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Original Article

ABC and XYZ Analysis in the Medical Store of a Government Tertiary Care Cancer Hospital of North India

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ABSTRACT

Introduction: Inventory management in hospital stores presents complex challenges, particularly in cancer care settings where high-cost medications and irregular demand patterns exist. Hospital administrators must maintain equilibrium between medication availability and budget constraints. Ineffective inventory practices lead to either stockouts that compromise patient care or overstocking, which results in medication wastage. The study is conducted because of frequent stockouts at the hospital's medical store. It will identify medications with high costs and high variation, high costs with little variation, and low costs with high variation using ABC and XYX analysis. This will help the institute develop procurement strategies to reduce stockouts and medication waste. **Materials and Methods:** This cross-sectional, descriptive, retrospective study was conducted at a tertiary care government cancer hospital in North India from March to May 2025. It included 286 medications regularly procured by the hospital's medical store. The data from July 2023 to June 2024 was analyzed for ABC and XYZ analysis. ABC analysis was conducted based on the Annual Consumption Value (ACV), dividing medications into three groups: Category A (top 70%), B (next 20%), and C (bottom 10%). XYZ analysis classified medicines according to monthly demand variability using the Coefficient of Variation (CV): X (CV<0.5), Y (CV 0.5-1.0), and Z (CV>1.0). Combining both methods created a 3×3 matrix for inventory management. Since the research used anonymized routine stock data, ethical approval was not needed. Data was analyzed using SPSS. **Results:** The study classified 286 drugs into nine segments based on purchasing value and demand variability to guide procurement planning. ABC analysis showed 29 expensive drugs (10.1%) accounted for 70% of the drug bill (₹8.95 crore of ₹12.71 crore), supporting the Pareto principle. XYZ analysis placed 65 drugs in Class X, 112 in Class Y, and 109 in Class Z. The ABC-XYZ matrix results in an efficient inventory system by integrating demand predictability. The study emphasized dynamic procurement strategies for 45 high and medium-value drugs in AZ, BZ, AY, and BY categories. Limitations included using monthly data that may miss daily variability and the need for multi-centre studies to validate the model. Despite these, ABC-XYZ integration can create efficiencies, reduce stockouts, and minimize wastage. **Conclusion:** Stable-demand, high-value medications (AX/BX) can be handled through programmed bulk purchasing, while erratic-demand, high-value drugs (AZ/BZ) require dynamic tracking and flexible procurement. Implementing ABC-XYZ techniques can reduce stockouts and wastage, enhancing medication availability and resource utilization. **Recommendation:** Future projects should propose real-time inventory tracking systems like barcode scanning, RFID, or IoT-based tools to reflect daily demand fluctuations

Keywords: ABC-XYZ Analysis, Inventory Optimization, Pharmaceutical Management, Cancer Care.

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INTRODUCTION

Inventory management in hospital stores presents complex challenges, particularly in cancer care settings where high-cost medications and irregular demand patterns exist. Hospital administrators must maintain equilibrium between medication availability (preventing treatment delays) with budget constraints (ensuring financial sustainability). Ineffective inventory practices lead to either stockouts that compromise patient care or overstocking, which results in medication wastage (Balkhi *et al.*, 2020; Kaur *et al.*, 2023).

Study by Quicke, Holloway and Green, as well as the MSH/WHO in their studies have shown that 10-20% of medications typically account for 70-80% of the annual consumption value in medical stores, following Pareto's principle (Quick *et al.*, 2018; Holloway

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and Green, 2019; MSH/WHO, 2020). A study conducted in 2018 at a 1,500-bedded Indian hospital also substantiated that 20% cost savings were achieved through systematic inventory control measures (Gandhi and Basur, 2018).

Inventory medications are categorized using ABC analysis based on their annual consumption value, with Category A representing the top 70% of total consumption value, followed by Category Bat 20% and Category Cat 10% (Ramanathan, 2006; Das, 2001). While effective for prioritizing expensive items, this approach may neglect important but inexpensive medications due to its focus on financial value (Gupta *et al*., 2007; Sikdar *et al*., 1996). To address this limitation, the current study incorporates XYZ analysis, which categorizes items based on demand variability. In the XYZ classification, demand for X-class items is stable (co efficient of variation<0.5), Y-class items are moderately variable (CV between 0.5 and 1), and Z-class items are extremely erratic (CV>1). This study adopts a more comprehensive inventory control approach that considers both financial impact and consumption predictability by combining ABC and XYZ analyses. This enables medical store operations to make more informed and balanced decisions.

The study was conducted because there were frequent incidents of stockouts in the medical store of the hospital under study, which further hampers patient care. Additionally, there were frequent incidents of expiry of medications. These incidents not only add additional work instore but also add to insufficiency in the work process of stores. The study is conducted to determine medications with high cost, medium cost and with maximum variation by using ABC and XYX analysis so that they can be procured in a manner that will prevent stockpiling and waste of costly drugs. ABC-XYZ analysis will set up a framework for the procurement strategies, as procurement strategies vary with the categorization of medications

This study was commenced to address challenges in the hospital's medical store, including frequent stockouts and medication expirations that considerably influence patient care and store operations. These recurring issues not only create additional workload for store staff but also reveal inefficiencies of medical stores. The primary objective of this research is to analyze medication inventory using ABC and XYZ classification techniques to categorize drugs based on their cost (high, medium, low) and consumption patterns (stable, moderate, variable). By implementing this combined ABC-XYZ analysis, the hospital aims to develop a more planned procurement framework that prevents both excessive stockpiling (which leads to wastage through expiration) and shortages of critical medications. The findings will enable differentiated procurement approaches tailored to each medication category, ultimately optimizing inventory levels, reducing costs, and ensuring regular availability of medications for patient care.

MATERIALS AND METHODS

This cross-sectional, descriptive, retrospective study was conducted at a tertiary care government cancer hospital in North India. The study was conducted from March 2025 to May 2025. The study included 286 medications procured regularly by the medical store of the hospital under study. Out of 400+ drugs in our formulary, 286 had complete 12-month cost and consumption data. They represent over 90% of annual expenditure. Moreover, this exceeds WHO's recommendation to analyze ≥80% of inventory value for meaningful ABC categorization in tertiary care (MSH, 2019). The data from July 2023 to June 2024 was used for the required ABC and XYZ analysis.

ABC Analysis was performed based on Annual Consumption Value (ACV), categorizing 286 medications into three groups: Category A (top 70% of ACV), Category B (next 20%), and Category C (bottom 10%). At the same time, an XYZ analysis was conducted to classify medicines according to demand variability on a monthly basis from July 2023 to June 2024, using the Coefficient of Variation (CV): Class X (CV<0.5; low variability), Class Y (CV 0.5-1.0; moderate variability), and Class Z (CV>1.0; high variability). Combining ABC and XYZ classifications created a 3×3 matrix that grouped medicines into nine categories to aid in inventory management policies.

Since the research involved only analysis of anonymized data, specifically routinely collected stock data, ethical approval was not required. There were no human or animal subjects involved. Data was analyzed using SPSS.

RESULTS

A total of 286 medications were included in this study. The total annual consumption value of these medicines is Rs 12.71 crore from March 2023 to February 2024. The ABC Analysis is performed considering the Annual Consumption value (A=Top 70%, B=Next 20%, C=Bottom 10%) Category A comprises 29 high-value drugs (10.1% of the total stock) that account for 70.41% (₹8.95 crore out of ₹12.71 crore) of the total expenditure. Category B comprises 45 drugs (15.7% of the total stock), which account for 19.50% (₹2.48 crore out of 12.71 crore), while Category C contains 212 drugs (73.9%) using only 9.99% (₹1.27 crore) of the total expenditure (Figures 1-3).

XYZ Analysis is performed considering demand variability on monthly basis over the year using the coefficient of variation (X=Stable [CV<0.5], Y=Moderate [0.5≤CV≤1.0], Z=Erratic [CV>1.0]). This creates 9 priority categories (AX through CZ) with tailored procurement strategies. XYZ analysis classified the same 286 drugs based on variability in demand every month with the help of the Coefficient of Variation (CV). Class X had 65 items with regular demand (CV<0.5), Class Y contained 112 items with moderate variability (CV 0.5-1.0), and Class Z contained 109 items with extremely erratic demand (CV>1.0). Tables 1 and 2 summarize the results of the ABC and XYZ analyses.

A Combination of ABC and XYZ methods resulted in a nine-cell matrix, allowing accurate classification of inventory. High-value drugs with stable demand (AX, BX) comprise 28 items, while high-value, volatile demand drugs (AZ, BZ) comprise 15 items, necessitating more stringent monitoring and procurement processes. Similarly, AY Medicines comprising 15 medicines out of 286 are high value with moderate demand, stressing on a stringent procurement strategy. Monthly Demand Variation of Medication in Categories A, B and C is reflected in Figure 4.

AY medicines which account for 15 Medicines out of 286 Medicines, comprise of the maximum portion of the Annual Consumption Value of the year July 2023 to June 2024, which is Rs 4.6 Cr, followed by AX medicines, which accounts for 9 Medicines out of 286 Medicines comprising of Annual Consumption value of Rs 2.6 Cr. The graphical representation of nine categories of medications reflecting the budget consumed annually is in Figure 5.

These findings align with a previous study by Sharma and Patil, which achieved a 60-70% reduction in stockouts using similar inventory management techniques in a public hospital (Sharma and Patil, 2022). In another study, a 50% decrease in medicine wastage through ABC classification and 30% improvement in procurement efficiency for oncology drugs were reported when ABC-XYZ techniques were implemented across multiple hospital locations (Gupta and Gupta, 2018; Liu *et al.*, 2017). The present pilot supports the effectiveness of ABC-XYZ integration in improving operational efficiency by reducing stockouts and clinically significant wastage. The technique enables cost impact and demand variability-based prioritization of procurement, allowing for evidence-based inventory decisions. Short-term studies are, however, needed to better capture cost-saving implications; preliminary results endorse the implementation of ABC-XYZ inventory control as a strong framework in tertiary care cancer hospitals managing expensive drugs.

DISCUSSION

The study effectively classified 286 drugs into nine segments according to their annual purchasing value and variability of demand, and a more sophisticated yet realistic framework for procurement planning was formulated. The ABC analysis indicated that 29 expensive drugs (10.1%of the total stock) covered almost 70% of the hospital's yearly drug bill (₹8.95 crore out of ₹ 12.71 crore), substantiating the Pareto principle and consistent with the results of earlier research by (Gupta and Gupta, 2018; Liu *et al.*, 2017). By way of contrast, the XYZ analysis ranked the same drugs by demand stability, placing 65 drugs in Class X (stable demand), 112 in Class Y (moderate fluctuation), and 109 in Class Z (high fluctuation). This two-stage categorization enabled a more differentiated ABC-XYZ matrix that responded to the deficiencies of value-only driven inventory systems by integrating the predictability of demand into procurement choices, as argued in a study by Kumar and Chakravarty (2015) Procurement plans can be adjusted based on ABC-XYZ classification: high-value, predictable-demand drugs (AX/BX) may be purchased via scheduled ordering with buffer stocks, and high-value, highly variable-demand drugs (AZ/BZ) may be ordered based on projections and current need determinations. These findings are in line with earlier research by Sharma and Patil (2022), who observed a 60-70% decrease in stock outs with similar inventory models, and by Gupta and Gupta (2018) who witnessed up to 50% decrease in wastage of drugs using ABC analysis alone.

The study highlighted the benefits of closely monitoring 45 high and medium-value drugs classified as AZ, BZ, AY, and BY. These

Table 1: XYZ Analysis of Medicines in the Medical Store of the Hospital under study.

Category of Medicines	Number of Medicines	Percentage of total Medicines
Category X	65	22.7
Category Y	112	39.1
Category z	109	38.1

Table 2: ABC-XYZ Matrix.

Demand Variation on Monthly Basis of 286 Drugs from March 2023 to Feb 2024	Annual Consumption Value of 286 Medicines from March 2023 to Feb 2024		
	A	B	C
X	High Value Very little variation (9 Medicines)	Medium Value Very little variation (19 Medicines)	Low Value Very little variation (37 Medicines)
Y	High Value Some variation (15 Medicines)	Medium Value Some variation (15 Medicines)	Low Value Some variation (82 Medicines)
Z	High Value High variation (4Medicines)	Medium Value High variation (11Medicines)	Low Value High variation (93 Medicines)

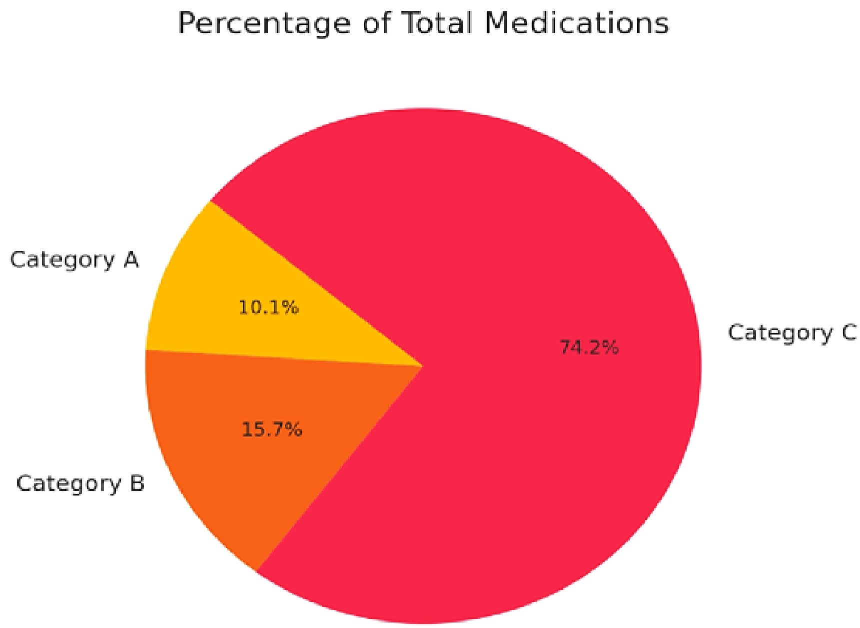

Figure 1: Percentage of Medication in different categories.

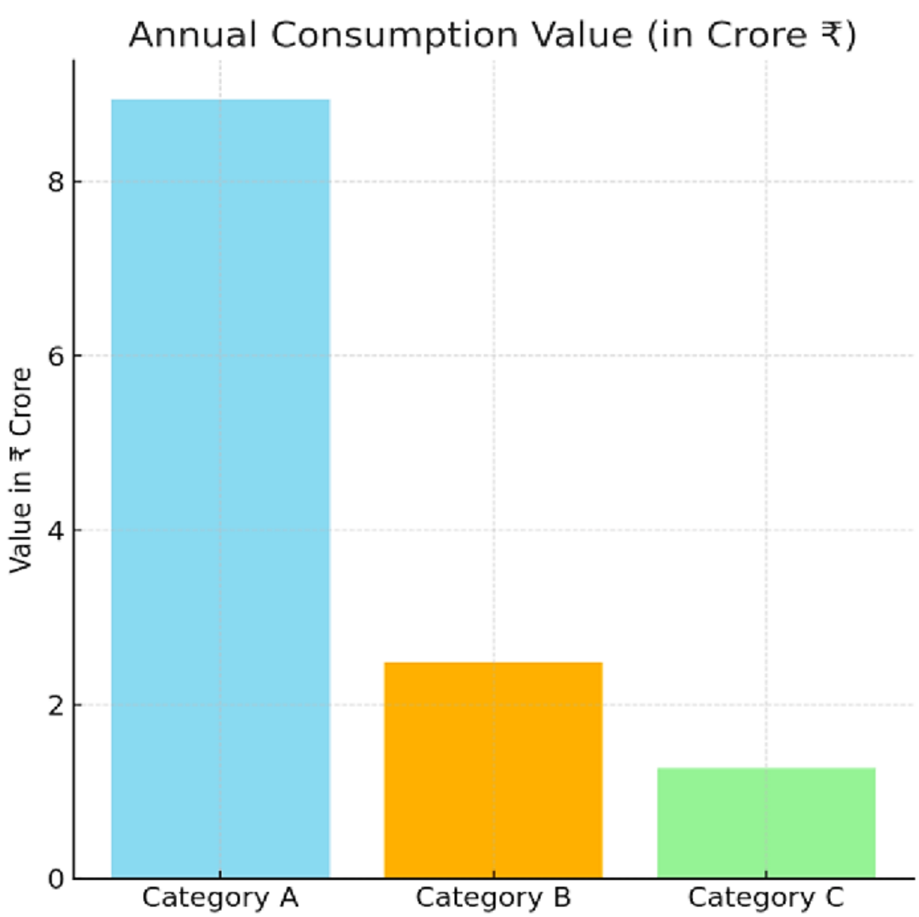

Figure 2: Annual Consumption Value of Medication in various categories.

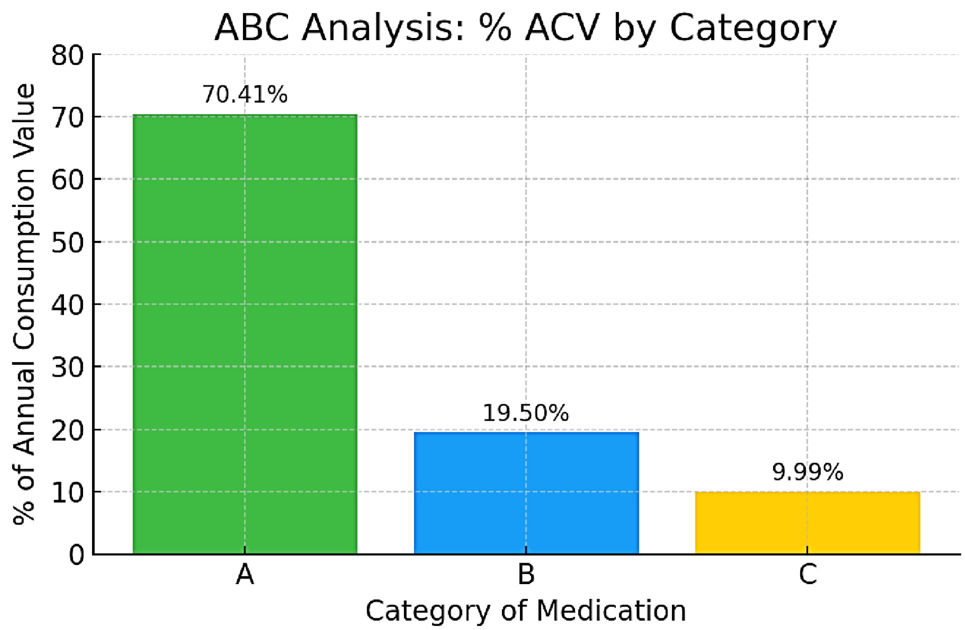

Figure 3: Percentage of Annual Consumption value in comparison to Total ACV.

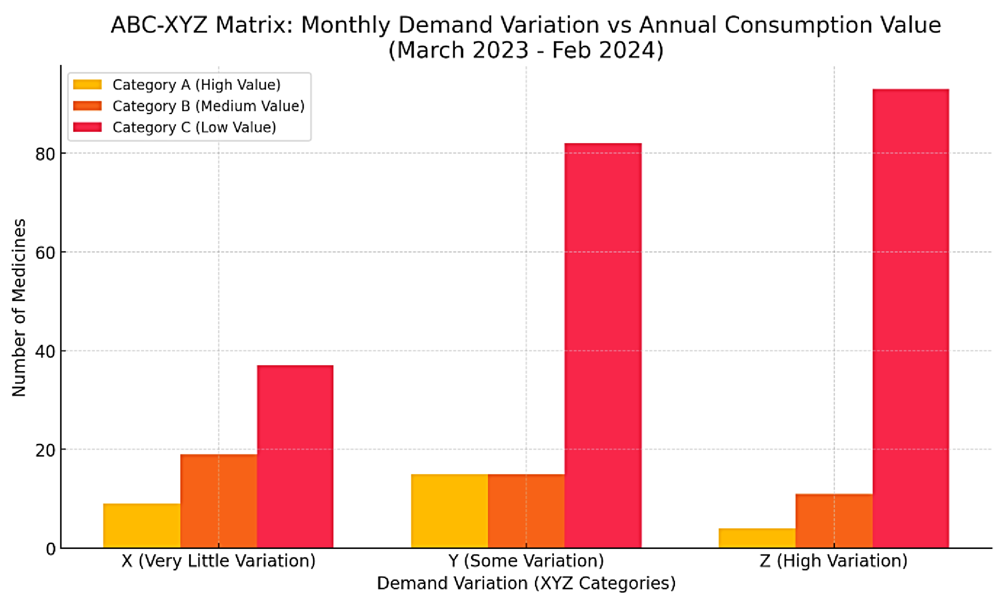

Figure 4: Monthly Demand Variation of Medication in Categories A, B and C.

drugs represented about 16% of the total stock and demonstrated variable patterns of demand change and so needed flexible and responsive procurement systems. By comparison, low annual usage items with stable or unstable demand-including CX and CZ types (about 130 medications)-could be addressed by on-demand procurement under lean inventory principles, a method that is supported by lean management methodologies (Womack, J. P., and Jones, D. T., 2003). This tiered approach can minimize emergency procurements and wastage during the study period. Though our research dealt with ABC-XYZ analysis, it opens avenues for integrating more prioritization frameworks like VED (Vital-Essential Desirable) analysis for maximally optimizing inventory.

In spite of this, certain limitations need to be recognized. Demand variability was measured on a monthly basis, which may fail to pick up finer daily variations, especially pertinent in oncology treatment (Jaju *et al.*, 2023, and Thawani *et al.*, 2004). In addition, this research was limited to one institution, which may limit the external validity of its results. It would be desirable for future research to incorporate real-time inventory management systems, Internet of Things (IoT) technologies, and forecasting using predictive analytics through machine learning to improve the accuracy of forecasts, (World Health Organization [WHO], 2023). Further, multi-centre studies could confirm the wider applicability of the model.

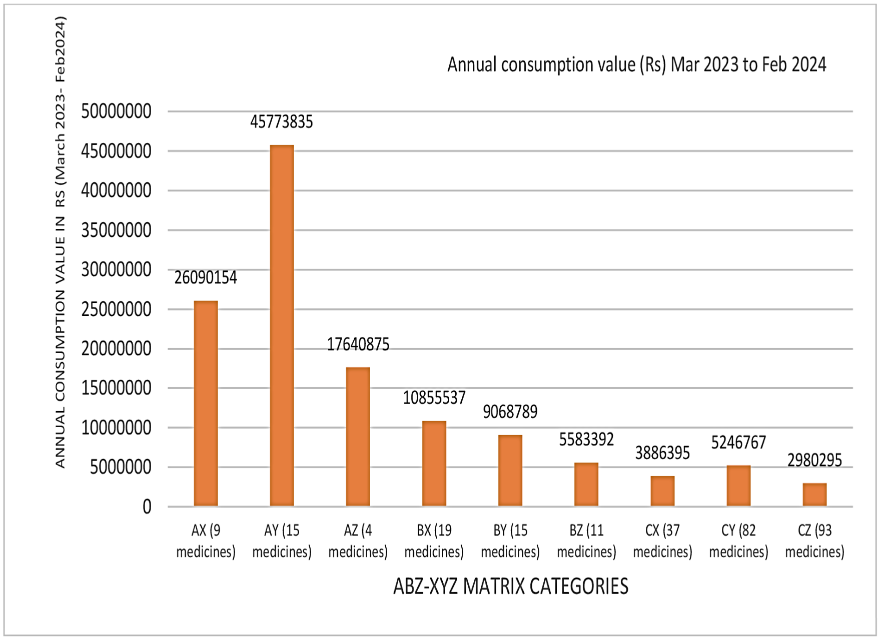

Figure 5: Graphical representation of nine categories of medications reflecting the budget consumed annually.

In spite of such limitations, ABC-XYZ integration in this study may create real efficiencies in operations, minimize medication stockouts, and cut unnecessary wastage. ABC-XYZ matrix thus presents an evidence-based, scalable platform balancing cost savings with clinical efficacy. It's implementation in tertiary care cancer hospitals may handle high-cost and variable-demand drugs, can measurably fortify pharmaceutical supply chains, enhance patient outcomes, and enable improved resource use.

CONCLUSION

Through examining both the annual value of consumption and variability in demand for 286 drugs, the research found that a limited percentage of medicines (Category A, 10%) covered most (70%) of the annual drug budget, substantiating the Pareto principle (20,21). Additional stratification by the XYZ method identified the requirement for differentiated inventory tactics. Stable-demand, high-value medications (AX/BX categories) can be handled through programmed bulk purchasing and automated ordering procedures, whereas erratic-demand, high-value drugs (AZ/BZ categories) call for dynamic tracking and a quick, flexible procurement channel. Implementation of ABC-XYZ technique can lead to a substantial decline in stockouts and can even reduce wastage of medicines. This highlights the potential of the ABC-XYZ matrix for enhancing medication availability and enhancing the use of resources. While the study is limited to one centre and based on monthly data, it provides a pragmatic, evidence-based approach to enhancing inventory control with continuity of patient care (Jaju *et al.*, 2023, and Thawani *et al.*, 2004).

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ABBREVIATIONS

ABC: Always Better Control; **ACV:** Annual Consumption Value; **CV:** Coefficient of Variation; **IoT:** Internet of Things; **RFID:** Radio Frequency Identification; **VED:** Vital Essential Desirable; **WHO:** World Health Organization.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

RECOMMENDATION

Future projects should aim to propose a model with real-time inventory tracking systems, like barcode scanning, RFID, or IoT-based systems to accurately reflect daily demand fluctuations. Additionally, integration of ABC-XYZ with VED (Vital-Essential-Desirable) analysis can also improve the prioritization of essential medicines, particularly oncology drugs. Machine learning and artificial intelligence-powered forecasting techniques must also be investigated to improve forecast trends for AZ/BZ category medications. Flexible procurement policies aligned to be able to handle variable demand, as well as continuous capacity development and training for stock managers, will be key in ensuring the benefits so far witnessed are maintained. These steps can make ABC-XYZ analysis a more durable, scalable technique for enhancing inventory efficiency, minimizing wastage, and guaranteeing continued access to critical drugs within resource-limited public health systems.

STUDY LIMITATIONS

***Retrospective Design*:** This method was used to determine Annual Consumption Values (ACV) and demand variability over one year. Monthly analysis is considered as this matches our bimonthly procurement schedules and provides detail for strategic planning. Future research could include patient-level daily demand patterns.

***Single-Institution Focus*:** Although generalizability may be limited, our hospital serves as a regional cancer care hub, and our formulary (comprising 286 drugs) captures more than 90% of our annual medication expenditure, consistent with WHO recommendations for ABC analysis in tertiary care. The Pareto distribution we observed (10% of drugs accounting for 70% of costs) validates the sample's representativeness.

***Emergency Procurement*:** We intentionally excluded these practices as they represent systemic failures (stockouts) that our ABC-XYZ model aims to prevent. The matrix would help us in the reduction of emergency orders through proactive categorization.

***Expiry and Supplier Issues*:** These will be considered in our next-phase implementation study, following establishing baseline demand patterns through this analysis. Supplier delays were excluded as they primarily affect lead times rather than demand variability.

SUMMARY

This study employed ABC and XYZ inventory techniques to analyze drug utilization patterns in the medical store of a government tertiary care cancer hospital in North India. The aim is to improve procurement strategies, reduce stockouts, and minimize medication wastage, especially for oncology drugs. A total of 286 medications were analyzed using retrospective data from July 2023 to June 2024.

ABC analysis showed that 29 high-value medications (10.1%) made up 70.41% of the total annual consumption value (₹8.95 crore out of ₹12.71 crore), aligning with Pareto's principle. XYZ analysis classified medicines by monthly demand variability, identifying 65 drugs with stable demand (X), 112 with moderate variation (Y), and 109 with high variation (Z). Combining ABC and XYZ analyses created a nine-cell matrix to help the hospital develop procurement strategies.

The ABC-XYZ matrix identified 45 high- and medium-value drugs with variable demand (AZ, BZ, AY, BY categories), requiring close monitoring and avoiding bulk procurement of these medications. The study recommends bulk procurement for stable, high-value items (AX/BX) and flexible procurement for drugs with unpredictable, high costs (AZ/BZ). Low-value items with uncertain demand can be managed and procured using on-demand procurement principles.

The study emphasizes the importance of evidence-based inventory practices in improving availability, cost-efficiency, and operational effectiveness in cancer care. While limited to a single centre and based on monthly variability data, the findings support the scalability of the ABC-XYZ model. Future integration with VED analysis, real-time tracking technologies (e.g., RFID, IoT), and AI-driven forecasting tools is recommended to optimize inventory control systems in healthcare institutions further.

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