ORIGINAL RESEARCH

ISSN (O): 2349-5332
CODEN: IRJPHY

ANALYZING INSULIN PREFERENCES: A FOUR-YEAR STUDY OF MIXTARD INSULIN VIAL AND PENFILL CARTRIDGE DISPENSING IN JORDAN

Bayan Ahmad Hasan Eldweib; PH[1], Widad Ziad Mouasher; PH[1], Taha Al-Qayam; PH[1]

[1]Pharmacist, Royal Medical Services, Jordan.

Submitted on: 02.02.2025; **Revised on:** 08.02.2025; **Accepted on:** 10.02.2025

ABSTRACT:

1. Introduction: Insulin is fundamental in diabetes management, and the injection method can greatly influence adherence among patients and treatment results. The Jordanian Royal Medical Services (JRMS) functions as the principal healthcare provider for military personnel and their families, distributing insulin in several forms to hospitals countrywide. This study examines two particular forms of Mixtard insulin: 10 ml vials designed for use with subcutaneous syringes and 3 ml Penfill cartridges used with the Novo Pen injector. Although both forms of treatment provide efficient insulin therapy, Penfill cartridges are consistently favored in diabetes management for their convenience, precision, and simplicity of use, particularly for frequent or flexible dose needs. This study analyzes the average monthly distribution of Mixtard vials and cartridges from the JRMS main stores to three principal hospitals - King Al-Hussein Military Hospital, Prince Rashid Ben Al-Hasan Military Hospital, and Prince Hashem Ben Al-Hussein Military Hospital - over a four-year period from 2020 to 2023, in order to comprehend the trends in insulin dispensing at JRMS.

2. Objective: The primary goal of this study is to examine the dispensing patterns of Mixtard insulin vials and Penfill cartridges in the specified JRMS hospitals. The study seeks to evaluate yearly shifts in average monthly quantities supplied and determine if a notable preference shift towards cartridges occurs over time, and to what degree this trend varies among hospitals. This investigation will clarify the various elements influencing alterations in insulin dispensing practices, including patient preference for simplicity of administration, potential increases in patient adherence, and JRMS regulations related to insulin supply management. The findings are expected to aid JRMS in making more informed choices regarding future resource allocation, optimizing inventory, and improving patient care strategies in diabetes management.

3. Methodology: This study is going to use a retrospective quantitative analysis incorporating data from the JRMS main medical stores, spanning the years 2020 to 2023. The dataset will include the average monthly quantities of Mixtard 10 ml vials and 3 ml Penfill cartridges distributed to the three hospitals, calculated through dividing the year total dispensed quantity by 12 months. This method considers any possible shortages, facilitating an unbiased comparison across years and hospitals. The statistical analysis will concentrate on recognizing trends in dispensing patterns for each hospital and form of insulin, while evaluating changes in the average monthly distribution during the study period. A comparative analysis among the hospitals will offer additional context, enabling the study to differentiate between hospital-specific preferences and general trends within the JRMS system.

KEYWORDS: Mixtard insulin, vial, Penfill cartridge, JRMS, military hospitals, diabetes management, insulin dispensing trends, Jordan.

Corresponding Author: B. A. H. Eldweib
E-mail: bayanalthwaib@yahoo.com
Mobile No: 00962797088378

Indian Research Journal of Pharmacy and Science; 41(2024)3206-3211;
Journal Home Page: https://www.irjps.in

1. INTRODUCTION:

Diabetes mellitus is a widespread chronic disease globally, affecting millions and presenting considerable problems to healthcare systems, especially with long-term patient management [1]. In Jordan, similar to several regions globally, the incidence of diabetes is escalating, exerting strain on healthcare systems to deliver accessible and efficacious treatment alternatives [2]. Insulin therapy is the fundamental treatment for individuals with type 1 diabetes and for those with type 2 diabetes who struggle to achieve sufficient glycemic control by oral medicines. Insulin regulates blood glucose levels, which, if uncontrolled, can result in serious problems such as cardiovascular disease, neuropathy, nephropathy, and retinopathy [3].

Effective diabetes management relies not only on insulin availability but also on the administration process, which can greatly influence patient adherence and quality of life. Two primary strategies of insulin administration are prevalent: conventional vials, utilized with subcutaneous (SC) syringes, and contemporary Penfill cartridges, employed with pen injectors similar to the NovoPen [4,5]. The selection among various forms frequently relies on criteria such as patient preference, clinical setting, and accessibility to resources. Although vials and syringes have been utilized for decades, cartridges are gaining popularity owing to their convenience and portability. This tendency is especially significant in contexts where patients might require self-administration of insulin beyond hospital or clinic environments, facilitating enhanced flexibility and autonomy in controlling their condition [6,7].

The Royal Medical Services (JRMS) is integral to the Jordanian healthcare system, delivering medical services to members of the military and their families [8]. The main medical stores of JRMS supply a wide range of pharmaceuticals, including insulin, to numerous military hospitals nationwide. This distribution is essential for guaranteeing that patients in these facilities have reliable access to their necessary insulin supplies. In such circumstances comprehending the patterns of insulin distribution from JRMS main stores to hospitals is crucial for optimizing resource allocation, maintaining inventory properly, and assuring efficient fulfillment of patient needs.

This study investigates the dispensing patterns of Mixtard insulin in two forms (10 ml vials and 3 ml Penfill cartridges) at three military hospitals: King Al-Hussein Military Hospital, Prince Rashid Ben Al-Hasan Military Hospital, and Prince Hashem Ben Al-Hussein Military Hospital. Mixtard insulin, a pre-mixed formulation, integrates both short-acting and intermediate-acting insulins, offering a comprehensive solution for daily blood glucose regulation. In JRMS facilities, Mixtard is readily available both in vial form, necessitating SC syringes, and cartridge form, compatible with pen injectors, enabling healthcare practitioners and patients to select the most appropriate administration technique.

This study examines the period from 2020 to 2023, utilizing average monthly dispensing quantities for each year to investigate patterns and discern any changes in demand for the two types of insulin. Dividing the annual distribution data by 12 yields monthly averages that account for potential shortages or fluctuations in stock availability, so offering a more accurate representation of overall dispensing trends. The analysis seeks to address fundamental inquiries: Has there been a movement in preference for Penfill cartridges, potentially indicating a trend towards more user-friendly administration methods? Do substantial differences exist in dispensing patterns among the three institutions, potentially indicative of variations in patient demographics, healthcare provider preferences, or logistical considerations?

Comprehending these tendencies is essential for many different reasons. Firstly, it provides insights on how JRMS's resource allocation corresponds with patient and provider requirements, which is essential for optimizing inventory and preventing stock shortages. Furthermore, the findings might inform future strategies for insulin procurement and distribution, guaranteeing that supplies are accessible in the appropriate form to satisfy patient demand. Ultimately, this information enhances the field of diabetes care by emphasizing the changing preferences in insulin delivery techniques within a particular healthcare system. If cartridge usage is continually rising, JRMS may plan on modifying its procurement practices to align with this trend, thereby augmenting patient satisfaction and hopefully improving adherence rates.

In summary, this study provides a detailed examination of Mixtard insulin distribution in JRMS hospitals, offering valuable insights into insulin usage patterns and resource allocation. The findings are expected to support JRMS in making informed decisions about insulin supply and distribution, ultimately contributing to better diabetes management within Jordan's military healthcare facilities.

2. METHOD:

This study utilized data from JRMS's central medical stores, detailing average monthly distributions of Mixtard 10 ml vials and 3 ml cartridges to King Al-Hussein Military Hospital, Prince Rashid Ben Al-Hasan Military Hospital, and Prince Hashem Ben Al-Hussein Military Hospital. This data, covering the period from 2020 to 2023, provides a clear perspective on supply distribution patterns by dividing the total issued amounts of each year by 12 to alleviate the effects of stock shortages or distribution delays.

The study utilized a descriptive strategy, concentrating on annual and hospital-specific distribution trends for the two types of insulin. This methodology was selected to emphasize variations in monthly supply averages and to ascertain any seasonal, logistical, or administrative influences on insulin distribution. The selection of a longitudinal analysis facilitates the identification of long-term trends, highlighting changes in hospital demands and possible variations in form preference that may impact JRMS's procurement strategy.

The analysis involved comparing the average monthly quantities of each insulin form dispensed per hospital annually, identifying year-over-year trends, particularly in demand variations between vial and cartridge forms, and examining supply distribution discrepancies across the three hospitals to ascertain if particular facilities exhibit distinct dispensing patterns. This comparative methodology facilitates a comprehensive analysis of the data to identify both hospital-specific and system-wide trends in insulin distribution, guaranteeing that the results are substantial and implementable.

3. RESULTS:

The data indicates notable patterns in the distribution of Mixtard insulin during the four-year period, demonstrating a transition from increased vial usage to a higher issuance of cartridges. This trend indicates a preference for the convenience of Penfill cartridges, particularly in the more recent years of the study (2022 and 2023). The change seems to indicate modifications by JRMS in response to patient or physician preferences (Table 1).

Table 1: Patterns of the distribution of Mixtard insulin

	Average Monthly Quantity in 2020		Average Monthly Quantity in 2021		Average Monthly Quantity in 2022		Average Monthly Quantity in 2023	
	Mixtard 10ml Vial	Mixtard 3ml Cartridge	Mixtard 10ml Vial	Mixtard 3ml Cartridge	Mixtard 10ml Vial	Mixtard 3ml Cartridge	Mixtard 10ml Vial	Mixtard 3ml Cartridge
King Al-Hussein Military Hospital	5891	12410	1466	17785	1009	19210	861	20614
Prince Rashid Ben Al-Hasan Military Hospital	5105	4036	3218	10027	2923	11593	2285	9141
Prince Hashem Ben Al-Hussein Military Hospital	4821	4788	2092	8606	2517	10361	1930	11849

At King Al-Hussein Military Hospital, the available data from 2020 indicates a markedly elevated average monthly distribution of vials, totaling 5,891 units, in contrast to 12,410 units for cartridges. By 2021, vial consumption diminished to 1,466 units, whereas cartridge usage increased to 17,785 units, signifying a notable change in preference. The trend persisted in subsequent years, with vial quantities decreasing to 1,009 units in 2022 and 861 units in 2023, whilst cartridge distribution peaked at 20,614 units by 2023. The steady rise in cartridge demand at this facility indicates a transition towards more user-friendly administration alternatives.

Prince Rashid Ben Al-Hasan Military Hospital exhibited a comparable trend, although with minor numerical variances. In 2020, the hospital dispensed an average of 5,105 vials monthly, whilst cartridges totaled 4,036 units. In the subsequent years, cartridge utilization rose markedly, averaging 10,027 units in 2021, reaching a peak level of 11,593 in 2022, and thereafter declining to 9,141 in 2023. Concurrently, the utilization of vials experienced a consistent annual decrease, diminishing from 5,105 in 2020 to merely 2,285 in 2023. This pattern indicates that cartridges emerged as the favored method for insulin delivery at this hospital as well.

A comparable pattern manifested in Prince Hashem Ben Al-Hussein Military Hospital, although with distinct variations. In 2020, the hospital delivered an average of 4,821 vials monthly, which decreased to

2,092 in 2021. Conversely, cartridge issuance rose consistently from 4,788 units in 2020 to 11,849 units by 2023. This incremental increase in cartridge utilization highlights a transition towards cartridges, presumably indicating a preference for the convenience they provide in insulin delivery (Figure 1).

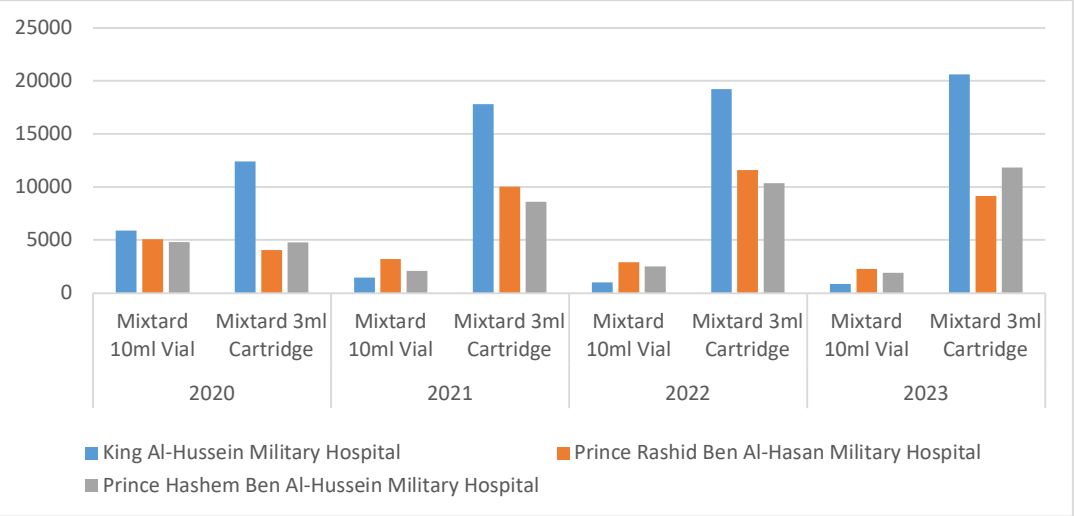

Figure 1: Patterns of frequencies of distribution of insulin during study period

A noticeable trend towards heightened cartridge utilization is observed across the three hospitals. King Al-Hussein Military Hospital exhibited the most significant rise in cartridge demand, while the other two hospitals demonstrated comparable trends, but at differing rates. The uniformity of these patterns across facilities indicates that this shift may represent a broader systemic preference rather than individual instances, perhaps influenced by JRMS regulations, patient feedback, or prevailing trends in diabetes treatment.

4. DISCUSSION:

Interpretation of Trends: The noted increase in cartridge utilization among all three hospitals underscores a rising preference for insulin delivery systems that emphasize user-friendliness and patient comfort. In contrast to vials, which necessitate thorough preparation and the utilization of subcutaneous syringes, cartridges are designed for compatibility with pen injectors, providing a more accessible option [9]. This transition is likely driven by the benefits of cartridges, which encompass enhanced dosing accuracy, less risk of dosing errors, and easier handling. These advantages are especially significant for patients with rigorous schedules or restricted motor skills, as pen injectors enable swifter and more efficient delivery than conventional syringe techniques [10].

Moreover, the preference for cartridges indicates that both patients and clinicians may regard them as preferable in improving the entire experience of insulin therapy. If this choice corresponds with enhanced patient adherence, JRMS's resource allocation systems may increasingly prioritize cartridges. The persistent decrease in vial distribution, coupled with increasing cartridge demand, may indicate a wider shift in clinical practice, potentially diminishing dependence on syringe-based insulin delivery. This reduction may allocate resources to specific areas where conventional vial-based systems remain essential or favored due to particular patient or treatment needs.

Implications for Resource Allocation: This study's data-driven results provide JRMS the potential to enhance its resource allocation and inventory management practices. In response to the increasing demand for cartridges, JRMS should prioritize their purchase and maintain sufficient inventory to satisfy the preferences of patients and clinicians. By adjusting to these shifting patterns, JRMS may attain enhanced inventory management, resulting in reduced occurrences of stock shortages and improved alignment between supply and demand. These modifications can reduce waste, decrease operational expenses, and guarantee prompt availability to insulin to those requiring it [11].

Moreover, reallocating resources to prioritize cartridge supply may improve patient satisfaction and facilitate continuity of care. This strategy realignment is especially crucial for hospitals facing increased cartridge demand, as it guarantees that these institutions are adequately prepared to fulfill patient needs. By addressing the preferences reflected in the data, JRMS optimizes resource use

and establishes the foundation for providing better patient-centered care.

Potential Impact on Patient Care: The growing preference for cartridges has substantial ramifications for patient care and diabetes treatment. Cartridges are linked to enhanced convenience, flexibility, and simplicity, which are essential elements in promoting patient adherence to recommended insulin regimens. Enhanced adherence is a crucial factor in achieving superior glycemic control, hence diminishing the likelihood of diabetes-related complications, including retinopathy, neuropathy, and cardiovascular diseases [11].

For patients who perceive syringe use to be intimidating or complicated, cartridges offer a more accessible and less anxiety-inducing alternative. This accessibility can enhance their confidence in independently managing their disease, cultivating a sense of empowerment and responsibility in their healthcare journey [4]. Improved adherence rates enhance the likelihood of favorable clinical outcomes, helping both individual patients and the wider healthcare system by alleviating the burden of managing advanced diabetic complications [10].

Furthermore, the transition to cartridges corresponds with global trends in diabetes management, where contemporary insulin delivery systems are progressively preferred [9,11]. By adopting these developments, JRMS establishes itself as a progressive institution that prioritizes the changing demands of its patient demographic.

Limitations: Although these findings provide significant insights, the study has its limits. A notable limitation is the dependence on authorized quantities as an alternative for actual consumption. This method fails to include unique patient demographics, adherence rates, or other clinical circumstances that may affect insulin selection. Moreover, fluctuations in supply resulting from unexpected shortages or logistical difficulties may influence the discerned trends, possibly obscuring or amplifying specific patterns.

Moreover, the study fails to investigate the underlying reasons for the preference of cartridges versus vials in depth, including clinical guidance, patient feedback, or external considerations such as cost or availability [4]. Subsequent research may rectify these shortcomings by integrating qualitative data or executing surveys of patients and clinicians to enhance the quantitative results.

Despite these constraints, the identified trends establish a robust basis for comprehending the changing dynamics of insulin dispensing within JRMS. These insights will provide a foundation for more informed decision-making and potential future research that explores patient-centered variables influencing these changes.

5. CONCLUSIONS:

This study analyzed the dispensing patterns of Mixtard insulin in two forms (10 ml vials and 3 ml Penfill cartridges) distributed from the Royal Medical Services (JRMS) central medical stores to three principal military hospitals in Jordan: King Al-Hussein Military Hospital, Prince Rashid Ben Al-Hasan Military Hospital, and Prince Hashem Ben Al-Hussein Military Hospital, during the period from 2020 to 2023. This research attempted to uncover changes in insulin distribution by evaluating the average monthly quantities provided to each hospital, specifically focusing on shifts in demand between vial and cartridge forms. The findings indicate a distinct and uniform preference transition towards Penfill cartridges in all three institutions, implying an increasing tendency for more convenient and user-friendly insulin delivery systems. he rise in cartridge distribution underscores a significant trend within the JRMS healthcare system, indicating a probable increased focus on patient convenience, user-friendliness, and possibly improved adherence to insulin therapy. Cartridges intended for NovoPen injectors have several advantages over conventional vials, which include enhanced dosing precision, increased portability, and less likelihood of dosing inaccuracies. These benefits render cartridges particularly advantageous for patients necessitating frequent or adaptable dosing, as well as for individuals who may encounter challenges with conventional syringes. The transition from vials to cartridges noted in this study corresponds with global trends in diabetes management, where pen injectors are progressively preferred by patients and healthcare professionals.

This tendency has considerable ramifications for JRMS's future resource allocation and procurement goals. With the increase in cartridge utilization, JRMS may need to modify its inventory and procurement strategies to guarantee an adequate supply of cartridges at its facilities, especially considering the possibility of supply chain disruptions that could impact patient care. Furthermore, by comprehensively analyzing the demand for various insulin formulations, JRMS can mitigate the likelihood of stock shortages or surplus inventory, hence improving its operating efficiency. Efficient resource management is essential in healthcare systems where resources are limited, as

optimizing inventory can lead to cost reductions and enhanced patient outcomes. The findings suggest possible advantages for diabetes management in JRMS hospitals. By prioritizing the availability of Penfill cartridges, JRMS could enhance patient adherence to prescribed insulin regimens, as cartridges are typically more user-friendly and may alleviate the psychological strain associated with insulin delivery. Improved adherence may result in better glucose control, fewer complications, and less healthcare expenses linked to diabetes-related hospitalizations and interventions. Consequently, this transition to cartridge utilization is perceived as a favorable advancement both logistically and from a clinical and patient-centered viewpoint. This study's findings highlight a notable and persistent transition towards Penfill cartridges at JRMS hospitals, indicating both patient and provider tendencies for more convenient insulin administration techniques. This change underscores the necessity of synchronizing JRMS's procurement strategies with the changing requirements of patients, guaranteeing the availability of appropriate resources to facilitate optimal diabetes management. By adopting this transition, JRMS can improve its service provision and facilitate superior health outcomes for patients managing diabetes in Jordan's military healthcare system. Looking forward, JRMS may leverage findings from this study to enhance its inventory management approaches, emphasize patient-centered care, and continually adjust to the evolving demands of diabetes treatment.

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CONFLICT OF INTEREST REPORTED: NIL; SOURCE OF FUNDING: NONE REPORTED