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Original Research Article

ABC–VED matrix analysis of drug inventory management in a tertiary care teaching hospital: a retrospective observational study

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ABSTRACT

Background: Drug inventory management is essential for ensuring uninterrupted availability of medicines while maintaining financial sustainability in tertiary care hospitals. ABC analysis categorizes drugs based on expenditure, whereas VED analysis classifies them based on clinical criticality. The combined ABC–VED matrix provides a comprehensive approach for prioritizing managerial control. The present study aimed to analyse drug inventory using ABC, VED, and ABC–VED matrix methods in a tertiary care teaching hospital.
Methods: A retrospective observational study was conducted using pharmacy procurement records over a one-year period at tertiary care teaching hopsital, New Delhi. Data on annual drug expenditure (ADE) for 4,581 drug items were analysed. ABC analysis categorized drugs according to expenditure, VED analysis classified drugs based on clinical importance, and an ABC–VED matrix was constructed for prioritization. Data were analysed using descriptive statistics.
Results: Of 4,581 drug items, 1,003 (22%) were classified under Category A accounting for 70% of ADE; 1,245 (27%) under Category B accounting for 20%; and 2,333 (51%) under Category C accounting for 10%. VED analysis showed 1,423 (31.06%). Vital items accounting for 30.44% of ADE; 2,758 (60.20%). Essential items accounting for 57.12%; and 400 (8.53%) Desirable items accounting for 12.44% of ADE. The ABC–VED matrix identified 1,967 (42.93%) items under Category I consuming 78.91% of ADE.
Conclusions: ABC-ED matrix analysis is an effective tool for rational drug inventory control in tertiary care hospitals. Focused monitoring of Category I drugs can improve financial efficiency while ensuring uninterrupted patient care.

Keywords: ABC analysis, VED analysis, Drug inventory, Annual drug expenditure, Hospital pharmacy, Inventory control

INTRODUCTION

Inventories constitute one of the most critical components of hospital working capital and account for the substantial proportion of the total operational expenditure. Effective inventory control encompasses and systematic procurement, storage, distribution, utilization of materials to ensure their timely availability and adequate buffering against the contingencies, cost-effectiveness, minimization of wastage. With rapid advancements in medical technology and pharmaceutical innovations, healthcare delivery costs have escalated disproportionately.[1] In India, healthcare inflation has shown a persistent upward trend and has been rising at nearly twice the rate of overall retail inflation. The average retail healthcare inflation stood at 7.14% in 2018–19, increasing sharply from 4.39% in the preceding fiscal year.[2] Kant et al reported that approximately one-third of a hospital's annual budget is allocated to the procurement of materials and supplies, including medicines.[3] This highlights the necessity of optimizing available financial

resources without compromising the quality of patient care. Consequently, careful planning, organization, and management of hospital drug stores are essential to ensure efficient clinical and administrative functioning.[4] The fundamental objective of a hospital supply system is to maintain adequate stock levels to guarantee uninterrupted service delivery.

The adoption of scientific inventory management techniques can significantly enhance institutional efficiency. Even marginal savings of 1–2% in inventory expenditure can markedly improve hospital productivity, profitability, and financial sustainability. Evidence from a study conducted in a 1500-bedded hospital demonstrated that structured inventory control measures resulted in nearly 20% savings on high-cost drugs.[5] In today's technologically advanced and competitive healthcare environment, financial sustainability depends on ensuring the availability of medicines and medical supplies at the right time, place, quantity, quality, and price, while safeguarding against supply–demand uncertainties and minimizing delays in service delivery.[6,7] Therefore, adherence to rational drug use principles and efficient inventory control practices is imperative to maximize patient coverage within existing budgetary constraints.[8] Various inventory management techniques are commonly employed in hospital settings, including ABC analysis (Always Better Control), VED analysis (Vital, Essential, Desirable), SDE analysis (Scarce, Difficult, Easily available), HML analysis (High, Medium, Low cost), and FSN analysis (Fast-moving, Slow-moving, Non-moving).[9]

Among these, ABC and VED analyses are the most widely utilized approaches. ABC analysis categorizes items based on their annual consumption value. Typically, around 10% of items account for nearly 70% of the total expenditure (Category A), the subsequent 20% account for approximately 20% of the expenditure (Category B), and the remaining 70% of items contribute to only 10% of the total cost (Category C).[10] This method assists administrators in identifying high-value items that require strict financial monitoring. Complementing cost analysis, VED analysis evaluates items according to their criticality. "V" denotes vital items indispensable for hospital functioning, "E" represents essential items whose absence may compromise the quality of care, and "D" includes desirable items whose non-availability does not significantly disrupt hospital operations.[11] The integration of ABC and VED analyses into an ABC-VED matrix provides a comprehensive framework by combining cost significance and criticality. This approach is considered particularly appropriate for hospital drug inventory management.[12] Previous studies have demonstrated the utility of these techniques in healthcare institutions. Antonoglou et al performed ABC and VED analyses in a general military hospital in Athens to evaluate annual consumption and expenditure patterns. Similarly, Yiğit analyzed medical material expenditures using inventory control methods.[13,14] Other researchers have reported varying classifications and managerial implications using ABC and VED methodologies.[15-17] The present study was undertaken in a tertiary care teaching hospital in North India that caters to a large patient population through direct admissions and referrals. Given the increasing demand for healthcare services, judicious utilization of available resources is essential. Accordingly, ABC analysis, VED analysis, and the combined ABC-VED matrix were applied to achieve effective inventory control of drugs in the hospital store. The study aimed to categorize drugs based on cost and criticality and to identify those requiring stringent managerial oversight.

METHODS

Study design and setting

This retrospective observational study was conducted in the central pharmacy of a tertiary care teaching hospital, tertiary care teaching hopsital, New Delhi. The hospital provides multispecialty services and caters to a large patient population.

Study period

The study included drug procurement data for one year (April 2023 to March 2024).

Data source

Procurement records from the hospital pharmacy were reviewed. Data regarding drug name, annual consumption, unit cost, and total annual expenditure were collected for all drug items procured during the study period.

Inclusion criteria

All drug items procured by the hospital pharmacy during the study period were included in the analysis.

ABC analysis

ABC analysis was performed by calculating the annual drug expenditure (ADE) for each item (annual consumption × unit cost). Drugs were arranged in descending order of ADE, and cumulative expenditure percentages were calculated. Items were categorized into: Category A: top 70% of total ADE, Category B: next 20% of total ADE, Category C: remaining 10% of total ADE.

VED analysis

VED classification was performed based on the clinical importance of drugs in consultation with senior clinicians and pharmacologists, and with reference to the hospital formulary and essential medicines list. Drugs were categorized as: Vital (V): life-saving drugs, non-availability may result in serious morbidity or mortality, Essential (E): drugs necessary for basic healthcare services, Desirable (D): drugs used for minor or self-limiting conditions.

ABC–VED matrix

An ABC–VED matrix was constructed by cross-tabulating ABC and VED categories, based on their criticality and cost aspects (Table 1). Subsequently, based on combined analysis, drugs were classified into category I; category II and category III.

Table 1: ABC-VED matrix.

	V	E	D
A	AV	AE	AD
B	BV	BE	BD
C	CV	CE	CD

Category I (AV, AE, AD, BV, CV), Category II (BE, CE, BD), Category III (CD).

Statistical analysis

Data were entered and analysed using Microsoft Excel 2021. Descriptive statistics were used to summarize frequencies and percentages. Data were double-checked for accuracy prior to analysis.

Ethical approval

Not required as the study involved analysis of procurement records without patient identifiers.

RESULTS

During the study period (April 2023–March 2024), a total of 4,581 drug items were procured, with a cumulative annual drug expenditure of Rs. 144 crores.

ABC analysis

ABC analysis showed that Category A included 1,003 (22%) items, which accounted for 70% of the total annual drug expenditure. Category B comprised 1,245 (27%) items contributing 20% of the expenditure. Category C constituted the largest proportion of items, 2,333 (51%), but accounted for only 10% of the total expenditure.

Thus, less than one-fourth of the total items consumed nearly three-fourths of the annual drug budget, whereas more than half of the items contributed to only one-tenth of the expenditure. The proportional distribution of drugs under ABC categories is illustrated in Figure 1.

VED analysis

According to VED analysis, 1,423 (31.06%) items were classified as Vital, accounting for 30.44% of total expenditure. Essential drugs formed the majority with 2,758 (60.20%) items contributing 57.12% of expenditure. Desirable drugs comprised 400 (8.53%) items and accounted for 12.44% of the total drug expenditure. The proportional distribution of drugs under VED categories is illustrated in Figure 2.

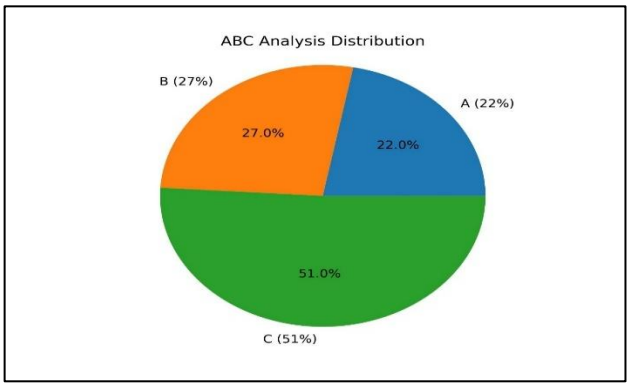

Figure 1: ABC analysis pie chart.

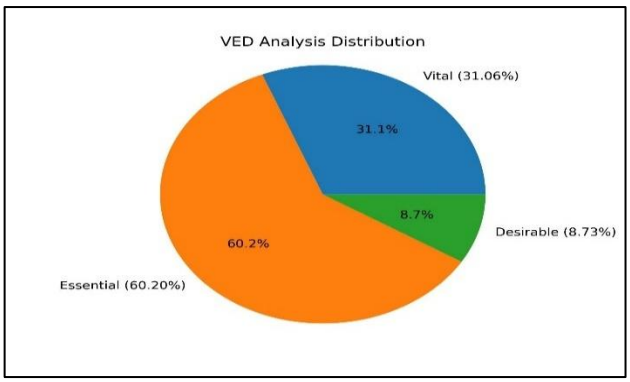

Figure 2: VED analysis pie chart.

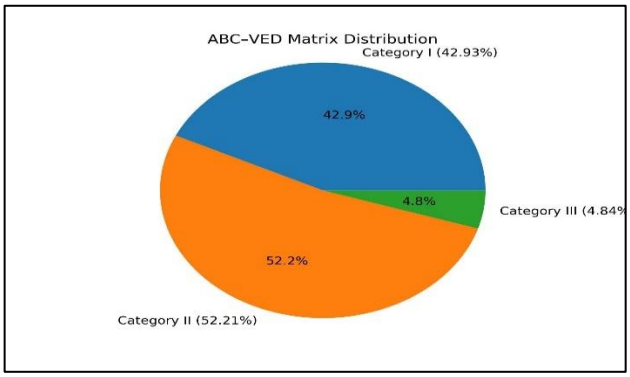

Figure 3: ABC–VED matrix distribution pie chart.

Figure 1 ABC Analysis Pie chart showing distribution of drug items according to ABC analysis in a tertiary care teaching hospital (April 2023–March 2024). Category A constituted 22% of items accounting for 70% of ADE, Category B constituted 27% accounting for 20% of ADE, and Category C constituted 51% accounting for 10% of ADE. Figure 2 VED Analysis Pie Chart showing distribution of drug items according to VED analysis. Vital drugs constituted 31.06% of items accounting for 30.44% of ADE, Essential drugs constituted 60.20% accounting for 57.12% of ADE, and desirable drugs constituted 8.73%

accounting for 12.44% of ADE. Figure 3 ABC–VED matrix distribution pie chart showing distribution of drug items according to ABC–VED matrix categorization. Category I comprised 42.93% of items consuming 78.91% of ADE, Category II comprised 52.21% consuming 20.15% of ADE, and Category III comprised 4.84% consuming 0.94% of ADE. Matrix analysis revealed that Category I comprised 1,967 (42.93%) items consuming 78.91% of total expenditure. Category II included 2,392 (52.21%) items accounting for 20.15% of expenditure, whereas Category III consisted of 222 (4.84%) items contributing only 0.94% of total expenditure (Table 2). Also, the distribution of items under ABC–VED matrix categories is depicted in Figure 3.

Table 2: ABC, VED and ABC-VED matrix analysis.

Category	Number of drugs	Drugs (%)	Cost (%)
ABC analysis			
A	1003	22	70
B	1245	27	20
C	2333	51	10
VED analysis			
V	1423	31.06	30.44
E	2758	60.20	57.12
D	400	8.53	12.44
ABC–VED matrix			
Category I	1967	42.93	78.91
Category II	2392	52.21	20.15
Category III	222	4.84	0.94

Comparative analysis

Table 2: Comparison of ABC, VED, and ABC–VED matrix findings with other recent studies.

Category	Present study	Verma et al (2025)[15]	Kulkarni et al (2025)[16]	Prachhai et al (2025)[17]	Sinha and Singh (2025)[18]
A (%)	22	12.89	26	18.18	2.6
B (%)	27	23.12	32.2	26.49	10.4
C (%)	51	64	40.8	55.32	86.9
V (%)	31.06	23.56	29.5	16	8.3
E (%)	60.20	52.89	51.2	36	18.2
D (%)	8.53	23.56	18.3	48	73.4
Category I (%)	42.93	41.78	47.88	30.20	–
Category II (%)	52.21	44.89	–	41.80	–
Category III (%)	4.84	13.34	–	28.00	–

DISCUSSION

Efficient drug inventory management is cornerstone of both rational pharmacotherapy and institutional financial sustainability in tertiary care hospitals where patient complexity, formulary breadth are substantial. In present study, 4,581 drug items with ADE of INR 144 crores were analysed using ABC, VED, ABC-VED matrix approaches to generate structured framework integrating economic, clinical priorities.

ABC analysis: cost concentration financial governance

ABC analysis revealed that 22% of items (Category A) accounted for 70% of total ADE, while 27% (Category B) and 51% (Category C) accounted for 20% and 10% of expenditure, respectively. This Pareto-type distribution underscores the concentration of financial burden within a relatively small segment of the formulary. For clinical pharmacologists, this finding highlights the need for rational prescribing oversight for high-cost drugs. Targeted prescription auditing of Category A drugs can significantly influence overall expenditure without affecting therapeutic availability. Similar ABC distribution patterns have been reported in recent tertiary care studies.[19-21] From a hospital management perspective, ABC stratification provides a practical financial control tool. By focusing administrative scrutiny on 22% of items, nearly 70% of expenditure can be effectively regulated. Such structured cost-based prioritization has been supported by contemporary inventory evaluations in tertiary hospitals.[19-22] However, ABC analysis alone remains limited as it does not account for therapeutic criticality. Low-cost drugs may be lifesaving, and exclusive reliance on cost-based classification may compromise patient safety if not supplemented with clinical prioritization.

VED analysis: clinical criticality and patient safety

VED analysis classified 31.06% of drugs as Vital, 60.20% as Essential, and 8.73% as Desirable. Although Desirable drugs constituted a small proportion of items, they accounted for 12.44% of total expenditure, indicating that certain non-critical drugs may still carry significant cost implications. Notably, Vital and Essential drugs together accounted for nearly 88% of the formulary. For clinical pharmacology practice, this distribution reflects alignment with essential medicine principles and therapeutic prioritization frameworks such as the National List of Essential Medicines (NLEM).[24] Ensuring uninterrupted availability of Vital drugs is crucial to prevent treatment delays, morbidity escalation, and medico-legal risk. From an administrative standpoint, VED analysis acts as a patient-safety safeguard. Medicine stock-outs in tertiary hospitals have been associated with adverse clinical outcomes and operational inefficiencies.[26] Therefore, zero stock-out tolerance for Vital drugs should be institutional policy. Comparable VED distributions have been documented in recent studies, although institutional variability persists due to differences in service profile and procurement systems.[19-22]

ABC–VED matrix: integrating cost and clinical priority

The ABC–VED matrix in the present study categorized 1,967 items (42.93%) under Category I, which consumed 78.91% of the ADE. Meanwhile, 2,392 items (52.21%) fell under Category II, accounting for 20.15% of the ADE, and 222 items (4.84%) were placed in Category III, consuming only 0.94% of the ADE. This integrated approach provides a more balanced prioritization strategy. Similar distributions of Category I concentration have been reported in recent matrix-based analyses.[19-22] For clinical pharmacologists, Category I represents drugs requiring strict utilization monitoring, antimicrobial stewardship integration (where applicable), and periodic drug utilization review to prevent irrational use and unnecessary expenditure.

For hospital management, Category I demands the highest degree of oversight. Administrative strategies such as Economic Order Quantity (EOQ) modelling, centralized procurement, expiry tracking, and rate contract optimization are particularly relevant. Contemporary literature emphasizes the growing role of digital inventory systems and data-driven supply chain management in optimizing such high-priority categories.[25] Furthermore, pharmaceutical pricing policies and cost-governance frameworks increasingly advocate systematic expenditure monitoring for high-cost essential medicines.[23] Category II items may be reviewed periodically at the middle-management level, while Category III items require minimal managerial intervention beyond routine monitoring.

Clinical–administrative convergence

The ABC–VED matrix functions not merely as an accounting tool but as a decision-support mechanism that aligns pharmacotherapy priorities with institutional financial planning. In resource-constrained health systems, drug expenditure constitutes a major operational cost component, necessitating rational allocation and systematic oversight.[23] By integrating cost containment with the uninterrupted availability of critical medicines, the matrix supports rational drug use, patient safety, financial accountability, efficient procurement, and the reduction of wastage and expiries. The findings of the present study reaffirm the continued relevance of ABC–VED matrix analysis in modern tertiary care hospitals and demonstrate its applicability as a bridge between clinical pharmacology and hospital administration.

Limitations

The present study has certain limitations. First, it was conducted in a single tertiary care teaching hospital, which may limit the generalizability of the findings to secondary care centres or primary health facilities with different service profiles and formulary structures. Drug consumption patterns are influenced by institutional case mix, specialty services, and procurement policies. Second, the study was retrospective in nature and relied on annual procurement and expenditure data. Seasonal variations in drug utilization and short-term fluctuations in demand could not be evaluated. Similarly, consumption data were analysed in aggregate, and department-wise or disease-specific utilization trends were not assessed. Third, the ABC–VED classification is dependent on local expert consensus for categorizing drugs into Vital, Essential, and Desirable groups. Although institutional protocols were followed, some degree of subjectivity in VED categorization cannot be entirely excluded. Fourth, the study did not evaluate clinical outcomes, stock-out frequency, wastage due to expiry, or cost savings achieved after implementation of the matrix-based control strategy.

Future prospective studies incorporating outcome-based and economic impact analyses would provide deeper insight into the effectiveness of ABC–VED-guided inventory management. Despite these limitations, the study provides a comprehensive overview of cost and criticality-based drug inventory prioritization in a tertiary care setting and offers a practical framework applicable to similar institutions.

CONCLUSION

The present study demonstrates that ABC–VED matrix analysis is an effective tool for prioritizing drug inventory management in a tertiary care teaching hospital. A relatively small proportion of drug items accounted for the majority of annual drug expenditure, while a substantial proportion were classified as Vital and Essential, underscoring the need to balance financial prudence with

uninterrupted therapeutic availability. By integrating cost-based (ABC) and criticality-based (VED) approaches, the matrix enables structured managerial oversight, rational resource allocation, and strengthened patient safety safeguards. In large tertiary care settings with extensive formularies, such stratification helps focus administrative and clinical monitoring efforts on high-impact drug categories.

Although the findings are derived from a single-centre retrospective analysis and do not assess direct clinical or economic outcomes, the study provides a practical and replicable framework for evidence-informed inventory governance. Future prospective, multi-centre studies incorporating outcome measures and cost-effectiveness evaluation would further validate the role of ABC–VED analysis in optimizing hospital pharmacy systems.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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