.8	Threshold met
7.No side effect or side effects managed as required	95%	90.1	101	91.0	10	9.0	Threshold not met
8.No drug-drug interactions	95%	47.8	53	47.8	58	52.2	Threshold not met
9. Any culture and sensitivity results in patient file	95%	38.7	43	38.7	68	61.3	Threshold not met
10.No Any adverse reactions in the treatment course	95%	99.0	101	99.0	10	1.0	Threshold met
11.Clinical improvement noted in patient record	95%	41.4	46	41.4	65	58.6	Threshold not met

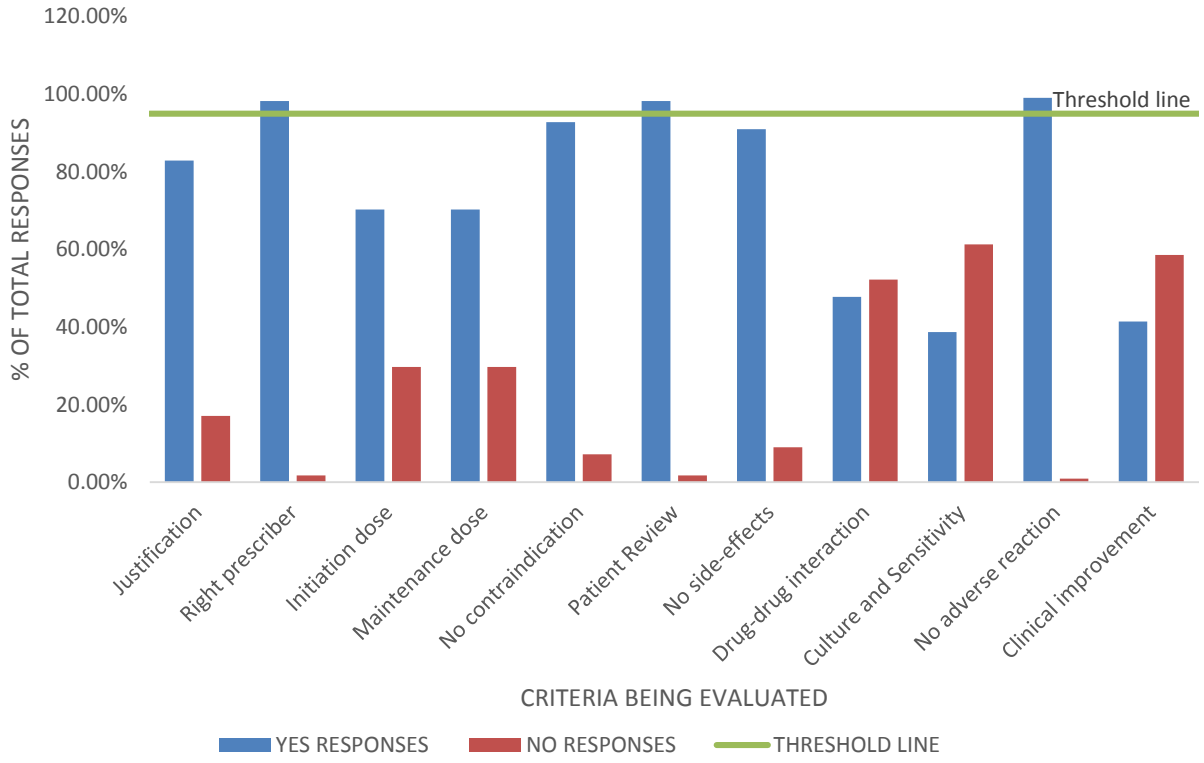

Figure 4.10: Results of Meropenem drug use evaluation at KNH in 2016.

The criteria (1-11) shown in Figure 4.10 are defined in detail in Appendix 7.

4.4.4: Factors affecting Meropenem utilization.

There are a number of factors that affect Meropenem utilization. In this study a number of factor were assessed, these included age, gender, Occupation, Level of education, the type of ward, disease condition in which Meropenem was indicated, Culture and sensitivity results, Potential drug-drug interaction and Adverse drug reaction.

For the purposes of this study, the factors affecting Meropenem utilization were analyzed. Justification for Meropenem prescribing was chosen as an indicator of Meropenem utilization as

this is one of the primary criteria upon which several other secondary criteria are based. The results are presented in Table 4.14.

Table 4.15: Factors affecting Meropenem utilization at Kenyatta National Hospital

Factors	***Categories***	***Justification for Meropenem prescribing***		***OR (95%CI)***	***Chi square (P value)***
Age		Yes	No		X^2 =6.49,
	Below 18 years	40 (93%)	3 (7%)	1.752(0.21, 14.65)	P=0.039*
	18 – 30 years	20 (87%)	3 (13%)	0.62 (0.12, 3.23)	
	Over 30 years	33 (73.3%)	12 (26.7%)	1.00	
Gender	Male	52 (88.1%)	7 (11.9%)	1.993 (0.710, 5.595)	X^2 =1.76,
	Female	41 (78.8%)	11 (21.2%)	1.00	P=0.185
Occupation	Employed	8 (88.9%)	1 (11.1%)	1.00	X^2 =1.271,
	Unemployed	72 (81.8%)	16 (18.2%)	0.70(0.29, 18.80)	P=0.53
	Unspecified	13 (92.9%)	1 (7.1%)	7.76(0.74,81.51)	
Level of education	Not yet in school	35 (97.2%)	1 (28%)	12.441(0.03,48.0)	X^2 =9.043, P=0.060
	Primary	32 (80%)	8 (20%)	0.687(0.053,9.92)	
	Secondary	13 (68.4%)	6 (31.6%)	2.22(0.15, 32.30)	
	Diploma	6 (75%)	2 (25%)	6.55(0.26,16.90)	
	Unspecified	7 (87,5%)	1 (12.5%)	(1.00)	
Culture and sensitivity results	Available	39 (90.7%)	4 (9.3%)	2.528 (0.773, 8.268)	X^2 =2.47,
	Not available	54 (79.4%)	14 (20.6%)	1.00	P=0.116
Adverse drug reaction	Yes	1 (100%)	0		X^2 =0.195,
	No	92 (83.6%)	18 (16.4%)		P=0.659
Ward	Medical	24 (70.6%)	10 (29.4%)		X^2 =16.335,
	Pediatrics	38 (100%)	0		P=0.003*
	Surgical	16 (69.6%)	7 (30.4%)		
	Specialized	14 (93.3%)	1 (6.7%)		
	Orthopedics	1 (100%)	0		
Type of infections	Cancer	0	6 (100%)		X^2 =37.277, P<0.001*
	Sepsis	25 (86.2%)	4 (13.8%)		
	Meningitis	19 (90.5%)	2 (9.5%)		
	URTI	6 (100%)	0		
	Pneumonia	15 (100%)	0		
	Peritonitis	5 (100%)	0		
	Others	23 (79.3%)	6 (20.7%)		
Potential drug-drug interaction	Yes	45 (77.6%)	13 (22.4%)	0.361 (0.119, 1.093)	X^2 =3.43, P=0.064
	No	48 (90.6%)	5 (9.4%)	1.00	

The results showed that there was an association between Age, Type of ward and Type of infection and justification for the Meropenem utilization with P values of (P=0.039, 0.003 and <0.001) respectively which were statistically significant. However the rest of the criteria analyzed showed no association with the justification for Meropenem prescribing with P values >0.05.

4.5: DISCUSSION

The study provided the data on the use of Meropenem in patients admitted to KNH in the Medical, Pediatrics, Surgical, Orthopaedic and Specialized wards. In the study Meropenem use did not reach the pre-set threshold of 95%. Most of the Meropenem therapy was started based on empiric therapy and microbial cultures were utilized only for 38.4% of the patients. A study conducted by Salehifar et al at a Tertiary Care university Hospital, Northern Iran showed that Meropenem culture and sensitivity was utilized in 38% of the prescriptions (35). In this study Meropenem was prescribed most frequently for severe sepsis, Meningitis and Pneumonia. The three were the most common diagnosis and the frequency of diagnosis was at 26.3%, 17.1% and 15.32% respectively. In the Iran study which studied 100 patient records, Meropenem was frequently prescribed in ICU (22%) and pneumonia was the most common diagnosis (35%) of all the cases (35). Another study by Soontornpas et al at the Srinagarind Hospital reported that Meropenem was used as empiric therapy 65.1% and Respiratory tract infections and sepsis were the most common diagnosis (39).

Males were more likely to be prescribed Meropenem than Females and this prescribing was justified (OR=2.0 95% CI 0.7-5.6). Patients who had culture and sensitivity done were more likely to be prescribed Meropenem compared to those without culture and sensitivity results and this was justified with (OR=2.5 95% CI 0.8-8.3) , More patients in Paediatric wards were put on Meropenem and this was justified due to the nature of the infections.

4.6: RECOMMENDATIONS

Though Meropenem is a Class A drugs there is need for recommending it use for serious infections, however culture and sensitivity results should be requested and the antibiotic changed based on the culture results

The Hospital DTC should put interventions to improve drug use including a feed back to prescribers, institution of prescribing restrictions, use of standard treatment guidelines, education and face-face discussions. After the intervention there is need for using another Meropenem DUE as a follow up to find out if there will be an improvement in the number of criteria meeting the pre-set threshold. The criteria which showed statistical significance which are age, type of ward and type of infection are worthy of attention. In most patients aged below 18 years with severe infections the use of strong antibiotics is recommended. For severe infections like sepsis the empirical use of Meropenem is recommended.

4.7: STUDY LIMITATIONS

The findings of this study are recommended however there were a number of limitations for the DUE which included lack of proper or incomplete documentation, lost or untraceable records and since the study was retrospective some aspects like patient knowledge of their medicines, adequate labelling of medicines and patient counselling could not be studied. The duration of the study was short (4 month), the number of records studied was low (110).

4.8: CONCLUSION

In the Meropenem use evaluation the most common diagnosis where Meropenem was indicated were Sepsis, Meningitis and Pneumonia, these are severe and life threatening infections and the use of Meropenem may have been justified. The type of ward influences Meropenem prescribing as the three common diagnosis are either done in the Medical, Pediatrics or the specialized units' wards. The study set a threshold of 95% on all the criteria that were evaluated, however only three out of the eleven criteria met the pre-set threshold. The study highlighted the high empiric prescribing of Meropenem without the use of Culture and sensitivity results and the lack of clinical improvement recorded in patient files despite the use of expensive and third line antibiotic. In this study justification for Meropenem prescribing was shown to be influenced by the type of ward, the type of infection and the age of the patient, however gender did not have any influence on the justification for Meropenem prescription. The drug use evaluation showed a high inappropriate use of Meropenem. The results will help in improving prescribing habits in order to reduce cost to patients, reduce unnecessary use of antibiotics and enhance rational antibiotic use. The results will also assist Physician to understand the gap in microbial diagnosis despite the financial burden of culture tests on patients.

CHAPTER 5.0

GENERAL DISCUSSIONS, RECOMMENDATIONS AND CONCLUSIONS

5.1: Summary of Findings.

The ABC analysis showed that Class A and B had an average of 245 drugs for the three years studied 2013, 2014 and 2015 and consumed 95% of the total drug budget in the hospital. The remaining drugs 576(70.9%), 566(69.8%) and 558(68.8%) for 2013, 2014 and 2015 respectively consumed only 5% of the total drug expenditure and these belonged to Class C.

VEN analysis of the KNH drug store revealed that a majority of the drugs belonged to the vital and essential categories, indicating that expenditure in the hospital is directed at serving the healthcare needs of the majority of the population. The VEN analysis also revealed that there is a high number of drugs that are non-formulary.

A combination of the ABC-VEN analysis identified drugs that are both vital and expensive and these were categorized as category I drugs. Category I drugs were an average of 252(31%) for the three years 2013.2014 and 2015 but these drugs consumed an average of 85% of the total drug expenditure. ABC analysis gave the expenditure in each of the therapeutic categories. Comparing the drug expenditure to morbidity patterns showed that there was mismatch between the drug expenditure per therapeutic category and morbidity patterns. Antibiotics and Anti-neoplastic consume the highest amount of the total drug expenditure in the hospital.

However morbidity methods are not very accurate as the morbidity data are at times incomplete and may underestimate the drugs required. In most cases a number of drugs are used to treat disease that belong to different therapeutic categories and estimating the drug expenditure may not be accurate.

ABC analysis assisted in identifying the most expensive drugs in Class A and hence the need for a DUE, to find out whether the use of these drugs was rational. Meropenem a third line antibiotic and which is expensive was identified for DUE. This was based on pre-set criteria. Most of the criteria did not meet the pre-set threshold. In this study Meropenem is mostly prescribed for Sepsis, Pneumonia and Meningitis, most of the Meropenem prescriptions culture

and sensitivity results. Several factors affect Justification for Meropenem prescribing these include age, type of infection and the type of ward, however gender did not have an effect on Meropenem utilization

5.2: General Recommendations

5.2.1 Recommendations for Policy

Drugs belonging to Class A require strict managerial control as it is this Class that the hospital can make maximum saving on its drugs budget. Class B drugs can be handled by middle level managers, whereas Class C drugs will require minimum control and these can be delegated to lower level managers. Class C drugs do not contribute significant savings.

Categorization of drugs by ABC-VEN matrix will assist to narrow down to few drugs where major savings can be achieved. Category I drugs will also require strict managerial control as these are both expensive and vital. There are a number of non-formulary items which will require review of the formulary for their inclusion. The DTC should focus on the Antibiotics and Antineoplastic drugs as these have been shown to spend a high amount of the hospital budget from all the classifications done. For the DUE the hospital DTC should put interventions to improve drug use including feedback to prescribers, improving the use of STG and restricting prescribing.

ABC-VEN analysis should be applied routinely in the drug store as it will help to improve the use of the limited resources and improve patient care. There is need to improve on the use of culture and sensitivity results before prescribing Meropenem regardless of the increased cost to patients.

5.2.2: Recommendations for future research

TC and Morbidity pattern showed a mismatch between drug expenditure per therapeutic category and the number of cases. There is need for further studies to find out the reasons for the mismatch. DUE should be done regularly and should conducted for all the class A drugs as these consume high amount of the hospital expenditure on drugs.

5.3: General Conclusions.

The study identified the Class A drugs where the hospital management should increase managerial control as it is in this class that major savings can be achieved. VEN classification of all the drugs identified the vital drugs which should be availed at all times in the hospital. The study also identified Category I drugs which are expensive and vital and these should be availed at all times to avoid more expensive emergency purchases. The drugs listed in the CE category can be purchased in bulk as these are cheap and essential and this will help reduce ordering costs. These measures will help to improve drug selection and control

The TC and Morbidity pattern highlighted the mismatch between the drug expenditure per therapeutic category and the morbidity pattern. The mismatch is shown in all cases when drug expenditure is compared to the KNH formulary list classification and the ATC codes classification. There is a high expenditure on Antibiotics and Antineoplastic drugs in the hospital. In the Meropenem DUE, only 27% of all the criteria met the pre-set criteria of 95%. The most common diagnosis were Sepsis, Meningitis and Pneumonia. Meropenem was prescribed empirically in 61.3% of the cases. A number of factors affected Meropenem prescribing these included age, type of infection and the type of ward. The high empiric use of Meropenem should be addressed as this is an expensive and third line antibiotic.

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8.0: APPENDICES

Appendix 1: ABC analysis data collection form.

ATC Drug classification	Drug Name	Pharmaceutical form and unit of issue	DDD's assigned (WHO)	Unit cost	Quantity for year_____	Total cost	Rank by value	Percentage of Total value	Cumulative percentage

Appendix 2: Data collection form for drug use evaluation

	Patient number				
	Diagnosis				
	Age				
	Weight				
	Sex				
	Date				
Criteria and Indication	Threshold	Observed			
Justification for the medicine being prescribed					
Prescription of the medicine					
Process indicators 1.Appropriate initiation dose for indication					
2.Appropriate maintenance dose for indication					
3.No contraindication for use of Drug X					
4.Laboratory monitoring carried where indicated					
5.Patient reviewed by a specialist(duration depends on drugs)					
6.No side effect or side effects managed as required					
7.No drug-drug interactions					
8. Appropriate patient education/counseling given					
Outcome indicators 1.Clinical improvement noted in patient record or no acute episodes in last (duration)					

Appendix 3: VEN category allocation form

Drug code	Drug Name	Pharmaceutical form	Unit of issue	VEN CATEGORY

Appendix 4: Therapeutic category allocation form.

Drug code	Drug Name	Pharmaceutical form	Unit of issue	Therapeutic category

Appendix 5: Morbidity data collection form

Year_____

ICD-10 CODE	HEADING	NUMBER OF CASES
A00-B99	Certain infectious and parasitic diseases	
C00-D48	Neoplasms	
D50-D89	Diseases of the blood and blood forming organs and certain disorders involving the immune mechanism	
E00-E89	Endocrine, nutritional and metabolic diseases	
F01-F99	Mental , Behavioural and Neurodevelopment disorders	
G00-G99	Diseases of the nervous system	
H00-H59	Diseases of the eye and adnexa	
H60-H95	Diseases of the ear and mastoid process	
I00-I99	Diseases of the circulatory system	
J00-J99	Diseases of the respiratory system	
K00-K95	Diseases of the digestive system	
L00-L99	Diseases of the skin and subcutaneous tissue	
M00-M99	Diseases of the musculoskeletal system and connective tissue	
N00-N99	Diseases of the Genitourinary system	

Appendix 6: Drug use evaluation questionnaire

1. Patient Serial number_____
2. Date_____
3. Diagnosis_____
4. Age ☐below 18 years ☐18-30years ☐ Over 30 years
5. Weight_____
6. Occupation ☐ Employed ☐ Unemployed
7. What is your monthly income

   ☐Kshs 0-5000 ☐Kshs 5000-10000 ☐Kshs 10000-30000 ☐OverKshs 30000

8. What is your highest level of Education ☐ Primary education ☐Secondary education ☐ Diploma level ☐Bachelors degree ☐Masters degree and above.
9. Justification for the medicine being prescribed, condition _____

   ☐ Yes ☐ No

10. Prescription of the medicine- Right prescriber initiating/ Reviewing treatment

    ☐ Yes ☐ No

11. Process indicators

    a) Appropriate initiation dose for indication ☐ Yes ☐ No

    b) Appropriate maintenance dose for indication ☐ Yes ☐ No

c) Contraindications for use of the medication ☐ Yes ☐ No

d) Patient reviewed by a Doctor ☐ Yes ☐ No

e) Any side effect or side effects managed as required ☐ Yes ☐ No

f) Any drug- drug interaction or potential interactions noted ☐ Yes ☐ No

g) Any culture results recorded where necessary

☐ Yes ☐ No ☐ Not necessary

h) Any adverse reactions in the treatment course ☐ Yes ☐

12. Outcome Indicator

a) Any clinical improvement noted in the patient records for condition being treated

☐ Yes ☐ No.

Appendix 7: Criteria and threshold for the Meropenem utilization at KNH

CRITERIA	INDICATIONS	Threshold	Observed	
			yes	no
1	**Justification for the medicine being prescribed**	95%	82.88%	17.12 %
	Severe pneumonia infection			
	Broncho pulmonary infection			
	Urinary tract infection			
	Intra-abdominal infection			
	Post- partum infection			
	Soft tissue infections			
	Bacterial Meningitis			
	Febrile neutropenia patients.			
2	**Prescription of the Medicine**			
	Right prescriber initiating/ reviewing treatment, prescription of third generation antibiotics should be initiated by a consultant or under the review by a consultant	95%	98.20%	1.80%
	Process Indicators			
3	**Appropriate Initiation dose for indication**	95%	70.27%	29.73 %
	Severe pneumonia			
	Adults and adolescents 500mg-1gm three time a day			
	Children from 3months -11 years and up to 50kg body weight- 10mg or 20mg/kg			
	Broncho-pulmonary infection			
	Adults- 2gm three times a day			
	Children- 40mg/kg			
	Complicated urinary tract infection			
	Adults- 500mg or 1g three times a day			
	Children- 10 or 20mg/kg			
	Complicated intra-abdominal infections			
	Adults- 500mg-1g three times a day			
	Children – 10-20mg/kg			
	Complicated skin and soft tissue infection			
	Adults-500mg or 1g three times a day			
	Children – 10mg or 20mg			
	Post-partum infections			
	Adults- 500mg or 1g three times a day			

Criteria	**Indications**	**Threshold**	**Observed**	
	Bacterial meningitis		Yes	No
	Adults- 2gms three times a day			
	Children – 40mg/kg			
	Febrile neutropenia patients			
	Adults- 1gm three times a day			
	Children – 20mg/kg			
4	**Appropriate maintenance dose for indication- as per initiation dose.**	95%	70.27%	29.73 %
5	**No Contraindication-**	95%	92.79%	7.21%
	I) Hypersensitivity to the active substance or excipients			
	II) Hypersensitivity to other Carbapenem antibacterial agents			
	III) Severe hypersensivity (e.g. anaphylactic reactions, severe skin reactions) to any other type of beta lactam antibacterial agents.			
	IV) Pregnancy and lactation			
6	**Patient reviewed by doctor at least once after initiation of Meropenem.**	95%	98.20%	1.80%
7	**No side effects or side effects managed as required**	95%	90.99%	9.01%
	Antibiotic associated colitis, Diarrhea, Convulsions, Headache, Oral and vaginal candidiasis, Redness at the injection site, Nausea and vomiting.			
8	**No drug-drug interactions- Drug interaction checked using Medscape drug interaction checker on all medicine the patient was put on**	95%	47.75%	52.25 %
9	**Meropenem Culture and sensitivity results recorded**	95%	38.74%	61.26 %
10	**No adverse drug reaction during the course of treatment**	95%	99.10%	0.90%
	Outcome Indicators			
11	**Clinical improvement noted in patient records**	95%	41.44%	58.56 %
	Temperature reduction, improvement noted by clinician, patient discharged. Patient deceased was noted as poor outcome			

Appendix 8: ABC Analysis results for the top 20 drugs at the KNH drug store 2013.

Total expenditure for the year 2013= Kshs 400,625,444.17

NO.	Item code	Item description	Unit of Issue	Unit price	Quantity	Total amount(Kshs)	% of total Expenditure	Cumulative percentage	VEN Category
1	SS001	Human Albumin -20% Solution	100ml Bottle	6800	2540	17272000	4.3%	4.3%	E
2	SG001A	Inj Acyclovir 250mg	Amp	1579.5	9900	15637050	3.9%	8.2%	V
3	SE053	InJHeparin sodium 5000IU/ml	5ml Vial	305.99	48600	14871114	3.7%	11.9%	V
4	SS025	Inj Na chloride 0.9% solution	500ml Bottl	42	304149	12774258	3.2%	15.1%	V
5	SC044	Inj Phenytoin Na, 50mg/ml	5ml Amp	238.6	41460	9892356	2.5%	17.6%	V
6	SA027A	Inj Cisatracurium 2mg/ml	10ml Amp	1432.7	5600	8023120	2.0%	19.6%	E
7	SS035	injectable three chamber bag	1000 ml Bag	3900	2010	7839000	2.0%	21.5%	E
8	SF059	Inj Meropenem 1gm	Vial	547.76	13800	7559088	1.9%	23.4%	E
9	SH033	Inj GCSF , 30 miu	prefilled syr	8700	820	7134000	1.8%	25.2%	V
10	SA028	Isoflurane -Liquid for inhalation	250ml Bottle	5100	1298	6619800	1.7%	26.9%	E
11	SC068A	Granisetron -3mg	Amp, 3ml	1495	4275	6391125	1.6%	28.5%	E
12	SH040	Docetaxel 80mg+ diluent	Vial	8780	720	6321600	1.6%	30.0%	E
13	ST007	EPO 2000 unit/ml SC/IV	prefilled syr	1485	4222	6269670	1.6%	31.6%	E
14	SJ042	Insulin Isophane 70/30 100iu/ml	10ml Vial	328	19000	6232000	1.6%	33.2%	E
15	SH058	Mycophenolate Na 360mg	Tablet	149.16	39600	5906736	1.5%	34.6%	E
16	SH012	Ciclosporin -Capsule 100mg	Caps	269.98	21000	5669580	1.4%	36.0%	V
17	SH049	Capecitabine -Tablet 500mg	tab	271.86	20730	5635657.8	1.4%	37.5%	E
18	ST006	Sterile Medicated paraffin Gauze	(10x40)10's pkt	875	6300	5512500	1.4%	38.8%	V
19	SV004	Oxytocin -Injection, 5IU	1ml Amp	67.2	75000	5040000	1.3%	40.1%	V
20	SE051	Enoxaparin) -Injection, 100mg/ml	0.4ml syringe	195.85	22800	4465380	1.1%	41.2%	E

Appendix 9: ABC Analysis results for top 20 drugs at the KNH drug store 2014.

Total expenditure for the year= Kshs 406,391,886.90

NO	Item code	Item description	Unit of issue	Unit price	Quantity	Total expenditure Kshs	% of total expenditure	Cumulative percentage	VEN Category
1	SG001A	Inj Aciclovir Na 250mg	Amp	1479.4	13555	20053267	4.9%	4.9%	V
2	SS001	Human Albumin -20% Solution	100ml Bottle	5250	2730	14332500	3.5%	8.5%	E
3	SE053	Inj Heparin Na 5000IU/ml	5ml Vial	290.03	45503	13197235.09	3.2%	11.7%	V
4	SS025	Inj Sodium chloride 0.9%	500ml Bottle/ ba	43	303562	13053166	3.2%	14.9%	V
5	SF059	Inj Meropenem - 1gm	Vial	636.11	17757	11295405.27	2.8%	17.7%	E
6	SE051	inj Enoxaparin) 100mg/ml	0.4ml syringe	266.89	39250	10475432.5	2.6%	20.3%	E
7	SS035	injectable three chamber bag	1000 ml Bag	3825.45	2156	8247670.2	2.0%	22.3%	E
8	SC044	Inj Phenytoin Na, 50mg/ml	5ml Amp	245.22	32465	7961067.3	2.0%	24.3%	V
9	SA027A	inj Cisatracurium , 2mg/ml	10ml Amp	1432.7	4945	7084701.5	1.7%	26.0%	E
10	SF025	Inj Ceftazidime 2gm	Vial	1950	3315	6464250	1.6%	27.6%	E
11	SA028	Isoflurane -Liquid for inh	250ml Bottle	4772.41	1308	6242312.28	1.5%	29.1%	E
12	SB044	Inj Paracetamol IV Sol. 10mg/n	Vial	255	22450	5724750	1.4%	30.5%	V
13	SH058	Mycophenolate Na 360mg	Tablet	147.59	37680	5561191.2	1.4%	31.9%	E
14	SH040	Inj Docetaxel 80mg+ diluent	Vial	6664.12	758	5051402.96	1.2%	33.2%	E
15	SF061	Inj Metronidazole 500mg	100ml Vial	82.61	60558	5002696.38	1.2%	34.4%	V
16	SF003	Inj Co-Amoxiclav 1.2g	Vial	97	48385	4693345	1.2%	35.5%	E
17	SJ042	Insulin Isophane 70/30. 100iu	10ml Vial	318.67	14670	4674888.9	1.2%	36.7%	E
18	SH033	Inj GCSF) 30 miu/0.5 ml	prefilled syringe	5071.24	904	4584400.96	1.1%	37.8%	V
19	SF026	Inj ceftriaxone 1g Na	Vial	34.24	131142	4490302.08	1.1%	38.9%	V
20	SH041	Inj Paclitaxel 100 mg	Vial	1893.71	2343	4436962.53	1.1%	40.0%	E

Appendix 10: ABC Analysis results for top 20 drugs at the KNH drug store 2015

Total expenditure for the year= Kshs 452,064,244.35

NO.	Item code	Item description	Unit of issue	Unit price	Quantity	Total consumption (Kshs)	% of total expenditure	Cumulative percentage	VEN category
1	SG001A	inj Aciclovir Na 250mg	Amp	1388	19470	27024360	6.0%	6.0%	V
2	SE051	Inj Enoxaparin) 100mg/ml	0.4ml syr	284	63200	17948800	4.0%	9.9%	E
3	SA028	Isoflurane -Liquid for inhalation	250ml Bottle	4057.39	4350	17649646.5	3.9%	13.9%	E
4	SF059	Inj Meropenem 1gm	Vial	891	16726	14902866	3.3%	17.1%	E
5	SU019	Inj Human immunoglobulin IV 5%	Vial	23000	585	13455000	3.0%	20.1%	N
6	SS001	Human Albumin -20% Solution	100ml Bottle	5250	1907	10011750	2.2%	22.3%	E
7	SC044	inj Phenytoin Na 50mg/ml	5ml Amp	245.22	33275	8159695.5	1.8%	24.1%	V
8	SA027A	Inj Cisatracurium 2mg/ml	10ml Amp	1432.7	5170	7407059	1.6%	25.8%	E
9	SS049	Triple chamber parenteral nutrition	2000ml bag	6880	996	6852480	1.5%	27.3%	E
10	SE053	Inj Heparin Na 5000IU/ml	5ml Vial	150	44100	6615000	1.5%	28.8%	V
11	SF003	Inj Co-Amoxiclav 1.2gm	Vial	140	47096	6593440	1.5%	30.2%	E
12	SS025	Inj Na chloride solution, 0.9% 500m	Bottle/bag	42	151480	6362160	1.4%	31.6%	V
13	SF059A	Inj Meropenem 500mg	Vial	420	14440	6064800	1.3%	33.0%	E
14	SH088A	Inj Trastuzumab 440mg	Vial	173200	33	5715600	1.3%	34.2%	N
15	SF025	Inj Ceftazidime 2gm	Vial	1950	2774	5409300	1.2%	35.4%	E
16	SH005B	Inj Calcium Folinate 50mg	Vial	600	7661	4596600	1.0%	36.4%	E
17	SF026	Inj ceftriaxone Na 1g	Vial	33.52	135300	4535256	1.0%	37.5%	V
18	SA001	Inj Atracurium 10mg/ml	5ml Amp	400	11110	4444000	1.0%	38.4%	E
19	SG087	Inj Caspofungin 70mg	Vial	28600	140	4004000	0.9%	39.3%	N
20	SH014	Inj Doxorubicin 50mg	Vial	1110	3600	3996000	0.9%	40.2%	E

Appendix 11: ABC-VEN Categorization for the top 30 drugs in Category I at the KNH drug store 2013.

NO	Item code	Item description	Unit of issue	Unit price	Quantity	Total amount (Kshs)	VEN category	ABC-VEN category
1	SS001	Human Albumin -20% Solution	100ml Bottle	6800	2540	17272000	E	AE
2	SA027A	inj Cisatracurium 2mg/ml	10ml Amp	1432.7	5600	8023120	E	AE
3	SS035	injectable three chamber	1000 ml Bag	3900	2010	7839000	E	AE
4	SF059	Inj Meropenem 1gm	Vial	547.76	13800	7559088	E	AE
5	SA028	Isoflurane -Liquid for inhalation	250ml Bottle	5100	1298	6619800	E	AE
6	SC068A	Granisetron -1mg per ml, 3ml	Amp, 3ml	1495	4275	6391125	E	AE
7	SC077	Pregabalin -75mg	caps/Tablet	51.79	43508	2253279.32	N	AN
8	SH032	Goserelin -Injection 3.6 mg	Prefilled Syr	12999	157	2040843	N	AN
9	SH055	Inj Rituximab 500mg	Vial	156000	12	1872000	N	AN
10	SC066	Gabapentin - capsules 300mg	capsules	20	79000	1580000	N	AN
11	SF103	Tecoplanning 200mg	vial	3039	494	1501266	N	AN
12	SH084B	Tacrolimus - capsules 5mg	caps	180	5600	1008000	N	AN
13	SE053	Inj Heparin Na 5000IU/ml	5ml Vial	305.99	48600	14871114	V	AV
14	SS025	Inj Sodium chloride 0.9%	500mls Bottle	42	304149	12774258	V	AV
15	SC044	Inj Phenytoin Na 50mg/ml	5ml Amp	238.6	41460	9892356	V	AV
16	SH033	Inj GCSF) 30 miu (300 mcg)/ 0.5 ml	prefilled syr	8700	820	7134000	V	AV
17	SH012	Ciclosporin -Capsule 100mg	Caps	269.98	21000	5669580	V	AV
18	ST006	Sterile Medicated paraffin Gauze	(10x40)10 pkt	875	6300	5512500	V	AV
19	SE070	Mannitol -Injectable solution 20%	500ml Bottle	230	3300	759000	V	BV
20	SA003	Inj Bupivacaine 0.5% 5mg/ml	20ml Vial	215	3500	752500	V	BV
21	SE054	Warfarin Na Tablet, 5mg	Tab	7	95996	671972	V	BV
22	SB022	Inj Morphine 10mg/ml	1ml Amp	93	7200	669600	V	BV
23	SJ026	Inj Dexamethasone Na 4mg	1ml Amp	14	47600	666400	V	BV
24	SS011	Inj Glucose -Injectable 10%	500ml Collaps	42	15820	664440	V	BV
25	SG037	Fluconazole -Injection 2mg/ml	100ml Vial	149	1500	223500	V	CV
26	SV005	Misoprostol -Tablet 200mcg	Tablet	25	8700	217500	V	CV
27	SS018A	Inj Sodium Lactate	1L Collapsible	90	2400	216000	V	CV
28	SJ003	Inj. Naloxone -0.4mg	Vial	500	430	215000	V	CV
29	SJ041	Glimepiride -2 mg	Tablet	10	19710	197100	V	CV
30	SU003	Antisnake Venom -Inj	Vial	16254	12	195048	V	CV

Appendix 12: ABC-VEN Categorization for the top 30 drugs in Category I at the KNH drug store 2014.

NO	Item code	Item description	Unit of issue	Unit price	Quantity	Total expenditure (Kshs)	VEN category	ABC-VEN category
1	SG001A	inj Aciclovir Na 250mg	Amp	1479.4	13555	20053267	V	AV
2	SE053	Inj Heparin Na 5000IU/ml	5ml Vial	290.03	45503	13197235.09	V	AV
3	SS025	inj Sodium chloride 0.9%	500mls Bottle	43	303562	13053166	V	AV
4	SC044	inj Phenytoin Na 50mg/ml	5ml Amp	245.22	32465	7961067.3	V	AV
5	SB044	Inj Paracetamol IV 10mg/ml	Vial	255	22450	5724750	V	AV
6	SF061	inj Metronidazole 500mg Bottle/bags	100ml Vial	82.61	60558	5002696.38	V	AV
7	SU019	Inj Human normal immunoglobulin 5%	Vial	23000	156	3588000	N	AN
8	SB043	Diclofenac Na SR 75mg	Tablet	35.27	58340	2057651.8	N	AN
9	SH032	Goserelin -Injection 3.6 mg	Prefilled Syringe.	6126.78	253	1550075.34	N	AN
10	SC066	Gabapentin - capsules 300mg	capsules	18.51	63620	1177606.2	N	AN
11	SF019	Azithromycin -Tablet 500mg	Tablet 3's	17.33	55058	954155.14	N	AN
12	SK030	Silver Sulphadiazine /Chlorhexidine	Tins 250g	488.71	1816	887497.36	N	AN
13	SS001	Human Albumin -20% Solution	100ml Bottle	5250	2730	14332500	E	AE
14	SF059	Meropenem -Powder for Injection, 1gm	Vial	636.11	17757	11295405.27	E	AE
15	SE051	Enoxaparin) -Injection, 100mg/ml	0.4ml syringe	266.89	39250	10475432.5	E	AE
16	SS035	injectable three chamber bag	1000 ml Bag	3825.45	2156	8247670.2	E	AE
17	SA027A	Cisatracurium -Injection, 2mg/ml	10ml Amp	1432.7	4945	7084701.5	E	AE
18	SF025	Inj Ceftazidime -Powder 2gm	Vial	1950	3315	6464250	E	AE
19	SE068	Magnesium sulfate -Injection 4%	100ml Bottle	157.47	5330	839315.1	V	BV
20	SH012	Ciclosporin -Capsule 100mg	Caps	209	4000	836000	V	BV
21	SJ004	Pralidoxime Mesylate -Injection 200mg	Amp	2000	380	760000	V	BV
22	SH011	Ciclosporin -Capsule 25mg	Caps	61.97	12150	752935.5	V	BV
23	SS023	Potassium Chloride infusion, 11.2%	10ml Amp	86	7700	662200	V	BV
24	SJ032	Metformin -Tablet 500 mg	Tablet	1.1	554200	609620	V	BV
25	SJ010	Flumazenil -Injection 100mcg/ml	5ml Amp	4843	45	217935	V	CV
26	SE016	Dopamine -40mg/ml (as hydrochloride)	5ml Vial / Amp	88.74	2390	212088.6	V	CV
27	SJ016	Carbimazole -5mg	Tablet	2.84	72500	205900	V	CV
28	SM050	Baby masks + spacer device	Pieces	1200	158	189600	V	CV
29	SE043	Furosemide -Tablet 40mg	Tablet	0.77	241600	186032	V	CV
30	SM022A	Ipratropium 250mcg + Salbutamol 1.25mg/m	Amp	65.74	2760	181442.4	V	CV

Appendix 13: ABC-VEN categorization for the top 30 drugs in Category I at the KNH drug store 2015.

NO	Item code	Item description	Unit of issue	Unit price	Quantity	Total consumption (Kshs)	VEN category	ABC-VEN category
1	SE051	inj Enoxaparin 100mg/ml	0.4ml syringe	284	63200	17,948,800.00	E	AE
2	SA028	Isoflurane -Liquid for inhalation	250ml Bottle	4057.39	4350	17,649,646.50	E	AE
3	SF059	Meropenem -Powder for Injection, 1gm	Vial	891	16726	14,902,866.00	E	AE
4	SS001	Human Albumin -20% Solution	100ml Bottle	5250	1907	10,011,750.00	E	AE
5	SA027A	Inj Cisatracurium 2mg/ml	10ml Amp	1432.7	5170	7,407,059.00	E	AE
6	SS049	Triple chamber parenteral nutrition	2000ml bag	6880	996	6,852,480.00	E	AE
7	SU019	Inj Human immunoglobulin IV 5%	Vial	23000	585	13,455,000.00	N	AN
8	SH088A	Inj Trastuzumab 440mg	Vial	173200	33	5,715,600.00	N	AN
9	SG087	Inj Caspofungin 70mg	Vial	28600	140	4,004,000.00	N	AN
10	SH063	Temozolomide -Capsule, 100mg	capsules	690	4950	3,415,500.00	N	AN
11	SH079	Inj Vinorelbine 10mg/ml	5mls Vial	15500	104	1,612,000.00	N	AN
12	SB045	Chlorzoxazone /paracetamol 250/300mg	Tablet	11.9	134120	1,596,028.00	N	AN
13	SC044	Inj Phenytoin Na 50mg/ml	5ml Amp	245.22	33275	8,159,695.50	V	AV
14	SE053	inj Heparin Na 5000IU/ml	5ml Vial	150	44100	6,615,000.00	V	AV
15	SS025	Inj Sodium chloride 0.9% isotonic	500mls Bottle/bag	42	151480	6,362,160.00	V	AV
16	SF026	inj ceftriaxone Na 1g	Vial	33.52	135300	4,535,256.00	V	AV
17	SH033	Inj GCSF 30 miu/ 0.5 ml	prefilled syringe	1750	1980	3,465,000.00	V	AV
18	SR007	Methylated Spirit B.P -70%V/V	5L tins	1057.41	2630	2,780,988.30	V	AV
19	SS010	Inj Glucose Solution, 5% Isotonic	500ml bag/Bottle	42.1	20000	842,000.00	V	BV
20	SV006	Misoprostol -vaginal Tablet ,25mcg	Tablet	182.5	3984	727,080.00	V	BV
21	SM022A	Ipratropiumm Br 250mcg /Salbutamol 1.2	Amp	114	6160	702,240.00	V	BV
22	SJ005	Protamine Sulfate -Injection, 10 mg/ ml	5 ml Amp	1075	620	666,500.00	V	BV
23	SE068	Magnesium sulfate -Injection 4%	100ml Bottle	129.2	5140	664,088.00	V	BV
24	SS012	Glucose -Injectable Solution, 50%	10ml Amp	55	11880	653,400.00	V	BV
25	SE043	Furosemide -Tablet 40mg	Tablet	0.75	354300	265,725.00	V	CV
26	SG069	inj Amphotericin B 50mg	Vial	350	732	256,200.00	V	CV
27	SV005	Misoprostol -Tablet 200mcg	Tablet	14	17420	243,880.00	V	CV
28	SG037	Fluconazole -Injection 2mg/ml	100ml Vial	198	1173	232,254.00	V	CV
29	SJ003	Inj. Naloxone -0.4mg (as hydrochloride)	Vial	500	460	230,000.00	V	CV
30	SA008	Ketamine -Injection 50 mg/ml	10ml Vial	100	2280	228,000.00	V	CV

Appendix 14: Prevalence of diseases conditions and expenditure at KNH for the years 2013-2015

ICD-10 CODE	Disease	2013				2014				2015			
		n(%)		Expenditure (exp)(Kshs)	% of Total exp	n(%)		Expenditure (Kshs)	% of total exp.	n(%)		Expenditure (Kshs)	% of total exp.
A00-B99	Certain infectious and parasitic diseases	2074	11.36%	68,834,890.50	20.17%	4815	9.93%	92,158,466.38	27.44%	5018	10.42%	114,027,233.84	31.10%
C00-D48	Neoplasms	1915	10.49%	66,720,112.54	19.55%	4800	9.90%	59,454,314.14	17.70%	5253	10.91%	72,503,071.51	19.77%
D50-D59	Diseases of the blood and blood forming organs and certain disorders involving	155	0.85%	31,299,875.50	9.17%	492	1.01%	31,817,401.38	9.47%	503	1.04%	32,040,738.75	8.74%
E00-E89	Endocrine, Nutritional and metabolic disorders	1091	5.98%	42,876,653.86	12.56%	2818	5.81%	44,919,615.37	13.37%	2840	5.90%	35,572,974.70	9.70%
F00-F99	Mental, Behavioural disorders	125	0.68%	1,893,972.70	0.55%	368	0.76%	3,155,536.60	0.94%	362	0.75%	1,609,848.00	0.44%
G00-G99	Diseases of theNervous system	903	4.95%	34,682,387.36	10.16%	1269	2.62%	20,271,075.50	6.03%	1324	2.75%	33,638,045.94	9.17%
H00-H59	Disease of the Eye and Adnexa	166	0.91%	2,208,031.00	0.65%	314	0.65%	2,456,214.04	0.73%	354	0.74%	2,000,968.50	0.55%
I00-I99	Diseases of the Circulatory system	2299	12.59%	19,955,542.69	5.85%	5306	10.94%	21,611,761.12	6.43%	5305	11.02%	20,558,476.17	5.61%
J00-J99	Diseases of the Respiratory system	1632	8.94%	12,906,915.40	3.78%	4774	9.85%	6,661,613.78	1.98%	4818	10.01%	10,381,563.32	2.83%
K00-K95	Diseases of the Digestive system	1113	6.10%	5,887,293.72	1.72%	2988	6.16%	6,788,311.90	2.02%	2920	6.07%	5,928,067.69	1.62%
L00-L99	Diseases of the Skin and subcutaneous	285	1.56%	1,390,649.83	0.41%	711	1.47%	1,084,347.60	0.32%	690	1.43%	1,168,053.50	0.32%
M00-M99	Diseases of the Musculoskeletal system and connective tissue	363	1.99%	22,207,498.82	6.51%	754	1.56%	23,225,299.86	6.91%	844	1.75%	19,747,695.56	5.39%
N00-N99	Diseases of the Genitourinary system	1336	7.32%	17,502,952.00	5.13%	3533	7.29%	13,099,194.80	3.90%	3831	7.96%	7,515,308.00	2.05%
S00-T99	Injuries, poisoining and certain other consequences of	2862	15.68%	12,987,370.00	3.80%	7274	15.00%	9,192,632.76	2.74%	6958	14.45%	10,011,750.00	2.73%
Total		18254	100.00%	341,354,145.92	100.00%	48484	100.00%	335,895,785.23	100.00%	48137	100.00%	366,703,795.48	100.00%

Appendix 15: Cost per DDD and DDD/1000 inhabitants for the top 30 drugs at KNH drug store in 2013.

No	ATC code	Item description	Unit of issue	Unit price	Quantity	Total amount in (Kshs)	DDDS	COST/DDD Kshs	DDD/1000 Inhabitants
1	J05AB01	Inj Aciclovir Na 250mg	Amp	1579.5	9900	15,637,050.00	4g	25272	0.15
2	B01AB01	Inj Heparin Na 5000IU/ml	5ml Vial	305.99	48600	14,871,114.00	10TU	122.4	30.38
3	N03AB02	Inj Phenytoin Na 50mg/ml	5ml Amp	238.6	41460	9,892,356.00	0.3g	286.32	8.64
4	J01DH02	Inj Meropenem 1gm	Vial	547.76	13800	7,559,088.00	2g	1095.52	1.73
5	L03AA02	GCSF Injection, 30 miu / 0.5 ml	syringe	8700	820	7,134,000.00	0.35mg	10150	0.18
6	A04AA02	Granisetron -1mg per ml, 3ml	Amp, 3ml	1495	4275	6,391,125.00	3mg	1495	1.07
7	A10AE01	Premixed Insulin 70%/30% 100iu	10ml Vial	328	19000	6,232,000.00	40U	13.12	118.75
8	L04AA06	Mycophenolate Na 360mg	Tablet	149.16	39600	5,906,736.00	2g	828.67	1.78
9	L04AD01	Ciclosporin -Capsule 100mg	Caps	269.98	21000	5,669,580.00	0.25g	674.95	2.10
10	H01BB02	Oxytocin -Injection, 5IU	1ml Amp	67.2	75000	5,040,000.00	15u	201.6	6.25
11	B01AB05	Inj Enoxaparin prefilled 100mg	0.4ml syr	195.85	22800	4,465,380.00	2TU	391.4	2.85
12	J01DD04	Inj Ceftriaxone Na 1g	Vial	33.52	124542	4,174,647.84	2g	67.04	15.57
13	N02BE01	Tab Paracetamol 500mg, scored	Tablet	2	1940000	3,880,000.00	3g	12	80.83
14	J01DD02	Inj Ceftazidime 2gm	Vial	1950	1940	3,783,000.00	4g	3900	0.24
15	J01CR05	Piperacillin+Tazobactam Na 4.5gm	Vial	1057	2700	2,853,900.00	14g	3288.44	0.22
16	J01DH51	Inj Imipenem + cilastatin 500mg	Vial	850	3000	2,550,000.00	2g	3400	0.19
17	L04AX05	Pirfenidone 200mg	tablets	1500	1620	2,430,000.00	2.4g	18000	0.03
18	RO3AC02	Salbutamol Nebulizer 5mg/ml	10ml Bottle	632	3600	2,275,200.00	10mg	126.4	4.50
19	N03AX16	Pregabalin -75mg	caps/Tablet	51.79	43508	2,253,279.32	0.3g	207.16	2.72
20	J01XD01	Inj Metronidazole 500mg	100ml Vial	36.6	61000	2,232,600.00	1.5g	109.8	5.08
21	J01CR02	Co-Amoxiclav 500mg+125mg	Tablet	9.5	220000	2,090,000.00	1gm	15.2	34.38
22	L02AE03	Goserelin -Injection 3.6 mg	Prefilled Syring	12999	157	2,040,843.00	0.129mg	465.8	1.10
23	M01AB05	Inj Diclofenac Na 25mg/ml	3ml Amp	44.1	45000	1,984,500.00	0.1g	58.8	8.44
24	J01XA01	Inj Vancomycin Hcl 500mg	Vial	350	5550	1,942,500.00	2g	1400	0.35
25	N05CD08	Midazolam -Injection ,5mg/ml	3ml Amp	220	8650	1,903,000.00	15mg	220	2.16
26	H02AB04	Inj Methylprednisolone Na 500mg	Vial	1544	1230	1,899,120.00	20mg	61.76	7.69
27	J01CR02	Co-Amoxiclav oral susp 228mg	Bottle	127	14000	1,778,000.00	1gm	27.85	15.96
28	B03AC	Iron sucrose -Injection 20mg/ml	5ml Amps	325	5400	1,755,000.00	0.1g	325	1.35
29	C10AA05	Atorvastatin -20mg	Tablet	3.45	480000	1,656,000.00	20mg	3.45	120.00
30	C01CA24	Inj Epinephrine Hcl 1mg/ml	1ml Amp	55	29500	1,622,500.00	0.5mg	27.5	14.75

Appendix 16: Cost per DDD and DDD/1000 Inhabitants for the top 30 drugs at KNH drug store in 2014.

No	ATC Codes	Item description	Unit of issue	Unit price	Quantity	Total expenditure (Kshs)	DDD'S	COST/DDD Kshs	DDD/1000 Inhabitants
1	J05AB01	Inj Aciclovir Na 250mg	Amp	1479.4	13555	20,053,267.00	4G	23670.4	0.21
2	B01AB01	Inj Heparin Na 5000IU/ml	5ml Vial	290.03	45503	13,197,235.09	10TU	116.01	28.44
3	J01DH02	Inj Meropenem 1gm	Vial	636.11	17757	11,295,405.27	2G	1272.22	2.22
4	B01AB05	Inj Enoxaparin 100mg/ml	0.4ml syringe	266.89	39250	10,475,432.50	2TU	533.78	4.91
5	N03AB02	Inj Phenytoin Na 50mg/ml	5ml Amp	245.22	32465	7,961,067.30	0.3G	294.26	6.76
6	J01DD02	Inj Ceftazidime 2gm	Vial	1950	3315	6,464,250.00	4G	3900	0.41
7	N02BE01	Inj Paracetamol I.V 10mg/ml	Vial	255	22450	5,724,750.00	3G	765	1.87
8	L04AA06	Mycophenolate sodium 360mg	Tablet	147.59	37680	5,561,191.20	2G	819.94	1.70
9	J01XD01	Inj Metronidazole 500mg	100ml Vial	82.61	60558	5,002,696.38	1.5G	247.83	5.05
10	J01CR02	Inj Co-Amoxiclav 1.2gm	Vial	97	48385	4,693,345.00	3G	242.5	4.84
11	A10AC01	Inj Insulin -Injection 70/30% 100iu/r	10ml Vial	318.67	14670	4,674,888.90	40U	12.75	91.69
12	L03AA02	Inj GCSF 300 mcg/ 0.5 ml syringe	prefilled	5071.24	904	4,584,400.96	0.35MG	5916.45	0.19
13	J01DD04	Inj ceftriaxone Na 1g	Vial	34.24	131142	4,490,302.08	2G	68.48	16.39
14	J01XA01	Inj Vancomycin Hcl 500mg	Vial	607.67	5865	3,563,984.55	2G	2430.68	0.37
15	H01BB02	Oxytocin -Injection, 5IU	1ml Amp	39.99	81550	3,261,184.50	15u	119.97	6.80
16	H02AB04	Inj Methylprednisolone Na 500mg	Vial	1630.51	1845	3,008,290.95	20MG	65.22	11.53
17	J01CR05	Inj Piperacillin+Tazobactam Na 4.5g	Vial	973.78	2729	2,657,445.62	14G	3029.54	0.22
18	J01DC02	Cefuroxime oral susp 125mg/5ml	100ml Bottle	393.88	6724	2,648,449.12	0.5G	78.78	8.41
19	A04AA02	Granisetron -1mg per ml, 3ml	Amp, 3ml	1378	1815	2,501,070.00	3MG	1378	0.45
20	L04AC02	Inj Basiliximab with diluent, 20mg	Vial	94593.9	26	2,459,440.10	40MG	189187.7	0.00
21	G04BE03	Sildenafil - Tablet, 25mg	Tab	448.96	5133	2,304,511.68	50MG	897.92	0.64
22	J01CR02	Co-Amoxiclav 500mg+125mg	Tablet	9.98	230620	2,301,587.60	1G	15.97	36.03
23	V03AF03	Inj Calcium Folinate 50mg	Vial	580.27	3928	2,279,300.56	60MG	696.32	0.82
24	J02AA01	Inj Amphotericin B 50mg liposomal	Vial	270	7900	2,133,000.00	35MG	189	2.82
25	M01AB05	Diclofenac Na 75mg SR	Tablet	35.27	58340	2,057,651.80	0.1G	47.03	10.94
26	A04AA01	Inj Ondansetron Hcl 2mg/ml	2ml Amp	147.21	12904	1,899,597.84	16MG	588.84	0.81
27	C01DA02	Nitroglycerine -Injection 2.5mgs/ml	10ml Amp	1100	1710	1,881,000.00	5MG	220	2.14
28	C01CA24	Inj Epinephrine Hcl 1mg/ml	1ml Amp	64.52	27800	1,793,656.00	0.5MG	32.26	13.90
29	C03DA01	Spironolactone -25mg	tab	12.7	140400	1,783,080.00	75MG	38.1	11.70
30	J01DC02	Inj Cefuroxime Na 750mg	Vial	57.93	29340	1,699,666.20	3G	231.72	1.83

Appendix 17: Cost per DDD and DDD/1000 inhabitants for the top 30 drugs at KNH drug store in 2015

No	ATC Codes	Item description	Unit of issue	Unit price	Quantity f	Total consumption	DDD'S	COST/DDD Kshs	DDD/1000 Inhabitants
1	J05AB01	Inj Aciclovir Na 250mg	Amp	1388	19470	27,024,360.00	4g	22208.00	0.30
2	B01AB05	Inj Enoxaparin 100mg/ml	0.4ml syring	284	63200	17,948,800.00	2TU	568.00	7.90
3	J01DH02	Inj Meropenem 1gm	Vial	891	16726	14,902,866.00	2g	1782.00	2.09
4	N03AB02	Inj Phenytoin Na 50mg/ml	5ml Amp	245.22	33275	8,159,695.50	0.3g	294.26	6.93
5	B01AB01	Inj Heparin Na 5000IU/ml	5ml Vial	150	44100	6,615,000.00	10TU	60.00	27.56
6	J01CR02	Inj Co-Amoxiclav 1.2gm	Vial	140	47096	6,593,440.00	3g	350.00	4.71
7	J01DD02	Inj Ceftazidime 2gm (as pentahydrate)	Vial	1950	2774	5,409,300.00	4g	3900.00	0.35
8	V03AF03	Inj Calcium Folinate 50mg	Vial	600	7661	4,596,600.00	60mg	720.00	1.60
9	J01DD04	Inj ceftriaxone Na 1gm	Vial	33.52	135300	4,535,256.00	2g	67.04	16.91
10	J02AX04	Inj Caspofungin 70mg	Vial	28600	140	4,004,000.00	50mg	2860.00	0.35
11	A04AA01	Inj Ondansetron Hcl 2mg/ml	2ml Amp	171	23320	3,987,720.00	16mg	684.00	1.46
12	A10AC01	Inj Insulin 70/30% 100iu/ml	10ml Vial	320	11935	3,819,200.00	40u	12.80	74.59
13	A04AA02	Granisetron -1mg per ml	1ml Amp	720	5175	3,726,000.00	3mg	2160.00	0.43
14	M01AB05	Diclofenac Na 100 mg EC	Tablet	0.75	4783800	3,587,850.00	0.1g	0.75	1195.95
15	J01CR05	Inj Piperacillin + Tazobactam Na 4.5gm	Vial	850	4135	3,514,750.00	14g	2644.44	0.33
16	L03AA02	Inj GCSF 300 mcg/ 0.5 ml	syringe	1750	1980	3,465,000.00	0.35g	2041.67	0.42
17	H02AB04	Inj Methylprednisolone Na 500mg	Vial	1630.51	1992	3,247,975.92	20mg	65.22	12.45
18	L04AA06	Mycophenolate sodium 360mg	Tablet	116	27240	3,159,840.00	2g	644.44	1.23
19	J01XA01	Inj Vancomycin Hcl 500mg	Vial	338	8840	2,987,920.00	2g	1352.00	0.55
20	G04BE03	Sildenafil - Tablet, 25mg	Tab	440	6310	2,776,400.00	50mg	880.00	0.79
21	N02AA01	Inj Morphine Hcl 10mg/ml	1ml Amp	69	39940	2,755,860.00	30mg	207.00	3.33
22	J01CF05	Flucloxacillin -Injection 500mg	Vial	145	17663	2,561,135.00	2g	580.00	1.10
23	M04AA01	Allopurinol -Tablet 100mg	Tablets	3.5	702700	2,459,450.00	0.4g	14.00	43.92
24	R03AC02	Salbutamol -respirator sol 5mg/ml	10ml Bottle	632	3189	2,015,448.00	10mg	126.40	3.99
25	J01CR02	Co-Amoxiclav 500mg+125mg	Tablet	15	132000	1,980,000.00	1g	24.00	20.63
26	J02AC01	Fluconazole -Capsule 50mg	Caps	140	14020	1,962,800.00	0.2g	560.00	0.88
27	N03AA02	Phenobarbital -Injection, 200mg/ml	Amp	330	5650	1,864,500.00	0.1g	165.00	2.83
28	J01DC02	Cefuroxime suspension125mg/5ml	100ml Bottle	279.5	6573	1,837,153.50	0.5g	55.90	8.22
29	C01CA03	Noradrenaline -Injection 2mg/ml	Amp	1100	1630	1,793,000.00	6mg	3300.00	0.14
30	R03BA02	Budesonide -200mcg inhaler (200 dose	Cans	835.92	2143	1,791,376.56	0.8g	16.72	26.79

Appendix 18: Ethical approval letter.