Inventory Analysis of Dental Consumables at a Tertiary Care Dental Hospital

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Abstract:
Background*: Inventory management in a healthcare system needs to be compatible with its operations and critical characteristics ensuring minimization of inventory-related cost as well as maximization of service level with a significant reduction in the price of treatment and wastage of resources. Over the years, numerous approaches and methodologies have been developed by the researchers and practitioners for modeling and analysis of varieties of inventory management systems in the healthcare sector. In this paper, the existing modeling approaches and solution methods concerning inventory systems in healthcare are classified and critically reviewed.*
Methods*: The ABC analysis according to the expenditure of expandable materials and VED analysis according to the criticality of the materials from the end-user department was done for expandable materials at a tertiary care dental hospital, for the financial year 2019-20. ABC-VED matrix analysis was done to classify dental consumables into Category I, II and III. Category I includes requiring top managerial control, whereas category II and III included consumables requiring middle and lower managerial control respectively.*
Results*: Of the 904 dental consumables used 3.98% (A Category) consumed 47.37% of total annual expenditure. About 14.71% (B Category) consumed 30.04% and 81.31% (C Category) accounted for 22.59% of the annual expenditure. The VED analysis found 22.35% items as vital, 43.14% as essential and 34.51% as a desirable category. ABC-VED matrix analysis categorized 58.18%, 37.33%, 4.49% of dental consumables as categories I, II, III respectively.*
Conclusion*: Scientific inventory management tools need to be applied routinely for efficient management of dental consumables, as it contributes to the judicious use of limited resources and the resultant improvement in patient care. The key operative word for inventory management is "**Neither Too Much, Nor Too Less.**" and aim for achieving "**Right consumable in the right quantity at the right price and at the right place**".*
Keywords*: ABC (Always, Better, Control) Analysis, VED (Vital, Essential, Desirable) Analysis, ABC-VED Matrix, Inventory control, Dental consumables*

I. Introduction

In financial parlance, inventory is defined as the sum of the value of raw materials, semi-processed materials, maintenance consumables, and finished goods at any given point of time.[1] "The operational definition of inventory would be the number of materials to be stocked for the smooth running of the plant." Since these resources are idle when kept in stores, inventory is defined as an idle resource of any kind having an economic value.[1,2]

Materials are vital to achieving the objectives of a health care organization.[3] Modern-day tertiary care dental hospitals are spending about one-third of its budget on purchasing various dental consumables.[4] With the advent of advanced dental and material science technology in the field of dentistry, has resulted in a disproportionate increase in the expenditure on health care.[5] A hospital supply system should ensure that adequate stock of required items to be maintained and an uninterrupted supply of all essential items to provide optimal care.[6] Therefore, various scientific approaches to inventory management include ABC (Always, Better, Control), VED (Vital, Essential, Desirable), FSN (Fast Moving, Slow Moving, Non-Moving), SDE (Scare, Difficult, Easy), HML (High, Medium, Low), SOS (Season-Off-Season).[5,6,7]

ABC and VED are the most commonly used inventory control techniques. But as ABC analysis considers only cost while VED considers criticality, the coupling matrix is most suitable for inventory analysis

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in the hospital.[8,9] Materials are categorized as A, B or C depending upon the annual consumption of the item. Group A includes 10% of items that consume about 70% of the budget. Group B includes the next 20% which consumes 20% of financial resources and Group C includes the remaining 70% items which account for 10%. "V" is for vital items without which a hospital cannot function, "E" is for essential items without which a hospital can function but may affect the number of services and "D" stands for desirable items, unavailability of which will not interfere functioning.[10,11]

The present study was conducted to undertake an ABC-VED analysis of dental consumables at central stores being held by a tertiary care dental hospital of the Armed Forces, Secunderbad to improve management and control of inventory of such stores.

Table 1: Inventory analysis classification and their considerations[12,13]

Sl. No	Title	Basis	Variables To Be Considered
1.	ABC (Always Better Control)	Value of Consumption	To identify inventory hot spots
2.	FSN (Fast Moving, Slow-moving, Non-Moving)	Consumption pattern of the materials	To control obsolescence
3.	HML (High, Medium, Low)	Unit price of the material	Mainly to control purchases
4.	XYZ	Value of materials in storage	To review the inventories and their uses at scheduled intervals
5.	VED (Vital, Essential, Desirable)	Criticality of the materials	To determine the stocking levels of materials
6.	SDE (Scarce, Difficult, Easy to obtain)	Problems faced in procurement	Lead time analysis and purchasing strategies
7.	GOLF (Government, Ordinary, Local, Foreign sources)	Source of the materials	Procurement strategies
8.	SOS (Seasonal-Off- Seasonal)	Nature of supplies	Procurement/holding strategies for seasonal items

II. Materials And Methods:

Study period: Study was an observational study carried out in a tertiary care dental hospital, for the financial year (from 1st April 2019 to 31st March 2020).[14]

Inclusion criteria: All expandable dental materials used in the dental hospital are included[14]

Exclusion criteria: Non – expandable materials are excluded[14]

Annual consumption data of expendable dental consumables for the financial year 2019-20 along with expenditure incurred on each item was retrieved from the expendables expense Register.[15] The data was further transcribed to an MS Excel spreadsheet for quantitative calculations.[16,17,18] For ABC analysis, the value of annual consumption of all dental consumables was calculated after multiplying the unit cost by annual consumption.[19] The annual expenditure of individual items thus worked out was arranged in descending order and the cumulative cost of all the items was calculated. The cumulative percentage of expenditure and the cumulative percentage of the number of items were then calculated for performing ABC analysis.[20]

For VED analysis, department wise specialists were asked to classify the consumables as Vital, Essential, or Desirable and distribution of dental consumables into VED classification is done along with percentages.[14,21] Then the above data was coupled into the ABC-VED matrix resulting in consumable categorization as Category I, II and III.[22,23]

Table 2: List of some important materials in the dental hospital[14,23]

Sr. No.	Material	Sr. No.	Material	Sr. No.	Material
1	Bone Graft	8	Composite Kit	15	Local Anesthesia
2	Implant	9	Mouth mask	16	Metal Brackets
3	X-ray Film	10	Cotton Rolls	17	BP Blades
4	Alginate	11	Devitalizer	18	Stainless steel crown
5	Glass Ionomer Cement	12	2ml Syringe	19	Paper Points
6	Gloves	13	GP Points	20	K-Files
7	Amalgam Alloy	14	Die Stone	21	RC Help

III. Result

The dental consumables inventory of the hospital in 2019-2020 consisted of 904 items. ABC analysis revealed A category items comprising 3.98% (36) expendable items consuming 47.37% of the total stores expenditure and B category items represented by 14.71% items (133) accounting for 30.04% expenditure. An astounding 81.31% (735) items were found to belong to category C, consuming only 22.59% of the total expenditure (Table 3). The results are also being graphically displayed in Figure 1 for better appreciation. After the ABC analysis, VED analysis was subsequently performed for ushering in the parameter of criticality in the analytical process. 22.35% (202) expendable items were found to belong to the V group, 43.14% (390) to E

group and the balance 34.51% (312) to D group of items (Table 4/Figure 2). Lastly, the results of the ABC and VED analysis were further classified into a combined matrix representing the three essential functional parameters of "Annual consumption, cost, and criticality". 58.18%, 37.33%, and 4.49% were found to be category I, II and III items respectively, accounting for 36.95%, 46.24% and 16.81% of dental consumables expenditure (Table 5 and Figure 3).

Table 3: ABC Analysis of dental consumables

Dental Consumables Analysis	Category			Total
	A	**B**	**C**	
Total Annual Consumption (%)	47.37	30.04	22.59	**100.00**
Value of Annual Consumption (Rupees)	1951242.70	1237701.92	930590.16	**4119534.78**
Number of items	36	133	735	**904**
Number as percentage	3.98	14.71	81.31	**100**

Table 4: Distribution of dental consumables into VED classification

Category	Number	Percentage
Vital	202	22.75
Essential	390	44.77
Desirable	312	32.48

Table 5: ABC – VED Matrix

Category	**V**	**E**	**D**	**Matrix classification**
A	AV (14)	AE (15)	AD (7)	**Category I (58.18%)**
B	BV (19)	BE (71)	BD (43)	**Category II (37.33%)**
C	CV (279)	CE (304)	CD (152)	**Category III (4.49%)**

Table 6: Categorization of materials according to ABC – VED Matrix

Category I	Category II	Category III
IOPA Films	Modeling wax	Dental Stone
Amalgam Alloy	Rubber Dam sheets	Sodium Hypochlorite
Glass Ionomer Cement	2ml Syringe	Zinc Oxide Powder
Alginate impression Material	Impression Compound	Formocresol

Table 7: Comparison of ABC, VED and ABC-VED matrix analysis of different studies

| Category	Present study %	Pund SB et al[23]	Hacer GunerGoren et al[25]	Gupta RK et al[26]	Anand et al[27]	S Khurana et al[19]	Nitin Gupta et al[14]	Biruk et al[22]	Sushil Kumar et al[13]	Poorwa Wandalkar et al[17]
A	3.98	16.8	80	15.24	18.6	3.4	13.5	15.14	70.03	13.4
B	14.71	21.8	17	22.54	24	6.9	21	22.47	19.98	16.5
C	81.31	61.4	3	62.22	57.4	89.6	65.5	62.39	9.98	70.1
V	12.1	35.3	43.08	31.11	13.2	32.4	47	31.19	19	50.9
E	59.4	50.4	19.2	60.32	38.8	61.3	37.6	67.43	68	40.2
D	28.5	14.3	37.7	8.57	48	6.2	15.4	1.38	13	8.9
I	58.18	47.9	84.8	42.86	28.7	33.8	51.6	39.91	21	57
II	37.33	43.7	13.3	52.38	41.1	60	33.5	59.17	51.17	35
III	4.49	8.4	1.8	4.76	30.2	6.2	14.8	0.92	27.83	8
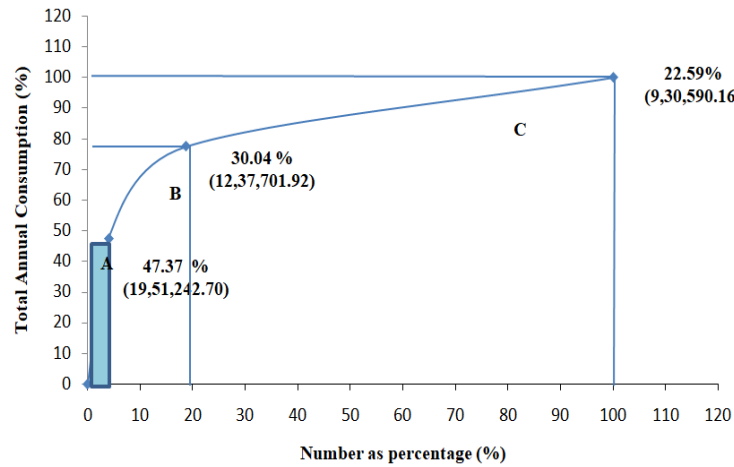
Figure 1: ABC analysis cumulative curve
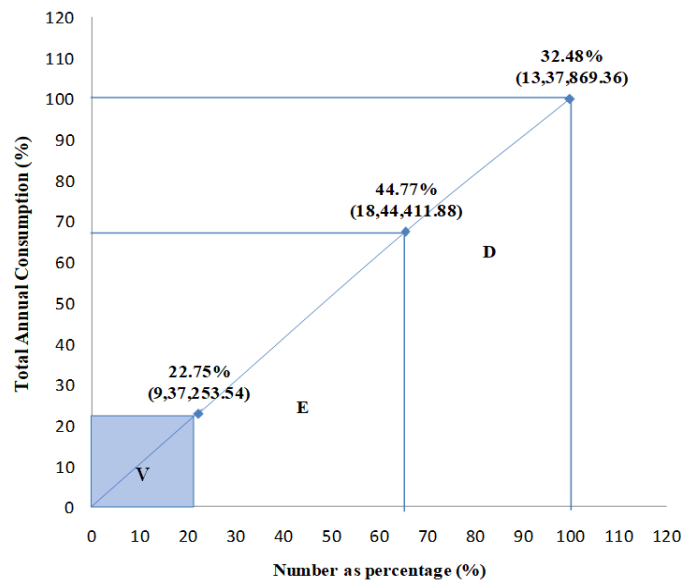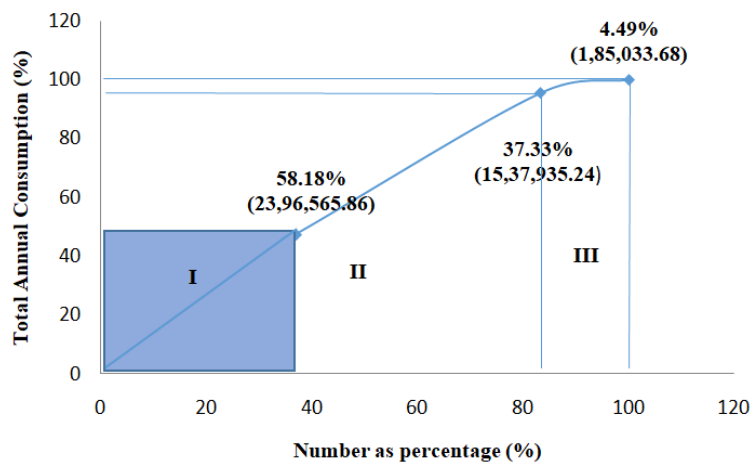
Figure 2: VED analysis cumulative curve

Figure 3: ABC-VED matrix analysis cumulative curve

IV. Discussion

Out of a total of 215 dental consumables, around 36(3.98%) accounted for 47.37 % of the annual expenditure and were classified as A category. Another 133(14.71%) of the consumables consumed 30.04% of the budget (B category), while the remaining 735(81.31%) accounted for only 22.59% of the annual expenditure (C category). These results are similar to the study conducted by Nitin Gupta et al.,[14] in a private dental hospital in Bangalore, India where out of 215 consumables, 29 (13.5%) dental consumables consume 70% of A category, 45 (21.0 %) consume 20 % of B category and the rest 141 (65.5%) dental consumables consume just 10 % of the total budget.

With regards to VED analysis, our study showed that the clinicians classified 202 (22.35%) of the consumables as Vital, 390 (43.14%) as Essential and 312 (34.51%) as Desirable. These results are in contrast to similar study obtained by Nitin Gupta et al.,[14] which revealed that out of 101 (47.0%) were considered 'Vital' by the constituted dental panel, 81 (37.6%) were 'Essential' and the rest 33 (15.4%) were considered 'Desirable'.

The ABC-VED matrix classification of the inventory depicted in [Table-5/Figure-3] reveals that 58.18% of the consumables constituted Category-I items. Fourteen items of Category-I items were both, high cost and vital, fifteen items were high cost and essential, seven items were high cost and desirable. Category- II items (37.33%) were constituted by intermediate cost and vital items numbering nineteen, intermediate cost and essential items numbering seventy-one, intermediate cost, and desirable items numbering forty-three. While Category-III items (4.49%) were constituted by two hundred and seventy-nine items as low cost and vital, three hundred and four items as low cost and essential and one hundred and fifty-two items as low cost and desirable items.

Based on ABC-VED matrix analysis a study by Nitin Gupta et al.,[14] revealed that around 51.6% of dental consumables were classified as category I, accounting for 14.4% of the total dental consumables expenditure. Category II consumables constituted 33.5% of dental consumables which consumed 20.9% of the total budget, while the remaining 14.8% consumables (category III) accounted for 64.7% of the total dental consumable expenditure.

A comprehensive view of the studies involving Inventory Control analysis using the ABC-VED matrix is provided in Table 7.[28]

In the tertiary care dental hospital facility, availability of services including dental consumables was a crucial factor for the provision of health care.[29] Besides criticality, the cost of the items was equally important.[30] The stock of these consumables needs to be maintained throughout the period for the smooth functioning of the hospital as their unavailability is unacceptable.[31] To prevent this, it is necessary to keep low-cost buffer stock always available while keeping close vigilance on the consumption and stock in hand.[32] Economics of materials control is a matter of self- presentation in today's competitive environment.[33] Materials control is a matter of rupee control.[34] Thus, the management of class I vital items would help in keeping a check on the annual budget and their availability. The management of class II items could help in providing all the essential items. Class III items can be managed by low-level management.[35]

V. Conclusion

Healthcare organizations across the world are dealing with the problem of understaffing, rising costs, volatile customer demand, and complicated payment mechanisms. Battling these huge issues, most healthcare firms tend to view inventory management as less than mission-critical, and thereby relegate it to an ancillary function. Like all businesses, dental practices have an industry standard when it comes to overhead and expenses. Overhead is a major factor in the net profit or bottom line of any practice. One of the key elements of overhead management is inventory control.

Our study has demonstrated the utilization and benefits of selective inventory control techniques in dental logistics management. What needs to be appreciated is that the operational efficiency of the central stores can be substantially improved by focusing on 526 dental consumables (58.18%) only out of the total inventory of 904 items, making store management function easier, efficient and contributing to optimal utilization of hospital resources. The study suffers from the limitation of being a single dental hospital study and thus the study findings cannot be generalized for all service hospitals. However, the concept of selective inventory control is universal for achieving the aim of "**Right consumable in the right quantity at the right price and at the right place".**

Future recommendations
1. Implementing Just in time inventory purchasing.[36]
2. Implementation of an automated system to measure the inventory index and other parameters of inventory control.[37]
3. Dental consumables should be reviewed periodically to remove non-moving items that are not in consumption for 3 months.[38]

4. The codification and classification of inventory were important to eliminate duplication of items in the warehouse and to achieve a physical control of inventories.[39,40]

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