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Research Article

An Analysis of Pharmaceutical Inventory Management at a Leading Teaching and Referral Hospital in Kenya

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Background: Proper pharmaceutical inventory management is critical in guiding decisions that mitigate cyclic stockouts. It sets purchasing priorities, informs the procurement of cost-effective drugs, and ensures that there is a balance between inventory expenditure and the demand for medications. This study aimed to evaluate the drug consumption and expenditure patterns at a leading referral hospital in Western Kenya i.e. the Jaramogi Oginga Odinga Teaching and Referral Hospital (JOOTRH). Drug consumption and expenditure data at JOOTRH was analyzed over 3 years (2018-2020) using Therapeutic Class (TC), Always Better Control (ABC), and Vital Essential and Non-essential (VEN) analysis. Data sources included the Kenya Health Information System (KHIS), bin cards, invoices, delivery notes, and patient files.

Results: The total pharmaceutical expenditure (TPE) over the study period was $ 1,329,213.91. The annual pharmaceutical expenditure (APE) was $ 389,158.51, $ 501,365.79, and $ 438,689.61 for 2018, 2019, and 2020 respectively. ABC analysis indicated that 53 (18.9%), 56 (19.9%), and 56 (19.9%) of items were Class A medicines in 2018, 2019, and 2020, respectively and consumed 70.2%, 71.7%, and 72.7% of the APE in 2018, 2019, and 2020 respectively. VEN analysis revealed that 173 drugs were classified as vital items in each of the years 2018, 2019, and 2020 and consumed 77.7%, 75.1%, and 74.2% of the APE in 2018, 2019, and 2020 respectively. TC analysis indicated that anti-infectives were the most consumed class of medicine over the study period and consumed 27.4%, 23.5%, and 30.4% of the APE in 2018, 2019, and 2020 respectively.

Conclusions: According to this analysis, Category I pharmaceuticals accounted for the majority of the total pharmaceutical expenditure at the hospital and require special attention for control.

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Background

Many of the diseases in the developing world can be alleviated by using cost-effective essential medicines [1]. These medicines are expected to meet the population's highest priority needs as far as health care is concerned [2][3]. Their selection relies on efficacy and safety data, cost-effectiveness, public health relevance, and prevalence of disease [2][3]. They should always be available, in dosage forms that are appropriate, and at prices that are pocket-friendly to individuals and health-care systems [2][3]. Many gains have been made in the forty-six years since the inception of the Essential medicine concept. However, gaps remain as far as improving health service delivery using low-cost and effective treatments is concerned. It is not surprising, then that a lack of access to essential medicines is one of the most serious global public health issues [2][3].

A study on the availability of essential medicines in some hospitals in Benin, Sierra Leone, Burkina Faso, Uganda, DRC, Mauritania, Togo, and Zimbabwe reported unacceptably low numbers of essential medicines [4]. Jingi et al reported that essential medicines were unavailable and unaffordable to patients in Western Cameroon [5]. Wangu and Osuga reported that stockouts were a common feature in many public hospitals in Nakuru County and Olubumni and colleagues reported that access to essential medicines in many hospitals in rural areas of South Africa was limited [6][7]. Inventory management is one method of ensuring that essential medicines are available in the healthcare sector [1]. Proper inventory management requires that a consistent supply of essential medicines is maintained in the hospital setting [1]. Tools such as Therapeutic Category (TC), Always Better Control (ABC), and Vital Essential and Non-essential (VEN) analyses are used. ABC analysis compares pharmaceutical costs within the formula and classifies drugs into three classes: Class A, B, and C [8]. Drugs in Class A make up between 10 and 20% of the stock and consume between 70 and 80% of the total pharmaceutical budget [8]. Drugs in class B make up between 10 and 20% of the stock and consume between 15 and 20% of the stock, while drugs in class C make up the lion's share of between 60 and 80% of the stock but consume only between 5 and 10% of the annual pharmaceutical budget [8]. VEN analysis guides the decision-making process as far as the purchase of medicines and stocks is concerned. V are vital life-saving medicines which are key in healthcare service delivery. E medicines are prescribed for less severe, significant, but not life-threatening illnesses. N stands for non-essential, high-cost, and low-therapeutic-range medicines indicated for minor illnesses [8].

ABC or VEN analysis alone is not always sufficient [1]. ABC analysis is primarily concerned with monetary value and overlooks the drug's importance [1]. In VEN analysis, expensive drugs may be incorrectly placed [1]. Therefore, an ABC-VEN matrix is often used and classifies drugs into various categories such as category I, II, or III [1][9][10]. This way, the procedures are allowed to complement each other. When this approach is taken, all vital and costly items are included in Category I (AV, BV, CV, AE, AN). Residual items from groups E and B are placed in Category II (BE, CE, BN), while the non-essential (desirable and cheap) items are placed in Category (CN) [1][11][12][13]. Pharmaceuticals in the first category require continuous monitoring and control, those in category II require regular control, and pharmaceuticals in the third category do not need to be controlled on a regular basis [1][8][11][12][13].

JOOTRH has been in operation for more than a century, having been established in the early 1900s to meet the health needs of workers in Kisumu, Kenya's then-port town. It has since expanded to become the referral hospital for more than ten counties in Western Kenya, with a population of more than ten million people. Regardless, no information is available on the status of the hospital's pharmaceutical inventory management. This research sought to evaluate JOOTRH's pharmaceutical inventory management by utilizing standard inventory tools such as ABC, VEN, and TC analysis.

Methods

Ethical considerations

Before the study began, relevant ethics committees, including the Kenyatta National Hospital/University of Nairobi Ethics and Research Committee (KNH-UON-ERC) and the JOOTRH Institutional Research and Ethics Committee, were consulted (JOOTRH-IREC). **P961/12/2019** and **IREC/JOOTRH/180/20** were the reference numbers for KNH-UoN-ERC and JOOTRH-IREC, respectively. Confidentiality was maintained by restricting access to obtained data to authorized study personnel.

Study design

This was a retrospective longitudinal study. Data on pharmaceutical drug expenditure was obtained from drug stores, and the relevant inventory tools (TC, VEN, and ABC analyses) were used. The study was conducted from January 2018 to December 2020.

Study site and eligibility

The study was conducted at JOOTRH. The hospital is in Kisumu County, about 360 kilometers north of Nairobi. It is a teaching and referral hospital that serves the counties of Vihiga, Migori, Kisumu, Nandi, Homabay, Siaya, Busia, Kisii, and Kakamega in Western Kenya. The 708-bed hospital provides curative, preventive, and rehabilitative services. The inclusion criteria were all medicines purchased by JOOTRH during the study period. Medicines donated or obtained outside of the formal tender process were excluded from the analysis.

Sample size

A technique known as universal sampling was used. To obtain the most accurate analysis possible, all relevant information was included.

Data collection

Consumption data from bin cards at the main pharmacy stores and the dispensing area was collected, as was expenditure data from invoices at the dispensing areas, stores, accounting, and procurement departments. The WHO Data Collection Form for ABC, TC, and VEN analysis was used [14]. See supplementary sections I for ABC data collection form, II for TC data collection form, and III for VEN data collection form. Pre-designed forms were used to document data on the ABC-VEN matrix, morbidity and drug expenditure. See supplementary sections IV for the ABC-VEN matrix form and V for morbidity and drug expenditure form. The Health Information System Database was accessed to provide information on the annual morbidity data and subsequent pharmaceutical expenditure. This information was transferred to a predesigned data collection form. The prices of the drugs, dosage form, quantity, code, units of issue, and annual expenditure were recorded.

Data analysis

Ten drugs were used to pretest the data collection form. The collected data was cleaned to remove duplicate entries. A daily schedule to verify and back up the information was established. In ABC analysis, the unit costs of all items purchased and consumed were listed. By multiplying the drug consumption in a year by the price of each unit and sorting the results from the highest to the lowest, the annual expenditure on specific medications was calculated. Thereafter, the amount of money spent on drugs was calculated. The cut-off for the ABC classification was determined by looking at the amount of money spent on the first 20% of drugs, the next 20%, and ultimately the final 60% of drugs. The VEN classification of pharmaceuticals makes reference to the Kenya Essential Medicines List of 2019 (KEML 2019). In this classification, a drug is considered vital if it saves lives and has major withdrawal effects. Those drugs that are indicated for significant but less severe illnesses are essential and drugs which are indicated for minor illnesses are non-essential. Ranking of all medications was then done using a form. The money (%) used for each of the classes was calculated. Drugs were then placed in a therapeutic category. An analysis of the morbidity pattern was done using the International Classification of Diseases criteria (ICD-10) [14]. Results were presented in tables, graphs, and charts.

Results

Drug expenditure at JOOTRH during the study period

Figure 1 shows the annual pharmaceutical expenditure at JOOTRH over the study period. 281 drugs were analyzed during the study period. $ 1,329,213.91 was consumed on drugs.

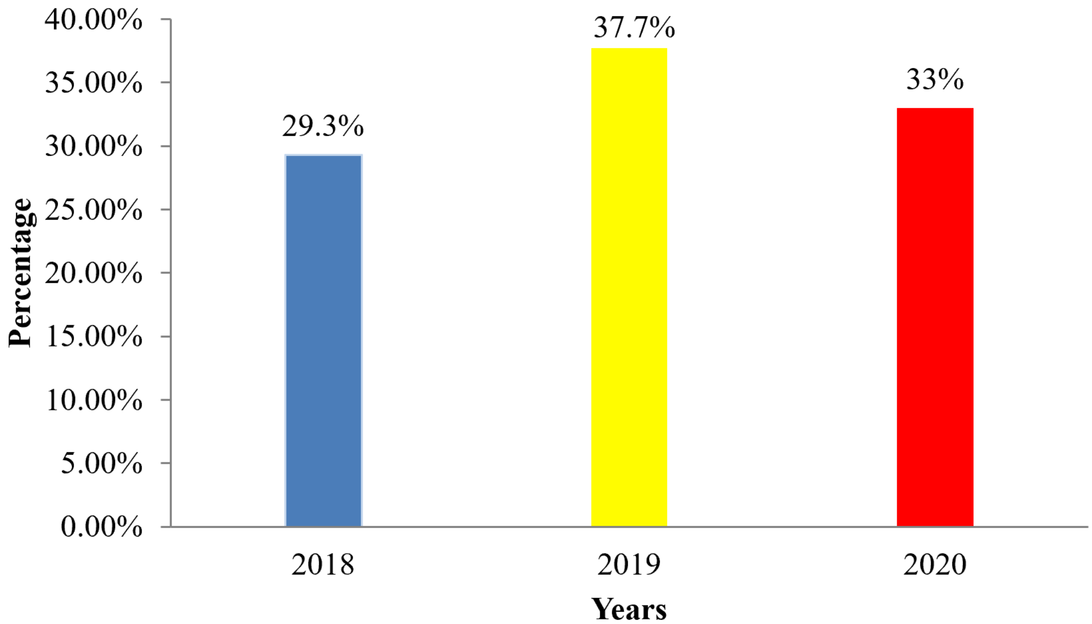

Figure 1. Summary of the annual pharmaceutical expenditure at JOOTRH over the study period

29.3% of this ($ 389,158.51), 37.7% ($ 501,365.79) of this, and 33.0% ($ 438,689.61) of this was used in 2018, 2019, and 2020 respectively. Table 1 summarizes the drugs that accounted for the majority of JOOTRH's total pharmaceutical expenditure during the study period. Flucloxacillin 250 mg capsules took up 5.0% of the expenditure during the study period. Table 1.

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Item	Unit size	2018	2019	2020	Total cost	% of the total value
Flucloxacillin Capsules 250 mg	Tin of 1000s	935	1075	1353	8,407,500	5.01
Normal Saline Solution 0.9% w/v	500 mL	24500	69000	44400	6,205,500	3.70
Ceftriaxone Injection IM/IV, 1g	Vial	42429	51426	42671	5,187,988	3.09
Erythropoietin 2000 I.U Injection β	Vial	1902	930	597	5,006,340	2.99
Enoxaparin Sodium 40mg/0.4mL Injection	Syringe	2570	4572	5592	4,546,038	2.71
Metronidazole Injection – 5mg/mL	Vial	52083	50833	45247	3,555,912	2.12
Ceftriaxone Injection IM/ IV, 250 mg	Vial	9943	15045	82227	3,538,095	2.11
Aceclofenac +Paracetamol Tabs 100/500 mg	Pack of 10s	1912	3495	2380	3,387,345	2.02
Heparin Injection – 5000 Units/mL	Vial	1282	6239	2325	3,308,256	1.97
Phenytoin Sodium 250mg/5mL Injection	Ampoule	2200	3038	3578	3,209,024	1.92
Oxytocin Injection – 5Iu/mL (Syntocinon)	Ampoule	12491	17052	1500	2,949,085	1.76
Amoxicillin/Clavulanic Potassium tabs (875+125 mg) 1gm	Pack of 10s	1243	3480	5531	2,922,390	1.74
Erythropoietin 5000 I.U Injection β	Vial	466	253	199	2,478,600	1.48
Paracetamol Solution For Intravenous Infusion 10 mg/mL, 100 mL	Vial	5241	21460	14086	2,447,220	1.46
Atracurium Injection-10 mg/mL, 5mL Ampoule	Ampoule	3952	2399	2175	2,387,280	1.42
Goserelin Implant 10.8 mg (As Acetate)	Syringe	18	112	67	2,344,300	1.39
Anti-D (Rh) Injection – 300 mcg	Vial	137	173	156	2,330,000	1.39
Flucloxacillin Capsules 500 mg	100'S	760	1181	1015	2,205,176	1.32
Halothane Inhalation	250 mL Bottle	179	192	168	2,193,730	1.31
Amoxicillin/Clavulanic Dispersible Tablets 228.5 mg	Pack of 10s	2574	1450	2036	2,151,300	1.28
Isoflurane Liquid For Inhalation	250 mL Bottle	176	206	177	2,068,300	1.23
Cefuroxime 500 mg tablets	Pack of 10s	2486	5369	2160	2,053,075	1.22
Diazepam Injection 5 mg/mL, 2mL ampoule	Pack of 10s	1650	3356	1243	1,993,431	1.19
Valproic Acid (Sodium Valproate) 200 mg tablets	Pack Of 100S	1540	1300	1610	1,913,500	1.14
H. Pyroli Kit	Kit	282	780	1160	1,866,480	1.11
Snake Venom Antiserum I.V Injection 10 mL vial	Vial	124	104	89	1,859,205	1.11
Insulin Biphasic 30/70 – 100 IU/mL	Vial	1336	2227	2143	1,711,800	1.02
Lactulose Solution 3.4 mg/mL,200 mL	Bottle	2237	1760	1890	1,707,230	1.02
Carboplatin Injection,10 mg/mL, 45 ml vial (450 mg)	Vial	74	166	217	1,599,500	0.95
Dextrose - 5% Euro Cap Bottle	500 mL	11873	13765	10207	1,433,800	0.86
TOTAL					**88,967,400**	**53.09**

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Table 1. Summary of the drugs that consume the total pharmaceutical expenditure at JOOTRH over the study period

Morbidity pattern analysis at JOOTRH during the study period

494,263 clinical cases were managed at JOOTRH between 2018 and 2020. Out-patients accounted for 450,310 (91.1%) of these cases, while in-patients accounted for 43,953 (8.9%).In 2018, 2019, and 2020, 152,290, 171,511, and 170,462 clinical cases were managed, respectively. When these cases were classified using the ICD-10 system, it was discovered that infectious and parasitic diseases accounted for 11% of all clinical cases at the hospital and consumed the most pharmaceutical expenditure (28.7%). Figure 2. Injury poisoning and other external cause consequences; class S00-T98 accounted for 13.6% of all clinical cases and 9.9% of total pharmaceutical expenditure. Figure 2.

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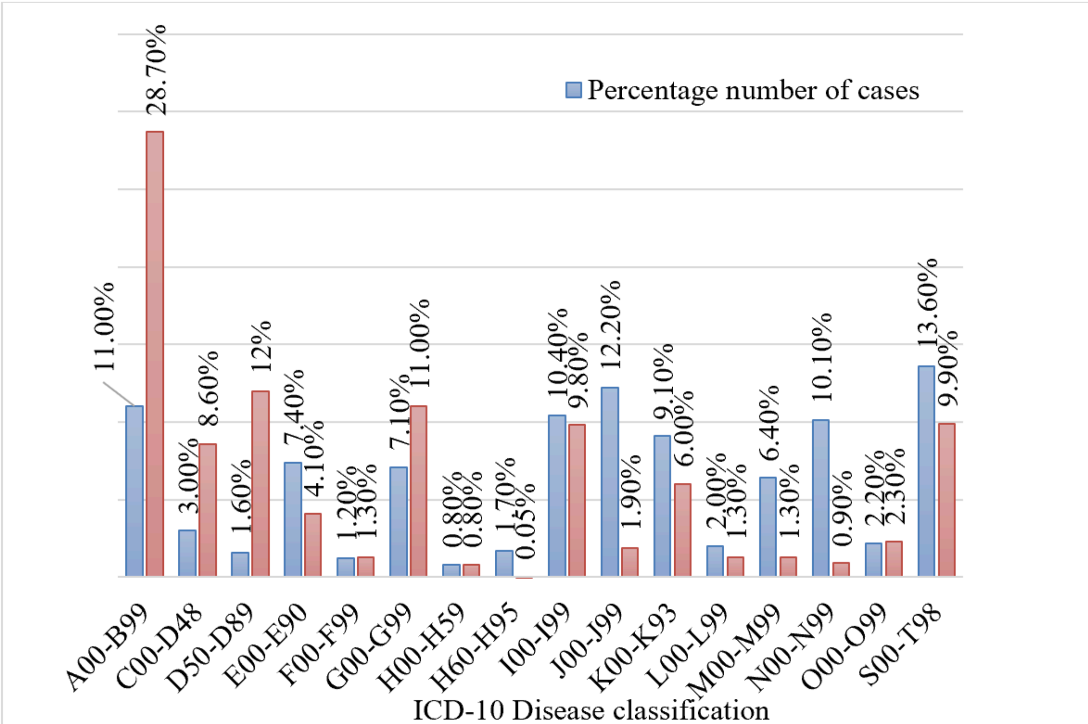

Figure 2. Summary of pharmaceutical expenditure on the basis of ICD-10 disease classification at JOOTRH over the study period

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

Therapeutic category analysis at JOOTRH during the study period

Therapeutic category analysis revealed that there were 25 therapeutic categories of drugs at JOOTRH during the study period. Figure 3. Drugs classified as anti-infectives consumed $ 358, 086.52 which was 26.9% of the TPE. Figure 3. The anti-infectives consumed 27.4%, 23.5%, and 30.4% of the TPE in 2018, 2019, and 2020 respectively.

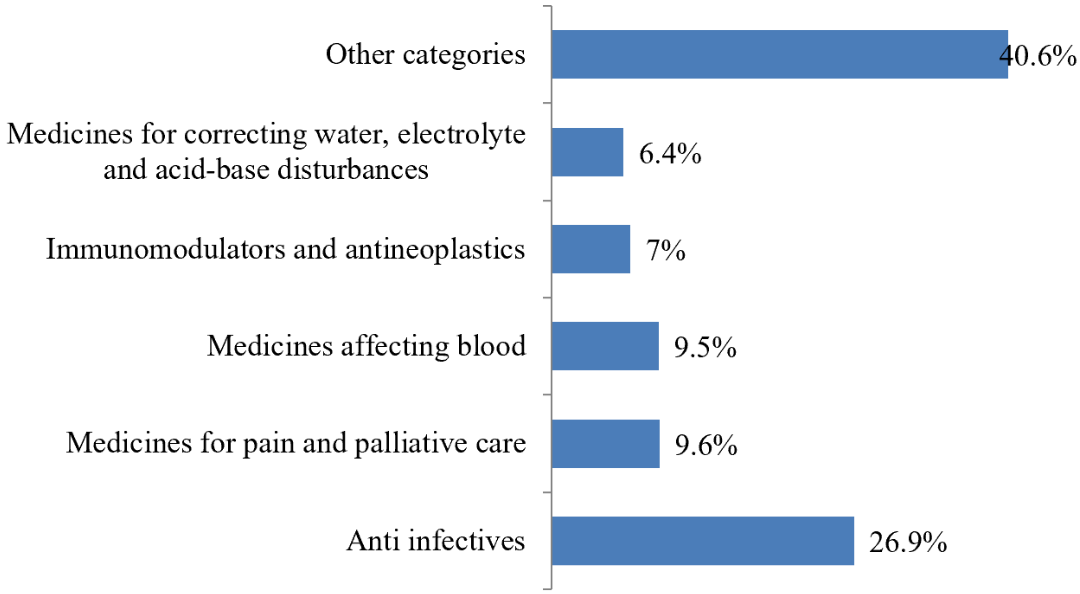

Figure 3. Summary of the therapeutic categories of drugs that consume pharmaceutical expenditure at JOOTRH over the study period

ABC classes and expenditure at JOOTRH during the study period

53(18.9%), 56(19.9%), and 56(19.9%) drugs were classified in class A in 2018, 2019, and 2020, respectively. Table 2.

Classification	n (%)			% annual expenditure on drugs		
Year	2018	2019	2020	2018	2019	2020
A	53(18.9)	56(19.9)	56(19.9)	70.2	71.7	72.7
B	56(19.9)	56(19.9)	56(19.9)	18.7	18.2	17.3
C	172(61.2)	169(60.1)	169(60.1)	11.1	10.1	10.0
Total	281(100)	281(100)	281(100)	100	100	100

Table 2. Summary of the number of drugs under ABC classification at JOOTRH and their expenditure over the study period

All three years registered 56(19.9%) class B drugs while class C drugs were 172(61.2%) in 2018, 2019, and 2020 both had 169(60.1%). Table 2. Class A drugs consumed much of the budget. Table 2. Class A drugs were 18.9% of all drugs in 2018 and used up 70.2% of the TPE. 19.9% of all drugs were in Class B, and used up 18.7% of the TPE. Class C took up 61.2% of all drugs and used up 11.1% of the TPE. Table 2. In 2019, 19.9% of all drugs were class A and used up 71.7% of the TPE. Another 19.9% of all drugs were in class B, and took up 18.2% of the TPE. The remaining 60.1% of the drugs were in class C, and took up 10.1% of the TPE. Table 2. In 2020, 19.9% of all drugs were in Class A and took up 72.7% of TPE. A further 19.9% of all drugs were class B and used up 17.3% of the TPE. According to Table 2, the remaining 60.1% of the drugs were in class C and took up 10% of the TPE.

VEN classification and expenditure at JOOTRH during the study period

Table 3 shows the results of the VEN analysis at JOOTRH. 61.6%, 23.5%, and 14.9% of the medicines belonged to the V, E, and N classes of drugs in each of the years 2018, 2019, and 2020.

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Classification	n (%)			% annual expenditure on drugs		
Year	**2018**	**2019**	**2020**	**2018**	**2019**	**2020**
V	173 (61.6)	173 (61.6)	173 (61.6)	38,502,749 (77.1)	48,317,384 (75.1)	41,810,056 (74.2)
E	66 (23.5)	66 (23.5)	66 (23.5)	8,144,214 (16.3)	11,428,941 (17.8)	10,227,800 (18.2)
N	42 (14.9)	42 (14.9)	42 (14.9)	3,309,315 (6.6)	4,614,002 (7.1)	4,276,729 (7.6)
Total	281 (100)	281 (100)	281 (100)	100	100	100

Table 3. Summary of the number of drugs under VEN classification at JOOTRH and their expenditure over the study period

Moreover, Class V drugs took up 77.1% of the TPE in 2018, Class E drugs took up 16.3%, and Class N drugs took up the remaining 6.6%. Table 4 shows that in 2019, class V drugs accounted for 75.1% of the TPE, class E drugs accounted for 17.8%, and class N accounted for the remaining 7.1%. Table 3. As shown in Table 3, class V drugs took up 74.2% of the TPE in 2020, class E drugs took up 18.2% of the TPE, and class N drugs took up the remaining 7.6% of the TPE. A significant finding was that pregabalin 150mg capsules, diclofenac sodium 75 mg injection, neonatal ampicillin + cloxacillin 90mg/0.6mL, pancuronium 4mg/2mL injection, atenolol 50 mg tablet, and sodium bicarbonate 8.4% injection made up 1.3% of the total drug consumption during the study period yet these medicines are not in the KEML 2019.

ABC-VEN matrix classification at JOOTRH during the study period

The ABC-VEN Matrix of drugs at JOOTRH facilitated nine sub-categorical classifications notably: AV, AE, AN, BV, BE, BN, CV, CE, and CN. Figure 4.

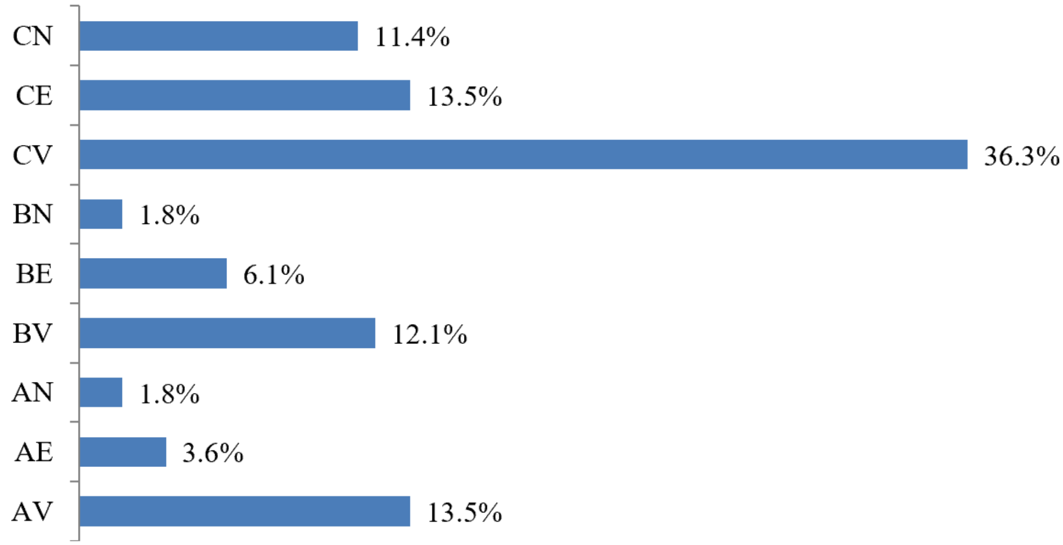

Figure 4. Summary of the proportions of drugs under the ABC-VEN matrix for JOOTRH over the study period

The AV group of drugs consumed the most budget, $ 619,020.63 (46.6%), while AN consumed the least, $ 24,268.19 (1.8%). Figure 4. Drugs in category AV took up the greatest proportion of TPE, accounting for 59.3%, 39.3%, and 43.6% in 2018, 2019, and 2020, respectively. In 2019 and 2020, group AN had the lowest utilization of expenditure, at 1.1% and 1.9%, respectively, while group BN had the highest utilization in 2018. The identified subcategories were again divided into three main categories: I, II, and II. Drugs such as ephedrine 30mg/mL injection, salbutamol nebulizing solution, lactulose solution, glucosamine 500mg + chondroitin 400mg, and ceftriaxone 1g injection in the AV, AE, AN, BV and CV categories were 67.3% of all items and took up 82.2% of the TPE. Table 4. Matrices BE, CE, and BN were classified under Category II and made up 21.4% of all drugs. These drugs took up 12.7% of the TPE. Medicines in the CN matrix such as dexchlorpheniramine 2mg + betamethasone 0.25mg were placed in category III, which made up 11.4% of all drugs and took up 5.1% of the TPE. Table 4.

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Classification	% (Total annual expenditure)			% Category totals
Year	2018	2019	2020	Total
Category I	44,084,377(88.3)	50,578,062(78.6)	45,618,508(81)	140,280,947(82.2)
Category II	4,809,524(9.6)	9,357,922(14.5)	7,582,273(13.5)	21,749,719(12.7)
Category III	1,062,377(2.1)	4,424,343(6.9)	3,113,804(5.5)	8,600,524(5.1)
Total	49,956,278	64,360,327	56,314,585	170,631,190.00

Table 4. Summary of the annual expenditure on drugs as per the ABC-VEN matrix at JOOTRH over the study period

Discussion

Based on how consistent the findings on the number and types of drugs available at JOOTRH when this research was conducted, there is a strong case to be made that the same procurement system could have been used to procure medicine during the study period. The difference in TPE between 2018 and 2019 could be due to a spending limit imposed on pharmaceutical purchases due to limited availability. Furthermore, the decrease in TPE and case management at JOOTRH between 2019 and 2020 may be due to the effects of COVID-19, which may have resulted in fewer hospital visits.

Infectious diseases were prevalent at JOOTRH during the study period, according to morbidity pattern analysis. It's easy to see why so much of the TPE was spent on flucloxacillin 250mg capsules. On the other hand, the medicines used to treat ear, nose, and throat diseases consumed the least amount of TPE. A plausible explanation is that many of the ENT diseases were treated at lower-tier hospitals, such as sub-county hospitals.

Our findings on TPE based on ABC classification at JOOTRH were mostly consistent with the findings of other studies. According to one study conducted in an Ethiopian region, class A drugs accounted for 15.3% of drugs at selected public health facilities, class B drugs accounted for 20.8% of all drugs, and class C drugs accounted for 63.8% of all drugs in the hospitals. The annual TPE for each of these classes was 69.9%, 19.9%, and 10.1%, respectively [15]. Bhondve et al. reported in an Indian tertiary hospital study that 23.7% of drugs were class A, accounting for 67.5% of the TPE, 50.2% were class B, accounting for 20.1% of the TPE, and 26.3% were class C, accounting for 12.4% of the TPE [16]. A report by Kivoto and co-authors showed that class A drugs took up 80% of annual drug consumption, class B drugs took up 15%, and class C drugs took up 5% [17]. Another report from Lodwar found that class A drugs took up 12% of TPE, class B drugs took up 18%, and class C drugs took up 70% of TPE [18].

The results of the VEN analysis appear to be consistent with previous findings. Endeshaw et al., for example, reported that V and E drugs (85.6% of all drugs) took up 94.9% of TPE in an Ethiopian hospital [15]. In Kenyatta National Hospital, V and E drugs (76.1% of all drugs) took up 92.2% of the TPE [17]. However, our findings differed markedly from those from some hospitals in some other parts of Kenya where non-essential drugs were most frequently procured at 50.4% and 52.1% [19][20]. Furthermore, 43.1% of the TPE in one of these hospitals was on non-essential drugs, and only 3.2% was being spent on essential drugs [19]. Financial constraints, ineffective use of budgets, failure to conduct drug prioritization, and improper drug classification policies could all be possible reasons for this observation [9].

According to the ABC-VEN matrix analysis, many of the medicines purchased (67.2%) had the potential to save lives and were critical in healthcare service delivery. These took up 82.1% of the TPE. Moreover, the quantities of category III drugs for minor illnesses were the lowest and took up the smallest percentage of the budget. Category II (21.4% of all drugs) took up 12.9% of TPE. Therefore, it could be argued that a deliberate decision was made to prioritize high-therapeutic benefit drugs, those with great public health impact, and low cost.

Category I drugs dictate close monitoring, should always be available in the hospital, have strict administration and dispensing controls, have up-to-date records, and require timely audits of their use [21]. Our findings suggest that these were largely practiced at JOOTRH.

Category II drugs made up a paltry 21.4% of TPE, suggesting that more affordable drugs could have been sourced from alternative avenues (suppliers). These drugs are inexpensive and require little supervision, but care should be taken to prevent losses. If the results on the expenditure and consumption rates of category III drugs are anything to go by, it appears JOOTRH spent little on drugs used to treat minor illnesses or those with little therapeutic benefit. This is in agreement with a study in Ethiopia where 84.7%, 13.2%, and 2.1% of the TPE was spent on categories I, II, and III respectively [22]. In an Iranian study, category I drugs accounted for 83.8% of drug expenditure, while categories II and III took up 13.5% and 2.7%, respectively [23]. A Turkish study established that category I drugs took up 75.3% of the TPE, category II took up 22.2%, and category III drugs took up 2.5% [24]. At the national level (Kenya), it was reported that category I drugs took up 82% of the TPE at Lodwar County Referral Hospital, while categories II and III took up 17% and 1%, respectively [18]. This study has enriched the data reserve at JOOTRH by providing expenditure rates for different drug categories and disease classes. The study has also shed light on some unacceptable hospital practices, e.g., the procurement of medicines without consulting the KEML 2019. More studies are needed to evaluate the cost of anti-infectives in hospitals. The disconnect between disease cases and expenditure also needs to be investigated. Furthermore, the high consumption of flucloxacillin 250mg capsules at a time when antimicrobial resistance is an emerging public health problem is concerning. The Medicines and Therapeutics Committee should review the class A drugs in the hospital in a bid to identify areas of overuse and underuse. The committee should also advocate for the use of less expensive class A drugs and delegate authority to one of its members to improve the efficiency of class A drug inventory control.

The VEN system should always be used at JOOTRH to prioritize drugs to purchase and determine stock levels. This is due to the fact that this system categorizes pharmaceuticals based on their utility in resolving public health issues. It also ensures that adequate quantities of drugs are obtained only from reputable sources. Regular therapeutic category analysis is also recommended because it allows for the study of drug costs and therapeutic benefits.

Limitations

This study was limited to three years because it was determined that data from other years was incomplete or missing. We also admit that because some drugs treat diseases in different categories and some diseases require drugs from different classes, an overlap in consumption and expenditure data may limit the voracity of the data collected in this study.

Conclusions

According to the findings, class A drugs accounted for a large portion of JOOTRH's total pharmaceutical expenditure. Furthermore, vital and essential drugs account for more than 90% of annual pharmaceutical expenditure. Category I drugs are expensive and consume more than half of the budget. Anti-infectives accounted for the majority of annual pharmaceutical expenditure, while medicines for the ear, nose, and throat accounted for the least. Injury, poisoning, and other external causes (class S00-T98) accounted for the majority of hospital clinical cases.

Availability of data and materials

The data used to support the findings are available on reasonable request from the corresponding author.

Competing interests

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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Author contributions

Conceptualization: KA, MOL, EG, and FO; Data curation: KA and MO; Formal analysis: KA and MO, Investigation: All authors; Methodology: KA and MOL; Project administration: KA; Resources: All authors; Software: KA and MO; Supervision: MOL, EG, and FO; Validation: MOL, EG, and FO; Visualization: KA and MO; Writing original draft: KA and MO; Writing review and editing: All authors

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List of abbreviations

JOOTRH: Jaramogi Oginga Odinga Teaching and Referral Hospital; TC: Therapeutic category; ABC: Always Better Control; VEN: Vital, Essential, and Non-essential; KHIS: Kenya Health Information System; TPE: Total Pharmaceutical Expenditure; APE: Annual Pharmaceutical Expenditure; KNH: Kenyatta National Hospital; UoN: University of Nairobi; ERC: Ethics and Research Committee; IREC: Institutional Research and Ethics Committee; WHO: World Health Organization; KEML: Kenya Essential Medicines List; ICD: International Classification of Diseases.

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