

Original Research Article

Inventory analysis in a tertiary hospital in Benin City, Nigeria Wednesday J Edefo^{1*}, Stella F Usifoh², Anthony W Udezi², Ikponwonsa C Edia¹

¹Department of Pharmacy, Federal Neuropsychiatric Hospital, Benin City. ²Departments of Clinical Pharmacy and Pharmacy Practice, Faculty of Pharmacy, University of Benin, PMB 1154, Benin City, 300001, Nigeria

* For correspondence: Email: edefojoshua2000@yahoo.com, Tel: 2347035800341

Abstract

Purpose: In resource limited countries like Nigeria with ever increasing drug needs, it is necessary to apply scientific tools for effective and efficient management of pharmaceuticals in the hospital. This study aims to identify the categories of drugs in Federal Neuro-Psychiatric Hospital (FNPH), Benin City that are available and make recommendation for strict managerial control.

Methods: The annual consumption and expenditure incurred for pharmaceuticals from 2014-2018 was analyzed. The ABC, VED and a matrix based on ABC and VED analysis was developed to narrow down the group of items for effective managerial monitoring.

Results: The ABC-VED matrix analysis of drugs for 2014, 2015, 2016, 2017 and 2018 revealed that category I items which were 21 (20.19%), 26 (21.14%), 27 (19.02%), 27 (18.12%), and 27 (18.49%) respectively consumed NGN18,991,634

(72.21%), NGN28,817,113 (74.22%), NGN37,955,459 (73.76%), 42,562,300, (70.79%), NGN44,430,522 (74.03%) for each year Annual Drug Expenditure respectively. This category which include olanzapine, amitriptyline, carbamazepine, nifedipine, consumables, risperidone, sodium valporate, diazepam, 10% dextrose water, 4.3 % dextrose saline, 5% dextrose saline, biperidine 5mg should have maximum attention and meticulous inventory control.

Conclusion: Scientific inventory management tools need to be applied strictly and routinely for category I of the ABC-VED matrix in order to save money for the establishment and reduce out of stock syndrome.

Keywords: ABC analysis, VED analysis, ABC-VED matrix, Category I, Inventory Analysis, Pharmacoeconomics

Indexing: Index Copernicus, African Index Medicus

Introduction

Pharmaceutical services are indispensable to any hospital especially with the global increase in population [1], as the hospital grows in size and number the need for pharmacy services also increase. Researches have revealed that, money spent on pharmaceuticals accounted for 17% -33% of all health expenditure [2,3]. The activities at pharmacy departments constitute part of the overall hospital clientele satisfaction thus out of stock of medicines in the department may lead to poor healthcare delivery and bad reputation for the healthcare organization [4]. Effective managerial controls of availability of pharmaceuticals are found to be very crucial for optimal and rational pharmacotherapy [5]. Attainment of this could need a mix of proper selection, quantification, procurement, distribution and use of

drugs based on consumption and morbidity pattern of the catchment area [6].

The stocking of hospital pharmacy items can be capital intensive and majority of hospital capital is held up in these items and it can be reduced by one-third of a hospital's budget by bringing efficiencies to important cost drivers [7,8]. It is almost impossible for hospital managers to monitor each and every drug used in hospitals hence the need to apply the Pareto principle which has metamorphosed into the Always Better Control (ABC) analysis "separating the vital few from the trivial many" because, for any group of things that contribute to a common cost, a relatively few contributors account for a majority of the cost [9]. In Pareto's analysis, about 10% of items consume about 70% of the budget (Group A). The next 10% inventory items consume 10% of the financial

resources (Group B) and the remaining 80% items account for just 20% of the budget (Group C). With the use of ABC, costing was found to be more detailed and precise and overhead costs diminished drastically [10-12].

ABC analysis has a shortcoming, which is that it is based only on monetary value and the rate of consumption of the pharmaceuticals. In a hospital, an item of low monetary value and consumption may be very vital or even lifesaving. Thus, their importance cannot be overlooked simply because they do not appear in category A hence the need for VED analysis which is based on criticality of an item [13].

In VED also known as Vital, Essential and Desirable, vital pharmaceutical items are lifesaving, critical for health services. It can be taken 24 hours of a day, 7 days of a week, a quarter of a year or 12 months of a year [14]. Essential pharmaceuticals are effective against less severe but significant illness, may be lifesaving, without which patient may be in difficulty but may be somehow substituted. It is mandatory at least once a day, or at least once in a week, or at least once in a month or once in a quarter of the year, but not as highly mandatory as vitals [14].

Desirable pharmaceuticals are effective for minor illnesses and low therapeutic advantage. These items are important to patients; however, patients will not die or face a traumatic condition due to the absence of these drugs/ reagents. [14] The limitation of the VED analysis is that desirable items that are expensive will not be given the adequate priority. This gap that exists by either ABC or VED system would be resolved by ABC-VED matrix [12,15].

The increasing population of Nigeria indicates increasing drug needs by the users of health services. However, the limited resources in the drug revolving fund (DRF) in Federal government owned hospital makes it imperative for studies of the inventory management in our hospitals. The objective of this study therefore, is to identify the categories of drugs in Federal Neuro-Psychiatric Hospital (FNPH), Benin City that are available and recommend inventory managerial control of these items.

Methods

Study setting and design

The study was done at Federal Neuro-Psychiatric Hospital (FNPH), Benin City, Nigeria. FNPH is a specialized tertiary hospital, a government owned establishment which has more than 250 beds and serves an average of 70 patients per day on outpatient basis. Majority of these patients receive a prescription

containing more than one medication. The institution has in its employ consultant psychiatrists, physicians, pharmacists, nurses, laboratory scientists, psychologists, sociologists, occupational therapists and health administrators among others.

This was a retrospective study in which ABC, VED and ABC-VED matrix analysis techniques were utilized to evaluate 5 years' pharmaceutical inventory management system of FNPH. Ethical and administrative approval for the study was granted by the Psychiatric Hospital Ethics Committee with ref no: PH/A.864/vol. vii/12

The cumulative expenditure incurred on each item was calculated for each of the years. For the purpose of this study, 1st January 2014 to 31st December 2014 was referred to as 2014, 1st January 2015 to 31st December 2015 was referred as 2015, 1st January 2016 to 31st December 2016 referred to as 2016, 1st January 2017 to 31st December 2017 referred to as 2017 and 1st January 2018 to 31st December, 2018 was referred as 2018.

Inclusion and exclusion criteria

All pharmaceuticals i.e., drugs and consumables that were purchased by the hospital management were included while medications donated to the hospital on goodwill were excluded from the study.

ABC Analysis

The annual expenditure of each drug item was calculated and was arranged in descending order and cumulative expenditure of each item was computed. The cumulative percentage of the expenditure and cumulative percentage of items on yearly basis was calculated. Thereafter, the drugs were divided into three groups namely, A, B and C based on their cumulative annual expenditure percentage of 70%, 20% and 10% respectively.

VED Analysis

The drugs from the hospital formulary were divided into three categories namely vital (V), essential (E), desirable (D) based on their criticality and utility for the patients

ABC-VED Matrix Analysis

Cross tabulating the results of ABC and VED analysis resulted into ABC-VED matrix analysis. Eight different subgroups were formed and these subgroups were then divided into three different categories namely, category I which comprised AV, AE, AD and CV with BV absent, category II comprised BE, BD and CE and category III comprised CD.

Results

ABC Analysis

The ABC analysis in the five years revealed that they all followed Pareto law though the cut offs were not

exactly 70%/20%/10% but acceptable.

The pharmaceutical items in category A, B and C constituted about 10%, 10%, 80% but took total budget percentage of about 70%, 20%, 10% respectively (Table 1)

Table 1: The ABC Analysis of the FNPH Pharmacy Store

Category	Number of items	% of items	ADE (in NGN)	% of ADE of the Pharmacy
2014				
A	7	6.73	18,750,325	71.29
B	10	9.62	4,944,185	18.81
C	87	83.65	2,605,839	9.90
2015				
A	8	6.50	28,360,145	73.05
B	11	8.95	6,659,550	17.15
C	104	84.55	3,805,626	9.80
2016				
A	8	5.63	37,558,764	72.96
B	13	9.16	9,048,326	17.56
C	121	85.21	4,851,665	9.48
2017				
A	9	6.04	43,867,711	72.96
B	13	8.73	10,577,630	17.59
C	127	85.23	5,679,163	9.45
2018				
A	8	5.48	43,341,652	72.22
B	15	10.27	10,910,810	18.18
C	123	84.24	5,762,887	9.6

Key: ADE = Annual Drug Expenditure, NGN= Naira

Pharmaceuticals in category A included olanzapine, risperidone, diazepam, valproate, carbamazepine, amitriptyline, flupentixol, haloperidol, fluphenazine, consumables (cotton wool, methylated spirit, syringes and needles)

The ABC analysis of FNPH revealed that a total number of 104 pharmaceuticals were stored during 2014 which increased in three successive years, and climaxed in 2017 with 149 items and slightly decreased in 2018 to 146 items. In the year 2014, 7 (6.73%), 10 (9.62%), 87 (83.65%) items were in A, B and C categories respectively with cost implications of the sum of NGN18,750,325 (71.29%), 4,944,185 (18.81%), 2,605,839 (9.90%) of annual drug expenditure (ADE) respectively. Similar percentages of A, B, and C categories were seen in successive years (Table 1).

VED Analysis

The VED analysis in FNPH drug store in Table 2 showed that in the year 2014, 16 (15.39%), 50 (48.08%), 38 (36.53%) items were grouped into V, E and D categories respectively costing for the sum of NGN 2,329,509 (8.86%), NGN23,272,060 (88.48%), NGN698,780 (2.66%) respectively. Successive years (2015-2018) of study revealed similar proportions of items and expenditure found in category V, E and D (Table 2).

ABC-VED Matrix Analysis

ABC & VED tables were cross tabulated for ABC-VED matrix analysis, seven different subcategories

were formed and these were further subdivided into three classes viz. class I, II & III where AE, AV, CV, AD were in class I, BE, CE in class II, and CD were in class III. Table 3.

The ABC-VED matrix analysis of drugs of 2014, 2015, 2016, 2017 and 2018 in Table 3 showed that category I items which were 21 (20.19%), 26 (21.14%), 27 (19.02%), 27 (18.12%), 27 (18.49%) respectively consumed NGN18,991,634 (72.21%), NGN28,817,113 (74.22%), NGN37,955,459 (73.76%), 42,562,300 (70.79%), NGN44,430,522 (74.03%) of each year Annual Drug Expenditure (ADE) respectively.

The pharmaceuticals in category II from 2014-2018 in Table 3 were 45 (43.27%), 54 (43.90%), 65(45.77%), 73 (48.99%), 71 (48.63%) respectively consumed NGN6,609,935 (25.13%), NGN8,883,086 (22.88%), NGN11,364,569 (22.08%), NGN15,404,394 (25.62%), NGN13,320,224 (22.20%) of the annual drug expenditure respectively.

Category III that are not expensive and desirable pharmaceutical items from the year 2014-2018, comprise 38 (36.54%), 43 (34.96%), 50 (35.21%), 49 (32.89%), 48 (32.88%) respectively consumed NGN698,780 (2.66%), NGN1,125,122 (2.90%),

NGN2,138,727 (4.16%), NGN2,157,810 (3.59%), NGN2,264,603 (3.77%) of the ADE respectively.

The comparison of the ABC, VED, ABC-VED Matrix in the pharmacy stores during the period of study as shown in Table 4 revealed that the proportion for A category for ABC analysis ranged

from 5.48% in 2018 to 6.73% in 2014, the percentage of V category in VED analysis ranged from 15.39% in 2014 to 17.07% in 2015 while that of category I in ABC-VED Matrix analysis was from 18.12% in 2017 to 21.14% in 2018.

Table 2: The VED Analysis of the FNPH Pharmacy Store

Category	Number of items	% of items	ADE (in NGN)	% of ADE of the Pharmacy
2014				
V	16	15.39	2,329,509	8.86
E	50	48.08	23,272,060	88.48
D	38	36.53	698,780	2.66
2015				
V	21	17.07	2,413,468	6.22
E	60	48.78	35,294,431	90.90
D	42	34.15	1,117,422	2.88
2016				
V	23	16.20	4,073,895	7.92
E	69	48.59	45,246,133	87.92
D	50	35.21	2,138,727	4.16
2017				
V	24	16.10	3,879,989	6.45
E	76	51.01	53,078,705	88.28
D	49	32.89	3,165,810	5.27
2018				
V	23	15.75	1,098,718	1.83
E	74	50.68	55,546,428	92.55
D	49	33.57	3,370,203	5.62

Key: ADE = Annual Drug Expenditure, NGN= Naira

Some of the items in the vital (V) category were Normal saline, salbutamol inhaler, parenteral aminophylline, parenteral propofol, parenteral biperidine 5mg, 10% dextrose water, parenteral diazepam, 4.3 % dextrose saline, 5% dextrose saline, 5% dextrose water, and Darrow's solution.

Table 3: The ABC-VED Matrix Analysis of the FNPH Pharmacy Store

Category	Number of items	% of items	ADE (in NGN)	% of ADE of the Pharmacy
2014				
I	21	20.19	18,991,634	72.21
II	45	43.27	6,609,935	25.13
III	38	36.54	698,780	2.66
2015				
I	26	21.14	28,817,113	74.22
II	54	43.90	8,883,086	22.88
III	43	34.96	1,125,122	2.90
2016				
I	27	19.02	37,955,459	73.76
II	65	45.77	11,364,569	22.08
III	50	35.21	2,138,727	4.16
2017				
I	27	18.12	42,562,300	70.79
II	73	48.99	15,404,394	25.62
III	49	32.89	2,157,810	3.59
2018				
I	27	18.49	44,430,522	74.03
II	71	48.63	13,320,224	22.20
III	48	32.88	2,264,603	3.77

Key: ADE = Annual Drug Expenditure, NGN= Naira

Items that were in category I included olanzapine, amitriptyline, carbamazepine, nifedipine, consumables, risperidone, sodium valporate, diazepam, 10% dextrose water, 4.3 % dextrose saline, 5% dextrose saline, and biperidine 5mg. Some items in Category II were flupentixol, citalopram, benzhexol 5mg, fluphenazine 25mg, Artemisinin based Combination Therapy, paracetamol, cefuroxime, hydrocortisone, amoxycillin/clavulanate 625mg, amlodipne, and ceftriaxone 1g. Pharmaceuticals found in this category III were antacid, chlorpheniramine, doxycycline, prochlorperazine, albendazole 2mg, liquid Paraffin, cimetidine, erythromycin, nitrofurantoin, cotrimaxazole, pyrimethamine/sulphadoxine, promethazine 50mg, hydrogen peroxide, propranolol, piroxicam

Table 4: Comparison of the ABC, VED and ABC-VED Matrix Analysis in FNPH, Benin City Pharmacy Store

	2014	2015	2016	2017	2018
A	7 (6.73%)	8 (6.50%)	8 (5.63%)	9 (6.04%)	8 (5.48%)
B	10 (9.62%)	11 (8.95%)	13 (9.16%)	13 (8.73%)	15 (10.27%)
C	87 (83.65%)	104 (84.55%)	121 (85.21%)	121 (85.23%)	123 (84.24%)
V	16 (15.39%)	21 (17.07%)	23 (16.20%)	24 (16.10%)	23 (15.75%)
E	50 (48.08%)	60 (48.78%)	69 (48.59%)	76 (51.01%)	74 (50.68%)
D	38 (36.53%)	42 (34.15%)	50 (35.21%)	49 (32.89%)	49 (33.57%)
I	21 (20.19%)	26 (21.14%)	27 (19.02%)	27 (18.12%)	27 (18.49%)
II	45 (43.27%)	54 (43.90%)	65(45.77%)	73 (48.99%)	71 (48.63%)
III	38 (36.54%)	43 (34.96%)	50 (35.21%)	49 (32.89%)	48 (32.88%)

Discussion

In a resource limited health care system where there is ever growing demand of drug need, the optimal utilization of the available is key thus the exigency of application of various scientific analysis to mitigate the above-mentioned challenges.

The Always Better Control (ABC) analysis of 2014-2018 revealed that about one-tenth of pharmaceutical items took more than two-thirds of the annual drug expenditure (ADE) in any of the years reviewed. This agreed with a study done in Ethiopia [12] where about one-tenth of the items consumed slightly above four-fifths of the total drug expenditure. Similar studies such as done in India [11,16] also gave similar proportion of ABC as compared to this study. This tool used in this study showed that ABC analysis would assist in effective management of drug items in the A category, with almost 70% of ADE of the drug store, however, the limitation of this analysis is that, it would compromise on the availability of items of vital drugs from B and C categories hence the need for Vital Essential Desirable (VED) analysis

The analysis on the criticality of medications in the FNPH pharmacy stores from the year 2014 to 2018, i.e., the vital, essential and desirable (VED) medications and consumables revealed that about one-sixth of the items were vital pharmaceuticals, nearly half the number of items were essential pharmaceuticals while about one-third the total number of items were desirable pharmaceuticals. This stance is almost in consonance with another study in South Sudan [17] which revealed that less than one-tenth of items constituted Vital, about half the number of items were considered essential and slightly below half the number of items were considered desirable. A similar study done elsewhere in India, [18] posited that about one-sixth of the inventory were vital drugs, about half essential while one-third of the total number of pharmaceuticals were considered desirable.

VED analysis alone is considered ideal control of identified vital and/or essential items, both categories accounting for not less than 93% of ADE of the

pharmacy. However, category A also contains one (about 13%) desirable item of hospital consumables (such as latex gloves, cotton wool, syringes and needles and methylated spirit) and since it is not possible to ignore the desirable group completely then the need for ABC-VED matrix analysis.

The inventories of pharmaceuticals in the Federal Neuro-Psychiatric Hospital (FNPH), from 2014-2018 using ABC-VEN matrix analysis revealed that one-fifth of the items were either vital or expensive. This category of pharmaceuticals requires stringent managerial control in order to optimize the annual budget on pharmaceuticals while eliminating out of stock of the items. In order to save some money from this class of drugs, safety stock levels should be reduced while inventory management and purchase of these pharmaceuticals should be done regularly, once in a month at the most.

Pharmaceuticals in the category of both essential and not expensive constituted nearly half the number of pharmaceuticals in the drug store and consumed about one-quarter of total capital expended on pharmaceuticals. This finding is in line with other studies [11,16,18], Inventory management should have moderate safety stock level because these pharmaceuticals are relatively cheaper though less critical than items in category I. Purchase of category II items should be done every quarter of the year since they have higher buffer stock in order to avoid expiration of items to the barest minimum.

One-third of the medication which was in category III consumed about one-twentieth of the annual drug expenditure. This proportion is not quite different from that of other researches [19,20]. These items should be the least prioritized pharmaceuticals in terms of inventory control management due to the fact that the class of items is either easily substituted or have questionable pharmacological efficacy and very cheap. Requisition for these items should be done twice a year. Comparison of the different scientific tools of inventory control analysis revealed that similar proportions of the different categories of the analysis were seen for the five years period of the study. This slight variation in proportions of items in

the categories is in agreement with a study done in India [11] while the one which was conducted in Ethiopia differs [12].

Conclusion

Pharmaceuticals in category I in the ABC-VED matrix in FNPH such as olanzapine, amitriptyline, carbamazepine, nifedipine, consumables, risperidone, sodium valporate, diazepam, 10% dextrose water, 4.3 % dextrose saline, 5% dextrose saline, biperidine 5mg constituted one-fifth of the total pharmaceuticals and consumed nearly three-quarter of annual expenditure on pharmaceuticals that should be strictly and regularly managed.

Nearly half the number of pharmaceuticals that should have regular inventory management were in category II. These are less critical and expensive items and include citalopram, fluphenazine 25mg, artemisinin-based combination therapy, paracetamol, cefuroxime, amoxycillin/clavulanate 625mg, amlodipne, and ceftriaxone 1g.

Antacid, chlorpheniramine, doxycycline, prochlorperazine, albendazole 2mg, liquid paraffin, cimetidine, erythromycin, nitrofurantoin, cotrimaxazole were among pharmaceuticals in category III that should have the least regular inventory management due to the fact that they are the least critical and expensive.

Conflict of Interest

We declare no conflict of interest

Contribution of Authors

We declare that this work was done by the authors named in this article and all liabilities pertaining to claims relating to the content of this article will be borne by the authors. WJE, SFU and AWU conceived the study. WJE and ICE collected the data. SFU and WJE performed the data analysis. WJE wrote the first draft. All authors contributed to the final draft and approved it for publication

References

- Roser M, Ortiz-Ospina E. World Population Growth-Our World in Data. <http://ourworldindata.org> Accessed 12/2/2019
- Kant S, Pandaw C S, Nath LM. A management technique for effective management of medical store in hospitals. *Medical store management technique. J Acad Hosp Adm.*1997; 8(9): 41-7.
- Organization for Economic Cooperation and Development. Health at a Glance: OECD Indicators, OECD Publishing. 2013. Available at: http://dx.doi.org/10.1787/health_glance-2013-en, Accessed on: 10/02/2018
- Management Sciences for Health. Managing Drug Supply: The Selection, Procurement, Distribution, and Use of Pharmaceuticals 2nd ed, Kumarian Press Books on International Development, USA. 1997
- Abula T, Ashagrie G. Assessment of drug utilization from prescribers and dispensers perspectives in selected towns of Amhara region, Ethiopia. *Ethiop. J. Health Dev.* 2003
- Gupta S, Kant S. In: Hospital stores management - An integral approach. New Delhi: Jaypee Brothers Medical Publishers (P) Ltd; 2000. Inventory control; p. 60-72.
- Anand T, Ingle G, Kishore J, Kumar R. ABC-VED Analysis of a Drug Store in the Department of Community Medicine of a Delhi Medical College *Indian J Pharm Sci.*2013;75(1): 113-117.
- Anonymous Anonymous. Supply Chain: Cost of goods Grab executives' attention. *Health Facil Manage.* 2008; 21: 30-32.
- Dhoka D, Choudary L. ABC Classification for Inventory Optimization. *IOSR Journal of Business and Management. IOSR-JBM.* 2013;15(1): 38-41.
- Ramanathan R. ABC inventory classification with multiple-criteria using weighted linear optimization. *Comput Oper Res.* 2006;33(3): 695-700.
- Singh S, Gupta K A, Devnani M. ABC and VED Analysis of the Pharmacy Store of a Tertiary Care, Academic Institute of the Northern India to Identify the Categories of Drugs Needing Strict Management Control. *Journal of Young Pharmacists.*2015; 2(7): 76-80
- Yigeremu M, Woldegerima B, Shibes W, Migbaru S. ABC-VEN matrix analysis of pharmaceutical inventory management in Tikur Anbessa Specialized Hospital for the years 2009 to 2013, Addis Ababa, Ethiopia. *Indian Journal of Basic and Applied Medical Research;* 2016; 5, (2), 734-43
- Poorwa W, Pandit P, Zite A. ABC and VED analysis of the drug store of a tertiary care teaching hospital. *Indian Journal of Basic and Applied Medical Research.* 2013; 3 (1):126-31.
- Management Science for Health. Managing Access to Medicines and Health Technologies. 2012. Available at: apps.who.int/medicinedocs/documents/s19617en/s19617en.pdf . Accessed on: 11/02/2018
- Dwivedi S, kumar A, Kothiyal P. Inventory Management: A Tool of Identifying Items That Need Greater Attention for Control. *The Pharma Innovation.* 2012;1(7):125-27.
- Kumar M, Chakravarty B A. ABC-VED analysis of expendable medical stores at a tertiary care hospital. *Medical Journal Armed Forces.* 2015;71: 24-7
- Gupta R, Gupta KK, Jain BR, Garg RK. ABC and VED analysis in medical stores inventory control. *MJAFI.*2007;63:325-27
- Doshi RP, Patel N, Jani N, Basu M, Mathew S. ABC and VED analyses of drug management in a government tertiary care hospital in Kerala. In: iHEA 2007, 6th World Congress: *Explorations in Health Economics Paper.* 2007
- Devnani M, Gupta AK, Nigah R. ABC and VED analysis of the pharmacy store of a tertiary care teaching, research and referral healthcare institute of India. *J Young Pharmacists.*2010 ;2: 201-205.
- Kassie G, Mammo M. Assessment of pharmaceuticals store management in woreda health offices of west Harergea zone, Ethiopia. *Int. Res. J. pharm.* 2014;5(8):642-45.