CLINICAL DEMAND AND RESOURCE MANAGEMENT: A FOUR-YEAR ANALYSIS OF HUMAN ALBUMIN USAGE AND COST-EFFECTIVENESS IN JORDANIAN ROYAL MEDICAL SERVICES HOSPITALS.

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Submitted on: 01.06.2025; **Revised on:** 04.06.2025; **Accepted on:** 06.06.2025

Abstract:
Resource Management is used in clinical practice for the management of conditions including hypoalbuminemia, liver cirrhosis, sepsis, and critical illnesses that necessitate fluid resuscitation rendering it indispensable in intensive care and specialized medical departments. It is imperative to ensure the efficient distribution and utilization of human albumin within JRMS hospitals in order to maintain high standards of patient care while optimizing financial and logistical resources.

2. Objective: The main objective of this study is to examine the dispensing habits of Human Albumin in five prominent JRMS hospitals: King Hussein Medical Hospital, Queen Alia Heart Institute, Prince Rashid Ben Al-Hasan Military Hospital, Prince Hashem Ben Al-Hussein Military Hospital, and Queen Alia Military Hospital. The study will focus on identifying variations in albumin utilization associated with hospital specialization, prescribing practices, treatment protocols, and patient demographics

3. Methodology: This study will use a descriptive and analytical approach to investigate the dispensing patterns of Human Albumin within the five selected JRMS hospitals over the period from 2020 to 2023. Data will be systematically gathered from the records of JRMS medical warehouses, detailing the average monthly quantities of albumin distributed to each hospital.

4. Results: From 2020–2023, JRMS hospitals showed rising human albumin 20% use, from 1,894 to 3,371 units. King Hussein Medical Center led in distribution due to critical care demands. Alia Heart Institute and northern hospitals also increased usage, likely from surgical and ICU needs. Policy and patient load influenced distribution trends. Human Albumin 20% use increased at JRMS hospitals, notably at King Hussein, Queen Alia Heart, and Prince Rashid hospitals, likely due to more patients, surgeries, and dosing preferences. In contrast, usage varied at Prince Hashem and Queen Alia hospitals, reflecting differences in policies, case mix, or treatment alternatives. These findings show increased albumin use linked to higher patient loads and critical care needs, with hospital variations reflecting institutional factors.

5 Conclusions: Rising albumin use across JRMS hospitals reflects growing clinical demand and institutional practices. Understanding these trends is essential for optimizing resource allocation and improving patient care strategies

Keywords: Human Albumin 20%, Jordanian Royal Medical Services, JRMS, albumin utilization, hospital dispensing trends,

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Indian Research Journal of Pharmacy and Science; 43(2025); 3252-3259
Journal Home Page: https://www.irjps.in

1. INTRODUCTION:

Human albumin is an essential plasma protein used in a wide range of clinical applications. It is essential to maintain oncotic pressure for the transport of various endogenous, and exogenous molecules and functions as a circulation stabilizer. It is especially important in hypoalbuminemia, liver cirrhosis, nephrotic syndrome, burns, sepsis, and acute critical illness requiring fluid resuscitation [1,2]. Human albumin is regularly used in hospitals as a mainstay treatment in intensive care units and special units to treat patients with impaired fluid balance and severe physiological stress.

The Jordanian Royal Medical Services (JRMS) is one of the largest providers of medical care in Jordan that extends services to military personnel, their families and selected civilian population. JRMS owns several hospitals and medical centers across Jordan and functions as an integral part of the Jordanian healthcare system [3], human albumin is one of the essential medications and biological agents available in JRMS. Management and distribution of this vital resource require careful planning as the decrease or the increase in its supply can affect care given to patients. To maintain high medical treatment standards while utilizing less financial and logistic resources, it is imperative to ensure rational and equitable distribution of albumin.

This research uses the data of Human Albumin 20% dispensed from JRMS medical warehouses to five major hospitals in the years 2020 to 2023. These hospitals are King Hussein Medical Hospital, the largest tertiary hospital at the JRMS that cater to a large number of different specialized cases and critical care ones. The Queen Alia Heart Institute, which mainly provides cardiovascular medicine and surgery which usually use albumin for managing fluid imbalances post-operatively or in critically ill cardiac patients. Prince Rashid Ben Al-Hasan Military Hospital serves Jordan's northern region. It manages various medical and surgical cases. Therefore, it requires albumin for several internal medicine and emergency needs. Prince Hashem Ben Al-Hussein Military Hospital routinely uses albumin in varied specialties as a general hospital with multidisciplinary services and Queen Alia Military Hospital plays a crucial role in the provision of health services, where albumin use is determined by the medical conditions seen within the facility [3].

The goal of this research is to evaluate the distribution of albumin at these hospitals and to study the causes of its usage using the average quantities dispensed per month over the four years. This research is also aiming to identify trends that could be related to the specialization of hospitals, prescription preferences of doctors, treatment protocols or consumer profiles. By evaluating the distribution of albumin, the study seeks to understand how doctors in different hospitals prefer to use albumin and the differences in its usage. In addition, temporal variations in albumin utilization may indicate changes in JRMS's healthcare policies, procurement practices, or related medical practices involving albumin therapy.

Albumin itself isn't cheap and the uncontrolled distribution of albumin will also mean hospitals will incur extra costs. The overuse of albumin in cases when other volume expanders can be used can lead to wastage of resources. While underuse of albumin in cases when aggressive fluid resuscitation or oncotic effect is needed can lead to adverse outcomes. Maintaining an equilibrium necessitates ongoing evaluation of consumption habits as well as adherence to evidence-based guidelines pertaining to the designated appropriate use of albumin [4]. This study will inform policymakers, hospital administrators and clinical practitioners about the distribution of albumin at a hospital level. The results may assist in enhancing purchasing methods, streamlining treatment practices, and guaranteeing that albumin is assigned as dictated by medical need instead of supply limitations. Also, this analysis may contribute to the discussions related to the other pharmaceutical within JRMS regarding data-driven decision-making [5]. After this background section, in the following sections the study will present the methodology used to assess albumin dispensing trend followed by the subsequent results of the data analysis. The discussion section will consider possible reasons for patterns seen in terms of hospital and system specific factors. Finally, the study will wrap up with the recommendations and suggestions on how to enhance the efficiency and effectiveness of albumin use in JRMS hospitals.

2. METHOD:

This study applies a descriptive and explanatory approach to assess the dispensing behaviors of Human Albumin 20% in five primary hospitals at the Jordanian Royal Medical Services (JRMS) within the period of 2020-2023. With the main objective of assessing tendencies in albumin dispensing and find possible reasons behind differences in its use across those different hospitals. The analysis utilizes data from JRMS' medical stores on averaged monthly amount dispensed to each hospital of human albumin 20% during the reference period.

The study takes into consideration five hospitals, namely, King Hussein Medical Hospital, Queen

Alia Heart Institute, Prince Rashid Ben Al-Hasan Military Hospital, Prince Hashem Ben Al-Hussein Military Hospital, and Queen Alia Military Hospital. Each hospital has its own defining characteristics regarding their specialization, the type of patients being dealt with, and the treatment regimen which may perhaps affect their demand for albumin. The Human Albumin 20% dispensing data from JRMS warehouses to the five hospitals was used for this study. The data for this study spans 2020–2023 and reflect the monthly average quantities issued to each hospital in each year. This approach ensures that any deficiencies or discrepancies in the stock levels are included in the analysis.

The method involves comparing the four-year trend of albumin distribution and seeks to establish whether certain hospitals show higher or lower demand to imply differences in the prescription pattern, hospital protocol, or case mix of patients. The data is further investigated to examine whether shifts in dispensing patterns align with known clinical practices or are influenced by larger systemic changes, including procurement policies, hospital growth, or new clinical guidelines pertaining to albumin use. In order to better understand the findings in terms of the hospitals' medical background and to provide a deeper level of analysis, the study also takes into account the hospitals' medical regulations and drivers of albumin use. Hospitals that have specialized critical care units or cardiology units or nephrology units may have higher consumption of albumin due to their patient population. General hospitals that deal with more varied patients may have more variation in their use.

Although this study may show useful insights on the distribution of Human Albumin 20%, there are some constraints in our method that shall not be overlooked. This data only shows what amounts were taken from the central medical store to the five hospitals and it does not reflect what was actually given to patients or what clinical decisions were made. Moreover, inclusion of factors like hospital admission rates, disease severity, treatment protocols and other variables within the dataset which could have additional influence is not present. Therefor a systematic understanding of dispensing Patterns which forms an important basis for understanding albumin use across JRMS hospitals may be augmented by future studies including clinical variables. In general, this paper attempts to help in informing decision makers about the procurement activity as well as the dispensing of albumin in the JRMS healthcare system.

3. RESULTS:

3.1 Total Distribution Trends: The review of dispensing patterns of Human Albumin 20% at the five major Jordanian Royal Medical Services (JRMS) hospitals from 2020 to 2023 shows noteworthy trends in distribution that vary between individual hospitals (figure 1). The figures show that the total quantity of albumin issued has increased over the four-year period, indicating either a rising demand for albumin therapy or a shift in prescribing activities driven by evolving protocols. From 2020 to 2023, the total quantity of Human Albumin 20% dispensed across all hospitals steadily increased; 1,894 units, 2,573 units (+35.9% from 2020), 2,739 units (+6.5% from 2021) and 3,371 units (+23.1% from 2022). The growing demand for albumin in JRMS hospitals is well evident from the overall results, with the highest increase seen between 2020-2021.

King Hussein Medical Hospital had the highest albumin consumption among all hospitals included in this study, as it received the highest share of the Human Albumin 20% annually. In the year 2020, the hospital was supplied an average of 890 vials per month which steadily increased till it reached 1416 vials in the year 2023. This suggests a growing reliance on albumin therapy in this hospital, perhaps reflecting an increase in the number of critically ill patients who may need oncotic support, fluid resuscitation or therapy for hypoalbuminemia [1]. King Hussein Medical Hospital, the JRMS's largest and most specialized tertiary care center, undertakes complicated medical cases from all over Jordan, including those from intensive care units and the nephrology and liver disease departments which frequently use and administer albumin.

Queen Alia Heart Institute has kept up with the similar trend regarding the increased distribution of albumin. The dispensed amount was 414 vials per month in 2020, which rose progressively to 764 vials in 2023. Increased dependence on albumin in cardiovascular medicine is likely in an effort to treat cardiothoracic surgeries, critical cardiac cases and post-operative patients. Changes in distribution show the use of albumin at this hospital may be closely associated with procedure volumes and changing clinical protocols for the management of cardiac patients [2,6]. The significant rise in 2023 indicates a greater demand for albumin, possibly related to increased surgical procedures.

At Prince Rashid Ben Al-Hasan Military Hospital, the findings suggests that the use of albumin at this hospital may be marked by a rising demand. The

amounts which are used have increased from 369 vials per month in 2020 to 719 vials in 2023. As this hospital serves the northern region of Jordan, it is providing wide-ranging medical and surgical services. Thus, it is possible that use of albumin is spread over different specialist fields. The steady rise over the years could suggest that albumin's use is becoming more common across a range of specialties, including internal medicine, surgeries, and ICU.

The Prince Hashem Ben Al-Hussein Military Hospital's distribution of albumin, unlike other hospitals, experienced a more erratic trend. The hospital started with 104 vials per month in 2020 but increased to 230 vials per month in 2021. Followed by 222 vials in 2022 and thereafter dropped to 188 vials in 2023. This fluctuation may suggest that albumin dispensing is affected by various aspect such as patient admission rates, prescribing patterns, and intermittent supply shortages. The drop in 2023 could suggest that there are more conservative methods now to use albumin or there are concurrent alternative treatment options that lessen the reliance on Albumin.

A different trend was noted at Queen Alia Military Hospital, where though the distribution of albumin generally increased over the four years, there was some variability. Initially, 117 vials were received in 2020; this quantity increased steadily for this hospital to 234 in 2022 and then to 284 in 2023. The increase in dispensing of albumin may indicate a surge in its usage for patient management. However, in comparison to other hospitals, the overall quantities dispensed may be on the lower side due to the nature of medical management in this hospital. An increase was noticed in 2023 which may suggest some re-initiation or expansion of its use of albumin which could be the result of policy change or upsurge of cases requiring albumin.

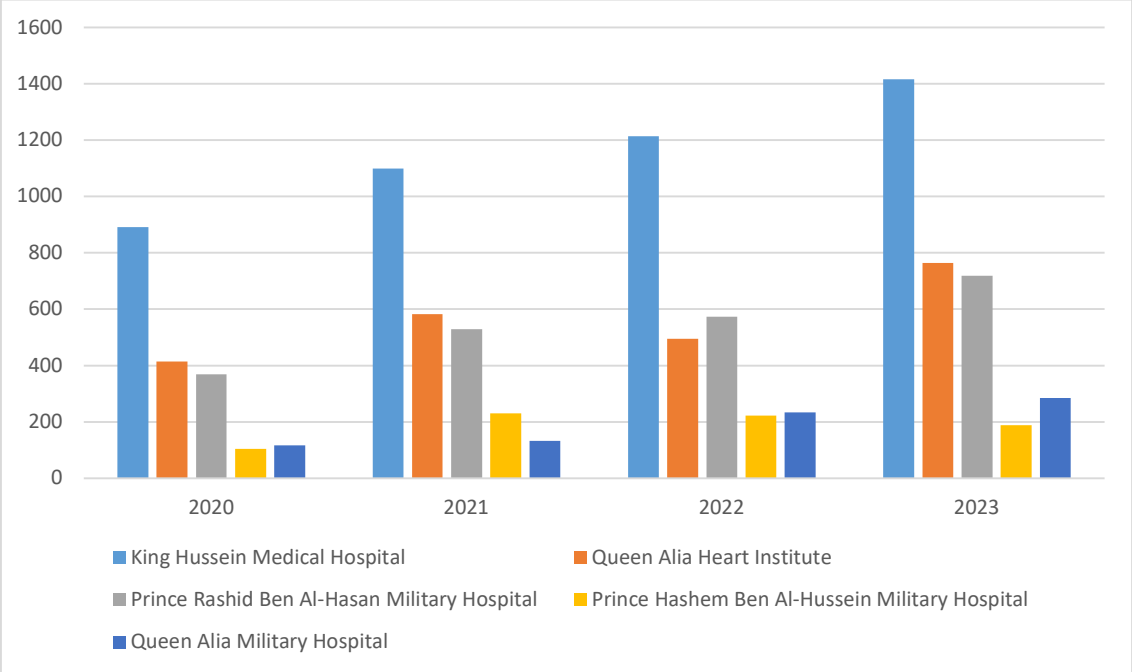

Figure 1: Total Distribution Trends among study hospitals

There seems to be an empirical Parallel increase in Human Albumin 20% use at the JRMS hospitals. These include King Hussein Medical Hospital, Queen Alia Heart Institute, and Prince Rashid Ben Al-Hasan Military Hospital. The rise of albumin distributions at these institutions points towards their increased number of patients and participation in critical surgical interventions as well as their plausible change in clinical preference for higher albumin dosing. At the same time, the more modest or varying trends observed at Prince Hashem Ben Al-Hussein Military Hospital and Queen Alia Military Hospital suggest a contrasting pattern of use, possibly attributed to differences in case mix, hospital policies, or access to alternative treatment options [1,6].

The Following table shows the percentage changes in albumin dispensing across the five hospitals, with notable increases in some years and some decreases in others. The information below shows that there's an overall increasing trend among usage with some spikes in usage among few of the hospitals. Most notable is Prince Hashem Ben Al-Hussein Military

Hospital in 2021 and Queen Alia Heart Institute In 2023 (tale 1).

Table 1: The percentage changes in albumin dispensing across the five hospitals

Year / Hospital	2020	2021	% Change (2020-2021)	2022	% Change (2021-2022)	2023	% Change (2022-2023)
King Hussein Medical Hospital	890	1099	+23.5%	1214	+10.5%	1416	+16.6%
Queen Alia Heart Institute	414	582	+40.6%	495	-14.9%	764	+54.4%
Prince Rashid Ben Al-Hasan Military Hospital	369	529	+43.4%	574	+8.5%	719	+25.2%
Prince Hashem Ben Al-Hussein Military Hospital	104	230	+121.2%	222	-3.5%	188	-15.3%
Queen Alia Military Hospital	117	133	+13.7%	234	+75.9%	284	+21.4%

These findings demonstrate the substantial increase in albumin distribution at these hospitals possibly due to their higher patient loads, greater involvement in critical illness. The variations among hospitals highlight the importance of institutional and clinical factors in albumin utilization patterns. The following section will discuss these findings in detail to try to identify the potential reasons behind these distribution discrepancies and the consequences of those discrepancies in the management of albumin in JRM hospitals.

4. DISCUSSION: Trends in Human Albumin 20% Utilization Across JRMS Hospitals: Over the study period of four years from 2020 to 2023, the patterns of distribution of Human Albumin 20% at the five JRMS hospitals showed dynamic changes in medical demand, hospital capabilities on one hand, and possibly evolving clinical preferences on the other. There is a steady overall increase in the dispensing of albumin. Dispensing shows a steady increase. In particular at King Hussein Medical Hospital, Queen Alia Heart Institute and Prince Rashid Ben Al-Hasan Military Hospital which exhibited a steady increase. According to the findings, these hospitals were witnessing annual growth in the use of albumin infusion. This trend does unveil an increasing reliance on infusions of the albumin solution and this growth may be due to an increase in admissions, the expansion or opening of new intensive care units or the growing awareness of albumin's usefulness in critical care.

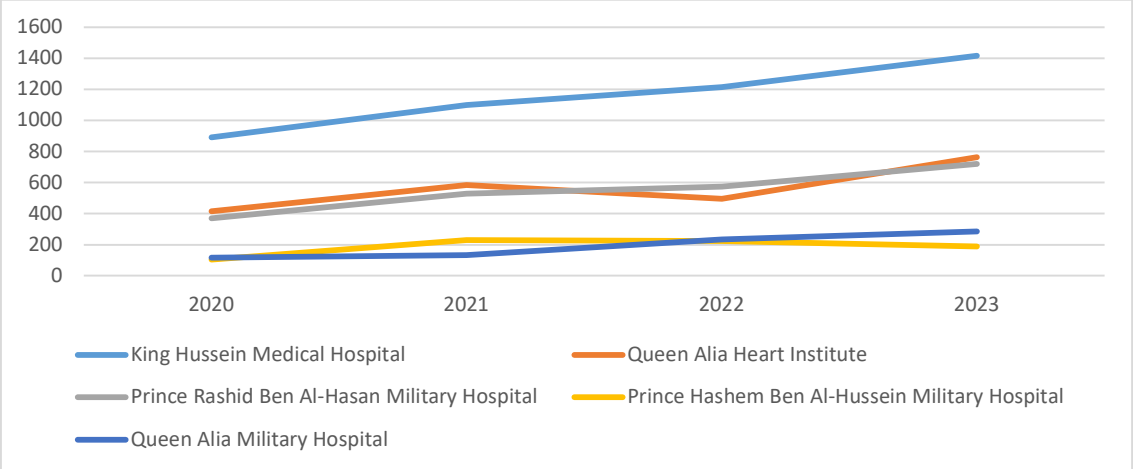

Figure 2: Trends in Human Albumin 20% Utilization Across JRMS Hospitals

King Hussein Medical Hospital (KH) surpassed the JRMS hospitals in albumin utilization. The monthly share of KH in albumin has increased from 890 vials in 2020 to 1416 vials in 2023. This trend reflects the tertiary care role of KH where albumin is frequently used in critical conditions such as sepsis, hypoalbuminemia, and liver disease [2]. The growing use of albumin may signify the greater embrace of evidence-based guidelines which recommend its use in certain medical conditions.

Queen Alia Heart Institute witnessed fluctuations in albumin usage as it drastically rose in 2021, reduces in 2022 and then again reaches the peak in 2023. The notable increase in 2023 with 764 vials per month suggests an increasing dependence on albumin therapy in the cardiac field. This could be due to an increase in the number of cardiac surgeries, more critical cardiac cases, or a change in postoperative management since Queen Alia Heart Institute used moderate amount of albumin in previous years. Its usage increased to its peak value in 2021. A major jump was seen thereafter in 2023.

Prince Rashid Ben Al-Hasan Military Hospital had an overall increase in the distribution of albumin, which increased from 369 vials per months in 2020 to 719 vials per month in 2023. Due to being one of the major referral hospitals in northern Jordan indicating a higher burden of critical cases requiring albumin therapy including trauma cases, surgical cases along with internal medicine cases of nephrotic syndrome and cirrhosis.

Prince Hashem Military Hospital had ups and downs in dispensing albumin. There was a sharp increase in the period of 2021-2022 but after that it started to see a depression in the following years. The pattern indicates variation in the number of inpatients, or change in practice, or a supply chain issue. The drop in 2023 could show tighter medication prescription or increased usage of other alternative options for treatment [6].

Queen Alia Military Hospital admission rates have consistently increased, especially since 2021. In 2023, albumin distribution increased to 284 vials from 117 vials in 2020. This could signify an enhancement in the hospital services or rising acknowledgment of albumin in patient management. However, this hospital's overall utilization of albumin is lower than other hospitals which indicates that the use of albumin here may be more selective which could be due to more different case mixes or medical staff preferences [7].

Factors Influencing Albumin Utilization: A number of reasons may have contributed to the differences in albumin dispensing at JRMS hospitals. The clinical demand is the main factor, as larger ICUs, surgical and internal medicine wards require more albumin by hospitals, modifications to treatment protocols may impact individual hospitals prescribing of albumin, whether due to international protocols or local protocols and issues related to the supply chain including shortages or variation in purchase price. Some hospital's patterns of albumin use showed a significant upswing which may hint that its applications in clinical care are broadening, since albumin has a long history for being used in hypoalbuminemia, liver cirrhosis and in critical care [6,8]. These observed trends may suggest a growing confidence in the indications of albumin in those cases among JRMS physicians. Economic factors also play a role in albumin utilization. As a treatment, it entails relatively high costs, which must be justified clinically. Hospitals under financial pressure may restrict albumin use to situations with proven benefits through stricter administration guidelines. On the other hand, institutions with more freedom in resources may also be more willing to increase the use of albumin [9].

Future Forecast of Albumin Demand: Based on the trends noted above, demand for albumin in JRMS hospitals is likely to escalate in the future especially within tertiary and referral hospitals. In view of their growing patient numbers, more complicated cases and the recent increase in surgeries and critical care, the use of albumin at King Hussein Medical Hospital and Queen Alia Heart Institute is expected to continue on the upswing. In the future, Queen Alia Heart Institute may require higher quantities of albumin due to increasing demand for cardiovascular care. Prince Rashid Ben Al-Hasan Military Hospital is anticipated to observe a consistent increase as it manages trauma cases and critically ill patients in the region's northern area. If albumin consumption trends remain the same, the Hospital may soon consume similar levels of the resource as King Hussein Medical Hospital. In the cases of Prince Hashem Ben Al-Hussein Military Hospital and Queen Alia Military Hospital its less clear on their future trends given the fluctuations in demand observed in recent years. If they undergo economic constrains or any change in prescribing policies, most probably they will get stabilize or have minor increases in usage. However, if any future expansion in critical care or surgical services may result in further growth in demand. Future use of albumin may also be affected by foreign guidelines, alternative therapies, supply chain improvements, and other external factors. If upcoming studies support the broader use of albumin therapy, hospitals may leverage them even more. On the other hand, if the prescribed criteria will get stricter over cost and effectiveness, then the growth may slow down.

Impact on Hospital Management and Resource Allocation: Hospital management within JRMS faces both opportunities and challenges with the increased demand for Human Albumin 20% and in order to avoid the impact of this increase on the JRMS supply network it is necessary to have a well-designed procurement plan that ensures steady supply of albumin. Hospitals that frequently use albumin should optimize the ordering process to avoid stock-outs that may affect patient care [6]. Cost-effectiveness also remains an important consideration. Though albumin is an important component in the management of patients [8,9], it is costly, which necessitates an evaluation of how often it is prescribed and the establishment of guidelines for the use of albumin within JRMS hospitals to ensure it is given to patients who will benefit the most and not exceed usage limit. JRMS hospitals can promote appropriate albumin use in various clinical settings by keeping the physicians and pharmacists informed of evidence-based guidelines, education programs for healthcare professionals may also help in better utilization of albumin. Future research should focus on determining optimum doses and assessing the costs–benefits of albumin therapy in JRMS hospitals.

5. CONCLUSION:

The dispensing of Human Albumin (20%) in the hospitals of the Jordanian Royal Medical Services during the years 2020-2023 shows significant trends in dispensing reflecting the clinical demand. Most of the hospitals have seen an overall increase in the total use of albumin indicating it is essential role in critical care, surgical recovery, and internal medicine. King Hussein Medical Hospital, which is the main referral center for complicated and critical cases, displayed the most steady and high increase among the five hospitals studied. The Queen Alia Heart Institute experienced notable rises and falls likely due to variations in cardiac surgical operations and ICU admissions. Prince Rashid Ben Al-Hasan Military Hospital has been reporting a steady growth in demand, indicating workload necessitating greater use of albumin. The results also show differences in prescribing practices, with some hospitals being more selective in their use of albumin. The variations seen at Prince Hashem Ben Al-Hussein Military Hospital and Queen Alia Military Hospital indicate that extraneous events such as, limitations due to supply limitations, hospital policy changes, or other factors that might have affected the dispensing patterns. The differences in albumin use indicate that prescribing standardization may be required across JRMS hospitals. In the future, more and more hospitals with growing critical care and surgical services will need Human Albumin 20% for patients therefor necessitate the need of careful planning in albumin purchasing and distribution process to minimize shortages at a reasonable cost. It is likely instrumental to introduce stringent guidelines for albumin use; educating physicians on evidence-based uses; and considering alternative therapies wherever appropriate. As JRMS hospitals continue to develop, further studies on cost-benefit of albumin therapy and a refinement of their use are well needed and an adequately inclusive strategy that balances clinical demands with financial viability will ensure albumin remains beneficial and available to patients who require it.

Limitations of the Study: This study has certain limitations, mainly its dependance exclusively on the dispense data which may not accurately reflect real consumption. Also, the lack of clinical data prevents direct association with patient outcomes. Moreover, stock shortages may have occurred in specific periods which might have influenced the distribution amount recorded.

Conflict of Interest: The authors have no conflict of interest to report in conducting this study.

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