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**The Effect of Consignment on the Price of Pharmaceuticals and Liquidity in a Private
Hospital in Mombasa, Kenya**

Submitted to:

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Pharmacy (Pharmacoeconomics)

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DECLARATION

In fulfilment of the requirements of the coursework degree of Master of Pharmacy, in the Discipline of Pharmacy, University of KwaZulu-Natal, Durban, South Africa, I, Shaheed Imtiaz Ganiwalla declare as follows:

- i. That the work described in this thesis has not been submitted to UKZN or other tertiary institution for purposes of obtaining an academic qualification, whether by myself or any other party.
- ii. The research reported in this dissertation, except where referenced, is my original work.
- iii. This dissertation does not contain other person's text, tables, data, graphs, or other information, unless specifically acknowledged as being sourced from other persons.
- iv. This dissertation does not contain other person's writing, unless specifically acknowledged as being sourced from other researchers. Where other written resources have been quoted, then:
 - a) Their words have been rewritten but the general information attributed to them has been referenced,
 - b) Where their exact words have been used, their writing has been placed inside quotation marks, and referenced.
- v. Where I have reproduced a publication of which I am the author, co-author, or editor, I have indicated in detail which part of the publication was written by myself alone and have fully referenced such publications.

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Dated: 22nd August 2022

PREFACE

This is a mini dissertation comprising of 50% research project component. The University of KwaZulu-Natal CR13 (c) directs that a dissertation “*may comprise one or more papers of which the student is the prime author, published or in press in peer-reviewed journals approved by the relevant college academic affairs board or in manuscripts written in a paper format, accompanied by introductory and concluding integrative material*”. As such a standalone methodology is not required, as it forms part of the submitted paper/manuscript chapter. The outline of each chapter is presented at the end of Chapter 1.

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TABLE OF CONTENTS

DECLARATION	ii
PREFACE	iii
ACKNOWLEDGMENTS.....	iv
ABBREVIATIONS AND ACRONYMS	vii
LIST OF TABLE AND FIGURES	ix
ABSTRACT	x
Background.....	x
Aim and Objectives.....	x
Methodology	x
Conclusion	xi
Chapter 1	1
Background	1
Introduction	3
Methodology.....	8
Study Setting:	8
Study Design:	9
Data Source:.....	9
Data Collection:.....	11
Data Management:	12
Data Analysis:	13
Ethical Consideration:	14

Layout of the Thesis:	14
References:	15
Chapter 2	18
Literature Review	18
Gaps in the literature	25
References	25
Chapter 3 - Submitted Paper.....	29
Manuscript.....	30
Chapter 4 - Synthesis, Conclusions, and Recommendations	69
Introduction	69
Strengths of the study:.....	69
Limitation of the study:.....	70
Conclusions drawn from the study findings:.....	70
Synthesized conclusion:	71
Significance of the study:.....	71
Recommendations:.....	72
Recommendations for future research:.....	72
Chapter summary:.....	73
Appendices	74
Appendix A – Proof of Submission	74
Appendix B – Ethics Approval	75
Appendix C – Hospital Permission Letter.....	76

ABBREVIATIONS AND ACRONYMS

BH	Bomu Hospital
CBK	Central Bank of Kenya
COVID	Coronavirus Disease
EXW	Ex-Works
FOB	Free On Board
GDP	Gross Domestic Product
HIV	Human Immunodeficiency Virus
IBM	International Business Machines
IQR	Interquartile Range
IT	Information Technology
JIT	Just In Time
KES	Kenya Shillings
LMIC	Low- and Middle-Income Countries
LPO	Local Purchase Order
MCS	Mkomani Clinic Society
MOH	Ministry of Health
MSH	Management Sciences for Health
NDA	Non-Disclosure Agreement

NHIF	National Health Insurance Fund
SGR	Standard Gauge Railway
SPSS	Statistical Package for Social Sciences
UHC	Universal Health Coverage
UKZN	University of KwaZulu-Natal
USD	United States Dollar
VAT	Value Added Tax
WHO	World Health Organization

LIST OF TABLE AND FIGURES

Tables

Table 1	List of products selected for analysis. All products are listed by their chemical composition, classification, formulation type, strength, and the proprietary name.
Table 2	Net percentage change in unit purchase price when procurement system changed from tenders in 2019 to tenders-for-consignment (hybrid system) in 2022.
Table 3	List of essential versus non-essential medicines as per the Kenya Essential Medicines list 2019.
Table 4	Mean unit purchase price to MSH International Medical Products Price ratio.

Figures

Figure 1	Price comparison for drugs on the Kenya Essential Medicines list 2019 across the three different procurement methods.
Figure 2	The pharmaceutical supply chain in Kenya.

ABSTRACT

Background

A well-structured procurement system will enable the acquisition of quality products in the correct quantity, at the right time, and the right cost. There are several procurement methods available for organizations' to choose from, and each method will alter the organizations financial position in its unique way. Bomu Hospital transitioned from a tender-based procurement system to a consignment model in 2020.

Aim and Objectives

This study aims to assess the impact of consignment on the financial health of Bomu Hospital. Specific objectives include: i) to determine the effect of consignment on the cost price of pharmaceuticals, ii) to assess the effect of consignment on the liquidity ratio, iii) to evaluate the effect of combining a tender and consignment system on the cost price of pharmaceuticals, and iv) to compare the mean adjusted cost price of pharmaceuticals with the Management Sciences for Health International Medical Products Price Guide 2015.

Methodology

The study used a retrospective pre-post observational design. Medicine purchase price data was collected from the 2019 tender document, 2020 consignment supplier invoices, and the 2022 tenders-for-consignment document. Liquidity was assessed by comparing the institution's cash flow statements from 2019 and 2020. Descriptive and inferential statistics were used to determine the effect of the two procurement systems on the purchase price of pharmaceuticals and its effect on the liquidity.

Results

The dataset included 65 products listed by proprietary name. Quantitative analysis of the purchase price obtained through tenders in 2019 and consignment in 2020 shows that

the price increased by a median of 4.78% [IQR = -5.66% - 12.71%] ($p=0.48$). However, when tenders-for-consignment were introduced, the price reduced by a median of 7.71% [IQR = -11.72% - 1.935%] ($p=0.65$). Consignment resulted in a direct cash savings of KES 4,427,266.10 in one year. The median price ratio was 4.4319 [IQR = 0.8496-12.6193].

Conclusion

Consignment offers substantial savings through reduced capital expenditure. However, eliminating competition results in higher purchase prices that can harm the affordability of medicines. Comparatively, tenders provide the best prices because of competition between suppliers. Combining both results in substantial savings for the institution without negatively impacting the cost of medicines.

Chapter 1

Background

In Kenya, registration of health facilities, health care professionals, and medicines is regulated however, medicine prices are not (Ongarora et al., 2019). Medicine prices are set through market forces such as demand and supply, competing brands of the same molecule, and macroeconomic forces such as inflation, fluctuations in interest rates, import taxes and duties, and disease patterns. Even though the government plans to implement universal health coverage (UHC) by 2030 through the National Health Insurance Fund (NHIF), only 11% of the Kenyan population was enrolled into scheme by 2014 (Ongarora et al., 2019). Only 16% of the informal sector workforce was covered by NHIF meaning that most Kenyans access their healthcare privately and through out-of-pocket payments (OOP) (Ongarora et al., 2019). Furthermore, government subsidies for healthcare are mainly through public facilities which are characterized by frequent stock-outs, overcrowding, long-waiting times, and sub-optimal delivery of healthcare (Ongarora et al., 2019). However, because of poor education levels, low-income patients associate expensive medication with increased quality, prefer private facilities to public ones due to proximity, flexible payment options, and better services (Ongarora et al., 2019).

Bomu Hospital (BH) is a private not-for-profit hospital located in Changamwe, a peri-urban suburb of Mombasa, Kenya. The mission of BH is to provide safe, affordable, high-quality health and wellness services – with a special commitment to the underserved – delivered by dedicated professional teams operating from modern and accessible facilities. Surrounding the hospital is the Kibarani slums, where the inhabitants earn less than United States Dollar (USD) 1.25 per day through casual labor and operating small businesses called “kiosks” (Ongarora et al., 2019). A major challenge for the hospital is to find a balance between catering for the slum dwellers, who mostly pay OOP, and cater for the affluent insurance and corporate clients. The aim of the hospital, however, is to treat all patients

equally irrespective of their background and social status. Therefore, it is essential that medicines are affordable and available to ensure access to healthcare services.

Medicines account for a large percentage of healthcare costs. For healthcare organizations, medicines can account for up to 80% of expenditure (Mostafa et al., 2019). Therefore, it is crucial for a hospital to critically evaluate the supplies it requires to operate efficiently and streamline its procurement procedures with the goal being to purchase high-quality products at the lowest-possible price with dependable after-sale service (Dranitsaris et al., 2017). The BH drug formulary was created to encompass products that would cater for the slum dwellers as well as the insured. In most instances, one generic per molecule was selected for slow-moving medicines. For the fast-moving items, the originator and two generics were selected with one generic being the lowest-priced generic. The formulary evolves annually to include new products (new molecules or unique formulation of existing molecules), prescriber preference, and disease pattern.

In a bid to contain cost, the hospital adopted a tendering system in 2014 to procure all supplies including pharmaceuticals. The World Health Organization (WHO) defines tenders as “any formal and competitive procurement procedure through which offers are requested, received and evaluated for the procurement of goods, works or services, and as a consequence of which an award is made to the tenderer whose tender/offer is the most advantageous” (Dranitsaris et al., 2017). Since Kenya does not restrict the number of generics per molecule, adopting an open tender would prove to be cumbersome and administratively taxing since it would be very difficult to evaluate the supplier and the quality of the product. Therefore, BH adopted a restricted tender that is limited to suppliers registered with the appropriate authorities (Dranitsaris et al., 2017). The issue of product quality is taken care of by pre-selecting the proprietary name on the tender document. However, unlike traditional tenders, BH does not specify the estimated annual requirements for the products. Therefore, the award is purely based on the lowest price.

With tenders, procurement of pharmaceuticals was strictly within the confines of the hospital formulary. Addition of new products or new formulations of existing products was only permissible after an “inclusion to formulary” form was filled and signed by the prescribing doctor. In this form, the doctor provided sound reasoning and supporting literature to justify inclusion of the requested product and explain why an existing product cannot be used. The reason for this rigid procedure to include new products into the formulary is because demand is highly influenced by marketing from pharmaceutical companies through the provision of kickbacks and incentives. Therefore, for the hospital to invest capital in the new product, sound justification backed by scientific literature is necessary.

Despite the considerable advantages of the tendering system, BH moved away from the tender system because a significant proportion of capital needed to be set aside for procuring stock. Being a not-for-profit organization, this can have a significant impact on the liquidity and therefore, profitability and future projects. As such, BH adopted the consignment model in 2020. Since this was a pilot project, consignment was limited to pharmaceuticals.

Introduction

The WHO health systems framework describes six building blocks required to strengthen health systems (Manyazewal, 2017). These are: (i) service delivery, (ii) health workforce, (iii) information, (iv) medical products, vaccines, and technologies, (v) financing, and (vi) leadership/governance (Manyazewal, 2017). Chang et al. (2019) note that adequate financing is essential to the other five health system building blocks but recognize that the limited resource is a universal constraint faced by all health systems. Governments of high-income countries can raise finance from direct taxes such as income tax, whereas low-and-middle-income countries (LMIC) raise revenue through indirect taxes such as sales tax and value-added tax (VAT) (Creese, 2011). Due to the regressive nature of indirect taxes, people with low income tend to pay a higher proportion of their income on tax, further reducing their

ability to access healthcare services (Creese, 2011). High medicine price restricts access to medicine which has a detrimental effect on the patients' health and the healthcare system (Mhlanga & Suleman, 2014). Therefore, medicine must be affordable to improve access to treatment (Mhlanga & Suleman, 2014).

Globally, expenditure on healthcare continues to rise and represents both public and OOP spending (WHO, 2019). The global expenditure on healthcare rose from USD 7.6 trillion in 2016 to USD 7.8 trillion in 2017, with high-income countries accounting for 80% of the total global spending (WHO, 2019). In low-income countries, the average health spending was USD 41 per person in 2017, a staggering 70 times lower than in high-income countries (WHO, 2019). Between 2000 and 2017, the total OOP expenditure more than doubled in LMICs (WHO, 2019). In most countries, irrespective of the income level, governments provide limited funding for medicines (WHO, 2019), driving OOP spending, which reiterates the need for medicines to be affordable to improve access to treatment (Mhlanga & Suleman, 2014). Pharmaceuticals represent a large proportion of global health expenditure ranging from 5% to 12% in developed countries to up to 40% in developing countries (Muhia et al., 2017).

Kenya is located on the East Coast of Africa and is a Sub-Saharan African country. The population of Kenya is 53.77 million with a gross domestic product (GDP) per capita of USD 2,006.8 (World Bank, 2021). Kenya is, therefore, classified as a LMIC. The government of Kenya aims to achieve UHC by 2030 through the National Health Insurance Fund (NHIF). To achieve UHC, access to medicine is essential, determined by the affordability, proximity to health facilities, availability, and acceptability (Ongarora et al., 2019). In developing countries, medicines can account for up to 60% of healthcare costs, and in Kenya, 28% of this comes from OOP (Ongarora et al., 2019).

Muhia et al. (2017) noted that to improve health management at an affordable rate, the procurement of pharmaceuticals and addressing the challenges faced play a critical role.

They also stated that pharmacists must be involved in the procurement cycle for medications (Muhia et al., 2017). Procurement is a core function of an organization and is particularly vital in a healthcare setting. A well-structured procurement system will enable the acquisition of quality products in the correct quantity, at the right time, and the right cost (Muhia et al., 2017). Smooth operations of hospital departments are, therefore, highly dependent on an efficient procurement system. There are several procurement methods available for organizations to choose from, and each method will alter the organization's financial position in its unique way.

Service organizations, such as hospitals, often purchase items of high value and may account for up to 80% of the total expenditure (Mostafa et al., 2019). As such, it is paramount that the procurement process be conducted according to the best practices to save costs, minimize waste, and streamline operations to gain competitive advantage (Mostafa et al., 2019). Streamlined, efficient, and effective procurement systems result in an organization achieving cost-savings through reduced inventories (Mostafa et al., 2019). On the contrary, a poor procurement process results in high costs, delays in executing projects, and delays in delivery of products and services (Mostafa et al., 2019). Therefore, an organization's performance is dependent on an efficient procurement system as it leads to quality products and services, satisfied customers, market performance, service innovations, and employee relationships (Mostafa et al., 2019).

This research will focus on three procurement systems i.e., a competitive tendering process, consignment, and tenders-for-consignment adopted in BH. The focus of the hospital lies on serving the under-served members of society where the morbidity and mortality are high partly because the price of essential medicine is substantially higher than the available income (Ongarora et al., 2019). Therefore, all paid services are highly subsidized. It is the mandate of the hospital's procurement and pharmacy department to ensure that the hospital's inventory falls within the annual budget yet ensures the availability of all commodities to allow smooth operations of all departments.

A competitive tendering process is most likely to result in a procurement process free of bureaucracy, is transparent, and results in the acquisition of quality drugs at the cheapest market rate (Muhia et al., 2017). The competitive bidding coupled with the prospect of bulk purchase is expected to reduce the drug costs by generating competition between pharmaceutical firms (Wouters et al., 2019). Procurement of pharmaceuticals through a competitive tendering process is becoming increasingly common due to the budgetary constraints (Wouters et al., 2019). In 2014, BH adopted a competitive tendering process for the procurement of all commodities. The tendering process resulted in a reduction in the total inventory held by the hospital since the products were governed by a formulary. The tendering system ensures all products are obtained through a legitimate supplier and at the best market rate. However, this still means that a significant proportion of capital is set aside for the purchase of commodities. Gümüş et al. (2008) mentioned that in inventory sourcing through the traditional way, the end-user orders from the vendor, and the vendor invoices the end-user when the goods reach his premise. The customer owns the product at this point (Gümüş et al., 2008).

Despite the significant advantages, there is a downside to the tendering process. Tendering is dependent on accurate consumption forecast which may be difficult to achieve and may result in stock-outs and supply disruptions (Wouters et al., 2019). In South Africa, Wouters et al. (2019) show that pharmaceutical tendering resulted in a consistent drop in price of anti-retroviral therapies, oncological products, family-planning agents, small-volume parenterals, and solid-dose medicines. However, due to a failure in accurately estimating the annual requirement, tenders led to a supply disruption resulting in shortages that needed to be procured off-contract at steep premiums (Wouters et al., 2019). Furthermore, stock-outs result in patients losing trust in the healthcare system (Wouters et al., 2019).

To further reduce the cost of inventory, BH adopted the consignment model in 2020 for pharmaceuticals. A consignment contract was signed between a willing supplier and the hospital prior to the supply of products. Contracts were signed on a first come-first serve

basis and the selection of products to be supplied on consignment was made by the head of the pharmacy department. To ensure its success, the consignment contract was drawn to mutually benefit the hospital and the supplier. For instance, two competing brands of the same molecule was not permitted under consignment; the supplier was allowed to market the products on consignment without restriction; and it was easier to introduce new molecules in the formulary. For the hospital, expired drugs were the responsibility of the supplier; a reduced cost of inventory; and fewer stock outs as the supplier replenishes the consumed quantity at the beginning of every month. However, this process effectively eliminates the competition between suppliers which can potentially drive-up the purchase price of pharmaceuticals.

Towards the end of 2021, the hospital management decided to re-introduce tenders for pharmaceuticals in a two-step process. In the first step, suppliers were invited to procure the tender document only if they were willing to supply on consignment. The complete hospital drug formulary was sent to willing suppliers, bids received and analyzed, and products awarded to successful bidders. In the second step, products awarded to suppliers willing to supply on consignment were deleted from the drug formulary. The remaining products were tendered for by suppliers who were willing to supply only through local purchase orders (LPO). For this study, this is called tenders-for-consignment or hybrid system, which effectively combines the advantages offered by the traditional competitive tendering process and consignment.

This study aims to address what the effect of adopting consignment would be on the purchase price of pharmaceuticals and the liquidity ratio. The specific objectives include: i) to determine the effect of consignment on the cost price of pharmaceuticals; ii) to assess the effect of consignment on the liquidity ratio; iii) to evaluate the effect of combining a tender and consignment system on the cost price of pharmaceuticals; and iv) to compare the mean adjusted cost price of pharmaceuticals with the Management Sciences for Health (MSH) International Medical Products Price Guide 2015. The following hypotheses will be tested:

Objective 1 and 3:

H_0 - There is no significant difference between the purchase price of pharmaceuticals when obtained through consignment and tenders, and when tenders-for-consignment (hybrid model) is introduced.

Significance of the study:

Consignment can have significant benefits to the financial position of an institution. It is worth examining how shifting substantial risks from the buyer to the supplier affects the purchase price of the pharmaceuticals in a hospital setting. Additionally, the findings of this study can lead to the development of policies such as merging a tender and consignment model to benefit the buyer and protect against the higher purchase price of pharmaceuticals. The results from this study will enable the management to align the procurement policy such that the purchase price of pharmaceuticals is consistent with the international reference prices. Finally, the findings of this study will guide administrators and managers on innovative, cost-effective procurement strategies that can afford substantial savings to an organization.

Methodology

Study Setting:

BH is a not-for-profit registered and recognized non-governmental healthcare organization. It is a project of the Mkomani Clinic Society (MCS). MCS came into existence in 1979 when a group of citizens who were conscious of the dire lack of accessible, affordable health care services for the poor and needy got together and established a small outpatient facility in the Mkomani area of Mombasa, Kenya. In the last 40 years, MCS has grown, and so have its activities. Today, MCS operates the BH, its flagship institution located in Changanwe, close to the Moi International Airport. The facility has several healthcare

programs that cater to the healthcare needs of the poor, malnourished, and the HIV affected and afflicted.

BH is a level four hospital offering outpatient, inpatient, maternity, theatre, maternal and child health services, laboratory, pharmacy, and radiology services. The hospital also operates one of the most extensive HIV care and treatment and prevention programs with over 24,000 active clients. These services are replicated in six medical centres spread across Mombasa, Kilifi, and Kwale Counties. Because of the geographical location of the hospital and its satellite sites, profitability is dependent on volume rather than mark-up. All profits generated are ploughed back into the organization i.e., no disbursements are made to the directors or board members.

Study Design:

This study used a pre-post observational design to assess the effect of consignment on the medicine procurement price and liquidity ratio. The author aims to determine the effect of a procurement policy change i.e., transition from tenders to consignment, on the purchase price of pharmaceuticals. The study will also assess the effect of consignment on the liquidity ratio.

Data Source:

A. Tenders

A hospital formulary governs the pharmaceutical inventory. All medicines listed in the formulary are grouped according to the physiological system they act on, such as the cardiovascular system, central nervous system, alimentary canal, and more. Under each physiologic system, the medicines are listed by their chemical composition, dosage form, and strength. Additionally, the formulary indicates a proprietary name adjacent to each chemical composition, dosage form, and strength.

Annually, the hospital invites suppliers to purchase tenders for pharmaceuticals, surgical and consumables, printing and stationery, maintenance, housekeeping, laboratory consumables, and catering. The invite is sent by email to current and potential suppliers. Upon purchasing the tender application form for pharmaceuticals, the complete formulary list (including chemical composition, dosage form, strength, and proprietary name) is sent to the supplier via email in a password-protected Microsoft Excel document. This ensures that the bidder cannot alter any part of the formulary except the column for price. Among other instructions for pre-qualification, the supplier is requested to quote per the smallest unit, i.e., per tablet, per ampoule, etc. The award period is from January to December of the subsequent year.

B. Consignment

Consignment is "the process of a supplier placing goods at a customer location without receiving payment until after the goods are used or sold" (Ru & Wang, 2010). Unlike traditional inventory sourcing, in consignment, the goods are owned by the vendor until used by the customer, and therefore, the customer does not incur any capital costs (Gümüş et al., 2008). BH transitioned from a tender-based procurement system to a consignment model in 2020. Since this was a pilot project, the consignment was limited to pharmaceuticals. With consignment, goods were supplied on a delivery note at the beginning of each month. When the user department makes a material requisition for a product on consignment, the procurement department must generate a LPO and a virtual goods received note (GRN) to feed the ordered products in the hospital information system (HIS). The products are then transferred to the user department for consumption. At the end of the month, the supplier conducts a stock take and raises an invoice for the products consumed. The invoices were used to collect price data for products on consignment.

C. Tenders-for-Consignment (Hybrid System)

After completing the consignment pilot phase, the hospital's tender committee noted that offering consignment on a first come-first-serve basis did not result in competition among suppliers, possibly resulting in a high purchase price of medicines. Towards the end of 2021, the hospital management decided first to release tenders for consignment, i.e., only to be purchased by suppliers willing to supply on consignment. After completing the selection and awarding phase of the tender-for-consignment, all drugs selected to be supplied using this system were deleted from the formulary. A second tender was released for bidding as described in A above.

Data Collection:

The 2022 formulary was used as a backbone for data collection since it has been built from the original document and includes products added annually. Generally, no products are deleted from the formulary unless withdrawn or discontinued from the market. The 2019 tender document was obtained from the hospital's finance department and edited to exclude all quotations except for the lowest quote for each product. All products, including those that did not have a bid (inserted as a zero value), were included for the initial data collection. The price data was inserted on the data collection tool. Next, the author signed a Non-Disclosure Agreement (NDA) with the hospital to access confidential supplier invoices to collect purchase price data for medicines under consignment. Since the author had prior knowledge of the consignment suppliers, only the relevant invoices were extracted. The price data for each product on consignment was converted to the unit price by dividing the price by the pack size. The unit price was inserted adjacent to the product on the data collection tool. Lastly, the 2022 tender-for-consignment document was obtained from the finance department, and the unit price for each product was added to the data collection tool. All data were collected in Microsoft Excel 2011 (version 2204), and all prices were listed in

Kenya Shillings (KES). Data collection was performed between 19th May 2022 and 28th June 2022 by the author.

For each molecule, the author determined whether it was listed in the Kenya Essential Medicines list 2019 (Kenya-Essential-Medicines-List-2019, n.d.). Each molecule was classified based on the physiological system it acts on. This information was obtained from the British National Formulary 2012 (Joint Formulary Committee, 2012).

The second objective of this study is to determine the effect of consignment on the liquidity ratio of the hospital. In analysing the liquidity ratio, a direct comparison of cash flow statements from 2019 and 2020 was made to determine any change to the liquidity. Liquidity was calculated using the formula:

$$\text{Liquidity} = \text{current assets/current liabilities (Bem et al., 2014)}.$$

To compare the purchase price with the international reference price, the author obtained the mean international buyer unit price from the MSH International Medical Products Price Guide 2015 (Frye, 2016). The buyer price was selected because it incorporates shipping costs whereas supplier prices are Free on Board (FOB) and Ex Works (EXW) (Frye, 2016).

Data Management:

The sample used for further analysis included products for which purchase price appeared in all three columns of the data collection tool, i.e., 2019 tender price, 2020 consignment price, and 2022 tender-for-consignment price. The unit price for 2019 and 2020 was adjusted for inflation upward to 2022. Inflation rates were obtained from the Central Bank of Kenya (CBK) website (<https://www.centralbank.go.ke/>) for each month in 2019 and 2020. The average annual inflation rate was calculated by adding the inflation rate for each month and dividing the total by 12. The following formula was used to calculate the inflation-adjusted price:

$$\text{Inflation-Adjusted Price} = (1 + a)^n \times \text{base price}$$

Where: a = average annual inflation rate

 n = number of years

The inflation-adjusted unit price in KES was converted to the USD for ease of comparison with the MSH International Medical Products Price Guide 2015. The exchange rate was obtained from the CBK website and was 1 USD = KES 113.57 (January 2022).

The mean international buyer unit price in USD was extracted from the MSH International Medical Products Guide 2015 and adjusted for inflation upward to 2022. Annual inflation rates for the United States were obtained from www.statista.com, and the average annual inflation rate was calculated by adding the annual inflation rates and dividing the total by seven (2015 – 2021). Inflation-adjusted price was calculated using the formula described above. The mean purchase price per unit was calculated for all drugs, and a mean purchase price to MSH international price ratio was calculated.

The 2019 current assets and current liabilities figures from the cash flow statements were adjusted for inflation to make them comparable to the 2020 figures. The inflation rate was obtained from the CBK website, and the inflation-adjusted figures were calculated using the formula described above. To further attribute cash-savings to consignment, the author obtained the monetary value of the closing stock of pharmaceuticals in the central stores as of 31st December 2019 and compared it to the year during which consignment was implemented.

Data Analysis:

Simple descriptive statistics was used to analyse the inflation-adjusted unit purchase prices listed in the three columns described above. A percentage price change was calculated for the difference in unit price seen between 2019 tenders and 2020 consignment. Similarly, the percentage price change was calculated for the difference in unit price seen

between the 2020 consignment and 2022 tenders-for-consignment. In both instances, the range, median percentage price change and the interquartile range (IQR) was calculated. The author also calculated a net price change expressed as a percentage when the procurement system changed from tenders to consignment to tenders-for-consignment. The range, median and interquartile range was calculated for the net price change. All calculations were done in Microsoft Excel 2011 (version 2204).

The mean unit purchase price to the MSH international price ratio was calculated and reported as a range, median and IQR.

Statistical analysis was used to evaluate whether any significant price difference was seen between the tendering process employed in 2019 and the consignment purchases adopted in 2020. The Levene's test was used to determine if the data were normally distributed. An independent t test was used to test for significance between the 2019 tender price and 2020 consignment price. Similarly, the independent t test was used to determine if adopting a tender-for-consignment system resulted in a significant price difference.

A simple mathematical formula was used to determine the percentage change in the liquidity ratio between 2019 and 2020. All statistical analyses were conducted using SPSS version 25.

Ethical Consideration:

The research received an exemption from ethics review from the University of KwaZulu-Natal Biomedical Research Ethics Committee, reference number: 00015018.

Layout of the Thesis:

Chapter 1 - Provides the introduction to the study including the research background and rationale, aims and objectives, and an overview of the methodology.

Chapter 2 - Provides the literature background to the study.

Chapter 3 - Comprises of the results, discussion and conclusion written in a manuscript format.

Chapter 4 - Provides the overall conclusions, recommendations, limitations, and strengths of the study.

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Chapter 2

Literature Review

With an increase in market competition, companies, including hospitals, are continuously sourcing innovative ways to reduce costs rather than focusing solely on increasing revenue (Ru & Wang, 2010). Inventory represents a large percentage of the total expenses incurred by an organization, and a hospital is no different. Service-oriented organizations can have their procurement expenditure as high as 80% of the total expenditure necessitating the procurement to be conducted according to best practices (Mostafa et al., 2019). Professionals involved in supply chain management are constantly seeking the most cost-effective method of managing inventory (Ru & Wang, 2010) to ensure efficient use of the limited financial resources (Maniadakis et al., 2018). By definition, procurement consists of attaining the right product, in the right quality and quantity, at the right time, in the right place, from the right source, and at the correct cost (Muhia et al., 2017). According to the WHO health expenditure report 2019, global spending on health increased from USD 7.6 trillion in 2016 to USD 7.8 trillion in 2017. The report also highlights that the rate at which global health spending increased exceeds the rate the economy grew (3.9% versus 3%) between 2000 and 2017. Pharmaceuticals represent a large proportion of global health expenditure ranging from 5% to 12% in developed countries to up to 40% in developing countries (Muhia et al., 2017). In Indonesia, the government found that medicines are an essential component of the healthcare system, and medicine price profoundly affects the total healthcare costs (Anggriani et al., 2020). In the United States, 25% of Americans are only able to buy prescription medicines with difficulty owing to the high cost of prescription medicines (Vincent Rajkumar, 2020). In Indonesia, the high healthcare costs prompted the Indonesian National Health Insurance Policy development in 2014 (Anggriani et al., 2020).

This research compares two procurement methods namely, tenders and consignment. The WHO defines tenders as “any formal and competitive procurement procedure through which offers are requested, received, and evaluated for the procurement of goods, works, or services, and as a consequence of which an award is made to the tenderer whose tender/offer is the most advantageous” (Dranitsaris et al., 2017). Tenders are expected to reduce drug costs because of price competition (Maniadakis et al., 2018; Dranitsaris et al., 2017) and reduce administrative inefficiencies (Wouters et al., 2019). There are several studies that highlight the advantages of the tendering system. In Europe, tendering resulted in cost containment when coupled with legal and stakeholder management (Maniadakis et al., 2018). Cost savings and increased transparency have been noted as other advantages of the tendering system (Maniadakis et al., 2018). In South Africa, an analysis of the price trends post tenders show that the price of anti-retroviral drugs, oncological products, family-planning agents, small-volume parenterals, and solid-dose medicines fell consistently between 2003 and 2016 (Wouters et al., 2019). Comparatively, the price of medicines in the private healthcare system in South Africa, where no tendering system exists, remained higher than in the public healthcare system (Wouters et al., 2019). Similar cost saving due to price reductions is noted in China (Wouters et al., 2019) and Netherlands (von der Schulenburg et al., 2011). Zuckerman et al. (n.d.) investigated the use of a competitive bidding system to address the disparity between the cost of orthopaedic implants and the reimbursement. They found that the process led to a reduced number of vendors and resulted in a 23% reduction of the budget for implants (Zuckerman et al., n.d.).

Despite the advantages of tenders, several studies note the drawbacks with the tendering system. For organizations that select one supplier, there is a risk of supplier default which can result in drug shortages (Dranitsaris et al., 2017). Wouters et al. (2019) note that in countries such as New Zealand and Netherlands, there have been cases of drug shortages due to supply disruptions because of overdependence on a single supplier.

Canada and Greece experienced drug shortages which prompted Greece to move from a single-supplier model to a three-supplier model for hospital procurement (Dranitsaris et al., 2017). In South Africa, the success of the tenders is dependent on accurate consumption forecasts (Wouters et al., 2019). There were large discrepancies noted in the total estimated and procured quantities of medicines in South Africa which resulted in supply disruptions forcing the government to buy off-contract at a much higher price (Wouters et al., 2019). Drug shortages can impact patient care, delay medical procedure, result in medication errors (Dranitsaris et al., 2017), and harm the patient's trust in the healthcare system (Wouters et al., 2019). Xu et al. (2016) show that in consignment, a manufacturer owns and controls the inventory at the retailer, which may be effective in reducing stockouts. This leads to improved customer service, employee efficiency, and lowers ownership costs (Xu et al., 2016).

Consignment is "the process of a supplier placing goods at a customer location without receiving payment until after the goods are used or sold" (Ru & Wang, 2010). Unlike traditional inventory sourcing, in consignment, the goods are owned by the vendor until used by the customer, and therefore, the customer does not incur any capital costs (Gümüş et al., 2008). Many large retailers such as Wal-Mart, Target, and electronics/computer manufacturers have adopted consignment models with their suppliers (Ru & Wang, 2010). The mathematical model by Ru and Wang (2010) shows that consignment results in a 50-50 split in profit between supplier and retailer, especially when the supplier makes the inventory decisions.

As Wu et al. (2016) described, market demand in uncertain environments, such as hospitals, must be supported by designing optimal promotional strategies. In traditional inventory sourcing, retailers use promotional means such as advertising to increase market demand (Wu et al., 2016). Adida and Ratisoontorn (2011) note that a significant benefit of consignment is that the retailer does not incur risks associated with demand uncertainty. This risk is borne entirely by the supplier. This benefit is essential for pharmaceuticals as the

demand for a particular product is highly dependent on prescriber preference, disease patterns at the time, and the influence of marketing by pharmaceutical companies. Gümüş et al. (2008) stipulate that an essential benefit of consignment is that it allows the supplier to offer new or expensive products that the customer would otherwise be hesitant to stock. A consignment policy reduces the average inventory creating more space for new products (Battini et al., 2010). This benefit can enable a pharmacy to expand its formulary without incurring additional costs to acquire the product. In their paper, Gümüş et al. (2008) formulate a mathematical model comparing traditional inventory sourcing to consignment without a change in pricing terms to enable them to analyse the effect of consignment from an operational point of view. The model shows that consignment can benefit both the customer and the supplier (Gümüş et al., 2008).

The significant savings of inventory costs are dependent on information sharing between the vendor and retailer (Lee & Cho, 2014). A contractual agreement between the vendor and the retailer will address specific issues such as who makes decisions regarding the minimum and maximum stock levels, what happens in the event of a stock out, who takes responsibility for expired stock, how to determine consumption, and the payment terms (Ru & Wang, 2010). A well-designed consignment system, including a well-documented contract, results in cost savings for the supplier due to economies of scale. At the same time, the retailer benefits from transferring inventory costs to the supplier (Lee & Cho, 2014). Battini et al. (2010) reiterated the need for strong and continuous collaboration between the vendor and retailer to create a situation where both parties gain equally. Furthermore, Battini et al. (2010) show, through their analytical model, that traditional inventory sourcing is always more expensive when compared to the consignment approach, and the benefits are consistently high in settings with high demand variation and space limitations.

There is limited literature on consignment in the healthcare setting and even fewer involving pharmaceuticals. Increasingly, hospitals have used consignment contracts for intraocular lenses, orthopaedic implants, and pulse generators (Adida & Ratisoontorn, 2011).

In a critical review titled "Consignment Stocking Policy Models for Supply Chain Systems," Sarker (2014) notes that the most popular categories for consignment include clothing, antiques, furniture, sports equipment, medical instruments, and books. Her literature review highlights several studies outlining consignment in a healthcare setting ranging from 1983 to 2012. Specifically, Chorak (1983) showed that hospitals using consignment were able to increase inventory without increasing the bills; Crans (1985) and Keys (1991) used the consignment model in the management of linen inventory; Zuckerman et al. (1994) managed to show a reduced cost of total joint implants through the implementation of consignment. In conclusion, Sarker (2014) finds that several products in the healthcare setting are being consigned, and further investigation is required in this area.

A case study at the University of Michigan revealed an annual savings of USD 1.3 million when a team consisting of physicians and administrators, including materials management, and purchasing, was formed to specifically narrow down the number of vendors supplying interventional supplies used in the treatment of advanced coronary disease and arrhythmias, and insisting on these being provided on consignment (Eagle, Knight, Moscucci, Strickberger, et al., 2002). A similar application has been made to reduce operating room costs, allowing millions to be saved. Implants represent a high unit cost item. Depending on the type of surgery, implants may account for a large percentage of the supply cost (Park & Dickerson, 2009). Park and Dickerson (2009) argue that through product standardization, surgeon, and vendor buy-in, the hospital can negotiate the supply of implants on a consignment basis. Along with strategies such as Lean Principles, consignment can help achieve savings in cost and improve workflow (Park & Dickerson, 2009). Another case study of three hospitals in the United States shows the successful implementation of a stockless inventory system. The most obvious benefit of a stockless inventory is an improved cash flow due to a significant reduction in the total costs (Wilson et al., 1992). The University of Michigan reduced its supplies inventory from USD 1.4 million in 1982 to USD 400,000 in 1988 and managed a fill rate of 99% (Wilson et al., 1992). EHG

hospital (name disguised) managed to save USD 300,000 in its first year of stockless inventory system while Tampa General Hospital reduced its inventory by approximately USD 700,000 within two years of implementing the stockless inventory system (Wilson et al., 1992).

In 1980, the Southeastern General Hospital in North Carolina battled the financial crisis that hugely impacted healthcare (Allen, 1985). The hospital's laundry system could no longer support the 365-bed hospital, with fresh supplies taking up to three days due to the rural location of the hospital (Allen, 1985). With an inability to afford capital expenditure towards purchasing hospital linen and garments, the hospital adopted a consignment model whereby the vendor maintained linen inventory at the hospital's store (Allen, 1985). This allowed Southeastern General Hospital to increase its stock from USD 75,000 to USD 200,000 while realizing significant cost savings and cash flow benefits (Allen, 1985). Other benefits include lower interest costs due to reduced borrowing and the ability to invest additional cash in income-generating activities (Allen, 1985). Furthermore, Southeastern General Hospital extended the consignment program to include all hospital textile, urological supplies, and most plastic disposable medical/surgical products (Allen, 1985).

Malhotra et al. (2017) use three exploratory case studies involving a large electronics manufacturer [LEM] with no experience in consignment, ABC supplier with experience in supplying on consignment, and XYZ – an experienced consignment buyer. They note that since inventory purchases are no longer paid in advance, the buyer is presented with an investment opportunity (Malhotra et al., 2017). The potential savings for the buyer can be utilized or invested in other income-generating activities (Malhotra et al., 2017). On the other hand, when compared to traditional inventory sourcing, suppliers will need to own more inventory with consignment (Malhotra et al., 2017). This may discourage suppliers with a high cost of capital from entering into a consignment agreement (Malhotra et al., 2017). However, they note that for consignment to be beneficial to both parties, IT systems are required to keep track of the inventory ownership (Malhotra et al., 2017). The findings show

that XYZ reduced its stock inventory from USD 1.6 million to USD 400,000; LEM analysed that adopting consignment could free USD 1.7 million in the capital (Malhotra et al., 2017).

A study conducted in Indonesia analysed the impact of pharmaceutical policies on medicine procurement pricing under Indonesia's social health insurance system (Anggriani et al., 2020). The researcher included this study in the literature review because the objective is similar to this research topic: to compare the purchase price of pharmaceuticals before and after an intervention. Similarly, in China, pharmaceutical expenditure accounted for 44.4% of total health expenditure [in 2001], which was much higher than either developed countries [10.3-18.5% in 1997] or middle-income countries [20.7% in Argentina, 1997] (Meng et al., 2005). However, in this study, the implementation of the new retail price control policy did not seem to have any significant effect on the hospital drug expenditures (Meng et al., 2005). The authors stipulate that price control regulations should be supplemented with rational use of drugs (Meng et al., 2005). Comparatively, Anggriani et al. (2020) conclude that pharmaceutical policy, including pricing and procurement policies, should be recommended in low- to middle-income countries. The policies adopted by Indonesia, including selection, pricing, and procurement, had a direct impact on reducing medicine procurement prices (Anggriani et al., 2020).

The significance of liquidity and profitability is highlighted in a study conducted by (Louw et al., 2016). Working capital management has become an important area of focus owing to the increase in competition between firms, which has put pressure on profit margins (Louw et al., 2016). Several studies have concluded a positive relationship between working capital and profitability and that if organizations' can reduce their investment in working capital, profitability increases (Louw et al., 2016). In their study, Louw et al. (2016) find that focusing on inventory management and payment policies can reduce investment in inventory. Policies such as just-in-time (JIT) delivery systems and consignment shifts the inventory risks to the suppliers (Louw et al., 2016). Some retailers offer deliveries directly

from the supplier to the customer, further decreasing their inventory costs (Louw et al., 2016).

Gaps in the literature

A literature review shows that a consignment model has not been well studied in a healthcare setting. From the available literature, and to the best of my knowledge, the model has been used in procuring high-unit cost items such as implants or interventional supplies used in cardiology and hospital linen management. All these show significant financial benefits of the consignment system. Only one paper outlines the use of consignment to reduce the number of stock-outs in a pharmacy retail setting (Saad et al., 2018). However, it does not answer the research question – what is the effect of changing the procurement method from a tender-based system to a consignment model on the purchase price of medicines?

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Chapter 3 - Submitted Paper

This article has been submitted to the Journal Value in Health Regional Issues. See the submission acknowledgment email as proof (Appendix A).

This chapter presents the submitted paper as per the journal stipulated format (https://www.ispor.org/docs/default-source/publications/vihri_instructions-for-authors_2021.pdf) and limitations in terms of graphs, tables, and word count. Written permission to conduct the study was sought from and granted by the Biomedical Research Ethics Committee of the University of KwaZulu-Natal, (00015018 and Appendix B). See also the Bomu Hospital permission letter (Appendix C).

SG was responsible for proposal development, data collection, and analysis (with the assistance of a statistician) and the write up. VB served as supervisor.

Manuscript

The Effect of Consignment on the Price of Pharmaceuticals and Liquidity in a Private Hospital in Mombasa, Kenya

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Precis: Competitive tendering and consignment provides the lowest price and financial savings, respectively. Combining both methods has an additive effect without affecting affordability.

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Number of Tables: 4

Abstract

Objectives:

This study aims to compare the effect of tenders and consignment on the purchase price of pharmaceuticals and the effect of consignment on the liquidity. The study explores the feasibility of combining tenders and consignment to accrue the benefits of each.

Methods:

A pre-post observational study design was used to retrospectively collect pharmaceutical purchase prices from the 2019 tenders, the 2020 consignment supplier invoices, and the 2022 tenders-for-consignment. Descriptive and inferential statistics were used to determine statistical significance. Cash flow statements from 2019 and 2020 were used to determine the change in liquidity. The mean purchase price was compared to the Management Sciences for Health International Medical Products Price Guide to determine the price ratio.

Results:

The dataset included 65 products listed by proprietary name. Quantitative analysis of the purchase price obtained through tenders in 2019 and consignment in 2020 shows that the price increased by a median of 4.78% [IQR = -5.66% - 12.71%] ($p=0.48$). However, when tenders-for-consignment were introduced, the price reduced by a median of 7.71% [IQR = -11.72% - 1.935%] ($p=0.65$). Consignment resulted in a direct cash savings of KES 4,427,266.10 in one year. The median price ratio was 4.4319 [IQR = 0.8496-12.6193].

Conclusion:

Consignment offers substantial savings through reduced capital expenditure. However, eliminating competition results in higher purchase prices that can harm the affordability of medicines. Comparatively, tenders provide the best prices because of competition between suppliers. Combining both results in substantial savings for the institution without negatively impacting the cost of medicines.

Highlights

- The use of consignment has been studied for high-value items in several industries including healthcare. Primarily, consignment has been employed as a method of procurement to accrue financial savings because of reduced capital expenditure and reduced cost of borrowing. These benefits allow firms to increase their inventory without incurring additional costs resulting in increased profitability. A well-documented consignment contract can reduce stockouts, improve fill-rates, and benefit the supplier and the customer equally.
- This research compares two procurement methods i.e., tenders and consignment to purchase pharmaceuticals in a hospital set-up. The findings contribute to the existing literature outlining the advantages and disadvantages of both methods, but further analyzes the effect of consignment on the purchase price of pharmaceuticals. The research also explores the possibility of combining tenders and consignment, as a hybrid model, to accrue the benefits of both.
- The findings from this research will enable administrators, procurement managers, and pharmacy managers to provide an innovative solution to manage scarce financial resources. Since pharmaceuticals represent a large percentage of the total expenditure, hospitals stand to benefit significantly if they can implement the consignment model. Furthermore, the hybrid model outlined in this research can be used to procure other items such as surgical and consumables, hospital linen, and orthopedic implants.

Introduction

Pharmaceuticals represent a large proportion of global health expenditure ranging from 5% to 12% in developed countries to up to 40% in developing countries ¹. In most countries, irrespective of the income level, governments provide limited funding for medicines ², driving out-of-pocket spending. High medicine price restricts access to medicine which has a detrimental effect on the patients' health and the healthcare system ³.

Kenya is a Sub-Saharan African country with a population of 53.77 million and a gross domestic product (GDP) per capita of USD 2,006.8 (World Bank, 2021). Kenya is, therefore, classified as a low-and middle-income country (LMIC). The government of Kenya aims to achieve universal health coverage (UHC) by 2030 through the National Health Insurance Fund (NHIF). However, only 11% of the total population was enrolled in this scheme by 2014 ⁴. To achieve UHC, access to medicines is essential ⁴.

Muhia *et al.* (2017) noted that to improve health management at an affordable rate, the procurement of pharmaceuticals and addressing the challenges faced play a critical role. Service organizations, such as hospitals, often purchase items of high value and may account for up to 80% of the total expenditure ⁵. As such, it is paramount that the procurement process be conducted according to the best practices to save costs, minimize waste, and streamline operations to gain competitive advantage ⁵. A well-structured procurement system will enable the acquisition of quality products in the correct quantity, at the right time, and the right cost ¹. Smooth operations of hospital departments are, therefore, highly dependent on an efficient procurement system.

This research focuses on three procurement systems i.e., a competitive tendering process, consignment, and tenders-for-consignment adopted in Bomu Hospital (BH), a private not-for-profit hospital located in Changamwe, a peri-urban suburb of Mombasa, Kenya. BH focuses mainly on serving the under-served members of society, and therefore, all paid services are highly subsidized. It is the mandate of the hospital's procurement and pharmacy department to ensure the hospital's inventory falls within the annual budget yet ensures the availability of all commodities to allow smooth operations of all departments.

A competitive tendering process is most likely to result in a procurement process free of bureaucracy, is transparent, and results in the acquisition of quality drugs at the cheapest market rate ¹. The competitive bidding coupled with the prospect of bulk purchase is expected to reduce the drug costs by generating competition between pharmaceutical firms ⁶. In 2014, BH adopted a competitive tendering process for the procurement of all commodities. The tendering process resulted in a reduction in the total inventory held by the hospital since a formulary governed the products. However, this still meant that a significant proportion of capital is set aside for the purchase of commodities.

Despite the many advantages, there is a downside to the tendering process. As seen in South Africa, tendering is dependent on accurate consumption forecast which may be difficult to achieve and may result in stock-outs and supply disruptions ⁶.

To further reduce the cost of inventory, BH adopted the consignment model in 2020 for pharmaceuticals. Consignment is "the process of a supplier placing goods at a customer location without receiving payment until after the goods are used or sold" ⁷. Unlike traditional inventory sourcing, in consignment, the goods are owned by the vendor until used by the customer, and therefore, the customer does not incur any capital costs ⁸.

A consignment contract was signed between a willing supplier and the hospital prior to the supply of products on a first come-first serve basis. To ensure its success, the consignment contract was drawn to mutually benefit the hospital and the supplier. However, this process effectively eliminates the competition between suppliers which can potentially drive-up the purchase price of pharmaceuticals.

Towards the end of 2021, the hospital management decided to re-introduce tenders for pharmaceuticals in a two-step process. In the first step, suppliers were invited to procure the tender document only if they were willing to supply on consignment. This is called tenders-for-consignment or hybrid system, which effectively combines the advantages offered by the traditional competitive tendering process and consignment. In the second step, products awarded on consignment were deleted from the drug formulary and were tendered for by suppliers who were willing to supply only through local purchase orders (LPO).

This study aims to compare the effect of tenders and consignment on the purchase price of pharmaceuticals and the effect of consignment on the liquidity. The study explores the feasibility of combining tenders and consignment to accrue the benefits of each. The researcher also compares the mean adjusted cost price of pharmaceuticals with the Management Sciences for Health (MSH) International Medical Products Price Guide 2015.

Method

Study Setting:

Bomu Hospital is a not-for-profit non-governmental healthcare organization with a mission to provide safe, affordable, high-quality health and wellness services – with a special commitment to the underserved – delivered by dedicated professional teams operating from modern and accessible facilities. As such, all services are highly subsidized. Profitability is dependent on volume rather than mark-up and all profits are ploughed back into the organization.

Study Design:

This study used a pre-post observational design to assess the effect of consignment on the medicine procurement price and liquidity ratio.

Data Collection:

The 2022 formulary was used as a backbone for data collection as it has been built from the original document and includes products added annually. Generally, no products are deleted from the formulary unless withdrawn or discontinued from the market. The 2019 tender document was obtained from the hospital's finance department and edited to exclude all quotations except for the lowest quote for each product. All products, including those that did not have a bid (inserted as a zero value), were included for the initial data collection. The price data was inserted on the data collection tool. Next, the author signed a Non-Disclosure Agreement (NDA) with the hospital to access confidential supplier invoices to collect purchase price data for medicines under consignment. Lastly, the 2022 tender-for-consignment document was obtained from the finance department, and the price for each product was added to the data collection tool. All price data were converted to the unit price by dividing the price by the pack size. Data was

collected in Microsoft Excel 2011 (version 2204), and all prices were listed in Kenya Shillings (KES).

For each molecule, the author determined whether it was listed in the Kenya Essential Medicines list 2019 ⁹. Each molecule was classified based on the physiological system it acts on as per the British National Formulary 2012.

The second objective of this study is to determine the effect of consignment on the liquidity ratio of the hospital. In analyzing the liquidity ratio, a direct comparison of cash flow statements from 2019 and 2020 was made. Liquidity was calculated using the formula:

$$\text{Liquidity} = \text{current assets/current liabilities}^{10}.$$

To compare the purchase price with the international reference price, the author obtained the mean international buyer unit price from the MSH International Medical Products Price Guide 2015 ¹¹. The buyer price was selected because it incorporates shipping costs whereas supplier prices are Free on Board (FOB) and Ex Works (EXW) ¹¹.

Data Management:

Products for which purchase price appeared in all three columns, i.e., 2019 tender price, 2020 consignment price, and 2022 tender-for-consignment price, were included for further analysis. All unit prices for 2019, 2020, and 2021 were adjusted for inflation upward to 2022. Inflation rates were obtained from the Central Bank of Kenya (CBK) website (<https://www.centralbank.go.ke/>). The following formula was used to calculate the inflation-adjusted price:

$$\text{Inflation-Adjusted Price} = (1 + a)^n \times \text{base price}$$

Where: a = average annual inflation rate

 n = number of years

The inflation-adjusted unit price in KES was converted to the United States Dollar (USD) for ease of comparison with the MSH International Medical Products Price Guide 2015. The exchange rate was obtained from the CBK website and was 1 USD = KES 113.57 (January 2022).

The mean international buyer unit price in USD was extracted from the MSH International Medical Products Guide 2015 and adjusted for inflation upward to 2022 using the annual inflation rates obtained from www.statista.com. The mean purchase price per unit was calculated for all drugs, and a mean purchase price to MSH international price ratio was calculated.

The 2019 current assets and current liabilities figures from the cash flow statements were adjusted for inflation to make them comparable to the 2020 figures. To further attribute cash-savings to consignment, the author obtained the monetary value of the closing stock of pharmaceuticals in the central stores as of 31st December 2019 and compared it to the year during which consignment was implemented.

Data Analysis:

Descriptive and inferential statistics were used to analyze the inflation-adjusted unit purchase prices listed in the three columns described above. A percentage price change was calculated for the difference in unit price seen between 2019 tenders and 2020 consignment, and between 2020 consignment and 2022 tenders-for-consignment. In all instances, the range, median percentage price change and the interquartile range (IQR) were calculated. An independent t test was conducted to examine the mean differences between prices for pharmaceuticals in a consignment

system with the mean prices for pharmaceuticals in a tender system, and the mean differences between prices for pharmaceuticals in a consignment system with the mean prices for pharmaceuticals in a hybrid system. An alpha value of 0.05 was used. The Levene's test was used to determine if the data were normally distributed. The author also calculated a net price change expressed as a percentage when the procurement system changed from tenders to consignment to tenders-for-consignment. The range, median and interquartile range was calculated for the net price change. All descriptive statistics were done in Microsoft Excel 2011 (version 2204). Inferential statistics were conducted in SPSS version 25.

The mean unit purchase price to the MSH international price ratio was calculated and reported as a range, median and IQR.

A simple mathematical formula was used to determine the percentage change in the liquidity ratio between 2019 and 2020.

Ethical Considerations:

The research received an exemption from ethics review from the University of KwaZulu-Natal Biomedical Research Ethics Committee, reference number: 00015018.

Results:

The 2022 formulary document consisted of 471 molecules listed by their chemical composition. Each chemical composition was further categorized into dosage form and strength, and for each dosage form and strength, a proprietary name was listed. A total of 754 products were listed by proprietary name in the 2022 formulary which was used as the data collection tool.

Comparatively, in 2019, the formulary consisted of 390 molecules corresponding to 577 products listed by proprietary name. A total of 81 molecules and 177 products listed by proprietary name have been added to the formulary between December 2019 and December 2021.

From the 2019 tender document, 64.6% (n=487) of the products had a quotation from the supplier. The remaining 267 products included those that did not have any bidder and products that were added in subsequent years i.e., 2020 and 2021. In 2020 when consignment was introduced, 22.5% (n=170) of the products were supplied on consignment. The remaining 584 products were procured after seeking a minimum of three quotations from the market. However, these (n=584) were not included in further analysis. Lastly, towards the end of 2021, the hospital introduced tenders-for-consignment to take effect in 2022. In this tender, 465 products had a quotation representing 61.7% of the total formulary. The remaining 289 products were tendered for separately but not included in further analysis.

Visual inspection of the data highlighted 65 products that had a quotation in all three columns of the data collection tool, i.e., 2019 tender price, 2020 consignment price, and 2022 tender-for-consignment price, representing 8.6% of the total formulary. These 65 products were included for further analysis. The 65 products listed by proprietary name represented 54 molecules acting on different physiological systems. Analysis of these 65 products showed that 12.3% (n=8) act on systemic infections such as bacterial, amoebic, and fungal; 4.6% (n=3) are preparations used

to treat vaginal and vulval fungal infections and urinary retention. Two of the three products represent the same formulation but different strength of the same chemical composition. Furthermore, 23.1% (n=15) act on the gastrointestinal system and include products such as antacids and simethicone, antispasmodics, proton-pump inhibitors, and local preparations for anal and rectal disorders; 13.8% (n=9) act on the central nervous system and mostly belong to non-opioid analgesics; and 16.9% (n=11) act on the respiratory system with most of the drugs being antihistamines and cough preparations. The remaining products (n=19) act on ear, nose, and oropharynx (n=3), endocrine system (n=3), nutrition and blood (n=4), eye (n=2), and skin (n=7). Table 1 highlights the list of 65 products with their chemical composition, classification, formulation, strength, and proprietary name.

Chemical Composition	Classification	Formulation	Strength	Proprietary Name
Ciprofloxacin	Infections - Antibacterial	Tablets	500mg	Kuin
Levofloxacin	Infections - Antibacterial	Tablets	500mg	Glevonix
Cefixime	Infections - Antibacterial	Suspension	100mg/5ml (35ml)	Ceflorex
Cefuroxime	Infections - Antibacterial	Tablets	500mg	Altacef
Metronidazole	Infections - Antibacterial	Injectible	5mg/ml	Metronidazole
Itraconazole	Infections - Antifungal	Capsules	100mg	Fulcover
	Infections - Antifungal	Capsules	100mg	Canditral
Albendazole	Infections - Anthelmintics	Tablets	400mg	ABZ
Clotrimazole	Obstetrics, Gynaecology, and Urinary Tract Disorders - Preparations for vaginal and vulval candidiasis	Pessaries	200mg	Candid V3
	Obstetrics, Gynaecology, and Urinary Tract Disorders - Preparations for vaginal and vulval candidiasis	Pessaries	100mg	Candid V6
Tamsulosin	Obstetrics, Gynaecology, and Urinary Tract Disorders - Drugs for genito-urinary disorders	Tablets	0.4mg	Contiflo OD
Aluminium oxide/Mg Hydroxide/Simethicone	Gastrointestinal system - Dyspepsia and gastro-oesophageal reflux disease	Suspension	200ml	Flatameal-DS
Aluminium Hydroxide/Mg Hydroxide/ Simethicone	Gastrointestinal system - Dyspepsia and gastro-oesophageal reflux disease	Suspension	180ml	Relcer gel
Sodium Alginate/Sodium bicarbonate/Calcium carbonate	Gastrointestinal system - Dyspepsia and gastro-oesophageal reflux disease	Suspension	200ml	Gaviscon
Esomeprazole	Gastrointestinal system - Antisecretory drugs and mucosal protectants	Tablets	20mg	Esome
	Gastrointestinal system - Antisecretory drugs and mucosal protectants	Tablets	40mg	Esome
Omeprazole	Gastrointestinal system - Antisecretory drugs and mucosal protectants	Capsules	20mg	Omeceer
Rabeprazole	Gastrointestinal system - Antisecretory drugs and mucosal protectants	Tablets	20mg	Razid
Rabeprazole/Mosapride	Gastrointestinal system - Antisecretory drugs and mucosal protectants	Tablets	20mg/15mg	Razid M

Dicyclomine/Paracetamol	Gastrointestinal system - Antispasmodics and other drugs altering gut motility	Syrup	10mg/40mg	Cyclopam
Hyoscine-N-butylbromide	Gastrointestinal system - Antispasmodics and other drugs altering gut motility	Injectible	40mg	Hysomide
Glycerine suppositories	Gastrointestinal system - Laxatives	Suppository	1g	Glycerin
	Gastrointestinal system - Laxatives	Suppository	2g	Glycerin
Hydrocortisone/Cinchocaine/Nemycin/Aesculin	Gastrointestinal system - Local preparations for anal and rectal disorders	Ointment	15gm	Anustat
Zinc Oxide/Bismuth Oxide/Bismuth subgallate/Balsum Peru	Gastrointestinal system - Local preparations for anal and rectal disorders	Ointment	25gm	Anusol
	Gastrointestinal system - Local preparations for anal and rectal disorders	Suppository	10's	Anusol
Aceclofenac	Central Nervous system - Non opioid analgesics and compound analgesic preparations	Tablets	200mg	Zyrtal OD
Aceclofenac/Paracetamol/Chlorzoxazone	Central Nervous system - Non opioid analgesics and compound analgesic preparations	Tablets	100mg/500mg/500mg	Zyrtal MR
Aceclofenac/Serratiopeptidase	Central Nervous system - Non opioid analgesics and compound analgesic preparations	Tablets	100mg/15mg	Zyrtal SP
Ibuprofen/Paracetamol	Central Nervous system - Non opioid analgesics and compound analgesic preparations	Tablets	400mg/325mg	Brustan
	Central Nervous system - Non opioid analgesics and compound analgesic preparations	Syrup	100mg/5ml	Brustan
Paracetamol	Central Nervous system - Non opioid analgesics and compound analgesic preparations	Effervescent Tablets	500mg	Cipladon
	Central Nervous system - Non opioid analgesics and compound analgesic preparations	Effervescent Tablets	1g	Cipladon
	Central Nervous system - Non opioid analgesics and compound analgesic preparations	Syrup	240mg/5ml	Panadol for children

	Central Nervous system - Non opioid analgesics and compound analgesic preparations	Infusion	1g	Paracetamol
Paradichlorobenzene/Benzocaine/Chlorobutanol/Turpentine oil	Ear, nose and oropharynx - Drugs acting on the ear	Drops	10ml	Otorex
Choline Salicylate/Benzalkonium chloride/Lidocaine	Ear, nose and oropharynx - Drugs acting on the mouth	Gel	10g	Dentogel
Chlorhexidine/Metronidazole/Lidocaine	Ear, nose and oropharynx - Drugs acting on the mouth	Gel	15g	Quadrajel
Dydrogesterone	Endocrine system - Sex hormones	Tablets	10mg	Duphaston
Dexamethasone	Endocrine system - Corticosteroids	Injectible	4mg	Dexamethasone
Metformin/Glibenclamide	Endocrine system - Drugs used in diabetes	Tablets	500mg/5mg	Glucomet N
Vitamin B complex (Vit. B1, B6, B12)	Nutrition and blood - Vitamins	Tablets	200mg/50mg/1000mcg	Neuroforte
Ca Citrate, Vitamin D3, Mg, Zn	Nutrition and blood - Minerals	Tablets	1000mg/200IU/100mg/ 4mg	Bonium
Carbonyl iron, folic acid	Nutrition and blood - Anaemias and some other blood disorders	Tablets	100mg/500mcg	Saferon plus
Glucosamine/Chondroitin	Nutrition and blood - Minerals	Tablets	500mg/400mg	Freeflex
Adrenaline	Respiratory system - Antihistamines, hyposensitization, and allergic emergencies	Injectible	1mg/ml	Adrenaline
Cetirizine	Respiratory system - Antihistamines, hyposensitization, and allergic emergencies	Tablets	10mg	Cezine
	Respiratory system - Antihistamines, hyposensitization, and allergic emergencies	Syrup	1mg/ml	Cezine
Levocetirizine	Respiratory system - Antihistamines, hyposensitization, and allergic emergencies	Tablets	5mg	Glencet
Levocetirizine/Montelukast	Respiratory system - Antihistamines, hyposensitization, and allergic emergencies	Tablets	5mg/10mg	Glemont L

Montelukast	Respiratory system - Antihistamines, hyposensitization, and allergic emergencies	Tablets	5mg	Montana
	Respiratory system - Antihistamines, hyposensitization, and allergic emergencies	Tablets	10mg	Montana
Salbutamol/Bromhexine/Guaifenesin/Menthol	Respiratory system - Cough preparations	Syrup	100ml	Ascoril
Terbutaline/Ambroxol/Guaifenesin/Sodium citrate/Levomenthol	Respiratory system - Cough preparations	Syrup	100ml	Aromel Plus
Terbutaline/Bromhexine/Guaifenesin/Menthol	Respiratory system - Cough preparations	Syrup	100ml	Brozedex
Dextromethorphan/Tripolidine/Pseudoephedrine/Menthol	Respiratory system - Cough preparations	Syrup	100ml	Ascoril D
Tetracycline	Eye - Anti-infective eye preparations	Ointment	0.01%	Ocucycline
Betamethasone/Neomycin	Eye - Anti-infective eye preparations	E/E drops	7.5ml	Probeta N
Mupirocin	Skin - Anti-infective skin preparations	Ointment	15g	Zupricin
Mupirocin/Betamethasone	Skin - Anti-infective skin preparations	Ointment	15g	Zupricin B
Clotrimazole	Skin - Antifungal preparations	Cream	15g	Candid
Ketoconazole/Zinc pyrithione	Skin - Antifungal preparations	Shampoo	200ml	Ketoplus
Lindane	Skin - Anti-infective skin preparations	Lotion	75ml	Liceoma
Clotrimazole/Beclomethasone dipropionate	Skin - Antifungal preparations	Cream	20g	Candid B
Miconazole/Beclomethasone/Neomycin	Skin - Antifungal preparations	Ointment	15g	Beclomin

Table 1 – List of products selected for analysis. All products are listed by their chemical composition, classification, formulation type, strength, and the proprietary name.

A price comparison between the tender system in 2019 and the consignment system in 2020 was done after converting the price in KES to USD and adjusting for inflation, showed that 44.6% (n=29) of the products resulted in a decrease in price when obtained through consignment. It was noted that 55.4% of the products showed a price increase when obtained through consignment. The percentage price change ranged from -35.85% to 96.16% [Median = 4.78%; IQR = -5.66% - 12.71%] with the highest price decrease seen in Ketoplus Shampoo[®] and largest price increase seen in Adrenaline injections [Laborate, India] (Table 2). Similar analysis was done to compare the unit price obtained through consignment with the unit price obtained when tenders-for-consignment was adopted. This showed that 66.2% (n=43) of the products show a decrease in price when tenders-for-consignment was used as a procurement method. Only 33.8% (n=22) products showed a price increase. Compared to tenders versus consignment, the percentage price change ranged from -169.11% to 22.85% [Median= -7.71%; IQR = -11.72% - 1.935%] (Table 2).

			Tender Price 2019	Consignment Price 2020	Hybrid System 2022			
Proprietary Name	Formulation	Strength	Price in USD	Price in USD	Price in USD	Percentage Change in Price (Tenders versus Consignment)	Percentage Change in Price (Consignment versus Hybrid)	Net Percentage Change in Price
Glycerin	Suppository	1g	0.1247	0.1926	0.0716	35.25	-169.11	-133.86
Glycerin	Suppository	2g	0.1424	0.2049	0.0872	30.52	-135.10	-104.59
Paracetamol	Infusion	1g	0.7796	1.1805	0.6164	33.96	-91.52	-57.56
Candid V3	Pessaries	200mg	0.9220	0.6820	0.6604	-35.18	-3.28	-38.46
Ocucycline	Ointment	0.01	0.2079	0.1967	0.1497	-5.66	-31.44	-37.10
Omeccer	Capsules	20mg	0.1819	0.1462	0.1308	-24.46	-11.70	-36.16
Ketoplus	Shampoo	200ml	8.4403	6.2130	6.4348	-35.85	3.45	-32.40
Flatameal-DS	Suspension	200ml	2.1828	2.1642	1.7434	-0.86	-24.13	-25.00
Brozedex	Syrup	100ml	1.4032	1.7707	1.2767	20.75	-38.69	-17.94
Brustan	Syrup	100mg/5ml	2.2348	2.1150	1.8931	-5.66	-11.72	-17.39
Brustan	Tablets	400mg/325mg	0.0935	0.0885	0.0792	-5.66	-11.72	-17.39
Dexamethasone	Injectible	4mg	0.0728	0.1476	0.0881	50.69	-67.58	-16.89
Glencet	Tablets	5mg	0.3056	0.2889	0.2642	-5.78	-9.36	-15.15
Canditral	Capsules	100mg	0.7796	0.7378	0.6824	-5.66	-8.12	-13.78
Glevonix	Tablets	500mg	0.4989	0.3935	0.4579	-26.80	14.06	-12.74
Anustat	Ointment	15gm	2.4427	2.7052	2.2101	9.71	-22.40	-12.70
Beclomin	Ointment	15gm	1.1954	1.2690	1.0742	5.80	-18.13	-12.33

Candid	Cream	15gm	1.9230	1.8494	1.7170	-3.98	-7.71	-11.69
Candid V6	Pessaries	100mg	0.4470	0.4230	0.4033	-5.66	-4.89	-10.56
Metronidazole	Injectible	5mg/ml	0.2339	0.2754	0.2201	15.09	-25.13	-10.04
Zupricin	Ointment	15gm	3.6588	3.5906	3.3460	-1.90	-7.31	-9.21
Zupricin B	Ointment	15gm	4.5632	4.4759	4.2265	-1.95	-5.90	-7.85
Cipladon/Parafast	Effervescent Tablets	500mg	0.0915	0.1033	0.0881	11.44	-17.31	-5.86
Ascoril	Syrup	100ml	1.3929	1.3182	1.3208	-5.66	0.20	-5.47
Ascoril D	Syrup	100ml	2.2036	2.0855	2.0956	-5.66	0.48	-5.18
Dentogel	Gel	10g	1.2993	1.2297	1.2415	-5.66	0.96	-4.71
Contiflo OD	Tablets	0.4mg	0.6029	0.5706	0.5785	-5.66	1.37	-4.29
Ceflorex	Suspension	100mg/5ml (35ml)	4.2908	4.3284	4.1384	0.87	-4.59	-3.72
Aromel Plus	Syrup	100ml	2.0269	2.2035	1.9724	8.02	-11.72	-3.71
Glemont L	Tablets	5mg/10mg	0.4740	0.4483	0.4579	-5.73	2.09	-3.64
Liceoma	Lotion	75ml	1.6111	1.6920	1.5673	4.78	-7.96	-3.18
Fulcover	Capsules	100mg	0.7484	0.8185	0.7326	8.56	-11.72	-3.16
Zyrtal OD	Tablets	200mg	0.2027	0.2233	0.1999	9.23	-11.72	-2.49
Montana	Tablets	10mg	0.3160	0.3485	0.3120	9.33	-11.72	-2.38
Montana	Tablets	5mg	0.2786	0.3064	0.2755	9.07	-11.20	-2.13
Altacef	Tablets	500mg	0.5197	0.4919	0.5107	-5.66	3.69	-1.98
Zyrtal SP	Tablets	100mg/15mg	0.2079	0.2304	0.2063	9.79	-11.70	-1.91
Kuin	Tablets	500mg	0.1663	0.1859	0.1664	10.55	-11.72	-1.17
Glucomet N	Tablets	500mg/5mg	0.0665	0.0685	0.0660	2.90	-3.74	-0.84
Cyclopam	Syrup	10mg/40mg	1.1330	1.0723	1.1271	-5.66	4.86	-0.80

Zyrtal MR	Tablets	100mg/500mg/500mg	0.2443	0.2769	0.2479	11.79	-11.72	0.07
Razid M	Tablets	20mg/15mg	0.2858	0.3246	0.2906	11.95	-11.72	0.23
Razid	Tablets	20mg	0.1455	0.1653	0.1479	11.95	-11.72	0.23
Anusol	Ointment	25gm	4.9893	5.1154	5.0630	2.46	-1.03	1.43
Neuroforte	Tablets	200mg/50mg/1000mcg	0.1143	0.1077	0.1167	-6.15	7.67	1.53
Quadrajel	Gel	15g	1.9749	1.8691	2.0252	-5.66	7.71	2.04
Bonium	Tablets	1000mg/200IU/100mg/ 4mg	0.1175	0.1112	0.1233	-5.66	9.82	4.16
Cezine	Tablets	10mg	0.1195	0.1426	0.1277	16.20	-11.72	4.48
Cipladon/Parafast	Effervescent Tablets	1g	0.1819	0.2029	0.1937	10.35	-4.74	5.61
Panadol for children	Syrup	240mg/5ml	2.6090	2.9020	2.7824	10.10	-4.30	5.80
Esose	Tablets	20mg	0.1299	0.1230	0.1409	-5.66	12.72	7.05
Otorex	Drops	10ml	1.5800	1.4953	1.7170	-5.66	12.91	7.25
Cezine	Syrup	1mg/ml	1.0914	1.0821	1.1799	-0.86	8.29	7.43
Freeflex	Tablets	500mg/400mg	0.2308	0.2181	0.2527	-5.82	13.71	7.89
Relcer gel	Suspension	180ml	1.8190	1.7215	2.0252	-5.66	14.99	9.33
Adrenaline	Injectible	1mg/ml	0.0062	0.1623	0.0881	96.16	-84.34	11.82
Probeta N	E/E drops	7.5ml	0.7068	0.7870	0.8013	10.19	1.78	11.97
Hysomide	Injectible	40mg	0.0333	0.2951	0.1673	88.73	-76.40	12.33
Esose	Tablets	40mg	0.1632	0.2164	0.2201	24.59	1.69	26.28
Gaviscon	Suspension	200ml	4.0434	4.6727	5.4592	13.47	14.41	27.87
Duphaston	Tablets	10mg	0.3929	0.6886	0.6186	42.94	-11.32	31.62
Candid B	Cream	20g	1.4240	2.7446	2.4654	48.11	-11.32	36.79

Anusol	Suppositories	10's	0.4158	0.5115	0.6630	18.72	22.85	41.57
ABZ	Tablets	400mg	0.0759	0.1476	0.1514	48.58	2.57	51.15
Saferon plus	Tablets	100mg/500mcg	0.0582	0.1640	0.1541	64.50	-6.40	58.10

Table 2 – Net percentage change in unit purchase price when procurement system changed from tenders in 2019 to tenders-for-consignment (hybrid system) in 2022.

The Levene's test for equality of variances showed no violations ($p = 0.296$). The results indicate that the purchase price of pharmaceuticals through the consignment system ($M=0.76$, $SD=0.53$) were higher than the purchase price through the tender system ($M=0.69$, $SD=0.61$) and with $t(128)=-0.71$, $p=0.48$, Cohen's $D = 0.12$. The purchase price of pharmaceuticals obtained through the consignment system ($M=0.76$, $SD=0.53$) were higher when compared to the purchase prices in the hybrid system ($M=0.72$, $SD=0.56$) and with $t(128)=0.456$, $p=0.65$, Cohen's $D = 0.08$.

The net percentage price change from tenders in 2019 to the tender-for-consignment (hybrid system) in 2022, shows that 61.5% ($n=40$) products displayed a decrease in price ranging from 0.80% to 133.86% [Median = 9.625%; IQR = 17.39% - 3.18%]. Twenty-five products, however, displayed an overall increase in price when the procurement system changed from tenders to consignment to tenders-for-consignment. The percentage price increase ranged from 0.07% to 58.10% [Median = 7.43%; IQR = 3.1% - 27.075%] (Table 2).

The results indicate that of the 54 molecules selected for further analysis, 29.6% ($n=16$) appeared in the Kenya Essential Medicines List (2019) and 42.6% ($n=23$) appeared in the MSH International Medical Products Price Guide (2015). Table 3 distinguishes between the molecules that are listed in the Kenya Essential Medicines List (2019) and those that are not.

Chemical Composition	Formulation	Strength	Kenya EML 2019 (Y/N)
Ciprofloxacin	Tablets	500mg	Y
Levofloxacin	Tablets	500mg	Y
Cefixime	Suspension	100mg/5ml (35ml)	Y
Cefuroxime	Tablets	500mg	N
Metronidazole	Injectible	5mg/ml	Y
Itraconazole	Capsules	100mg	Y
Clotrimazole	Pessaries	200mg	N
	Pessaries	100mg	
Aluminium oxide/Mg Hydroxide/Simethicone	Suspension	200ml	N
Aluminium Hydroxide/Mg Hydroxide/ Simethicone	Suspension	180ml	N
Sodium Alginate/Sodium bicarbonate/Calcium carbonate	Suspension	200ml	N
Esomeprazole	Tablets	20mg	N
		40mg	
Omeprazole	Capsules	20mg	Y
Rabeprazole	Tablets	20mg	N
Rabeprazole/Mosapride	Tablets	20mg/15mg	N
Dicyclomine/Paracetamol	Syrup	10mg/40mg	N
Hyoscine-N-butylbromide	Injectible	40mg	Y
Glycerine suppositories	Suppository	1g	N
		2g	
Albendazole	Tablets	400mg	Y
Hydrocortisone/Cinchocaine/Nemycin/Aesculin	Ointment	15gm	N
Zinc Oxide/Bismuth Oxide/Bismuth subgallate/Balsum Peru	Ointment	25gm	N
	Suppositories	10's	
Tamsulosin	Tablets	0.4mg	Y
Acetofenac	Tablets	200mg	N
Acetofenac/Paracetamol/Chlorzoxazone	Tablets	100mg/500mg/500mg	N
Acetofenac/Serratiopeptidase	Tablets	100mg/15mg	N
Ibuprofen/Paracetamol	Tablets	400mg/325mg	N
	Syrup	100mg/5ml	
Paracetamol	Effervescent		Y
	Tablets	500mg	

		1g	
		240mg/5ml	
	Infusion	1g	
Paradichlorobenzene/Benzocaine/Chlorobutanol/Turpentine oil	Drops	10ml	N
Dydrogesterone	Tablets	10mg	N
Dexamethasone	Injectible	4mg	Y
Metformin/Glibenclamide	Tablets	500mg/5mg	N
Vitamin B complex	Tablets	200mg/50mg/1000mcg	N
Ca Citrate, Vitamin D3, Mg, Zn	Tablets	1000mg/200IU/100mg/	N
		4mg	
Carbonyl iron, folic acid	Tablets	100mg/500mcg	N
Adrenaline	Injectible	1mg/ml	Y
Cetirizine	Tablets	10mg	N
	Syrup	1mg/ml	
Levocetirizine	Tablets	5mg	N
Levocetirizine/Montelukast	Tablets	5mg/10mg	N
Montelukast	Tablets	5mg	Y
		10mg	
Salbutamol/Bromhexine/Guaifenesin/Menthol	Syrup	100ml	N
Terbutaline/Ambroxol/Guaifenesin/Sodium citrate/Levomenthol		100ml	N
Terbutaline/Bromhexine/Guaifenesin/Menthol	Syrup	100ml	N
Dextromethorphan/Tripolidine/Pseudoephedrine/Menthol	Syrup	100ml	N
Tetracycline	Ointment	0.01	Y
Betamethasone/Neomycin	E/E drops	7.5ml	N
Mupirocin	Ointment	15g	Y
Mupirocin/Betamethasone	Ointment	15g	N
Chlorhexidine/Metronidazole/Lidocaine	Gel	15g	N
Clotrimazole	Cream	15g	Y
Ketoconazole/Zinc pyrithione	Shampoo	200ml	N
Lindane	Lotion	75ml	N
Clotrimazole/Beclomethasone dipropionate	Cream	20g	N
Miconazole/Beclomethasone/Neomycin	Ointment	15g	N
Choline Salicylate/Benzalkonium chloride/Lidocaine	Gel	10g	N
Glucosamine/Chondroitin	Tablets	500mg/400mg	N

Table 3 – List of essential versus non-essential medicines as per the Kenya Essential Medicines list 2019.

An analysis of the Essential Medicines showed similar trends as other drugs. When the procurement system changed from tenders in 2019 to consignment in 2020, the percentage price change ranged from -21.13% to 2,502.59% [Median = 10.29%; IQR = -2.85% - 69.20%]. Therefore, most essential medicines exhibited a price increase. With the introduction of tenders-for-consignment, the percentage price change ranged from -47.79% to 16.36% [Median = -10.47%; IQR = -22.00% - -4.46%]. All products except three displayed a price reduction when tenders-for-consignment was introduced. The net percentage price change ranged from -30.13% to 2,456.83% [Median = -1.13%; IQR = -13.45% - 7.06%]. Omeprazole 20mg capsules displayed the largest net price reduction whereas Adrenaline 1mg injections showed the largest net price increase when the procurement system changed from tenders to consignment to tenders-for-consignment (Figure 1).

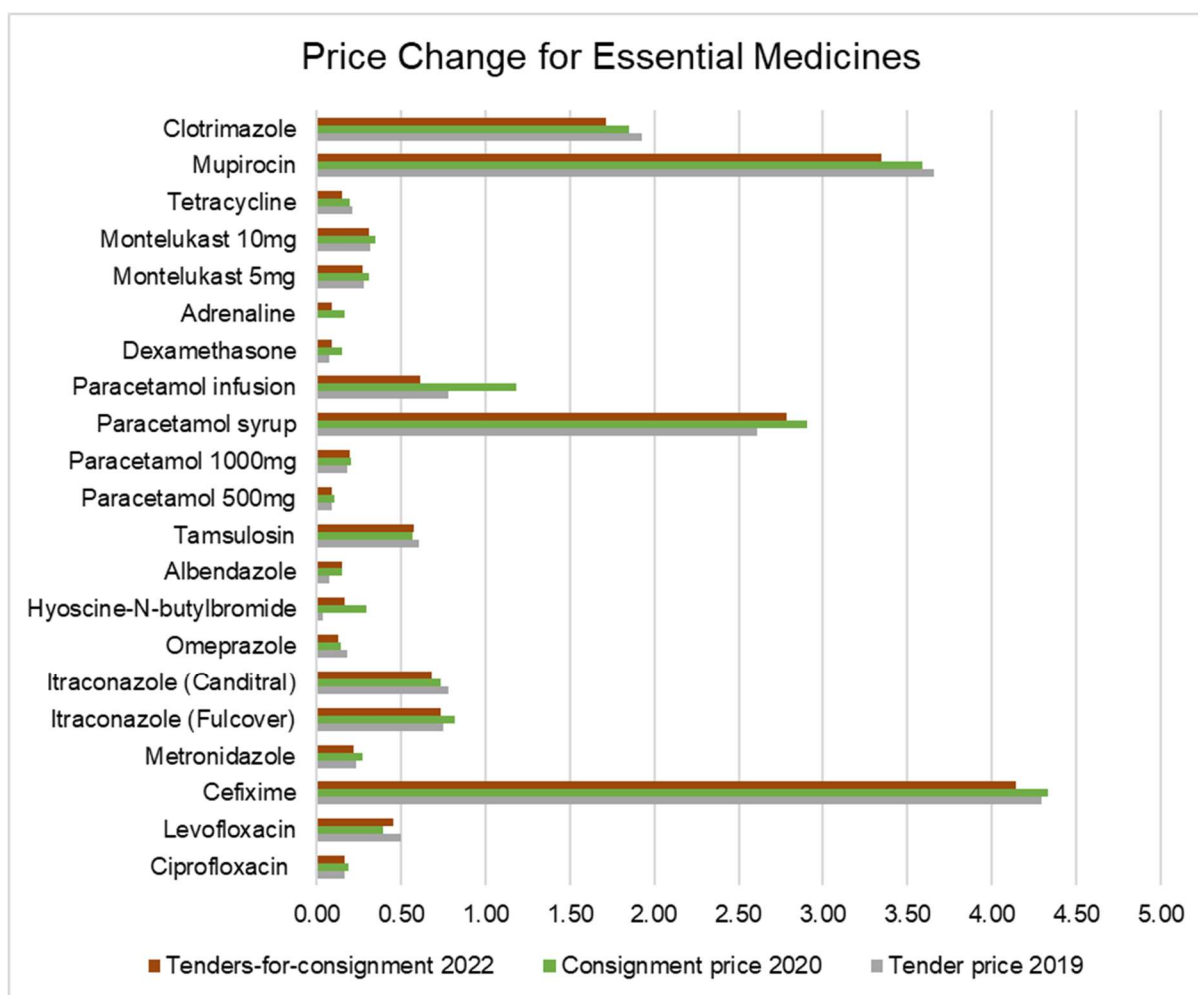


Figure 1 - Price change for Essential Medicines across the three procurement methods

The researcher compared the mean unit purchase price with the MSH International Medical Products Price 2015 and calculated the mean unit purchase price to MSH international reference price ratio. The mean unit buyer price in USD from the MSH international price guide was available for 23 out of the 54 molecules analyzed. The results show that the ratio ranges from 0.3810 to 203.5284 [Median = 4.4319; IQR = 0.8496-12.6193] (Table 4).

Chemical Composition	Classification	Formulation	Strength	Mean price in USD	MSH International Price Reference 2015 in USD adjusted for inflation	Mean Price:MSH reference price ratio
Dexamethasone	Endocrine system	Injectible	4mg	0.1028	0.2698	0.3810
Albendazole	Infections	Tablets	400mg	0.1250	0.3229	0.3870
Adrenaline	Respiratory system	Injectible	1mg/ml	0.0855	0.2204	0.3881
Hyoscine N Butyl bromide	Gastrointestinal System	Injectible	40mg	0.1652	0.3649	0.4528
Glycerin	Gastrointestinal System	Suppository	1g	0.1297	0.1598	0.8111
Glycerin	Gastrointestinal System	Suppository	2g	0.1448	0.1705	0.8496
Cefuroxime	Infections	Tablets	500mg	0.5074	0.4206	1.2064
Tetracycline	Eye	Ointment	0.01	0.1848	0.1481	1.2480
Clotrimazole	Obstetrics, Gynaecology, and Urinary Tract Disorders	Pessaries	100mg	0.4244	0.2803	1.5140
Dydrogesterone	Endocrine system	Tablets	10mg	0.5667	0.2537	2.2340
Montelukast	Respiratory system	Tablets	5mg	0.2868	0.0959	2.9913

Itraconazole	Infections	Capsules	100mg	0.7333	0.1654	4.4319
Itraconazole	Infections	Capsules	100mg	0.7665	0.1654	4.6327
Ciprofloxacin	Infections	Tablets	500mg	0.1729	0.0308	5.6170
Levofloxacin	Infections	Tablets	500mg	0.4501	0.0775	5.8106
Omeprazole	Gastrointestinal System	Capsules	20mg	0.1530	0.0176	8.6812
Tamsulosin	Obstetrics, Gynaecology, and Urinary Tract Disorders	Tablets	0.4mg	0.5840	0.0516	11.3168
Cetirizine	Respiratory system	Tablets	10mg	0.1300	0.0103	12.6193
Paracetamol	Central Nervous system	Effervescent Tablets	500mg	0.0943	0.0066	14.2054
Metronidazole	Infections	Injectible	5mg/ml	0.2431	0.0045	54.4891
Clotrimazole	Skin	Cream	20g	1.8298	0.0129	141.5224
Cefixime	Infections	Suspension	100mg/5ml (35ml)	4.2525	0.0275	154.8600
Cetirizine	Respiratory system	Syrup	1mg/ml	1.1178	0.0055	203.5284

Table 4 – Mean unit purchase price to MSH International Medical Products Price ratio

Liquidity was expressed as a ratio of current assets and current liabilities. In 2019, the inflation-adjusted current assets were valued at KES 362,859,455.63 and the current liabilities at KES 71,570,498.01. The liquidity ratio was 5.07. In 2020, after successfully implementing consignment for one year, the current assets were valued at KES 365,327,443.00 and the current liabilities at KES 65,942,724.00. The liquidity ratio increased to 5.54. The liquidity ratio improved by 9.3% after the introduction of consignment stock. To further evaluate the impact of consignment on the liquidity, the researcher compared the closing stock of pharmaceuticals in the central stores as of 31st December for 2019 and 2020. The total value of the closing stock as of 31st December 2019 was KES 7,329,125.30 and by the end of 2020, the value of the closing stock was KES 2,901,859.20 representing a 60.4% drop in the stock holding and a direct cash-saving of KES 4,427,266.10.

Discussion:

Findings from the data analysis shows that 81 molecules and 177 products listed by proprietary name were added to the hospital drug formulary between December 2019 and December 2021. Since tenders were not used as a form of procurement during this period, the addition of these products can be attributed to the implementation of consignment. Gümüş *et al.* (2008) stipulate that an essential benefit of consignment is that it allows the supplier to offer new or expensive products that the customer would otherwise be hesitant to stock. A consignment policy reduces the average inventory creating more space for new products ¹². This benefit allowed the pharmacy to expand its formulary without incurring additional costs to acquire the product.

A price comparison between the tender system in 2019 and the consignment system in 2020 showed that 44.6% (n=29) of the products resulted in a price decrease and 55.4% (n=36) of the products showed a price increase when obtained through consignment. The increase in price can be attributed to the elimination of competition between suppliers. As seen in Netherlands ¹³, China, and South Africa ⁶, tenders consistently result in lower purchase prices because of competition between pharmaceutical companies. Another reason for the price increase is several of the importers/distributors who were supplying through tenders opted not to participate in consignment. These products were obtained on consignment through wholesalers. Interestingly, 29 products exhibited a price reduction with consignment. In Kenya, the pharmaceutical supply chain is as shown in Figure 2.

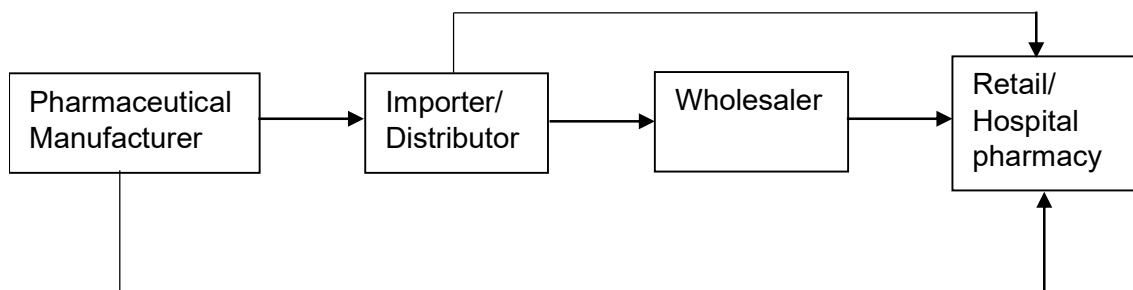


Figure 2 – The pharmaceutical supply chain in Kenya

At every stage of the supply chain, a markup is added resulting in a price increase. All 29 products that exhibited a price decrease with consignment were obtained directly from the importer/distributor thus, eliminating the wholesaler.

Towards the end of 2021, the hospital management adopted a hybrid procurement system that combines tenders and consignment. When tenders-for-consignment was advertised, several suppliers (wholesalers and importers/distributors) showed interest in participating.

Comparatively, in 2020 when consignment was introduced, suppliers were approached individually. Therefore, many willing suppliers may not have been aware of the new procurement model. The fewer suppliers may have contributed to the increase in price seen in 2020. However, by reintroducing competition through tenders, the hybrid system showed that more than half (n=43) of the products resulted in a decrease in price. Surprisingly, of the 22 products that exhibited a price increase, 16 products had shown a price decrease when consignment was introduced in 2020. This can be attributed to the administrative challenges of implementing consignment. The manual reconciliation of goods consumed against the invoice raised is a very time-consuming process that can result in delays in payment to suppliers. In the

case of the 22 products that exhibited a price increase with the hybrid system, two importers/distributors opted out of consignment sighting delays in payment as a major challenge. Thus, these 22 products were obtained on consignment but through a wholesaler. It is essential to invest in information technology (IT) systems that automate the tracking and administration of consigned goods ¹⁴. The IT system in BH was not equipped to handle inventory through consignment resulting in many of the processes being conducted manually. Overall, 40 products displayed a decrease in price when the procurement system changed from tenders in 2019 to tenders-for-consignment in 2022 indicating a clear advantage of the tendering system in obtaining the most favorable price.

A subset of the data collected comprised of essential medicines (n=16). The price trend for essential medicines is similar to the trend observed with the full dataset. When the procurement method changed from tenders to consignment, the essential medicines displayed a price increase. When tenders-for-consignment was introduced, the price reduced. A net percentage price reduction was observed from tenders to tenders-for-consignment. It is important that essential medicines are affordable and available to ensure access to healthcare services. Consignment resulted in a median price increase for essential medicines, which when coupled with the low available disposable income, would further affect the affordability of medicines ⁴.

A comparison of the mean unit purchase price with the MSH International Medical Products Price 2015 for 23 molecules revealed that the ratio ranges from 0.3810 to 203.5284. Of the 23 molecules compared, only six drugs resulted in a ratio of less than one. According to the MSH, the procurement price for generic drugs should be close to the MSH international buyer/supplier price with a ratio of close to 1 ¹⁵. The results from this study show that the median ratio is 4.4319. This shows that neither of the procurement methods resulted in purchase prices that are

comparable to the MSH international buyer price further questioning the affordability of medicines in BH.

A significant benefit of consignment is the immediate cash flow generated and savings accrued

¹⁴. Eagle *et al.* (2002) , Park & Dickerson, (2009) , and Wilson *et al.* (1992) show how implementing consignment resulted in millions in savings. Similarly, BH experienced a direct cash saving of KES 4,427,266.10 as the closing stock of pharmaceuticals reduced from KES 7,329,125.30 to KES 2,901,859.20 between December 2019 and December 2020. The liquidity ratio improved by 9.3% over the same period.

Limitations:

Only 65 products listed by proprietary name were included in the study. This represents less than 10% of the total formulary. Therefore, the results may not be generalizable to all products. Other factors such as changes in import duties, changes in logistic fees with the introduction of the standard gauge railway (SGR), and the effect of the COVID-19 pandemic on imports were not accounted for during analysis.

Conclusion:

The findings indicate that, although not significant, tenders resulted in the most favorable prices however, required capital to be invested in inventory. With consignment, inventory is stored at the user's premises but owned by the supplier until consumed, at which point there is a transfer of ownership. Consignment resulted in substantial financial savings for the institution which can be used for other income-generating activities. However, consignment eliminates competition between suppliers resulting in an increase in the price of pharmaceuticals thereby negatively affecting the affordability of medicines. Combining tenders and consignment resulted in the organization benefitting from reduced prices due to tenders and accruing financial savings due to consignment. However, a well-defined contractual agreement, information sharing between the buyer and the supplier, and a robust IT system is paramount for the successful implementation of consignment.

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Chapter 4 - Synthesis, Conclusions, and Recommendations

Introduction

This study was conducted to determine the effect of consignment on the purchase price of pharmaceuticals and the liquidity compared to purchases through a tendering system. Furthermore, the study assessed the feasibility of combining tenders and consignment to accrue the benefits of both forms of procurement. The rationale for this study was patient complaints received during customer feedback citing an increase in medicine prices during the year of consignment. Verbal communication with the head of the finance department found that implementing consignment had resulted in financial savings and better cash flow. However, these findings were neither formal nor documented and therefore, could not be attributed with certainty to the change in procurement methods. Literature review showed that consignment has been adopted by several industries such as electronics, furniture, large supermarkets and hypermarkets, clothing, and to some extent, in healthcare since the 1980s. In healthcare, consignment has been documented for high-value items such as implants, hospital linen, lenses, and interventional supplies required in cardiology. Only one study analyses the use of consignment in the pharmaceutical retail industry but focusses on stock-outs and refill rates rather than purchase price and working capital. This provided the author with an opportunity to produce original work but also present the findings to the hospital management to develop policies for inventory management.

Strengths of the study:

To the best of our knowledge, this study is the first of its kind. Several industries such as electronics, supermarkets, furniture, and clothing have adopted consignment. In a healthcare setting, consignment has only been studied for high-value items such as implants used in orthopaedics, linen management, and interventional cardiology supplies. However, the use of consignment for pharmaceuticals has not been explored. The study was able to

compare the advantages and disadvantages of tenders and consignment and provide a framework to combine the two procurement methods in a bid to extract maximum advantage for the buyer.

Limitation of the study:

Only 65 products listed by proprietary name were included in the study. This represents less than 10% of the total formulary. Therefore, the results may not be generalizable to all products. Other factors such as changes in import duties, changes in logistic fees with the introduction of the standard gauge railway (SGR), and the effect of the COVID-19 pandemic on imports and medicine prices were not accounted for during analysis. Also, a very simple mathematical formula was used to calculate the current ratio as a proxy to liquidity. Other factors such as accounts receivables, securities were not considered.

Conclusions drawn from the study findings:

The aim of this study was to assess the effect of consignment on the financial health of Bomu Hospital. Specific objectives were: i) to determine the effect of consignment on the cost price of pharmaceuticals; ii) to assess the effect of consignment on the liquidity ratio; iii) to evaluate the effect of combining a tender and consignment system on the cost price of pharmaceuticals; and iv) to compare the mean adjusted cost price of pharmaceuticals with the Management Sciences for Health International Medical Products Price Guide 2015. Based on the specific objectives, the following conclusions can be drawn:

- i. The findings show that consignment resulted in an increase in purchase price of pharmaceuticals by a median of 4.78% ($p=0.48$). This price increase would reflect in the selling price resulting in patient complains seen during customer feedback analysis.
- ii. Consignment resulted in substantial savings to the hospital. The closing stock of medicines in the central stores reduced by 60.4% reflecting a direct cash savings of KES 4,427,266.10 and the liquidity ratio improved by 9.3%.

- iii. Combining tenders and consignment resulted in a purchase price reduction by a median of 7.71% ($p=0.65$).
- iv. The mean purchase price to the MSH international price reference showed a wide range with a median ratio of 4.4319. This shows that neither of the procurement methods resulted in a purchase price that was comparable to the international reference price.

Synthesized conclusion:

Tenders represent the most transparent procurement system, generating sufficient competition to drive down the price of pharmaceuticals. A restricted tender only allows genuine suppliers to bid. Further restrictions, such as specifying the brand name, may control for quality which then leaves price as the only determining factor for an award. The findings indicate that tenders result in the most favourable price, however, requires capital to be invested in inventory. With consignment, inventory is stored at the user's premises but owned by the supplier until consumed, at which point there is a transfer of ownership. Consignment results in substantial financial savings for an institution which can be used for other income-generating activities. However, consignment eliminates competition between suppliers resulting in an increase in the price of pharmaceuticals thereby negatively affecting the affordability of medicines. Combining tenders and consignment results in the organization benefitting from reduced prices due to tenders and accruing financial savings due to consignment. However, a well-defined contractual agreement, information sharing between the buyer and the supplier, and a robust IT system is paramount for successful consignment.

Significance of the study:

The findings show that consignment can have significant benefits to the financial position of an institution but shifting substantial risks from the buyer to the supplier results in an increase in the purchase price of the pharmaceuticals. Additionally, the findings of this study will allow for the development of policies such as merging a tender and consignment

model to benefit the buyer and protect against the higher purchase price of pharmaceuticals. Also, the results from this study will enable the management to align the procurement policy such that the purchase price of pharmaceuticals are consistent with the international reference prices. Finally, the findings of this study will guide administrators and managers on innovative, cost-effective procurement strategies that can afford substantial savings to an organization.

Recommendations:

- i. Developing robust relationship with suppliers is essential for implementing a consignment model for pharmaceuticals as they represent a high value in their totality.
- ii. A well-structured, detailed, written contract should be signed by both parties before venturing into consignment. The contract should outline policies regarding re-stocking, expired drugs, pilferage and damaged goods, stock-taking and payment terms, and the point at which there is change of ownership.
- iii. The end-user must ensure proper standard operating procedures are outlined and relevant staff is trained on handling goods on consignment.
- iv. There must be sufficient investment made in IT infrastructure to accommodate inventory management through consignment.
- v. There must be continuous communication between the supplier and the buyer.

Recommendations for future research:

Future research can focus on determining whether consignment negatively impacted on the affordability of medicines. Additionally, after completing one year of implementing the hybrid model, a similar analysis can be done to determine the impact on the liquidity of combining tenders and consignment.

Chapter summary:

The final chapter highlights the conclusions drawn from the study findings, demonstrates the study significance, highlights the strengths and limitations of the study, and provides recommendations for implementing consignment successfully.

Appendices

Appendix A – Proof of Submission

8/22/22, 12:42 PM

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VIHRI-CEEWAA-2022-0175

Title

The Impact of Inventory Consignment on the Price of Pharmaceuticals and Liquidity in a Private Hospital in Mombasa, Kenya

Authors

GANIWALLA, SHAHEED
Ahmed, Aabid
Bangalee, Varsha

Date Submitted

22-Aug-2022

Author Dashboard

Appendix B – Ethics Approval



Mr Shaheed Ganiwalla (221001079)
School Of Health Sciences
Westville

Dear Mr Shaheed Ganiwalla,

Original application number: 00015018

Project title: The Impact of Inventory Consignment on the Price of Pharmaceuticals and Liquidity in a Private Hospital in Mombasa, Kenya

Exemption from Ethics Review

In response to your application received on [redacted], your school has indicated that the protocol has been granted **EXEMPTION FROM ETHICS REVIEW**.

Any alteration/s to the exempted research protocol, e.g., Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through an amendment/modification prior to its implementation. The original exemption number must be cited.

For any changes that could result in potential risk, an ethics application including the proposed amendments must be submitted to the relevant UKZN Research Ethics Committee. The original exemption number must be cited.

In case you have further queries, please quote the above reference number.

PLEASE NOTE:

Research data should be securely stored in the discipline/department for a period of 5 years.

I take this opportunity of wishing you everything of the best with your study.

Yours sincerely,



Prof Rajshekhar Karpooomath
Academic Leader Research
School Of Health Sciences

UKZN Research Ethics Office
Westville Campus, Govan Mbeki Building
Postal Address: Private Bag X54001, Durban 4000
Website: <http://research.ukzn.ac.za/Research-Ethics/>

Founding Campuses: ■ Edgewood ■ Howard College ■ Medical School ■ Pietermaritzburg ■ Westville

INSPIRING GREATNESS

Appendix C – Hospital Permission Letter



30th September 2021

MCS/ADM/1070/2021

Dr. Shaheed I. Ganiwalla,
Mombasa.

Dear Dr. Ganiwalla,

RE: APPROVAL TO CONDUCT RESEARCH AT BOMU HOSPITAL

We have reviewed your protocol titled: The Impact of Inventory Consignment on the Price of Pharmaceuticals and Liquidity in a Private Hospital in Mombasa, Kenya and have noted that you have complied with the requirements to conduct the study at Bomu Hospital.

This letter provides you with the approval to conduct the study at Bomu Hospital.

We wish you success in the research and look forward to reading the final report and published article.

Faithfully,

A black rectangular box redacting the signature of the Chief Executive Officer.

Dr. Aabid A. Ahmed, M. B. Ch.B., MSc. CRA (UK), PhD
Chief Executive Officer

BOMU HOSPITAL
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