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# Controlling Antihypertensive and Antidiabetic Agents Planning with the ABC Critical Index Method: A Case Study in Denpasar City Hospitals

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**ABSTRACT**

Non-communicable diseases such as hypertension (HT) and diabetes mellitus (DM) are the main causes of morbidity and mortality in Indonesia, including Denpasar City. Both diseases require long-term therapy with adequate drug availability to achieve successful treatment. Therefore, effective and efficient management of pharmaceutical preparation planning is very important in hospitals. This study aims to analyze the control of pharmaceutical preparation planning for hypertension and DM therapy using the ABC Critical Index method in hospitals throughout Denpasar City. This research is a descriptive observational study with a case study design conducted at four selected hospitals in Denpasar through a cluster random sampling technique. Data collected includes usage value, investment, selling price, and critical value of antihypertensive and antidiabetic drugs during 2024. The data were then analyzed using the Pareto ABC method and the Critical Index using Microsoft Excel and presented descriptively. The results show that antihypertensive and antidiabetic drugs are generally in the Pareto group C based on use value and investment, with the majority of critical value categories being in category E (>70%). ABC Critical index analysis shows that most drugs are in the $C_{ci}$ group, but planning priorities are in the $A_{ci}$ group, which includes drugs in the ARB, CCB, loop diuretics, insulin, and metformin classes. These findings provide a basis for improving drug procurement management and more appropriate budget allocation in hospitals and suggest that ongoing monitoring can minimize drug shortages that disrupt health services.

## INTRODUCTION

Non-communicable diseases (NCDs) are a major concern due to the need for support in preventing and managing NCDs and their risk factors. This aims to promote changes in people's behavior toward healthy living, especially since around 74% of all causes of death worldwide are NCDs (Putri et al., 2019). Hypertension (HT) and diabetes mellitus (DM) are among the NCDs with the highest incidence rates globally, including in Indonesia. If left untreated, these conditions can lead to various serious chronic diseases such as heart attacks, heart failure, strokes, and chronic kidney failure (Thurlow et al., 2021). Effectively managing HT and DM is crucial in preventing serious complications. Therefore, monitoring and controlling blood pressure and blood sugar levels are crucial (Antar et al., 2023; Casmuti et al., 2023). In Bali Province, the 2018 Basic Health Research (Riskesdas) ranked HT 16th among Indonesian provinces (Suantika and Putri, 2022). The Bali Provincial Health Office reported it as one of the top 3 NCDs in 2018. Bali's diabetes prevalence is 1.5%, nearly half that of DKI Jakarta, the highest in Indonesia (Astutisari et al., 2022). Denpasar City has the second-highest number of diabetes cases after Tabanan Regency, with a prevalence rate of 15.54% among Bali's total population (Dinkes Provinsi Bali, 2020).

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With the rising incidence of HT and DM worldwide, including in Indonesia, particularly in Bali Province, it is crucial for health service facilities to consistently provide the appropriate types and amounts of medication necessary for managing these conditions. Hospitals play a vital role as comprehensive health service institutions, offering a range of services that include promotive, preventive, curative, and rehabilitative care. They cater to individual health needs through inpatient, outpatient, and emergency services, along with various essential health facilities (Kemenkes RI, 2016). Pharmaceutical services are integral to hospital operations (Yusuf et al., 2024). These services provide direct patient care through clinical pharmacy, management of medications, medical devices, and consumables, aiming to enhance patient health and quality of life (Kemenkes RI, 2016). Proper management of pharmaceutical preparations, medical devices, and medical disposables is essential for providing effective clinical pharmacy services that support successful patient therapy (Agus et al., 2023; Pratasik et al., 2023). Additionally, effective inventory management plays a critical role in hospital operations, significantly contributing to the hospital's economic well-being. Therefore, it is vital to manage pharmaceutical supplies with care, responsibility, and diligence (Syavardie and Yolanda, 2022).

Inventory management in healthcare facilities, such as hospitals, remains a pressing issue that requires thorough evaluation. To ensure the availability of essential medications for patients, hospitals can implement effective planning of pharmaceutical supplies, medical devices, and medical disposables. Inventory planning serves as the initial stage of pharmaceutical inventory management, aiming to identify the types and quantities of supplies needed based on disease patterns and healthcare requirements within the hospital (Agus et al., 2024). Inventory control is essential as it directly affects a company's inventory costs. It must be aligned with demand; excess inventory can lead to damage, high storage costs, and significant investment (Fatimah et al., 2022). Poor inventory planning can result in stockouts, dead stock, overstock, stagnant stock, and expired stock (Hadidah and Rochmah, 2016).

Before determining the planned inventory quantity, it is essential to prioritize the types of inventory. The combination of the Always Better Control-Vital, Essential, Non-essential (ABC-VEN) method or the ABC critical index is an effective strategy for assessing the priority of drug types based on cost and therapeutic aspects. Given the diverse inventory items hospitals manage, this method helps minimize waste and stockouts (Rofiq et al., 2020; Agus et al., 2024). While other inventory planning methods exist, such as Economic Order Quantity (EOQ), Reorder Point (ROP), safety stock, and Just in Time (JIT), the ABC-VEN method is particularly well-suited for calculating optimal order quantities to reduce total inventory costs (Sulistyo et al., 2023). Research by Taddele et al. (2019) and Nguyen et al. (2022) supports the use of the ABC-VEN combination in managing pharmaceutical preparations, medical devices, and consumables in hospitals. This approach enhances the efficiency of financial resources by identifying opportunities for significant savings and reducing hospital expenses due to the procurement of inappropriate or excessive drugs, as well as minimizing waste and stockouts in healthcare facilities (Yuliawati et al., 2020; Nguyen et al., 2022).

Based on the background description that has been provided, this study aims to analyze planning control in several hospitals in Denpasar City, specifically identifying the priority types of antihypertensive and antidiabetic drugs that need to be procured based on the health service needs of these hospitals. Previous studies have employed the ABC critical index method. For instance, Yuliawati et al. (2020) focused on planning control for acute respiratory infection therapy in a pharmacy. Taddele et al. (2019) used the ABC-VEN matrix method to identify drugs requiring strict management control, although their study did not focus on specific diseases. Additionally, Surtikanti et al. (2019) concentrated on drug inventory control in a Community Health Center. So, this study differs from previous research by specifically focusing on inventory control for HT and DM, addressing the urgency of these diseases. Furthermore, the selected hospitals represent a comprehensive view of Denpasar City.

## METHODS

## Study Design

This study is an observational case study conducted in hospitals across Denpasar City, focusing on those with a comprehensive history of inventory data for HT and DM treatment. The research was carried out from February to May 2025, utilizing a cluster random sampling method. The study encompasses four clusters: West, East, North, and South Denpasar, with each cluster represented by one hospital that meets the inclusion and exclusion criteria. Thus, a total of 4 hospitals were selected from the 14 hospitals in Denpasar City: Bali Mandara Regional Public Hospital (South), Wangaya Regional Public Hospital (North), Puri Raharja Public Hospital (East), and Udayana Army Hospital (West).

Inclusion criteria for the study included hospitals in Denpasar City that had cases of hypertension and diabetes mellitus, along with complete inventory data for the year 2024. This data comprised usage, investment, and selling prices for drugs that were not obtained through grants, donations, or external assistance. Additionally, hospitals needed to be willing to categorize hypertension and diabetes mellitus drugs based on the VEN category. Hospitals that faced obstacles or limitations in obtaining research data collection permits were excluded from the study.

## Research instrument

Digital data collection sheets summarize inventory data, including usage statistics, drug purchases, prices, and critical inventory values.

## Data Analysis

This study uses quantitative data, including usage, investment, and inventory prices, alongside qualitative data on critical inventory value (VEN). Data analysis was performed using Microsoft Excel, employing the calculation stages of the ABC Critical Index method. The results were then presented in descriptive formats, including tables and graphs, to enhance the readability of the research findings. The analysis process can be detailed in the following stages:

1. Calculation and determination of the Pareto ABC usage value for all hospital inventory
   a. Multiply each inventory's usage data by its unit price to get the usage value.
   b. Convert usage values to percentages, sort from highest to lowest, and calculate cumulative percentages.
   c. Group cumulative percentages by the Pareto ABC principle:
      - Group A: up to 70% cumulative usage is assigned a weight of 3;
      - Group B: 70% to 90% cumulative usage is assigned a weight of 2;
      - Group C: 90% to 100% cumulative usage is assigned a weight of 1.
2. The calculation and determination of Pareto ABC investment value for all hospital supplies follows the same data processing stages as the usage value, but it utilizes purchasing or investment data instead.
3. The selection of antihypertensive and antidiabetic agents is based on the management guidelines for HT and DM as published by the Ministry of Health of the Republic of Indonesia (Kemenkes RI, 2020; Kemenkes RI, 2021).
4. The prescribing physician or pharmacist on duty at the relevant hospital pharmacy determines and weights critical values for antihypertensive and antidiabetic agents based on the VEN criteria. In this system, V is assigned a weight of 3, E is given a weight of 2, and N receives a weight of 1.
5. The calculation of the ABC critical index (ci) for antihypertensive and antidiabetic agents is based on the following factors: the weight of usage (UW), investment (IW), and critical (CW) value. This is achieved by applying a specific formula that incorporates these elements:

$$ABC_{ci} = UW + IW + (2 \times CW) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

The results of the $ABC_{ci}$ calculation determine the priority of antihypertensive and antidiabetic agents in specific categories:

- $A_{ci}$ = 9.5-12.0
- $B_{ci}$ = 6.5-9.4
- $C_{ci}$ = 6.4-4.0 (Satibi, 2017).

## RESULT AND DISCUSSION

## ABC Usage Index Overview

Pareto ABC analysis based on value-in-use refers to drug usage data, specifically the amount used within a specified period (Pratiwi et al., 2023). As shown in **Table 1**, total inventory items and their usage can vary significantly between hospitals due to factors such as service type, patient volume, daily demand uncertainty, and individual inventory management policies (de Assis et al., 2022). Data analysis indicates that the inventory for each hospital aligns with Pareto's law: Group A (10-20% of items) accounts for 70% of usage cost, Group B (15-20% of items) represents 20% of usage cost, and Group C (60-80% of items) covers 10% of usage cost (Satibi, 2017).

**Table 1. Grouping of Supplies Based on ABC Usage Indexes**

| Group | All inventory items | | Antihypertensive | | Antidiabetic | |
|---|---|---|---|---|---|---|
| | (n (%)) | (IDR (%)) | (n (%)) | (IDR) | (n (%)) | (IDR) |
| **Northern Denpasar** | | | | | | |
| **A** | 51 (4.3) | 18,348,070,498.4 (70.0) | 1 (2.3) | 106.120.000,0 | 3 (21.4) | 840,852,250.6 |
| **B** | 95 (8.0) | 5,315,990,352.5 (20.0) | 5 (11.4) | 278.960.234,5 | 1 (7.5) | 63,146,880.0 |
| **C** | 1044 (88.0) | 2,650,451,490.8 (10.0) | 38 (86.4) | 258.383.946,0 | 10 (71.4) | 40,903,503.1 |
| **Total** | **1190 (100.0)** | **26,314,512,314.8 (100.0)** | **44 (100.0)** | **643.464.180,6** | **14 (100.0)** | **944,902,860.7** |
| **Eastern Denpasar** | | | | | | |
| **A** | 78 (10.3) | 10,088,406,951.0 (70.0) | 2 (8.3) | 150.793.020,2 | 8 (50.0) | 2,327,855,853.9 |
| **B** | 133 (17.1) | 2,900,112,005.3 (20.0) | 6 (25.0) | 116.194.192,6 | 2 (12.5) | 39,184,472.0 |
| **C** | 546 (72.1) | 1,450,886,457.0 (10.0) | 16 (66.7) | 38.645.111,9 | 6 (37.5) | 43,899,152.2 |
| **Total** | **757 (100.0)** | **14,439,405,413.3 (100.0)** | **24 (100.0)** | **305.632.324,7** | **16 (100.0)** | **2,410,939,478.0** |
| **Southern Denpasar** | | | | | | |
| **A** | 87 (10.1) | 14,967,754,942.6 (70.0) | 1 (3.7) | 71.867.655,4 | 4 (28.6) | 512,237,120.1 |
| **B** | 141 (16.3) | 4,286,749,952.3 (20.0) | 1 (3.7) | 25.529.677,7 | 0 (0.0) | 0.0 |
| **C** | 636 (73.6) | 2,151,634,105.1 (10.0) | 25 (92.6) | 120.825.818,4 | 10 (71.4) | 33,490,692.4 |
| **Total** | **864 (100.0)** | **21,406,139,000.0 (100.0)** | **27 (100.0)** | **218.223.151,5** | **14 (100.0)** | **550,727.812.5** |
| **Western Denpasar** | | | | | | |
| **A** | 113 (9.5) | 11,479,631,802.0 (70.0) | 2 (6.9) | 93.266.100,0 | 3 (21.4) | 718,617,655.0 |
| **B** | 235 (19.7) | 3,299,270,660.0 (20.0) | 16 (55,1) | 215.757.030,0 | 10 (71.4) | 137,915,300.0 |
| **C** | 844 (70.8) | 1,634,236,186.0 (10.0) | 11 (38.0) | 17.023.750,0 | 1 (7.2) | 3,390,400.0 |
| **Total** | **1192 (100.0)** | **16,419,138,648.0 (100.0)** | **29 (100.0)** | **326.046.880,0** | **14 (100.0)** | **859,923,355.0** |

In the Pareto ABC analysis of antihypertensive drug use value, the North Denpasar cluster hospitals accounted for the highest number of items (44; IDR 643.4 million), predominantly classified in the Pareto C group (North, East, and South Denpasar clusters). Here, antihypertensive drugs made up over 65% of all supplies in the group, though they required relatively low funding compared to other Pareto categories (**Table 1**). Examples of these drugs in this group include ACE inhibitors (ACE-I) and calcium channel blockers (CCB). In contrast, West Denpasar hospitals showed a different trend, with the highest value in Pareto B (51.7%; iDR 173 million), featuring diuretics and beta blockers. In all clusters, the Pareto A group contained the fewest drug items (1-2), yet these absorbed significant funds on average. This is likely because the use of antihypertensives in these hospitals is influenced by specific conditions rather than being a primary treatment. These drugs are often prescribed for long-term blood pressure maintenance or as adjuncts in cases of uncontrolled blood pressure or comorbidities such as heart failure or stroke. Consequently, the lower frequency of use results in their classification into the dominant Pareto B or C groups. In contrast, the Pareto A group is limited in item count but includes pharmaceutical preparations for other disease therapies that are more frequently used and higher in price (Nasution et al., 2024). It is crucial to monitor the availability of drugs in Pareto group A to prevent shortages, as they are considered fast-moving items based on prescribing patterns and epidemiological data, while also absorbing the largest budget. Meanwhile, group C requires oversight to avoid excessive quantities and expiration risks due to lower turnover and demand (Satibi, 2017; Yuliawati et al., 2020; Putri et al., 2022). In the analysis of antidiabetic drugs, the Pareto ABC analysis of use value reveals significant differences from antihypertensive drugs.

Notably, the East Denpasar cluster demonstrates a predominance of antidiabetic items within the Pareto A group (50% of usage and valued at IDR 2.32 billion). This cluster also contains the highest number of antidiabetic items compared to others (**Table 1**), with long-acting/fast insulin serving as an example of an antidiabetic in this group. Conversely, the North and South Denpasar clusters predominantly feature antidiabetic items in the Pareto C group, while the West Denpasar cluster falls into the Pareto B group, with over 70%. Examples from these clusters include sulfonylureas, biguanides, and alpha-glucosidase inhibitors. Overall, the variations observed in the Pareto ABC value-of-use analysis indicate that drug utilization is influenced by prescribing patterns, types of preparations, and price variations across hospitals (Yuliawati et al., 2022). Furthermore, research by Nasution et al. (2024) supports this, highlighting that drug use patterns—including types and quantities—are shaped by patient morbidity profiles, drug characteristics (such as long-term doses at relatively low prices), and hospital-specific prescribing policies.

## ABC Investment Index Overview

The Pareto ABC analysis of investment value identifies how funds are allocated across various inventory uses, ranking them from largest to smallest budget. This analysis helps calculate total investments (Yuliawati et al., 2022). **Table 2** illustrates the distribution of inventory items according to Pareto's law, displaying their order from largest to smallest, as in the results for usage values, even though the amount of funds is different.

**Table 2. Grouping of Supplies Based on ABC Investment Indexes**

| Group | All inventory items | | Antihypertensive | | Antidiabetic | |
|---|---|---|---|---|---|---|
| | (n (%)) | (IDR (%)) | (n (%)) | (IDR) | (n (%)) | (IDR) |
| **Northern Denpasar** | | | | | | |
| **A** | 95 (8.0) | 24,901,049,896.5 (70.0) | 2 (4.5) | 209,713,063.5 | 3 (21.4) | 867,334,025.5 |
| **B** | 172 (14.5) | 7,154,792,583.4 (20.0) | 7 (16.0) | 267,079,697.6 | 1 (7.5) | 63,975,280.0 |
| **C** | 923 (77.5) | 3,577,622,760.5 (10.0) | 35 (79.5) | 171,735,215.1 | 10 (71.4) | 45,102,767.6 |
| **Total** | **1190 (100.0)** | **35,633,465,240.4 (100.0)** | **44 (100.0)** | **648,527,976.2** | **14 (100.0)** | **966,412,073.1** |
| **Eastern Denpasar** | | | | | | |
| **A** | 85 (11.2) | 11,881,576,614.8 (70.0) | 2 (8.3) | 163,564,442.9 | 8 (50.0) | 2,427,577,592.1 |
| **B** | 149 (19.7) | 3,432,934,607.4 (20.0) | 6 (25.0) | 131,804,259.7 | 2 (12.5) | 46,959,381.5 |
| **C** | 523 (69.1) | 1,706,516,136.5 (10.0) | 16 (66.7) | 45,657,254.8 | 6 (37.5) | 52,348,246.6 |
| **Total** | **757 (100.0)** | **17,021,027,358.7 (100.0)** | **24 (100.0)** | **341,025,957.4** | **16 (100.0)** | **2,526,885,220.2** |
| **Southern Denpasar** | | | | | | |
| **A** | 94 (11.0) | 21,813,267,155.9 (70.0) | 1 (3.7) | 99,924,457.9 | 4 (28.6) | 517,237,120.1 |
| **B** | 154 (18.0) | 6,287,253,031.1 (20.0) | 1 (3.7) | 31,531,811.3 | 0 (0.0) | 0.0 |
| **C** | 616 (71.0) | 3,130,578,913.3 (10.0) | 25 (92.6) | 166,889,810,0 | 10 (71.4) | 33,490,692.4 |
| **Total** | **864 (100.0)** | **31,231,099,100.3 (100.0)** | **27 (100.0)** | **293,346,079.2** | **14 (100.0)** | **550,727,812.5** |
| **Western Denpasar** | | | | | | |
| **A** | 120 (10.1) | 11,943,251,560.0 (70.0) | 2 (6.9) | 94,724,100.0 | 4 (28.6) | 667,323,000.0 |
| **B** | 246 (20.6) | 3,433,786,850.0 (20.0) | 16 (55,1) | 211,176,120.0 | 6 (42.9) | 39,515,00.0 |
| **C** | 826 (69.3) | 1,715,785,440.0 (10.0) | 11 (38.0) | 34,431,250.0 | 4 (28.6) | 285,484,020.0 |
| **Total** | **1192 (100.0)** | **17,092,823,850.0 (100.0)** | **29 (100.0)** | **340,331,470.0** | **14 (100.0)** | **956,758,520.0** |

Additionally, the total number of inventory items and the corresponding investment amounts can vary between hospitals, influenced by the complexity of services provided and drug consumption patterns dictated by patient conditions and clinical decisions made by medical personnel. This aligns with the demand for pharmaceutical preparations in healthcare, which closely relates to drug recommendations by physicians based on patient conditions (Saha and Ray, 2019). Groups A and B require special attention, as they account for nearly 90% of hospital funding. This focus is crucial to prevent losses from stock shortages or inefficient resource use (Yuniasih et al., 2017; Fahriati et al., 2021). In the description of antihypertensive and antidiabetic drugs, the investment value follows a Pareto grouping pattern similar to that of use value. Most items demonstrate Pareto C dominance in quantity, while the largest investments are concentrated in Pareto A (**Table 2**). This trend indicates that the drugs in group C are typically used long-term and are available at relatively lower prices (Nasution et al., 2024). A closer look reveals that the investment value, expressed in monetary terms (IDR), is typically

greater than the use value. This discrepancy arises because the investment value encompasses all funds budgeted or spent on goods available in the warehouse, including unused inventory from previous periods. In contrast, the use value only accounts for the inventory utilized within a specific timeframe. Consequently, investment value generally includes reserve stock and anticipates future needs, leading to a higher valuation compared to use value (Kumar and Pande, 2023). This comparison highlights several implications regarding the relationship between investment value and use value. First, effective inventory planning in hospitals is indicated by the closeness of inventory usage values to their investment values. In the South Denpasar Cluster, where these values align, it reflects successful planning and procurement, demonstrating financial efficiency and accurate resource allocation for patient therapy (**Table 2**). Conversely, a significant gap between usage and planned investment values suggests planning inaccuracies, leading to wasted funds due to maintenance costs associated with unused drugs, such as storage, temperature monitoring, and logistics management (Rarung et al., 2020). Unused medications can deteriorate or expire, increasing the hospital's financial burden without providing any therapeutic benefit. Funds spent on these unused medications should instead be directed towards procuring fast-moving medications, which optimizes their availability according to patient needs. This misallocation disrupts stock rotation, elevates the risk of accumulating slow-moving inventory, and ultimately affects the continuity of pharmaceutical services (Suryagama et al., 2019). Therefore, it is crucial to synchronize investment with usage to support efficient, patient-centered pharmaceutical services, as outlined in Indonesian Minister of Health Regulation No. 72/2016.

## Critical Indexes of Antihypertensive and Antidiabetic Agents Overview

Critical values using the VEN method help determine the importance and criticality of supplies based on their impact on health. This method aids in prioritizing procurement based on patient treatment needs, enabling hospitals to develop effective and efficient plans (Rahmawati et al., 2022). Results indicate that over 70% of antidiabetic and antihypertensive drugs fall into the essential (E) group (**Figure 1**). This suggests these medications are effective for treating chronic diseases and hold high therapeutic significance, while allowing for a delay in availability of up to 48 hours (Alexandri et al., 2020; Rahmisi et al., 2024).

In DM therapy, oral antidiabetics like metformin, glimepiride, acarbose, gliquidone, and gliclazide are categorized as essential drugs (E). This classification aligns with WHO recommendations and the 2023 National Formulary in Indonesia (Bailey, 2017; Sahin et al., 2024; Pinem et al., 2025). Zupadly and Aulia (2024) reported that drugs classified in category E are intended for treating chronic diseases or common medical conditions. This category includes antidiabetic drugs, which account for 71.18%, as well as gastrointestinal and antihyperlipidemic drugs. Similarly, Norachuriya et al. (2024) noted that both antidiabetic drugs and oral antidiabetic medications fall under this essential group (E), as they are utilized in severe but non-life-threatening situations and for disorders of lower severity. Category vital (V) includes insulin, a life-saving drug for those who cannot produce their own or do not respond to oral medications. In contrast, non-essential (N) preparations, such as insulin pen needles, are primarily used in outpatient settings and are not a priority for inpatient or emergency services (Zaim et al., 2021; Thota and Akbar, 2023). For antihypertensive medications, research results show that almost all hospitals categorize these medications as essential (E). This means these medications are considered essential for controlling high blood pressure, which carries the risk of chronic complications, but they are not classified as vital (Huda et al., 2020). The essential antihypertensive drug classes included in this study are diuretics, ACE inhibitors/ARBs, beta blockers, CCBs, and vasodilators, and they are also in accordance with the hypertension therapy guidelines issued by the Indonesian Ministry of Health (Kemenkes RI, 2021; Winanti, 2024). A similar study by Damayanti et al. (2024) also supports the classification of CCBs (nifedipine, amlodipine) and ARBs (candesartan) used in outpatients as category E, as they play a role in long-term therapy and are

tolerated if a 2–3-day gap occurs with alternative therapies. Additionally, Zulpadly and Aulia (2024) in their study also confirm that antihypertensives, along with antidiabetics and antihyperlipidemics, are classified as essential medications for chronic diseases and general medical conditions.

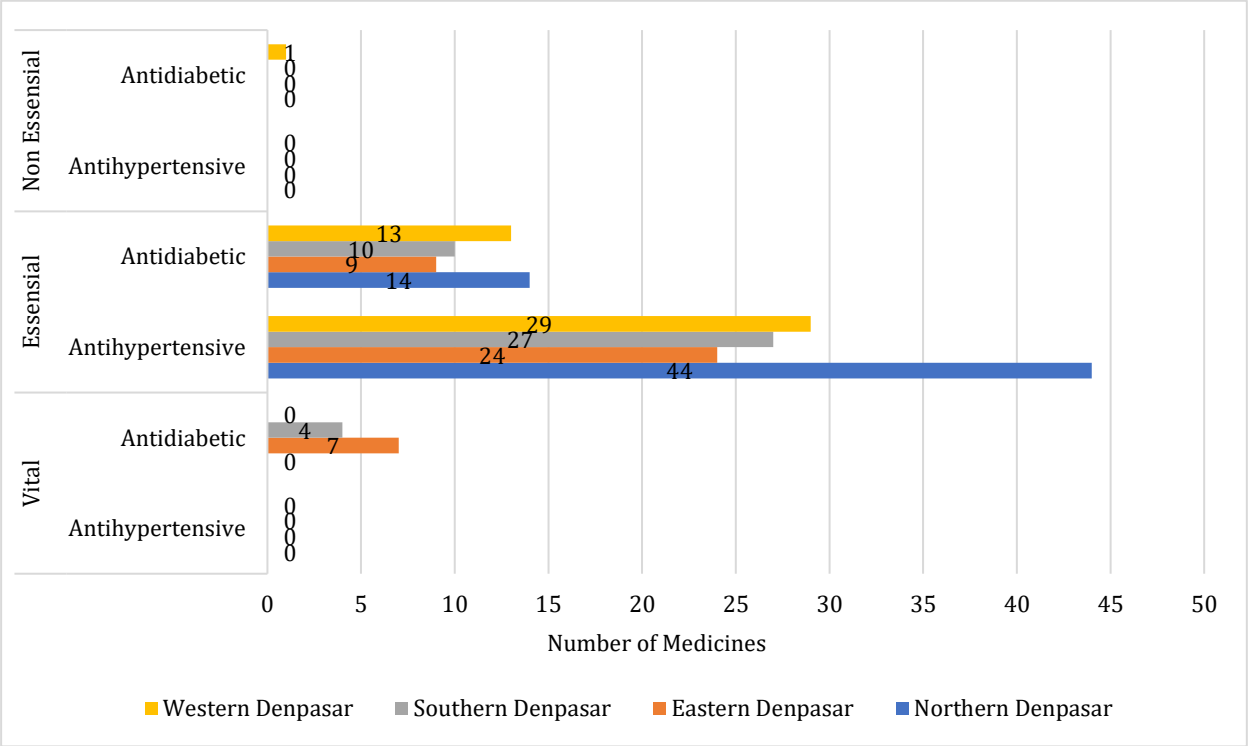


**Figure 1. Grouping of Critical Indexes for Antihypertensive and Antidiabetic Agents**

## ABC Critical Indexes of Antihypertensive and Antidiabetic Agents Overview

ABC critical index analysis integrates Pareto ABC and VEN methods to deliver a comprehensive overview of a drug product's economic value and criticality. This approach differs from traditional Pareto ABC analysis, which focuses only on monetary value and consumption (Fitriana et al., 2017; Putri et al., 2022). The results indicated variations in the distribution of the ABC critical index for antihypertensive and antidiabetic drugs (**Figure 2**). Notably, the $C_{ci}$ group dominated the North and South Denpasar clusters, comprising over 60% of the item types. This group was primarily categorized as CE (Pareto C with essential criticality), including antidiabetic medications such as acarbose, gliclazide, and glimepiride, as well as amlodipine for antihypertensives (Damayanti et al., 2024; Norachuriya et al., 2024). This aligns with research by Yuliawati et al. (2022), which also found a dominance of the $C_{ci}$ group in DM preparations (>50%) in pharmacies with joint medical practices in Denpasar. Despite their low value, medications in the $C_{ci}$ group require proper management to prevent hoarding and expiration risks. This can be achieved through effective control measures, such as utilizing stock cards (Amer and Jawad, 2023). In contrast, the West Denpasar cluster shows a dominance of the $B_{ci}$ group (71%), with metformin being an example—a drug with moderate value, both in terms of usage and investment (Amer and Jawad, 2023; Norachuriya et al., 2024). Metformin, as a first-line antidiabetic, is widely used; however, due to its relatively low price and criticality as an essential drug, it falls into the $B_{ci}$ group. Meanwhile, the East Denpasar cluster shows a different pattern, with a dominance of the $A_{ci}$ group (50%), with various types of insulin being categorized as vital due to their high price and crucial function as a life-saving drug (Amer and Jawad, 2023).

To ensure the continuous availability of essential medications during the planning stage, priority must be given to drugs registered in the $A_{ci}$ group. These priority preparations are crucial

as they are the most frequently used in medical procedures within healthcare facilities. It is vital to maintain adequate stock levels of these preparations to prevent shortages, as this could lead to significant losses. Such losses not only diminish patient satisfaction but also prolong the time it takes for patients to receive necessary medications, ultimately delaying their care. To prevent stockouts in the $A_{ci}$ group, strict supervision is essential, including accurate documentation, monitoring, and decision-making by authorized personnel like the Head of the Pharmaceutical Installation. Procurement can be improved by shortening lead times, ordering in smaller quantities more frequently, and increasing the number of local suppliers or distributors. It's also important to ensure appropriate transportation methods, maintain accurate minimum stock levels, and have sufficient warehouse capacity (Satibi *et al.*, 2019). In this study, the procurement priority for hypertension drugs included the ARB group (valsartan and candesartan), loop diuretics (furosemide), and CCBs (nifedipine), with insulin identified as the primary antidiabetic drug.

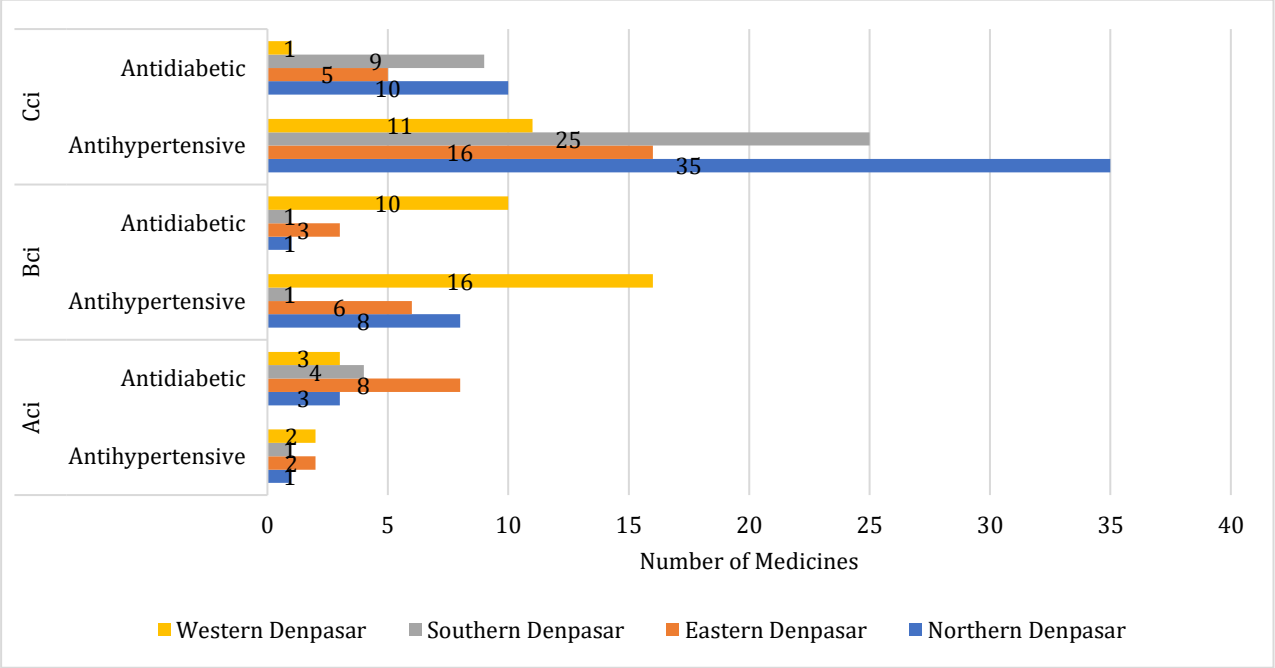


**Figure 2. ABC critical indexes ($A_{ci}$, $B_{ci}$, $C_{ci}$) of Antihypertensive and Antidiabetic Agents**

The $B_{ci}$group also requires constant attention to prevent losses and delays in health services, with drug inventory levels kept at a minimum. While the $B_{ci}$ group is important for treatment, it does not require as intensive monitoring as the Aik group. Preparations in the $C_{ci}$ group incur lower costs, allowing for less strict control. Oversight for both groups can be conducted every two or three months or as deemed necessary by relevant agencies, providing a basis for future planning (Reski et al., 2016). While strict supervision of supplies in the $B_{ci}$ and $C_{ci}$ groups isn't necessary, excessive procurement should be avoided to prevent budget waste and expiration risks. It's important to eliminate low-consumption drugs, particularly those not sold within the year (Putri et al., 2022; Yuliawati et al., 2022). Each hospital or healthcare facility has distinct priorities in procuring antihypertensive, antidiabetic, and other medications. Although antihypertensive and antidiabetic drugs constitute only a small proportion of the total hospital medication inventory, the findings of this study indicate that these drug groups play a strategic role in pharmacy management, particularly in drug investment planning and control. As therapies for chronic diseases, antihypertensive and antidiabetic medications are characterized by high and continuous utilization, which cumulatively exerts a substantial impact on investment value and inventory costs. Priority analysis using the ABC

critical index method (a combination of ABC and VEN analyses) demonstrates that drug management based on clinical and economic priorities can support more rational and efficient investment decisions. Therefore, despite being limited to specific therapeutic groups, the results of this study are relevant for strengthening hospital drug investment policies and may serve as a foundation for the gradual development of inventory management strategies for other therapeutic categories. Nevertheless, inventory planning and control using this method should be conducted periodically to accommodate potential changes in drug prices and consumption patterns associated with evolving disease trends. Furthermore, the findings of the ABC critical index analysis may assist healthcare facilities in developing standard drug formularies and inventory budgets to meet future demand. Effective inventory control is essential to minimize discrepancies between drug availability and actual needs, particularly in the context of uncertain demand, thereby reducing the risk of drug shortages and service disruption (Fahriati et al., 2021; Srihartini, 2021).

The researcher acknowledges several limitations in this study, particularly regarding the adequacy of the research sample to represent the population. This insufficiency restricts the determination of inclusion and exclusion criteria, potentially introducing bias. For instance, the study did not limit the type of hospital used in the sample, which matters because different hospital types offer varying health services (specialist or sub-specialist) based on patients' health conditions.

## CONCLUSIONS

This study concludes that antihypertensive and antidiabetic drugs at Denpasar City Hospital primarily fall into the Pareto C group, with critical values largely in category E (70%). Priority procurement ($A_{ci}$ group) for antidiabetic agents includes insulin and metformin, while antihypertensive agents focus on ARBs (valsartan and candesartan), CCBs (nifedipine), and loop diuretics (furosemide). It's believed that ongoing monitoring can minimize drug shortages that disrupt health services.

## AUTHORS' CONTRIBUTIONS

ANY was responsible for the research design, methodology, and writing of the original draft of the publication manuscript. KMWP and NPAPW assisted with the research permit application, ethical clearance, and data collection and analysis. PMDK contributed to data management, visual representations, and oversaw the editing process.

## CONFLICT OF INTERESTS

The author declares that there is no conflict of interest related to the research, writing, or publication of this article.

## ETHICAL CONSIDERATION

This research has fulfilled the research ethics rules of the Health Research Ethics Committee of Wangaya Regional Public Hospital with No. 000.9.2/995/RSUDW; 000.9.2/996/RSUDW on March 11, 2025, and Bali Mandara Regional Public Hospital with No. 053/EA/KEPK.RSBM. DISKES/2025;054/EA/KEPK.RSBM.DISKES/2025 on April 29, 2025.

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