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Medical Store Management: An Integrated Economic Analysis of a Tertiary Care Hospital in Central India

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ABSTRACT

Economic analysis plays a pivotal role in the management of medical store. The main objectives of this study were to consider always better control-vital, essential and desirable (ABC-VED) analysis with economic order quantity (EOQ), comparison of indexed cost and the actual cost, and to assess the expenditure for the forthcoming years. Based on cost and criticality, a matrix of nine groups by combining ABC and VED analysis was formulated. Drug categories were narrowed down for prioritization to direct supervisory monitoring. The subgroups AE and AV of the categories category I and II should be ordered based on EOQ. The difference between the actual annual drug expenditure (ADE) and the derived indexed cost using the cost inflation index (CII) was calculated. Linear regression was used to assess the expenditure for the forth coming years. The total ADE for the financial year of 2010–2011 was Rs. 1,91,44,253 which was only 7.68% of annual hospital expenditure. Using the inflation index, the indexed cost of acquisition of ADE for year 2010–2011 was Rs. 1,95,10,387. The difference between the two was estimated to be 2.11%. Thus, the CII justifies the demand of increased budget for next year and prompts us for cautious use of drugs. By taking into consideration the ADE of last 10 years, we have forecasted the budget for forthcoming years which will help significantly for making policies according to the available budget.

Keywords: ABC-VED matrix, budget forecasting, indexed cost, integrated economic analysis

INTRODUCTION

Hospital supply systems should ensure adequate stock of all the required items to maintain uninterrupted supply. Advances in medical care and drugs have disproportionately increased the expenditure on health care delivery.[1] Therefore, about one-third of the hospital budget is spent on purchasing various materials and supplies including medicines.[2] This necessitates the effective and efficient management of medical store by keeping a close supervision on important drugs, prevention of pilferage, and priority setting in purchase and distribution of drugs. A study suggested that review and control measures for expensive drugs can bring about 20% savings in medical store budget.[3] Hence, the essentiality of inventory control is emphasized. The inventory control can bring about substantial improvement not only in patient care but also in the optimal use of resources.[4] Continuous quality management in medical store can provide the value added services to the patients. Of all inventory control systems

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available, the always better control (ABC) and vital, essential and desirable (VED) matrix is the most preferred for medical stores.[5]

ABC analysis is "Always Better Control" analysis based on Pareto's principle of "Vital few and trivial many" depending on capital investment of the items. Although ABC analysis is based on the monetary value and rate of consumption of the item, there are items which have low capital investment and consumption but is life saving. Therefore, to overcome the limitation of ABC analysis, VED is applied. VED analysis is based on the need of the drug in the hospital and classified as 'Vital, Essential and Desirable'. Combination of ABC and VED matrix allows more meaningful control over the inventory.[6] Economic order quantity (EOQ) is another form of inventory control model which balances the possessing cost with the cost of running out of the items.[7] It is the level of inventory that minimizes total inventory holding costs and ordering costs. EOQ only applies when demand for a product is constant over the year and each new order is delivered in total when the inventory reaches zero. A fixed cost is charged for each order placed, regardless of the number of units ordered. EOQ along with ABC-VED analysis is proposed to be the most effective and efficient model for inventory control.[8] Ours is a tertiary care centre and number of patients coming to the hospital is increasing with passage of time. To satisfy the healthcare needs of the increased number of patients, increased capital is required every year. The government hospitals have to claim the budget in advance for the future year. This budget can be accessed from the actual budget consumed in the previous year using the cost inflation index (CII). The application of CII justifies the claim for increased annual drug expenditure (ADE). Based on previous economic data, prediction for the future can be done using regression analysis. This helps in framing the policies to ensure uninterrupted supply of drugs in the limited budget. Detailed literature search revealed scanty data regarding the relevance of CII and regression analysis in medical store management.

We therefore considered it worthwhile to carry out an integrated economic analysis of the medical store. The main objectives of the study were to consider ABC-VED analysis along with EOQ, to assess the indexed cost of acquisition of ADE, comparison of indexed cost and the actual cost and to forecast expenditure for the forthcoming years.

MATERIALS AND METHODS

The annual drug consumption and expenditure on each item was collected from the medical store of a tertiary care hospital in Central India, for the financial year 2010–2011. The data were transcribed in a MS-Excel spreadsheet and arranged in the descending order based on ADE. Then cumulative cost, cumulative cost percentage, and percentage of number of items were calculated and based on capital investment; A, B and C items were separated. Group A was constituted by approximately first 10% items which consumed 70% of the budget. The next 20% were group B items which took 20% of the financial resources. Group C included remaining 70% items accounting for just 10% of the budget.[9] VED classification of items was done in consultation with physicians and senior staff of department of pharmacology. Vital category included the drugs which should be available in the hospital at all times and are critically required for the survival of the patients. Essential items, as per WHO, are those which satisfy the health care needs of the majority of the population and are intended to be available at all times and in adequate amounts.[10] Desirable items are those of lowest criticality, the shortage of which would not be detrimental to the health of the patients. A matrix of nine groups by combining ABC and VED analysis was formulated.[11] Two drug categories (I and II) requiring different types of monitoring based on the ABC-VED matrix was identified to direct supervisory monitoring. Category I comprised of AV, AE, AD, BV and BE groups and required high management priority. Category II with lower management priority constituted items belonging to BD, CV, CE and CD groups of the ABC-VED matrix.[12] The first alphabet in the category denotes its place in ABC analysis while the second alphabet is for its place in VED analysis.

The annual hospital expenditure (AHE) was obtained from the office of the hospital superintendent. Indexed cost of acquisition[13] of ADE for the year 2010–2011 was calculated using the formula where the year 2009–2010 was taken as the base. The CII as determined[14] by the Government of India was applied as suggested.[15]

$$\text{Indexed cost of acquisition of ADE for 2010–2011} = \frac{(\text{ADE of 2009–2010}) \times (\text{Index factor for 2010–2011})}{\text{Index factor for base year 2009–2010}}$$

The difference between the actual ADE and the derived indexed cost was calculated. Percentage of actual ADE and percentage of indexed cost in comparison to ADE of the previous year were estimated and finally the difference between the two was calculated. Linear regression was used to assess the expenditure

for the forth coming years taking into consideration the ADE of last 10 years. Statistical calculations were performed with the help of Graph Pad Prism, version 3.02.

RESULTS

The AHE as obtained from the superintendent office for the year 2010–2011 was Rs. 24,91,61,000. The drug formulary consisted of 210 items, out of which 165 were available in 2010–2011. The total ADE of medical store for the financial year 2010–2011 was Rs. 1,91,44,253. The drug expenditure included the expenditure for 28,068 indoor admissions and 4,59,569 outdoor patients who were dispensed with drugs for 3 days routinely except for specialty clinics where the drugs were dispensed for 7 days. The split of ADE incurred on ABC and VED categories of drugs during the financial year 2010–2011 is shown in Table 1. The cutoff values were not exactly 70%, 20%, and 10% but differed marginally. Category I consisted of 52 drugs and 113 drugs in category II.

The ABC graph of the year 2010–2011 using cumulative cost and % items has different curves representing groups A, B, and C consuming about 70%, 20%, and 10% of the total budget, respectively [Figure 1]. ABC-VED cumulative curve is shown in Figure 2. However, the individual drug budget cannot be visualized from this graph which can be best represented by plotting the percentage cost of each drug with respect to ADE [Figure 3]. This concave type of plotting showed the individual drug expenditure as a percentage of the total ADE at a glance which can be further used for EOQ. The indexed cost of acquisition of ADE for year 2010–2011 came out to be Rs. 1,95,10,387 using the ADE for year 2009–2010, i.e. Rs. 1,73,42,566 as the base. The index factor for the year 2010–2011 as fixed by the Government of India was 711 and that of 2009–2010 was 632. The difference between the actual ADE and the indexed cost is Rs. 3,66,133.8. The percentage of actual ADE as compared to that of previous year was found out to be 110.39% whereas the percentage of indexed cost as compared to that of previous year was found out to be 112.5% after inflationary correction. The difference between the two came to be just 2.11%. The ADE for the forthcoming years applying linear regression from 2011 to 2015 is in Table 2 and shows a statistically significant value (P<0.001) which will be helpful for framing the policies for the respective years. The actual ADE for the financial year 2010–2011 was maximum (Rs. 1,91,44,253) and minimum in the financial year 2003–2004 (Rs. 87,80,577). Using the

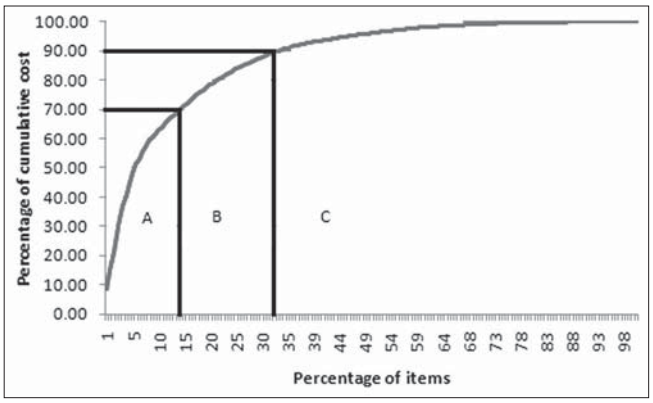

Figure 1: ABC analysis of drugs for the financial year 2010–2011

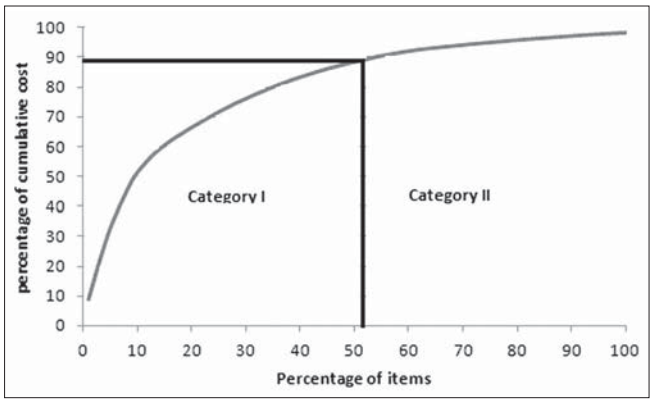

Figure 2: ABC-VED cumulative curve for the financial year 2010–2011

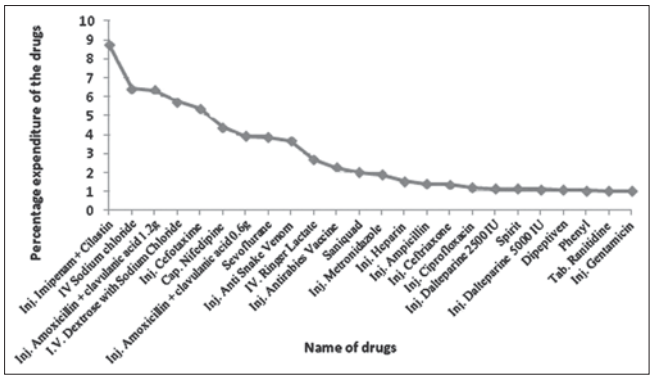

Figure 3: ABC analysis depicting percentage cost of each drug of group A with respect to annual drug expenditure in the year 2010–2011

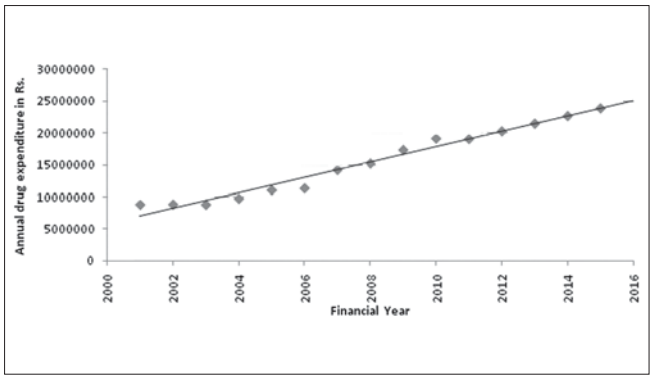

Figure 4: Annual drug expenditure for last 10 and forthcoming years using regression analysis

Table 1: Split of annual drug expenditure depending on ABC-VED analysis for financial year 2010–2011

Category	A			B			C			Total		
	Actual expenditure (Rs)	Percent	No. of drugs	Actual expenditure (Rs)	Percent	No. of drugs	Actual expenditure (Rs)	Percent	No. of drugs	Actual expenditure (Rs)	Percent	No. of drugs
V	41,97,864	21.9	6	16,26,410	8.5	12	4,70,871	2.4	22	62,95,145	32.8	40
E	90,90,190	47.5	17	19,26,884	10.1	16	12,28,837	6.4	80	1,22,45,911	64	113
D	2,06,555	1.1	1	1,88,610	1	2	2,08,032	1.1	9	6,03,197	3.2	12
Total	1,34,94,609	70.5	24	37,41,904	19.6	30	19,07,740	9.9	111	1,91,44,253	100	165

Percent is of total drug expenditure

Table 2: Projected annual drug expenditure for the next 5 years using linear regression analysis

Financial year	Projected annual expenditure (Rs.)	Coefficient of determination (r^2)	'*P*' value
2011–2012	1,90,70,533	0.92	<0.001
2012–2013	2,02,75,939		
2013–2014	2,14,81,345		
2014–2015	2,26,86,752		
2015–2016	2,38,92,159		

linear regression function of Graph Pad Prism, version 3.02, the forecasted ADE for the forthcoming years till 2015 showed that for the financial year 2011–2012, budgetary requirement is Rs. 1,90,70,533 [Figure 4].

DISCUSSION

We preferred the integrated economic analysis due to the paucity of data in the literature. In a tertiary care centre, along with proper care, timely availability of drugs is a prime concern. From our study, we found that the ADE for the year 2010–2011 was 7.68% of AHE. This percentage of ADE is lower compared to previous studies.[2,16] This reflects more refined drug inventory in our tertiary hospital. For drug inventory management if only ABC analysis based on cost factor alone is considered, control of only 24 drugs (out of 165) from group A consuming about 70% of the drug budget is needed. This group requires greater monitoring as it has fewer drugs, consuming most of the budget. We also noted that not all the drugs in this group were vital. It had drugs from the essential and desirable category such as injection imipenam–cilastin combination, injection amoxicillin–clavulanic acid, and dipeptiven. Due to this, the availability of drugs of vital nature from B and C categories (12 + 22) will be compromised. Similarly, if VED analysis is considered alone as ideal, control is to be exerted on 40 vital and 113 essential drugs accounting for 96.8% of ADE. However, the VED classification differs from hospital to hospital depending on the health care needs of the patients. Moreover, we had a desirable drug in group A, which consumed a good chunk of the budget. Hence, a desirable group cannot be ignored totally. Thus, not only criticality analysis, but the cost factor also has to be taken into consideration. Therefore, the coupling of ABC-VED analysis is used for prioritization. From the ABC-VED matrix, it is absolutely clear that all stock is not equally valuable and hence, does not require the same management focus.

Categorization of drugs by the ABC-VED matrix helped us to narrow down our focus on category I drugs which required high management priority and stringent control as they consumed the maximum budget. From our study, we found category I drugs consumed about 89.1% of the budget. Rational use of drugs with deletion of nonessential drugs and imposition of fixed budget to this category can bring about substantial savings without harming the patient care. Category II drugs consumed nearly 10.9% of the budget. The ABC-VED matrix can help us in improving the drug availability and lesser emergency purchase and adequate inventory control, thereby reducing the financial budget.

The cumulative curve does not depict the actual expenditure consumed by each drug which is well cited from the concave graph. In our study, it was observed that maximum budget was consumed by injection imipinem–cilastin combination whereas in the previous study the same place was secured by injection cefotaxim.[16] We could not predict the exact cause for this observed change in our study, but plausible explanation for this may be a resistance pattern developed by the microorganisms or different antimicrobial drug policy in our institution. Moreover, the concave curve has helped us to decide EOQ and time of order placement. EOQ is the amount of inventory to be ordered at one time for the purpose of minimizing annual inventory cost. It is the size of the order which gives maximum economy in purchasing any material and ultimately contributes toward maintaining the materials at the optimum level and at the minimum cost. The subgroups AV and AE of category I comprised of only 23 drugs, holding a valuable budget of 69.5%, should be monitored for EOQ and ordering of these items must be rational and justifiable. As category II drugs consumed limited amount of budget, these drugs can be ordered once or twice in a year using EOQ and shelved to save management efforts without blocking substantial capital. EOQ along with ABC-VED analysis can be effectively applicable in non-government hospitals where there is no limitation of maintaining the stock of 3 months only. Being a government

hospital, we can keep stock of drugs for 3 months only as per directives of Government of Maharashtra. To avoid unavailability of drugs, order placement has to be done in advance to cover the processing time. Therefore, concave plotting is preferred over the cumulative plotting.

The indexed ADE for the financial year 2010–2011 was just 2.11% higher than actual ADE. At present, very few studies are available to compare the indexed ADE, but still this figure is less as compared to the previous study where it was 2.84%.[16] This may be attributed to smaller drug formulary of our hospital and to some extent, the continuous efforts made by us to satisfy the healthcare needs of our area within limitation of budget of medical store. The inflation index represents the general trend and is not constant for all commodities. In developing country where the value for money is changing every day, the purchasing power of the currency is also changing. Due to this impact, the item which cost low in the current year will cost more in the forthcoming years. Hence, the application of CII makes sense for prediction of the drug expenditure with the use of inflation factor. As the inflation factor for the future years cannot be predicted in advance, hence the drug expenditure prediction for the forthcoming years cannot be done with CII but it can be done better using regression analysis. Therefore, the ADE for the forthcoming years was estimated using regression analysis.

One of the secondary objectives of inventory management is the financial forecasting for the forthcoming years. In Government institutions where the financial resources are already fixed, planning can be done for the future based on the economic data of today. However, such planning does not include the inclusion and exclusion of any drug in inventory or any unavoidable circumstances such as epidemic which can then cause economic burden. In such cases, we recommend to spare 5% of the total budget. Moreover, the forecasting of ADE for the future years using the ADE of the previous year's helps us to visualize the increasing trend in the consumption of the budget. This also helps for justifying the demand of increased budget during allocation of the budget in government institutions for next year. We found coefficient of determination (r^2) as 0.92 which suggest that 92% of the variation is shared between financial years and forecasted budget, respectively. The application of CII which includes the inflation factor also gives another justification for the increased claim for the budget. Forecasting of the budget for coming years helps in deciding the policies in advance to curb the deficiency of drugs and to satisfy the healthcare needs of society. Hence, economic analysis plays a pivotal role in the management of medical store. Thus, we recommend that ABC-VED analysis along with EOQ and integrated economic analysis should be strictly followed in every government medical college to utilize the available limited budget for maximum gains.

CONCLUSION

ABC-VED analysis identifies drugs requiring stringent control for the optimal use of resources. Due to inflation, total expenditure for the drugs is increased each year which supports the higher budgetary requirement for the forthcoming years. At the same time, forecasting of budget helps for better management of medical store. Hence, ABC-VED along with EOQ and integrated economic analysis optimizes the costs of medicare services besides making materials available to the patients which can increase the quality of healthcare services.

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