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Pareto ABC Analysis of Pharmaceutical Preparations for Diabetes Mellitus at Ngesti Waluyo Christian Hospital

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ABSTRACT
The availability of therapeutic drugs for diabetes mellitus is one of the factors that determines the success of diabetes mellitus treatment, thus inventory control management is needed that can guarantee the availability of sufficient, safe, and quality drugs. This study will evaluate the Pareto results of drugs for diabetes mellitus therapy and to evaluate the pharmaceutical inventory management system during 2022-2023 at Ngesti Waluyo Christian Hospital. The study collecting data from the pharmacy information system based of medicine name, consumption amount, and selling price. The cumulative percentage from the use value, used to determine categories ABC. The results of the study showed a decrease in category A from 6 drugs (2022) to 1 drug (2023). Pareto data in 2022 contained 6 A drugs and 3 B drugs which were mostly not included in the first line therapy in the hospital formulary, in Pareto 2023 it changed to category C. Pareto data in 2023 showed 1 A drug and 3 B drugs mostly included in the first line therapy. Management of pharmaceutical preparations is still done manually even though there is a pharmacy information system that records patient treatment, so that several drugs were found to be overstocked and during 2022-2023 there was a shortage of stock and empty supplies for some time. The conclusion is that there is an improvement in drug selection for diabetes mellitus therapy based on the hospital formulary. As shown by Pareto data in 2022, there are 9 drugs on A and B category mostly not included in the first line drugs, down to 4 drugs in 2023 almost all are first-line therapy. Drug inventory management has not been able to utilize data from the pharmacy information system so that there are still excess and shortages of stock during 2022-2023.

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INTRODUCTION

Diabetes mellitus is a degenerative disease caused by an imbalance of insulin in the body. The prevalence of type 2 diabetes mellitus globally is 8.3% of the world's population. Indonesia is ranked 7th out of all countries in the world with a prevalence of 2.1%. Type 2 diabetes mellitus is a disease that cannot be cured, but can be prevented by good management or self-management of the sufferer. Perception of the disease is one of the factors that influences a diabetes sufferer in managing themselves (Fahmi, 2017; Mahatvavirya, 2024). Based on data obtained from the Temanggung Health Department,

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diabetes mellitus sufferers who receive treatment at the Ngesti Waluyo Christian Hospital have a higher prevalence than the national diabetes prevalence in Indonesia. The prevalence of diabetes mellitus patients at the Ngesti Waluyo Christian Hospital in 2014 was 10.9%, in 2015 it was 13%, and in 2016 it was 12%. This reflects the prevalence of type 2 diabetes mellitus cases in Temanggung Regency (Puspasari et al., 2017),

The management of pharmaceutical inventory in healthcare institutions has increasingly become a point of focus, particularly in relation to optimizing drug procurement and utilization strategies to enhance patient care while minimizing costs. In this context, the application of the ABC analysis, derived from the Pareto principle, has gained recognition as a vital tool in assessing drug consumption and expenditure. This research project investigates the application of ABC classification for the management of drugs utilized in the treatment of diabetes mellitus at Ngesti Waluyo Christian Hospital in Temanggung for the years 2022 and 2023. The study aims not only to categorize these drugs based on their consumption patterns but also to provide insights that may enhance the hospital's procurement strategies, ensuring an optimal balance between accessibility and cost-effectiveness.

ABC analysis is an effective inventory management technique that segregates items into three categories: 'A' items, which represent the highest value and require stringent control; 'B' items of moderate value that warrant a balanced management strategy; and 'C' items with the lowest value that may require minimal oversight (Fahriati et al., 2021; Zulpadly & Syarofina, 2023). This classification facilitates improved decision-making regarding procurement, allowing healthcare facilities to prioritize inventory investments that have substantial impacts on operational budgets and patient outcomes (Mani & Haridasan, 2018; Mfizi et al., 2023; Mohammed & Workneh, 2020). Within hospital pharmacies, understanding the consumption patterns of critical drugs, especially those intended for chronic conditions like diabetes, directly informs stock levels and subsequently supports the delivery of timely and effective care (Kivoto et al., 2018; Mfizi et al., 2023; Umadevi & Umamaheswari, 2023)

The evaluation at Ngesti Waluyo Christian Hospital specifically targets the procurement and usage narratives of diabetic medications, an essential segment of health services due to the growing incidence of diabetes mellitus within the population. Categorization of medicines not only facilitates better financial management but also emphasizes the clinical implications stemming from drug availability (Kivoto et al., 2018). Additionally, the systematic application of ABC analysis offers a framework for identifying financial burdens associated with these medications; a methodology that has been validated in various healthcare settings across diverse demographic backgrounds, highlighting its general applicability and efficacy (Kastanioti et al., 2016; Umadevi & Umamaheswari, 2023). Studies conducted in different health facilities have shown that well-executed ABC analysis positively correlates with inventory turnover rates and cost reductions (Mohammed & Workneh, 2020; Pund et al., 2016).

The combination of ABC with other evaluative methods, such as the VEN (Vital, Essential, Desirable) classification, accentuates the clinical relevance of the medications categorized (Jobira et al., 2021). This dual approach bolsters strategic planning by aligning inventory management practices with clinical needs, thereby ensuring that critical medicines

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are prioritized and readily available (Wahyuni, 2016). It also serves to reduce risks associated with stockouts or overstock, both of which can detrimentally affect healthcare outcomes (Irwanto & Irwanto, 2023; Wahyuni, 2016).

The study encapsulates a broader implication for health management systems, particularly in developing regions where healthcare resources often face constraints (Handayany & Basri, 2022). By efficiently categorizing and managing drug stocks based on their use value, healthcare systems can redirect efforts towards enhancing pharmaceutical care, optimizing procurement practices, and ultimately enriching patient satisfaction and health outcomes (Bizimana et al., 2020). The presence of a structured evaluation framework at Ngesti Waluyo Christian Hospital would not only highlight immediate savings potentials but may also bolster overall management practices, paving the way for future advancements in pharmacy services.

The ongoing analysis will entail a comprehensive review of drug procurement data from the past two years, charting trends in utilization that will elucidate the demand versus supply dynamics specific to diabetes medications (Dheeshan et al., 2023). Such insights are invaluable for healthcare administrators aiming to dynamically adjust procurement strategies in response to shifting patient needs and external market influences. The intricacies of drug valuation and categorization also bring to light the critical interdependencies and overarching considerations that hospital pharmacies must navigate to ensure the sustainability and efficacy of their operations in delivering diabetic care (Gizaw & Jemal, 2021; Kastanioti et al., 2016). The problem in this study is the Pareto ABC description based on the use value and inventory control of medicines for diabetes mellitus in 2022 and 2023 at Ngesti Waluyo Christian Hospital, Temanggung.

METHODS

This research is a descriptive observational (non-experimental) case study using existing data in 2022 and 2023 (retrospective) on the volume of use and selling price of diabetes mellitus drug preparations at Ngesti Waluyo Christian Hospital. The population and sample of the study were all data on the use of diabetes mellitus drugs during 2022 and 2023. The data obtained were confirmed by interview methods with the pharmacy installation manager in order to obtain a more comprehensive discussion. The data analysis technique used quantitative data analysis to determine the difference in use value obtained from the multiplication of the selling price and how much sales volume. In addition, quantitative analysis is used to find the cumulative percentage of use value as the basis for grouping used to analyse Pareto ABC (Activity Base Cost) (Nguyen et al., 2022).

The steps or procedures for drug classification in Pareto ABC analysis begin by identifying all diabetes mellitus drug products at Ngesti Waluyo Christian Hospital and then taking data in the form of sales units, sales price per unit, and sales volume per year. Then the next step is to calculate the use value by multiplying the sales price by the volume of use. The results of the use value are converted into percentages and then sorted from the largest to the smallest percentage. Then the cumulative percentage is calculated from the largest to the smallest percentage. The first 10–15% of the materials account for approximately 70% of

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cumulative cost (Class A), 20–25% are Class B materials which account for a further 20% of cumulative cost and the remaining 65–70% are Class C materials which account for a mere 10% of the total value (Dheeshan et al., 2023; Fahriati et al., 2021).

Data for the study concern the pharmaceuticals stocks of Ngesti Waluyo Christian Hospital. The data were collected via an observational in the pharmaceutical internal hospital system. This will involve gathering data on annual drug expenditures and usage frequencies during the 2022-2023 period. Recorded data on medicine name, consumption amount and selling price on a monthly basis during 2022-2023.

All data is entered into an Excel table and separated between 2022 (January to December) and 2023 (January to December). The first column is the name of the drug, the second column is the unit of use, the third column is the selling price, and the fourth column is the use value. The use value of the drug is calculated by multiplying the amount of consumption by the selling price in the same unit. After that, the use value column is sorted from the largest (first row) to the smallest (last row). Based on the results of the use value sorting in the fourth column, the cumulative percentage of use value is calculated (fifth column) from the first row to the last row, so that increasing percentage figures are obtained. The cumulative percentage data of use value in the fifth column is used as the basis for determining category A for use value up to 70%, category B for use value up to 80%, and the rest will be included in category C.

Several inherent limitations of this research: reliance on retrospective data may introduce biases related to data completeness and accuracy, the study's scope, confined to a single hospital, limits the generalizability of the results to broader healthcare settings, potentially overlooking variations in drug utilization patterns across different institutions or regions, the dynamic nature of drug availability and formulary changes over the study period could complicate the evaluation process, limiting the effectiveness of the ABC analysis. In order to reduce the possibility of bias and misinterpretation in this study, interviews were conducted with pharmacy installation staff to confirm the data and provide additional explanations regarding the findings of the Pareto ABC results obtained.

Table 1. Interview questions

Category	Question #	Detailed
Pareto ABC evaluation for 2022 and 2023	1	How is data on the use of antidiabetic drugs recorded and managed?
	2	What are the most frequently used antidiabetic drugs during 2022 and 2023?
	3	Based on the usage value data, is there a change in the prescription trend of antidiabetic drugs used during that period?
	4	How do pharmaceutical companies group or classify drugs based on their level of use?
	5	Are there any obstacles in collecting data on the usage value of antidiabetic drugs? If so, how can they be overcome?

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Category	Question #	Detailed
Evaluation of drug inventory control management	1	How is the antidiabetic drug inventory control system implemented?
	2	Does the pharmacy use a specific method for inventory control, such as the Pareto ABC method?
	3	How is the reorder planning process for antidiabetic drugs carried out, is the available stock also taken into account in the planning?
	4	How is the reordering process carried out for antidiabetic drugs?
	5	Are there specific standards or policies that regulate the minimum and maximum stock levels for antidiabetic drugs and how to handle excess or insufficient drug stock?
	6	How do you handle drugs that are approaching their expiration date or drugs that are rarely used?
	7	Is there a drug stock evaluation system, such as expiration date, overstock, or insufficient stock? If so, how many times a year is the system evaluated?
	8	What is the drug management and arrangement system implemented?
	9	Has there ever been a shortage of antidiabetic drug stock during the 2022–2023 period? If so, what is the cause and what is the solution?
	10	How is the performance evaluation of the drug inventory control system carried out, especially for antidiabetics?

RESULTS AND DISCUSSION

Ngesti Waluyo Christian Hospital implements a diverse antidiabetic drug procurement system, primarily using the e-catalog and e-purchasing systems. The solution to this shortage involves considering alternative drugs with doctors or trying to obtain drugs from other distributors, with BPJS patients sometimes receiving a copy of the prescription to obtain the drug later if it is not available at that time. Ngesti Waluyo provides various types of antidiabetic drugs, both in oral and injectable forms. These drugs are used to control blood sugar levels in patients with diabetes mellitus. Based on the data obtained, there were several drugs that were predominantly used during the study period, such as Acarbose, Novorapid, Levemir, Glimepiride, and Sansulin. The results of the Pareto ABC analysis showed that antidiabetic drugs can be classified based on the value of use and their contribution to the total value of drugs used in the hospital.

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Table 2. Pareto ABC Analysis 2022

Diabetes mellitus's Drugs	Quantity of use	Selling Price (in Rupiah)	Value of use (in Rupiah)	Cumulative Percentage	ABC Class
Novorapid inj	1.353		116.177.517	17,680	A
Acarbose 100 mg	99.782	85.879	89.803.800	31,346	A
Levemir flexpen inj	908		73.449.110	42,523	A
Forxiga 10 mg	3.855	900	71.537.621	53,410	A
Glimepiride 2 mg	52.282		68.123.446	63,776	A
Sansulin log-g disp	812	80.900	67.193.062	74,002	A
Apidra inj	776		63.138.154	83,610	B
Metformin 500 mg	248.666	18.557	45.033.413	90,463	B
Acarbose 50 mg	47.245		31.904.549	95,318	B
Gliquidone 30 mg	17.372	1.303	15.650.074	97,700	C
Eclid 50 mg	8.720		11.118.000	99,392	C
Fonylin MR	717	82.730	1.935.900	99,686	C
Glimepiride 1 mg	6.022		1.336.282	99,890	C
Metrix 2 mg	85	81.364	367.991	99,946	C
Glibenclamide 5 mg	1.878		316.255	99,994	C
Pioglitazone HCL 15 mg	30	181	40.854	100,000	C
		675			
		901			
		1.275			
		2.700			
		222			
		4.329			
		168			
		1.362			

Pareto ABC results of antidiabetic drugs in 2022, there are 6 drugs in category A, while there are 3 drugs in category B. The nine drugs show a significant contribution to the value of use. The Pareto ABC results reflect the distribution of drugs in class A (6 drugs) and class

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B (3 drugs) which has an impact on the difficulty of inventory management to avoid stock shortages, thus requiring a larger stock buffer than for the nine drugs.

Table 3. Pareto ABC Analysis 2023

Diabetes mellitus's Drugs	Quantity of use	Selling Price (in Rupiah)	Value of use (in Rupiah)	Cumulative Percentage	ABC Class
Acarbose 50 mg	50.060	85.879	4.299.117.758	74,261	A
Glimepiride 1 mg	5.992	81.364	487.530.691	82,682	B
Eclid 50 mg	5.457	80.900	441.471.300	90,308	B
Metformin 500 mg	260.670	901	234.837.603	94,365	B
Acarbose 100 mg	127.233	900	114.509.700	96,343	C
Apidra inj	1.397	81.360	113.659.920	98,306	C
Glibenclamide 5 mg	613	82.730	50.713.306	99,182	C
Gliquidone 30 mg	21.676	675	14.637.803	99,435	C
Fonylin MR 60 mg	478	18.557	8.870.294	99,588	C
Glimepiride 2 mg	48.478	181	8.779.275	99,740	C
Nevox 500 mg	2.436	2.700	6.577.200	99,853	C
Forxiga 10 mg	3.698	1.303	4.818.494	99,937	C
Pioglitazone HCL 15 mg	233	4.329	1.008.727	99,954	C
	568	1.750	994.000	99,971	C
Novorapid inj	695	1.362	946.451	99,987	C
Sansulin rapid disp	567	673	381.591	99,994	C
Levemir flexpen inj	1.573	168	264.893	99,999	C
Sansulin log-g disp	240	222	53.256	100,000	C
Pioglitazone HCL 30 mg	20	1.275	25.500	100,000	C
Metrix 2 mg					

The Pareto ABC results in 2023 for category A only have 1 drug, Acarbose 50 mg and for category B there are only 3 drugs, Glimepiride 1 mg, Eclid 50 mg, and Metformin 500 mg. The change in the number of drugs in categories A and B which previously had 9 drug items in 2022 to only 4 drug items in 2023 according to the interview results is *"doctors prescribe more oral drugs and there is a change in the doctor's prescribing pattern so that insulin is not included in category A - Inf-1"*

Comparison of Pareto ABC results with diabetes mellitus management guidelines written in the Ngesti Waluyo Christian Hospital Formulary shows similarities in the choice of first-line oral antidiabetic drugs, namely the number of first-line drug use in Pareto ABC is in category A (Acarbose, Glimepiride and Metformin). Differences in drugs between the hospital formulary and Pareto ABC results appear in other drugs such as specific insulin, combination insulin, and oral drugs, Pioglitazone and Eclide. Several drugs were also found that were recommended in the hospital formulary, but were not recorded in Pareto ABC. This difference

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is due to drug availability factors and doctor preferences in choosing therapy, according to interview results.

Ngesti Waluyo Christian Hospital implements a digital pharmacy information system in recording and managing data on the use of antidiabetic drugs. The process begins when the drug is received, where data such as the drug, batch number, and quantity are directly inputted into the warehouse system. Every drug expenditure and input transaction is automatically recorded through an electronic stock card integrated with the system. The advantage is the ease of monitoring drug use in real-time, which is the basis for Pareto analysis. This system does not yet have an automatic warning feature when stock reaches the minimum limit, so monitoring is still done manually. Metformin is a first-line drug in type 2 diabetes therapy because of its effectiveness in lowering blood glucose levels and the additional benefit of increasing insulin sensitivity. Acarbose 100 mg (a class of α-glucosidase inhibitors) as a first-line drug also plays a role in controlling postprandial glucose levels. Glimepiride 2 mg and Gliquidone are less frequently used, in accordance with the characteristics of sulfonylurea drugs which are more often prescribed as additional therapy for patients who require increased insulin secretion.

Management of antidiabetic drugs is carried out through the e-catalog and e-purchasing systems and is recorded automatically, making it easier to track stock and drug use. The reorder planning process takes into account available stock, with a system that lists purchasing suggestions based on on-hand stock. Reorders are carried out periodically for regular drugs, while for drugs in the BPJS e-catalog, planning is carried out every one to two months. The hospital implements stock management to ensure the availability of frequently used antidiabetic drugs for one month. The process includes checking stock by pharmacists through the system when planning drug purchases. Stock rearrangement is carried out every week based on the level of use. The head pharmacist and the head of warehouse stated that *"drugs included in the fast-moving category such as Metformin and Glimepiride are provided in monthly stock to ensure availability, while slow-moving drugs are only ordered as needed. This procurement policy refers to the previous year's BPJS formulary with limited provision of commonly used items. Stock control is carried out by considering the routine visit patterns of BPJS patients who come every month for check-ups, as well as adjustments based on seasonal trends in drug use. This management system is designed to ensure adequate availability of antidiabetic drugs while maintaining efficiency in managing drug supplies in the hospital."* Monitoring of drug availability has not been carried out optimally, which risks causing stock imbalances if there is a sudden change in drug requirements.

In inventory control, the consumption method is used to determine drug procurement needs. Ngesti Waluyo Christian Hospital does not have a formal stock level or quantity policy, currently the formula for determining minimum and maximum stock levels is based on waiting time, amount of use, and stock. Drug procurement policies are managed by taking into account overstock conditions, where orders will be postponed until stock decreases to the required limit. The drug dispensing process uses the FIFO (First In, First Out) and FEFO (First Expired, First Out) methods which are applied to drug arrangement. Improvements are still needed in the pharmacy information system at Nfesti Waluyo Hospital because according to

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the pharmacist, *"The system evaluation is still limited. The hospital does not yet have a structured stock evaluation system. Stock opname is only carried out twice a year-inf-1."* Limitations in the evaluation of this system can affect the efficiency of stock management at Ngesti Waluyo Christian Hospitals with better stock evaluation systems generally use methods such as ABC analysis to optimize procurement and prevent excess or shortage of stock as found in the previous study (Bertoni et al., 2014; Kastanioti et al., 2016; Mani & Haridasan, 2018)

During the 2022-2023 period, there were several cases of antidiabetic drug stock shortages. One of the main causes is late distribution from the distributor or empty stock at the factory. Drugs that are experiencing stock shortages include Gliquidone, Glimepiride 1 mg, and Bioglitazone. The Gliquidone stock shortage occurred because the distributor ran out of supply, while Glimepiride 1 mg experienced an unexpected increase in use. Bioglitazone also experienced a shortage because it was previously unavailable, but was then needed by several new patients. Acarbose 50 mg and 100 mg have experienced stock shortages due to production constraints by the drug manufacturer. In dealing with the lack of drug stock, the pharmacy usually reports the stock shortage condition to the doctor to replace the drug with an available alternative, look for supplies from other distributors, coordinate with other partners or other hospitals to obtain the drug, or provide a copy of the prescription to general patients to buy the drug outside the hospital. For BPJS patients, a copy of the prescription is made that can be used on the next visit when the drug is available.

The antidiabetic drug inventory control system at Ngesti Waluyo Christian Hospital implements several evaluation mechanisms by ensuring the availability of drugs so that there is no stock shortage. Evaluation includes periodic stock monitoring, implementation of a low stock warning system, and management of excess stock by delaying reorders. The antidiabetic drug inventory control system at Ngesti Waluyo Christian Hospital still requires further evaluation to ensure its effectiveness. Shifts in the types of drugs in the ABC classification due to changes in treatment patterns should be directly adjusted to inventory management. Optimal application of the ABC method can help hospitals determine procurement priorities and ensure the availability of drugs with high use value is maintained. The application of antidiabetic drug inventory management with the Pareto system will ensure that category A drugs are always available because they play an important role in patient care. Category B drugs need to be managed with strict monitoring so that there is no shortage or excess stock. Meanwhile, drugs in category C must be further evaluated to determine whether they are maintained or their needs need to be reviewed to avoid inefficient stock. Optimizing the management system based on the ABC method will help improve the effectiveness of drug distribution and prevent critical stock or financial waste.

CONCLUSION

Pareto of drugs for diabetes mellitus in 2022 shows a total of 16 drugs, of which there are 6 category A drugs and 3 category B drugs. While in 2023 it shows a total of 19 drugs, with 1 category A drug and 3 category B drugs. The types of category A and B drugs in 2022 are 5 out of 9 drugs that are not included in the first line of therapy based on the hospital formulary,

which decreased to 1 in 4 drugs in 2023. The efficiency and improvement of drug prescribing patterns for diabetes mellitus at Ngesti Waluyo Christian Hospital in 2023 showed better results than the previous year. Recording of drug use has been done digitally. The results of the evaluation of pharmaceutical inventory management show that they still do not use a minimum and maximum stock calculation system that can be synchronized with digital records of drug use. As a result, during 2022-2023 there is excess stock on several drugs that can be at risk of expiration or damage, as well as several times there were out-of-stock and shortages due to the absence of an order reminder system. The manual reordering process carried out by pharmacists is at risk of errors because it only relies on the pharmacist's ability to remember and check the amount of medicine in stock.

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