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ANALYSIS OF MEDICINE STORAGE IMPLEMENTATION IN THE PHARMACY WAREHOUSE OF Dr. Hospital. HASRI AINUN HABIBIE

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ABSTRACT

Medicine storage is an essential component of pharmaceutical quality assurance because inappropriate storage conditions and inadequate inventory practices may affect medicine quality, safety, and availability. This study aimed to analyze the implementation of medicine storage practices in the pharmacy warehouse of Dr. Hasri Ainun Habibie Regional Hospital. A qualitative descriptive approach was employed. Data were collected through direct observation, interviews, and document review involving three informants consisting of the Head of the Pharmacy Installation, the pharmacy warehouse officer in charge, and pharmaceutical technical staff. Data were analyzed descriptively by comparing observed practices with applicable Good Storage Practices (GSP) principles. The findings showed that medicines were generally organized according to type, dosage form, storage requirements, and specific categories, with FEFO applied for stock rotation. Incoming medicines were checked based on purchase documents, quantity, batch number, expiration date, and physical condition, while stock cards supported inventory monitoring. The storage room was maintained in a clean and orderly condition, with adequate ventilation and lighting, temperature control, and protection against insects and rodents. Storage cabinets and medicine refrigerators were also maintained properly, and expired medicines were separated from active stock. However, LASA medicines were not consistently provided with specific labels, and some procedures required greater standardization to ensure consistent implementation. The study concludes that medicine storage practices were generally implemented appropriately, although improvements are needed in LASA identification, standardization of operational procedures, continuous monitoring, and personnel competency to strengthen pharmaceutical quality assurance.

Keywords: *medicine storage; Good Storage Practices; pharmacy warehouse; inventory management; FEFO; LASA*

INTRODUCTION

Medicines are essential components of healthcare delivery, and maintaining their quality throughout the pharmaceutical supply chain is fundamental to ensuring patient safety and therapeutic effectiveness. Pharmaceutical quality is not determined solely during manufacturing but must also be preserved during transportation, storage, distribution, and handling. Inappropriate storage conditions may contribute to physical or chemical degradation, loss of potency, contamination, and deterioration of pharmaceutical products, potentially compromising their therapeutic value and increasing the risk of patient harm. Therefore, medicine storage should be considered an integral component of pharmaceutical quality assurance rather

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than merely an administrative or logistical activity [1][2].

Pharmacy warehouses have a strategic role in maintaining the quality, availability, and integrity of medicines before they are distributed to healthcare facilities or patients. Effective storage requires the implementation of appropriate procedures covering environmental conditions, facility management, product arrangement, inventory control, documentation, security, personnel competency, and monitoring activities. Good Storage Practices (GSP) provide a systematic framework for ensuring that pharmaceutical products remain within appropriate quality parameters throughout the storage period. These practices include adequate control of temperature, humidity, ventilation, lighting, cleanliness, stock rotation, product segregation, and protection against contamination or physical damage [1][2].

Environmental conditions are particularly important because many pharmaceutical products are sensitive to temperature, humidity, light, and other external factors. Failure to maintain appropriate storage conditions can accelerate product deterioration and potentially affect the stability and effectiveness of medicines. In addition to environmental control, proper organization and inventory management are required to prevent expired medicines, stock losses, overstocking, and shortages. Consequently, pharmaceutical warehouse management requires the integration of physical storage conditions with systematic inventory and quality-control mechanisms [1].

Despite the existence of established storage standards, evidence from different countries indicates that implementation of GSP remains inconsistent. A scoping review involving studies from 10 countries found substantial gaps in several GSP components. Climate, light, ventilation and temperature control, as well as stock and bookkeeping practices, demonstrated relatively low levels of compliance across the reviewed studies. The findings suggest that the presence of storage procedures does not necessarily ensure their consistent implementation in routine pharmaceutical operations. The review consequently emphasized the importance of personnel training, enforcement of appropriate controls, and systematic monitoring of storage practices [1].

Evidence from hospital-based settings similarly demonstrates the importance of evaluating storage practices comprehensively. Vargas et al. [2], in an assessment of medicine storage practices in a hospital setting, emphasized that inadequate storage practices may contribute to medicine degradation and identified the need to evaluate different dimensions of GSP implementation. Such evidence indicates that medicine storage should be assessed not only in terms of the physical arrangement of products but also through the broader organizational and operational processes that support pharmaceutical quality.

Recent studies further demonstrate that gaps in GSP implementation remain an important concern. Al-Hawasli and Rajab [3], reported deficiencies in the implementation of GSP in pharmaceutical import warehouses and identified organizational and resource-related factors as barriers to effective compliance. Their findings reinforce the importance of

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adequate infrastructure, equipment, personnel competency, and organizational commitment in maintaining pharmaceutical product integrity. Similarly, Villaizan-Beraun et al. [4], found that a specialized medicine warehouse achieved 74.53% overall compliance with GSP, while considerable differences existed among individual components. Particularly low compliance was observed in personnel and self-inspection, demonstrating that an overall compliance level may conceal weaknesses in specific areas of warehouse management.

Inventory management represents another critical dimension of pharmaceutical storage. Medicines must be systematically arranged, identified, documented, monitored, and rotated to minimize the risk of expiry and wastage while maintaining product availability. Inadequate stock management may result in accumulation of expired or near-expiry medicines, inefficient use of financial resources, and disruption of medicine availability. Therefore, effective medicine storage requires the integration of environmental monitoring, physical organization, stock control, documentation, and routine evaluation to ensure that pharmaceutical products remain safe and suitable for use [1].

Although previous studies have examined GSP compliance in pharmacies, hospitals, and pharmaceutical warehouses, important gaps remain in understanding medicine storage implementation as an integrated operational process. Existing research has frequently focused on individual components of storage practices or specific types of pharmaceutical facilities, while comprehensive assessments combining environmental conditions, inventory organization, documentation, personnel practices, facility management, and quality-control mechanisms remain important. Furthermore, variations in infrastructure, organizational capacity, regulatory requirements, and human resources mean that findings from one setting cannot necessarily be generalized to other healthcare facilities. A context-specific assessment is therefore necessary to identify implementation gaps and determine areas requiring improvement.

Accordingly, systematic analysis of medicine storage implementation is important for evaluating whether established pharmaceutical storage standards are effectively translated into routine warehouse practices. Such an assessment can identify strengths, weaknesses, and operational gaps that may influence the quality and availability of medicines. The present study therefore aims to analyze the implementation of medicine storage practices in a pharmacy warehouse by examining key dimensions of pharmaceutical storage management, including storage conditions, inventory organization, documentation, personnel practices, facility management, and compliance with applicable standards. The findings are expected to provide evidence for strengthening pharmaceutical quality assurance, improving warehouse management, reducing medicine wastage, and supporting the safe and continuous availability of medicines.

Literature Review

Good Storage Practices and Pharmaceutical Quality

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Good Storage Practices (GSP) represent an essential component of pharmaceutical quality management aimed at maintaining the quality, safety, stability, and efficacy of medicines throughout the storage period. Pharmaceutical products may undergo physical, chemical, or microbiological deterioration when exposed to inappropriate environmental conditions or handled improperly. Therefore, pharmaceutical storage should be implemented through standardized procedures covering facility conditions, product handling, environmental monitoring, documentation, security, cleanliness, and personnel responsibilities. GSP principles are closely connected with broader pharmaceutical quality assurance because appropriate storage conditions are necessary to preserve product integrity from receipt until distribution or use [5][1].

International regulatory frameworks generally emphasize similar fundamental principles for pharmaceutical storage, although specific requirements may differ according to the regulatory context. Ballal et al. [5], demonstrated that pharmaceutical storage and transportation guidelines across different regulatory frameworks share common requirements concerning temperature control, product protection, documentation, handling, and monitoring. These requirements indicate that storage should not be regarded merely as a physical activity but as a controlled quality-assurance process.

Evidence from empirical studies demonstrates that implementation of GSP remains variable across pharmaceutical facilities. Ching et al. [1], through a scoping review covering studies from several countries, identified substantial variation in compliance with GSP among pharmacies and medicine outlets. Problems were reported in areas such as temperature and climate control, ventilation, lighting, stock and bookkeeping, and other storage-related practices. These findings indicate that the existence of formal standards does not necessarily guarantee consistent implementation in daily operations.

Similarly, Vargas et al. [1], found that medicine storage practices in a hospital setting required systematic assessment of environmental and organizational factors to ensure pharmaceutical product quality. More recent evidence from Villaizan-Beraun et al. [4], showed that compliance with GSP within a specialized medicine warehouse varied among different components of storage management. Such findings reinforce the importance of assessing GSP implementation comprehensively rather than relying on a single overall compliance indicator.

Storage Conditions and Inventory Management

Appropriate storage conditions are fundamental to maintaining the stability and integrity of medicines. Temperature, humidity, lighting, ventilation, cleanliness, and physical organization can influence the quality of pharmaceutical products. Medicines that are stored outside their recommended environmental conditions may experience accelerated degradation, loss of potency, or other forms of deterioration. Consequently, pharmaceutical warehouses should provide appropriate environmental controls and conduct regular monitoring to detect deviations from established requirements [2].

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Temperature and humidity are particularly important because variations in environmental conditions may affect the stability of pharmaceutical products. However, appropriate storage involves more than environmental monitoring. Pharmaceutical products should also be protected from contamination, excessive light, physical damage, and inappropriate handling. Proper shelving, product segregation, identification, and organization are therefore necessary components of effective pharmaceutical storage. Ghozali and Astuti [6], in their assessment of pharmaceutical storage in rural public health centers in Indonesia, emphasized the importance of evaluating actual storage conditions against established standards to identify areas of nonconformity.

Storage management is also closely related to inventory management. A pharmacy warehouse must maintain sufficient medicine availability while minimizing overstocking, expiration, wastage, and unnecessary financial expenditure. Effective inventory management includes accurate stock recording, monitoring of expiration dates, appropriate stock rotation, procurement planning, stock-level monitoring, and systematic evaluation of inventory performance. Poor inventory practices may lead to stock-outs, excess inventory, expired medicines, and inefficient utilization of financial resources.

Previous studies have demonstrated the importance of systematic inventory management in pharmaceutical services. Silva-Aravena et al. [7], examined inventory management in a hospital pharmacy and demonstrated the usefulness of decision-support approaches in improving inventory-related decisions. Pentrakan and Srinon [8], emphasized the importance of inventory management indicators for evaluating pharmacy performance and identifying areas requiring managerial improvement. Mahidin et al. [9], similarly demonstrated the relevance of inventory administration practices in public hospitals, indicating that inventory management is an important component of healthcare supply-chain performance.

Inventory management also requires balancing medicine availability and cost efficiency. Mufti and Almaktoom [10], highlighted the relationship between inventory costs and medicine availability in pharmacy operations. This suggests that effective pharmaceutical warehouse management should not focus solely on maintaining adequate stock but should also ensure that medicines are stored and managed in a manner that minimizes expiration, wastage, and unnecessary inventory costs.

Regulatory Compliance and Personnel Competence

Pharmaceutical storage is subject to regulatory requirements intended to protect the quality and safety of medicines. Regulations and technical standards establish requirements concerning storage facilities, environmental conditions, product handling, documentation, security, monitoring, and quality assurance. Compliance with these requirements is important because deviations may compromise pharmaceutical quality and increase operational risks. Seevers et al. [11], emphasized the importance of protecting pharmaceutical product quality

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throughout distribution and handling, demonstrating that quality assurance must extend beyond manufacturing to subsequent stages of the pharmaceutical supply chain.

However, regulatory compliance does not depend solely on the availability of written procedures. The effective implementation of standards requires adequate infrastructure, monitoring mechanisms, documentation systems, managerial commitment, and competent personnel. Nguyen et al. [12], in examining the implementation and maintenance of GSP principles in hospitals in Ho Chi Minh City, demonstrated the importance of organizational and human-resource factors in maintaining appropriate storage practices.

Personnel competence is particularly important because pharmacy warehouse staff are directly involved in receiving, arranging, storing, monitoring, documenting, and distributing medicines. Personnel must understand storage requirements, environmental monitoring, stock rotation, expiration-date control, documentation procedures, and actions required when deviations occur. Inadequate knowledge or training may result in inappropriate storage practices even when adequate facilities and written procedures are available.

Recent evidence continues to demonstrate challenges related to compliance and human resources. Al-Hawasli and Rajab [3], reported gaps in the implementation of GSP in drug import warehouses and highlighted organizational and resource-related challenges affecting compliance. Villaizan-Beraun et al. [4], also identified personnel-related aspects and self-inspection among areas requiring particular attention in pharmaceutical warehouse compliance. These findings indicate that sustainable GSP implementation requires continuous personnel development, routine supervision, internal assessment, and organizational support.

Thus, regulatory compliance and personnel competence should be considered interrelated components of pharmaceutical storage management. Regulations establish the standards that must be achieved, while competent personnel and effective organizational systems determine whether those standards are consistently translated into operational practice.

Pharmaceutical Warehouse Management and Research Gap

Pharmaceutical warehouse management represents an integrated system that combines storage practices, environmental control, inventory management, regulatory compliance, documentation, infrastructure, personnel, and quality assurance. Effective warehouse management is necessary to ensure that medicines remain available, traceable, and suitable for use while minimizing product losses and operational costs. Yimenu et al. [13], in their assessment of pharmaceutical warehouse management among private pharmaceutical wholesalers in Ethiopia, demonstrated the importance of systematic warehouse practices in supporting pharmaceutical supply operations.

The different components of warehouse management are interconnected. Appropriate infrastructure alone cannot guarantee pharmaceutical quality if storage procedures are poorly implemented.

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Similarly, an effective inventory system may not prevent medicine wastage if expiration monitoring and stock rotation are inadequate. Personnel competence is also necessary to ensure that environmental monitoring, documentation, inventory control, and regulatory requirements are consistently implemented. Shweta et al. [14], emphasized the interconnected nature of warehouse activities within pharmaceutical supply chains, suggesting that warehouse performance should be understood as an integrated rather than isolated process.

Previous international studies have consistently demonstrated the importance of GSP, appropriate storage conditions, inventory management, regulatory compliance, and personnel competence. Nevertheless, differences remain in the level of implementation among facilities and countries. Ching et al. [1], reported considerable variability in GSP compliance, while Al-Hawasli and Rajab [3] and Villaizan-Beraun et al. [4], demonstrated that specific areas of pharmaceutical warehouse management may continue to show implementation gaps despite the existence of formal standards. This variation may be influenced by differences in infrastructure, available resources, organizational capacity, personnel competence, monitoring systems, and regulatory environments.

A further limitation in the existing literature is that several studies have focused on individual aspects of pharmaceutical management, such as storage conditions, inventory management, or regulatory compliance. Although these studies provide valuable evidence, medicine storage implementation is inherently multidimensional. Weaknesses in one component may influence the effectiveness of other components. Therefore, assessing medicine storage through an integrated framework may provide a more comprehensive understanding of actual implementation and identify specific areas requiring improvement.

Based on the reviewed literature, medicine storage implementation can be conceptually understood as an integrated process involving Good Storage Practices, storage conditions, inventory management, regulatory compliance, personnel competence, and warehouse management. These components interact to maintain pharmaceutical quality, safety, availability, and operational efficiency. A comprehensive assessment of these dimensions can therefore provide evidence regarding the extent to which established storage standards are translated into routine pharmacy warehouse practices. This conceptual foundation supports the analysis of medicine storage implementation and provides a basis for identifying operational gaps and developing evidence-based improvements in pharmaceutical warehouse management.

RESEARCH METHODS

Research Design

This study employed a qualitative approach with a descriptive observational design. The study was designed to assess the implementation and suitability of medicine storage practices in the pharmacy warehouse of Dr. Hasri Ainun Habibie Regional Hospital. The qualitative descriptive approach was used to obtain a comprehensive description of actual

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medicine storage practices and to identify areas of compliance and non-compliance with applicable pharmaceutical storage standards.

Research Setting and Period

The study was conducted in the pharmacy warehouse of Dr. Hasri Ainun Habibie Regional Hospital. The research setting was selected because the pharmacy warehouse serves as an important facility for the receipt, storage, management, and distribution of medicines within the hospital. Data collection was conducted during the research period specified by the researchers.

Research Focus

The focus of this study was the implementation of medicine storage practices in the pharmacy warehouse. The assessment covered several aspects, including warehouse facilities and infrastructure, environmental conditions, medicine arrangement and organization, stock rotation, expiration-date monitoring, inventory administration, documentation, cleanliness, security, and personnel-related storage practices. These aspects were assessed based on applicable Good Storage Practices (GSP) principles and relevant pharmaceutical storage requirements.

Data Sources

The study used primary data obtained through direct observation of medicine storage practices and the physical conditions of the pharmacy warehouse. Secondary data were obtained from relevant documents and records available at the pharmacy warehouse, including storage procedures, inventory records, documentation, and other supporting administrative documents relevant to medicine storage management.

Data Collection Technique

Data were collected through direct observation and document review. Direct observation was conducted to assess the actual implementation of medicine storage practices, including the arrangement of medicines, environmental conditions, warehouse facilities, cleanliness, security, stock organization, and monitoring procedures. Document review was conducted to examine the availability and implementation of relevant records, procedures, and administrative documentation. A structured observation checklist based on applicable pharmaceutical storage standards was used to ensure systematic data collection.

Research Instrument

The primary research instrument was a structured observation checklist developed based on Good Storage Practices and applicable pharmaceutical storage requirements. The checklist covered key assessment components, including facilities and infrastructure, storage conditions, medicine organization, inventory management, documentation, cleanliness, security, and monitoring. The instrument was used to systematically document the conformity of observed practices with the established requirements.

Data Analysis

Data were analyzed using qualitative descriptive analysis. The observed conditions and practices were systematically reviewed and compared with the applicable pharmaceutical storage requirements. Each assessment component was categorized according to its conformity with the established standards. The results were then synthesized descriptively to

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identify strengths, non-conformities, and areas requiring improvement in medicine storage implementation.

RESEARCH RESULTS

The study involved three informants who were directly involved in pharmaceutical service and medicine storage activities at the pharmacy warehouse of Dr. Hasri Ainun Habibie Regional Hospital. The informants consisted of the Head of the Pharmacy Installation, the person responsible for the pharmacy warehouse, and a pharmaceutical technical staff member. Their professional backgrounds and positions provided complementary perspectives on the implementation of medicine storage practices.

Table 1. Characteristics of Informants

No.	Informant Code	Position	Educational Background
1	GF	Head of Pharmacy Installation	Pharmacist
2	SCL	Pharmacy Warehouse Officer in Charge	Pharmacist
3	UMB	Pharmaceutical Technical Staff	Diploma in Pharmacy

Placement and Organization of Medicines in the Storage Warehouse

The placement of medicines in the pharmacy warehouse was assessed based on medicine categorization, dosage forms, storage requirements, stock rotation, and the identification of medicines with similar names or appearances (Look-Alike Sound-Alike/LASA).

The interview with GF, the Head of the Pharmacy Installation, indicated that medicines were grouped according to their characteristics and storage requirements. Controlled substances, psychotropic medicines, high-alert medicines, generic tablets, and medical consumables were stored in designated areas or rooms. However, medicines with similar names or appearances were reportedly separated without specific LASA labeling:

> *"The placement of medicines is adjusted to the available warehouse space. Medicines are grouped into B3, psychotropic medicines, high-alert medicines, generic tablets, and medical consumables, with these categories stored in separate areas. Medicines with similar names or appearances are separated, but they are not specifically labeled as LASA."* (GF, August 23, 2024)

SCL, the officer responsible for the pharmacy warehouse, stated that medicine placement also followed the FEFO principle and dosage-form classification:

> *"Medicines are arranged according to the FEFO (First Expired, First Out) system and dosage forms. Medicines with similar names or appearances are identified as LASA."* (SCL, August 23, 2024)

In contrast, UMB emphasized that medicine placement should consider medicine type, storage temperature, alphabetical arrangement, and explicit LASA identification:

> *"Medicines should be arranged according to type, storage temperature, and alphabetically. Medicines with similar names or appearances should be given LASA labels."* (UMB, August 24, 2024)

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The interviews therefore indicated that medicines were generally categorized according to dosage form, type, and storage requirements, and FEFO was reportedly applied. However, there was a discrepancy among informants regarding LASA identification. While medicines with similar names or appearances were separated, specific LASA labeling was not consistently implemented.

The observation findings confirmed that medicines were separated and arranged according to their respective categories. Separate storage areas were available for B3 medicines, psychotropic medicines, high-alert medicines, tablets, and medical consumables. However, medicines categorized as LASA were not consistently provided with specific LASA labels.

Documentary evidence showed that medicines were accompanied by stock cards, while the cold-storage cabinet was equipped with temperature and humidity monitoring devices. The storage area also displayed appropriate identification symbols for B3 medicines.

Overall, the findings indicate that medicine organization in the pharmacy warehouse had been implemented through categorization, stock-card utilization, and stock-rotation practices. Nevertheless, the specific identification of LASA medicines remained an area requiring improvement.

Management of Incoming and Outgoing Medicines

The management of incoming and outgoing medicines involved procedures for receiving, checking, recording, storing, and issuing pharmaceutical products. The assessment focused on the verification of incoming medicines, including conformity with purchase documents, quantity, batch number, and expiration date, as well as the application of stock-rotation principles during medicine distribution.

GF explained that medicines received from suppliers were checked against the invoice and physical condition before being stored. Photographic documentation was also performed. For medicine distribution, FEFO was prioritized:

> *"When medicines arrive at the warehouse, we check the invoice, purchase order, and physical condition of the medicines. After checking, we take photographs. For medicines issued from the warehouse, we prioritize FEFO; medicines with the nearest expiration date are issued first. When medicines have the same expiration date, FIFO is applied."* (GF, August 24, 2024)

SCL similarly reported that incoming medicines were checked against the invoice, including the expiration date and batch number:

> *"When medicines arrive from the distributor, they are checked against the invoice, and the expiration date and batch number are verified before the medicines are placed on the storage shelves. FIFO is rarely used because the medicines have expiration dates."* (SCL, August 24, 2024)

UMB described a similar procedure, emphasizing verification of quantity, batch number, and expiration date:

> *"The medicine procurement process begins with placing the order and contacting the supplier. When the medicines arrive, the quantity, batch*

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number, and expiration date are checked. For medicines with the same expiration date, FIFO is used; otherwise, FEFO is applied." (UMB, August 24, 2024)

The interview findings demonstrate that incoming medicines were subject to verification before storage, particularly with regard to the purchase documentation, quantity, batch number, and expiration date. For outgoing medicines, the FEFO principle was prioritized, while FIFO was used in specific circumstances, particularly when products had the same expiration date.

The findings from interviews were consistent with the observed warehouse practices, in which medicines were arranged to facilitate stock rotation and expiration-date monitoring. Stock cards were also available for stored medicines, supporting the recording and monitoring of inventory movements.

Overall, the management of incoming and outgoing medicines had incorporated essential verification and stock-rotation procedures. The implementation of FEFO was particularly important for minimizing the risk of medicine expiration during storage.

Condition of the Medicine Storage Room

The physical and environmental condition of the medicine storage room was assessed in terms of room size, temperature, humidity, ventilation, lighting, cleanliness, and protection against insects and rodents.

GF reported that the storage area measured approximately 15 × 12 m and maintained a temperature of approximately 22–25°C. The room was also equipped with adequate lighting and ventilation and was protected against insects and rodents:

"The medicine storage room is approximately 15 × 12 meters. The temperature is maintained at around 22–25°C. The storage room has adequate lighting and ventilation and is free from insects and rodents. Cleaning personnel also clean the area regularly." (GF, August 24, 2024)

SCL confirmed that the storage room was maintained at a temperature below 25°C and was equipped with ventilation:

"I do not know the exact size of the warehouse, but the medicine storage area is free from insects and rodents. The temperature is maintained below 25°C, and the room has ventilation." (SCL, August 24, 2024)

UMB provided similar information and estimated the room size at approximately 15 × 12 meters:

"The medicine storage room is approximately 15 × 12 meters. The warehouse is free from insects and rodents, the temperature is around 22–25°C, and the room has adequate ventilation." (UMB, August 24, 2024)

The interview findings indicated that the storage room had ventilation, adequate lighting, controlled temperature, and protection against insects and rodents. The observations supported these findings. The storage room was observed to be clean and orderly, with ventilation available and no visible signs of insect or rodent infestation. Cleaning personnel were also assigned to maintain the cleanliness of the storage area.

Documentary evidence further indicated that cleanliness of the medicine storage room was routinely maintained. The observed storage area appeared

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organized, with no significant accumulation of dust or dirt in the medicine storage area.

Overall, the medicine storage room demonstrated appropriate physical and environmental conditions based on the aspects assessed in this study, particularly with regard to cleanliness, ventilation, temperature control, lighting, and protection from pests.

Condition of Medicine Storage Cabinets and Refrigerated Storage

The condition of medicine storage cabinets and refrigerated storage facilities was assessed in terms of cleanliness, physical condition, temperature and humidity monitoring, appropriate use of refrigeration equipment, stock identification, and separation of expired medicines.

GF stated that the storage cabinets were routinely cleaned and that the medicine refrigerator was maintained in good condition and was not used for storing food:

> *"The storage cabinets are cleaned every day by cleaning personnel. The medicine refrigerator is in good condition and is never used to store food. Each medicine has a stock card, and expired medicines are not kept in the storage cabinets; they are immediately separated into the designated expiration area."* (GF, August 24, 2024)

SCL provided similar information:

> *"The medicine storage cabinets are kept clean because they are regularly cleaned by the cleaning service. The medicine refrigerator is in good condition and is never used to store food. Each medicine in the storage cabinet has a stock card."* (SCL, August 24, 2024)

UMB confirmed that the cabinets and refrigerator were routinely maintained:

> *"The storage cabinets are cleaned every day by the cleaning service. The medicine refrigerator is in good condition and is not used to store food. Expired medicines are not stored together with active stock; they have a separate designated area."* (UMB, August 24, 2024)

The interview findings indicate that medicine storage cabinets were routinely cleaned and that the refrigerator was dedicated to medicine storage. Stock cards were available for medicines, while expired medicines were reportedly separated from active inventory.

Direct observation showed that the medicine storage cabinets were generally clean, orderly, and arranged to facilitate medicine identification and retrieval. Temperature and humidity monitoring devices were also available in the storage area. The cabinets and refrigeration equipment were observed to be in functional condition, with no significant physical damage identified.

Documentary evidence supported the observation findings, showing that the storage facilities were in good physical condition and equipped with temperature and humidity monitoring devices.

Overall, the storage cabinets and refrigerated storage facilities were adequately maintained based on the observed indicators. The availability of stock cards, environmental monitoring devices, routine cleaning, and separation of expired medicines supported the

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implementation of medicine storage procedures in the pharmacy warehouse.

DISCUSSION

Implementation of Medicine Placement and Organization

The findings of this study indicate that medicine placement in the pharmacy warehouse was generally organized according to medicine type, dosage form, storage requirements, and specific categories such as psychotropic medicines, high-alert medicines, B3 medicines, tablets, and medical consumables. The implementation of FEFO was also reported by the informants as an important stock-rotation principle. These practices indicate that the pharmacy warehouse had established a systematic approach to medicine organization and retrieval.

The implementation of medicine placement is consistent with the principles of Good Storage Practices (GSP), which emphasize systematic arrangement, appropriate segregation, product identification, and stock rotation to maintain medicine quality and minimize the risk of errors. Ballal et al. [5] explained that pharmaceutical storage standards generally require medicines to be arranged in a manner that facilitates identification, handling, monitoring, and protection from inappropriate storage conditions. Similarly, Ching et al. [1], identified product arrangement, stock management, and appropriate storage conditions as important components of GSP implementation.

The use of FEFO in the study setting is also appropriate for pharmaceutical inventory management because medicines with the nearest expiration dates should generally receive priority for distribution. This practice can reduce the accumulation of near-expiry products and minimize pharmaceutical wastage. The findings are consistent with the broader concept of pharmaceutical inventory management, in which stock rotation and expiration-date monitoring are essential for maintaining medicine availability while reducing losses. Silva-Aravena et al. [7], emphasized the importance of systematic inventory management in hospital pharmacy operations, particularly in supporting decisions related to stock availability and utilization.

However, the most important finding in this aspect concerns the identification of LASA medicines. The observations demonstrated that medicines with similar names or appearances were separated but were not consistently provided with specific LASA labels. This represents a potential weakness in medicine-storage implementation because physical separation alone may not provide sufficient visual warning to personnel during medicine selection. Clear identification is particularly important for medicines that have similar names, packaging, or appearances because selection errors may occur during routine warehouse operations.

This finding indicates that medicine organization in the study setting has achieved a relatively good level of physical segregation but has not been fully supported by standardized risk identification. Therefore, improvement should focus not only on where LASA medicines are placed but also on how they are visually identified and monitored. This is important because GSP should

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encompass both physical storage arrangements and operational controls designed to minimize medication-related risks [1][2].

The finding is also relevant to the concept of integrated warehouse management. Shweta et al. [14], emphasized that pharmaceutical warehouse activities are interconnected, meaning that physical arrangement, product identification, inventory control, and operational procedures should function as a unified system. Consequently, the implementation of medicine placement in the study setting can be considered substantially established, although LASA identification remains an important area for improvement.

Management of Incoming and Outgoing Medicines

The findings demonstrate that the management of incoming medicines involved verification of purchase documents, physical products, quantities, batch numbers, and expiration dates before medicines were placed into storage. The management of outgoing medicines prioritized FEFO, while FIFO was applied under certain circumstances, particularly when medicines had the same expiration date. These practices demonstrate the existence of basic control mechanisms for maintaining the traceability and appropriate rotation of pharmaceutical products.

The verification of incoming medicines is an essential component of pharmaceutical warehouse management because medicines should be checked before acceptance and storage. The verification of product identity, quantity, batch number, expiration date, and accompanying documentation supports traceability and reduces the possibility of discrepancies entering the inventory system. Yimenu et al. [13], demonstrated that effective pharmaceutical warehouse management depends on systematic processes for receiving, storing, recording, and distributing pharmaceutical products.

The application of FEFO identified in this study is also consistent with the principles of pharmaceutical inventory management. Medicines with shorter remaining shelf lives need to be prioritized to minimize expiration-related losses. This principle is particularly relevant in hospital pharmacies because medicine expiration may result not only in financial losses but also in reduced availability of medicines required for patient care. Mufti and Almaktoom [10], emphasized the importance of balancing medicine availability and inventory costs, while Silva-Aravena et al. [7], demonstrated the importance of structured inventory decision-making in hospital pharmacy settings.

The presence of stock cards further supports the implementation of inventory control. Stock documentation allows warehouse personnel to monitor medicine movement and compare physical inventory with recorded stock. Mahidin et al. [9], emphasized that inventory administration is an important element of pharmaceutical supply management because accurate records support stock monitoring and operational decision-making.

Nevertheless, the findings also suggest that the implementation of inventory management could be strengthened through greater standardization of receiving and issuing procedures. Although the informants

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described similar practices, the explanations regarding the use of FIFO and FEFO were not completely uniform. This variation indicates that operational understanding may differ among personnel. Such differences can potentially affect consistency if procedures are not supported by standardized written protocols, routine supervision, and continuous training.

This finding corresponds with previous evidence showing that the existence of GSP standards does not necessarily guarantee uniform implementation in daily pharmaceutical operations. Ching et al. [1], reported variability in stock and bookkeeping practices across different pharmaceutical facilities. Therefore, maintaining effective medicine inventory management requires not only the application of FEFO/FIFO but also standardized procedures, accurate documentation, personnel competence, and periodic monitoring.

Condition of the Medicine Storage Room

The findings indicate that the medicine storage room was generally maintained in appropriate physical and environmental conditions. The room had ventilation, adequate lighting, routine cleaning, and protection against insects and rodents. The reported temperature was approximately 22–25°C, and observations confirmed that the storage environment was clean and orderly. These findings suggest that the basic environmental requirements for medicine storage had been incorporated into routine warehouse management.

Environmental control is a fundamental component of GSP because temperature, humidity, light, ventilation, cleanliness, and pest control may influence the stability and quality of pharmaceutical products. Vargas et al. [2], emphasized that inappropriate storage conditions may contribute to medicine deterioration and therefore require systematic monitoring. Similarly, Ching et al. [1], identified temperature, climate, ventilation, and lighting as important areas of GSP implementation.

The temperature conditions observed in this study are generally consistent with the requirements for medicines that can be maintained under controlled room-temperature conditions. However, interpretation of storage temperature should always consider the specific manufacturer's storage instructions for each pharmaceutical product because not all medicines have identical stability requirements. Therefore, maintaining a general room temperature within an acceptable range should be complemented by product-specific storage information and continuous environmental monitoring.

The cleanliness of the storage room is another positive finding. The absence of visible dust, dirt, insects, and rodents, combined with routine cleaning activities, demonstrates that environmental hygiene was incorporated into warehouse operations. Adequate cleanliness is important because contamination and pest infestation may compromise pharmaceutical product integrity. Good Storage Practices therefore require not only temperature control but also appropriate sanitation and protection of pharmaceutical products from environmental hazards [5][1].

The findings are also relevant to the study by Ghozali and Astuti [6], which emphasized the importance of conformity assessment in pharmaceutical storage

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facilities. Their study illustrates that actual storage conditions need to be assessed against established requirements rather than relying solely on the existence of storage facilities. In the present study, direct observation provided additional evidence that the reported environmental conditions were reflected in actual warehouse conditions.

Despite these positive findings, continuous monitoring remains necessary. Environmental conditions may fluctuate over time due to equipment malfunction, changes in weather, power interruptions, or operational activities. Consequently, appropriate storage cannot be established solely through a single observation. Regular recording, review of monitoring results, and corrective action when deviations occur are necessary to ensure sustained compliance.

Condition of Medicine Storage Cabinets and Refrigerated Facilities

The study findings show that medicine storage cabinets and refrigerated facilities were generally maintained in good condition. The cabinets were routinely cleaned, medicines were accompanied by stock cards, and the refrigerator was dedicated to medicine storage rather than food. Expired medicines were also reported to be separated from active inventory. Observations further indicated that the storage cabinets were orderly and that temperature and humidity monitoring devices were available.

The physical condition of storage facilities is an important component of pharmaceutical quality assurance because inadequate cabinets, refrigerators, or monitoring devices may expose medicines to inappropriate environmental conditions or physical damage. Ballal et al. [5], emphasized the importance of appropriate storage infrastructure and environmental controls in maintaining pharmaceutical quality throughout storage and distribution.

The separation of expired medicines from active inventory represents an important control mechanism. Expired medicines should not remain mixed with usable stock because this may increase the risk of accidental distribution or administration. The separation of expired products also facilitates inventory monitoring and subsequent disposal according to applicable procedures. This practice is consistent with the broader principles of pharmaceutical inventory control, which seek to minimize wastage and prevent inappropriate use of pharmaceutical products.

The availability of stock cards for medicines is another positive aspect identified in this study. Stock cards provide a mechanism for documenting medicine movement and supporting physical inventory control. This finding corresponds with the importance of stock and bookkeeping practices identified in the scoping review by Ching et al. [1]. Accurate documentation is particularly important in hospital pharmacy warehouses because medicine movement must remain traceable from receipt through storage and eventual distribution.

The availability of temperature and humidity monitoring equipment also indicates that environmental control was supported by physical monitoring infrastructure. However, the presence of monitoring devices alone does not necessarily demonstrate effective monitoring. The effectiveness of such

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systems depends on whether measurements are recorded routinely, reviewed by responsible personnel, and followed by corrective action when deviations occur. Villaizan-Beraun et al. [4], demonstrated that compliance with GSP may vary considerably across specific components, indicating that the availability of facilities should be distinguished from their consistent operational use.

The findings are broadly consistent with previous research showing that pharmaceutical warehouse management requires the integration of infrastructure, environmental control, documentation, inventory management, and personnel practices. Yimenu et al. [13], emphasized that effective pharmaceutical warehouse management involves interconnected activities rather than isolated storage functions. Therefore, the relatively good physical condition of the storage facilities in the present study represents an important foundation for maintaining medicine quality, but its effectiveness depends on continuous monitoring and appropriate operational procedures.

CONCLUSION

The implementation of medicine storage practices in the pharmacy warehouse of Dr. Hasri Ainun Habibie Regional Hospital was generally consistent with the principles of Good Storage Practices. Medicines were appropriately categorized and arranged, stock rotation was supported by FEFO, incoming and outgoing medicines were subject to verification, and inventory documentation was maintained through stock cards. The storage room, cabinets, and refrigerated facilities were also maintained in clean, orderly, and functional conditions, with environmental monitoring and separation of expired medicines. Nevertheless, the identification of LASA medicines was not yet consistently supported by specific labeling, and differences in the understanding of some stock-rotation procedures indicate the need for greater standardization. Therefore, strengthening LASA labeling, standard operating procedures, routine monitoring, documentation, and personnel training is recommended to ensure consistent medicine storage practices and support the quality, safety, and availability of medicines.

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