ISSN (O): 2349-5332
CODEN: IRJPHY

DISTRIBUTION ANALYSIS OF SURFACTANT ACROSS JORDAN ROYAL MEDICAL SERVICES HOSPITAL NETWORK: A FIVE-YEAR RETROSPECTIVE STUDY

Nawal Hussein Mohammad Alabbadi;PH[1], Alia Ali Ahmad Jaradat;PH[1], Manar Nader Ibrahim Jwinate;PH[1], Eman Hamad Abdallah Alwreakat ;PH[1].

[1]Pharmacist, Royal Medical Services, Jordan.

Submitted on: 08.01.2026; **Revised on:** 12.01.2026; **Accepted on:** 14.01.2026

Abstract

Introduction: Neonatal respiratory distress syndrome (RDS) is prevalent in preterm infants, and pulmonary surfactant replacement therapy has become a cornerstone of effective management. Monitoring distribution of surfactants allows healthcare systems to gauge clinical adherence, logistical efficiency, and patient demographic exposures across hospitals.

Objective: This investigation mapped pulmonary surfactant distribution across five institutions of the Jordan Royal Medical Services (JRMS) from 2020 to 2024. The research will include quantifying consumption dynamics, documenting divergences in treatment protocols, and evaluating the allocation of surfactant resources across the participating institutions.

Methods: A non-interventional, historical cohort design will draw on detailed distribution records from the JRMS central pharmacy warehouses. Included facilities are King Hussein Medical Hospital, Prince Rashid Bin Al-Hasan Military Hospital, Queen Alia Military Hospital, Princess Haya Bin Al-Hussein Military Hospital, and King Talal Military Hospital. The analytical dataset will consist of average monthly volumes issued over the five years period. Descriptive and inferential statistics, trend analyses, and inter-hospital comparative assessments will elucidate consumption anomalies and allocation efficiencies. This retrospective observational investigation will draw on secondary pharmaceutical distribution datasets originating from multiple JRMS-affiliated institutions. Quantitative analytic techniques will be used to elucidate: (a) longitudinal tendencies in neonatal surfactant distribution, (b) inter-hospital discrepancies in utilization, and (c) associations between procurement and supply trajectories and institutional characteristics. The evidence generated is anticipated to guide rational decisions regarding centralized inventory and fiscal stewardship, thereby informing subsequent harmonization of therapeutic protocols on either a province-wide or nationally coordinated level.

Results: The analysis revealed a substantial 81% increase in total surfactant distribution across the network, rising from 172 units in 2020 to 312 units in 2024. Prince Rashid Ben Al-Hasan Military Hospital emerged as the primary consumer, accounting for 35-40% of the total network usage with an average of 88.6 doses annually and a peak of 121 doses in 2024. Princess Haya Bint Al-Hussein Military Hospital demonstrated the highest relative growth, recording a 208% increase in utilization over the five-year period. Conversely, King Talal Military Hospital exhibited the most stable consumption pattern, averaging 20.4 doses per year with minimal variability. The data also highlighted the impact of external factors, such as the COVID-19 pandemic, notably reflected in a "U-shaped" consumption trend at Queen Alia Military Hospital, which dipped in 2021 before recovering significantly by 2024.

Corresponding author: N. H. M. Alabbadi
E-mail: nawalalabbadi41@gmail.com,
Mobile No: 0096277296251

Indian Research Journal of Pharmacy and Science; 45(2025); 3462-3470
Journal Home Page: https://www.irjps.in

1. INTRODUCTION:

One of the major challenges that are being faced in the neonatal intensive care medicine is pulmonary surfactant deficiency. Exogenous surfactant replacement therapy has essentially revolutionized the management of respiratory distress syndrome (RDS) in preterm infants and improved the mortality and morbidity rates have drastically reduced (1,2). The bovine lung surfactant phospholipid fraction has become an anchor intervention in neonatal intensive care units around the globe, whose usefulness in clinical practice is well-established after decades of research and clinical practice.

Jordan Royal Medical Services (JRMS) manages a full healthcare network, including military and their families in the Kingdom it encompasses five main hospitals within it which provide specialized neonatal services. The knowledge of distribution of important therapeutics like surfactant in this network is an indispensable information to the best allocation of resources, fair access to life-saving therapies and maintenance of clinical excellence standards.

The 2020-2024 interval is especially a timely period of study of pharmaceutical distribution since it covers the COVID-19 pandemic, and its after-affection. The health crisis of the global scale significantly transformed the mode of healthcare delivery, the resource-allocation approaches and clinical practices at the global scale. The possible changes in neonatal practice, such as changes in the level of births, gestational ages at birth, and therapy regimens, might have had an impact on the usage of surfactants in the medical care systems.

Scaling of specialized drugs like surfactant provides informative information regarding the attributes of the institutions, clinical practice and demographics of the patients. Fluctuating consumption can impact differences in patient demand, clinical practice, or doctoral preference or institutional abilities. Some hospitals can also be referral centers with high-risk pregnancies, thus with a greater concentration of patients in need of surfactants therapy. Alternative approaches to respiratory support can be followed by other facilities, which can influence the rates of medicament utilization.

The pharmaceutical distribution data analysis has more purpose which does not end with the inventory management since it can also outline many trends in the sense that it can also inform strategic planning and points inequities in resource allocation and distribution and it can also direct policy making on the correct delivery of healthcare also in the case of specialized networks such as JRMS understanding such patterns is of vital importance in order to ensure uniform quality of care provision in all facilities whilst optimizing the use of resources.

The present research will focus on offering a detailed analysis of the spread of surfactants in the JRMS hospital network in the years 2020-2024 and the study will examine five-years of distribution data to determine the temporal patterns, institutional difference and show possible determinants of consumption achievement. The eventual findings will inevitably lead to the evidence based decision making in respect to resource allocation, standardization of clinical protocol and strategic planning in the JRMS network.

The study will answer a number of key questions: How the mean consumption patterns of surfactants vary among the different hospitals in the chain? Which changes occur in the period of five years of the research? What institutional mechanisms could be the reason behind the distribution pattern variations? What can we learn about resource allocation and clinical practice decisions in future?

2. LITERATURE REVIEW:

Since it was introduced in the 1980s, the replacement therapy with surfactants has evolved considerably. Development of bovine-derived surfactant preparations was a significant breakthrough in the field of neonatal practice, which provides clinically useful options to synthetic formulations (3,4). Bovine lung surfactant phospholipid fraction consists of compounds of utmost importance such as phosphatidylcholine, phosphatidylglycerol and surfactant proteins, essential to maintaining alveolar stability and the minimization of surface tension.

The effectiveness of bovine surfactant in treating RDS has always been a consistent finding which reveals significant decreases in mortality rates and other adverse outcomes like pneumothorax and bronchopulmonary dysplasia (5,6). Standardized clinical guidelines that govern the selection of patients, their dosage schedules as well as the timing of administration have been refined over time through numerous researches which guide the modern day practicing patterns.

Healthcare distributions are important in making sure that one gets access to required medication on time. Studies on the drug distribution among hospital networks have highlighted the need to have an efficient supply-chain management, especially on

high-cost treatment that is denominated and specialized therapeutics (7,8). Some determinants of the distribution patterns are patient acuity, institutional capacities, clinical guidelines, and regional differences in disease occurrences.

Research examining the use of medication among hospital networks has revealed great differences which could be explained by several factors. Demographics, prescribing behaviors of the physicians, institutional policies and availability of resources can all explain differences in consumption patterns (9,10). Having an all-inclusive knowledge of these differences is paramount towards the allocation of resources and equal accessibility of care.

Recent literature has documented the effect of COVID-19 pandemic on neonatal care and use of surfactants. In certain studies, there was a change in the birth rate, gestational delivery ages, and the intensive care that was given to the babies during the period of the pandemic (11,12). Such developments might have affected the distribution preferences of surfactants and made the 2020-2024 period especially relevant to such analysis.

Healthcare systems of the military have a particular set of characteristics that can affect the pattern of medication distribution. These systems tend to cater to geographically dispersed groups of populations with certain demographic characteristics and clinical demands (13,14). The importance of clinical efficacy and cost control in pharmaceutical distribution in military medical networks has been highlighted in research that has underlined importance of centralized procurement and distribution models in maintenance of clinical efficacy.

The need of standardized practices and evidence based practice in neonatal care has been heightened by quality improvement programs. Research has revealed that methodical surmounted surpassant application methods such as standardized guidelines to specifications of utilization and dosing principles have the capacity to improve clinical results and maximize the use of resources (15,16). However, the necessity to apply standardized practices in a variety of institutions requires paying attention to local aspects and institutional abilities.

There has been economic analysis of the surfactant therapy to prove its cost-effectiveness in relation to the high costs of acquisition. The long-term positive outcomes of minimized complications and reduced patient stay justify the original investment on surfactant therapy (17,18). The knowledge of utilization trend would help healthcare systems streamline their expenditure on these costly but highly effective treatments.

Studies of regional disparities in practice of neonatal care have indicated that there are significant differences in the approaches used in the treatment despite their living in the same healthcare system. This can be as a result of differences in the training of doctors, the culture in the institution, the patients or the availability of resources (19, 20). These variations can help the devising of strategies that can be used to enhance the uniformity of care and patient outcomes.

3. METHODOLOGY:

The current retrospective observational research was quantitative in nature and embraced the approach by undertaking a methodological framework that examines data on the distribution of the surfactant that is distributed to the JRMS hospital network. The study was designed with the focus on the analysis of the time variance and institutional variation in the medication distribution patterns over a period of five years.

Study Setting and Population: The study covered five major hospitals in the JRMS network including King Hussein Medical Hospital, Prince Rashid Ben Al-Hasan Military Hospital, Queen Alia Military Hospital, Princess Haya Bint Al-Hussein Military Hospital and King Talal Military Hospital. These are the main referral centers of neonatal care in the military medical system and function on a heterogenous population of military staff and their families.

Data Collection: The retrieved distribution data pertained to the main medical warehouses of JRMS (2020-24). The information contained the mean amount of phospholipid fraction obtained by each hospital per month, which was made available as bovine lung (surfactant) medication that was distributed to each participating hospital. This methodology meant that it was able to cover medication patterns of distribution in a comprehensive manner whilst considering the possibility of a stock shortage or a disruption in the supply chain.

Data Variables: The main variables which were analyzed included: Hospital identification, Year of distribution (2020-2024), Monthly averages of surfactants quantities that were shipped to each facility, Temporal changes in patterns of

distributions and Inter hospital differences in consumption.

Statistical Analysis: Each hospital was tested using descriptive statistics which included indicators of central tendency (mean, median) and variability (standard deviation, range) and the characteristics of the distribution. Trend analysis was done to determine the trends over a time of five years. The comparative analysis analyzed hospital differences based on the total consumption, variability, and growth trends.

The statistical analytical plan involved: Annual averages in the individual hospitals calculated, Annual performance and growth rate evaluation, Coefficient of variation analysis in order to measure relative variability and determining the temporal patterns.

Conventionally, the hospitals are ranked comparatively based on the consumption values and variability.

Quality Assurance: The quality of data was maintained by checking the source records and cross reference with institutional reporting system. The missing or incongruent points of data were located and corrected by consulting the warehouse management and target hospitals.

Limitations: Some of the limitations were been recognized. It was analyzed based on distribution data as opposed to actual consumption data, which is not necessarily a perfect reflection of clinical utilization patterns. The patterns of distribution may be affected by factors like inventory management practices, stock rotation policies and emergency transfers between facilities even when the need of the clinical need is not a factor. Moreover, the research failed to address the patient level variables like the gestational age, weight of birth or clinical severity which have a direct impact and requirement of using the surfactant.

Ethical Considerations: The paper used aggregate distribution statistics with no names of patients, so the privacy issues have been removed. The study was carried out within the institutional policies of using administrative data to improve quality and carry out research.

4. RESULTS AND DISCUSSION:

The distribution analysis of surfactant throughout the JRMS hospital network revealed certain patterns and trends that can serve as a valuable discovery of dynamic of the medication utilization and the institutions characteristics.

Overall Distribution Patterns: There was a steady increase in total surfactant distribution among all the five hospitals during the period between 2020 and 2024 in both terms of total number of aggregated amount (172 in 2020 to 312 in 2024) which is a 81% increase in terms of relative amount over the study period. This high increase implies that there is growth in the clinical services, changes in the clinical protocols, or a demographic change in the group of patients who will be in the surfactant therapy (figure 1).

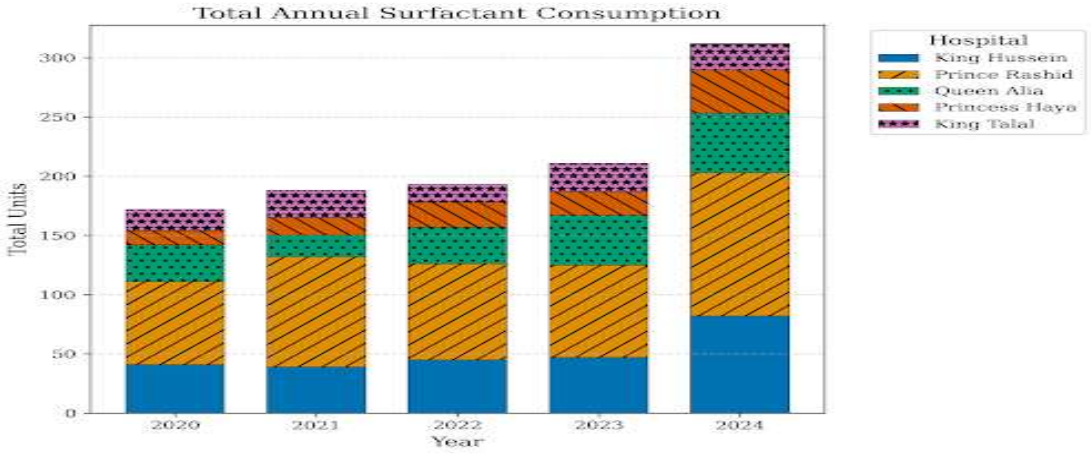

Figure 1: Total annual surfactant consumption

Individual Hospital Analysis: As a result of the study, Prince Rashid Ben Al -Hasan Military Hospital became the single largest consumer of surfactant medicine during the research period. Having the average dose of 88.6 every year this facility always contributed to about 35-40 percent of

the total network use. The hospital had the highest absolute levels of consumption with a high figure of 121 doses in 2024, however, it also had the highest level of variability (SD 19.9) which showed changing trends in the utilization patterns which might be attributed to the hospital being a key referral center to high-risk cases encountered by neonatal units.

King Hussein medical Hospital was the second largest in total consumption of 50.8 doses annually on average. The facility saw an especially high growth in 2024, increasing from 47 doses in 2023 to 82 doses in 2024, a 74 percent year-over-year growth. This spike is indicative of the possible neonatal services growth or shift in the process of referrals which focused more high-risk cases in this institution.

Queen Alia Military Hospital showed a U-shapes consumption trend, whereby the consumption started to decline in 2021 (18 doses) but then recovered at the same pace until 50 doses were reached in 2024. Such a trend can indicate the presence of the influence of COVID 2019 on clinical services in 2021, and consequently, the recovery and subsequent increase. The ability of the hospital to almost increase its consumption by almost three times compared to the lowest amount the hospital consumed in 2021, to the 2024 levels is highly scaled which indicate a significant capacity for expansion.

The relative growth was the most significant at Princess Haya Bint Al Hussein Military Hospital while maintaining the low levels of absolute consumption. The facility increased its usage of surfactants by three times the number of doses in 2020 (12 doses) to 2024 (37 doses), which is a 208 cent per cent increase in use within the period. This trend of growth portrays an indication of major growth of neonatal services or better capacity to handle more complicated cases that need surfactant therapies.

King Talal Military hospital had the most constant consumption pattern with insignificant change about the average of 20.4 doses per year. The consumption of the facility was between 15 to 24 doses during the five-year follow-up period and can be evaluated as a sign of stability in clinical practices and the demographics of the patients. This stability can be of a more specialized role or homogeneous referral patterns (figure 2).

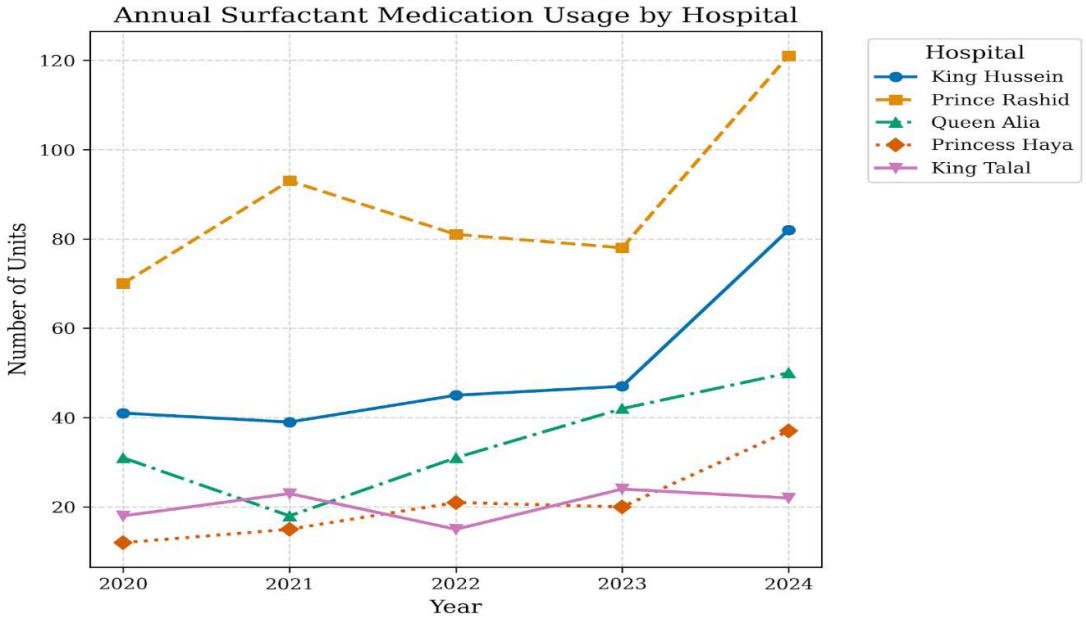

Figure 2: Annual surfactant medication usage by hospital

Temporal Trends Analysis: 2024 was an unparalleled year in the history of surfactant use in the network, with the results of all hospitals but one (King Talal) showing significant growth. All this 81% growth between 2020 and 2024 greatly outpaced the normal rates of population growth, indicating that there were other factors which were contributing to the increased utilization (figure 3).

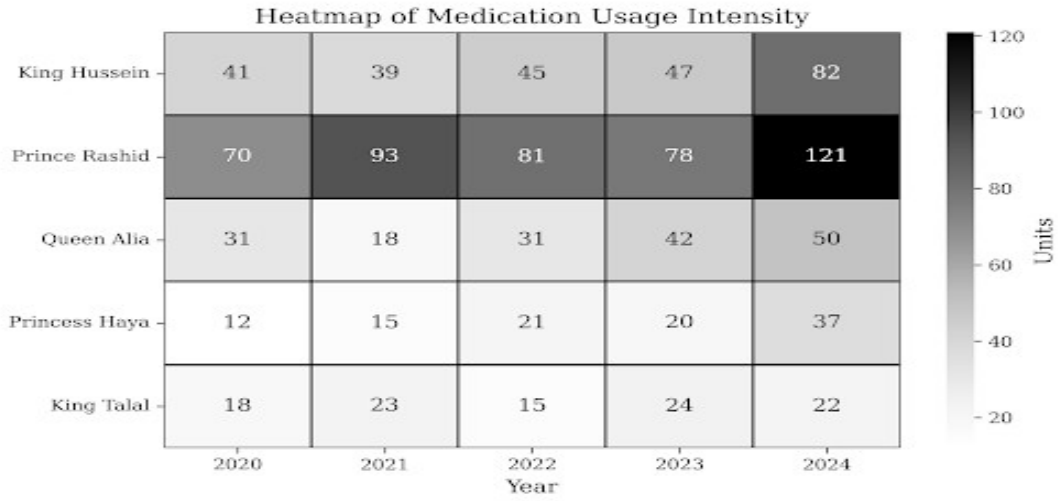

Figure 3: Heatmap of medication usage intensity

The 2021 statistics indicated trends presumably due to COVID 19 pandemic. The consumption at Prince Rashid Hospital was 93 doses which may be related to the fact that it is a possible regional referral center during the period when the healthcare system became overwhelmed. On the other hand, the point where Queen Alia Hospital had the lowest consumption (18 doses) was in 2021 and might be due to the service cuts or changes in patient flow as a result of pandemic conditions.

Variability and Consistency Analysis: The coefficient of variation test explained the unique institutional features. Prince Rashid Hospital was the largest consumer with the highest relative variability (22.5 percent), implying it is a highly adaptable referral hospital to the region. Conversely, King Talal Hospital showed the lowest variability (21.6 percent) meaning that there are no variations in the operations or the patient demographics.

Clinical Practice Implications: The distribution trends witnessed are probably the result of a number of clinical considerations. The increased consumption in hospitals can be high-risk pregnancy referral centers, have more active neonatal intensive care units, or have more aggressive treatment plans. The discrepancy in consumption patterns presupposes the variation in clinical approach or patient groups in institutions.

The urgent increase in 2024 in several hospitals can suggest a variety of possibilities: neonatal care expansion, shifts in clinical practices towards earlier or more frequent surfactant use, demographics towards high-risk pregnancies, or the ability to handle difficult cases, which earlier were sent to other hospitals.

Resource Allocation Considerations: The fact that the consumption is concentrated in Prince Rashid Hospital (35 to 40 percent of overall network usage) suggests that it has a vital role to play and is one of the regional referral centers. This trend has significant consequences regarding resource distributions because the facility must have an adequate inventory to handle routine cases as well as possible surge capacity during the periods of referrals. The observed growth trends especially the 81 percentage growth in aggregate consumption has serious budget implications since the cost of surfactant therapy is so high. These trends are also necessary to make proper forecasting and budgeting in the JRMS system.

Comparative Network Analysis: Comparing the hospitals in the network, there rise different levels regarding levels of consumption and growth trends. Both Prince Rashid and King Hussein hospitals are high volume centers with high growth patterns. Queen Alia Hospital has a good recovery and growth opportunities. The highest relative growth is observed in Princess Haya Hospital although the volumes are not large. King Talal Hospital has regular, constant utilization trends.

These trends indicate that there are varying roles in the network, where some of the hospitals act as regional referral centers and others function locally. The awareness of these roles is important in the decisions regarding strategic planning and resource allocation.

5. CONCLUSIONS:

This in-depth analysis of the distribution of surfactant among the JRMS hospital network between 2020 and 2024 can provide considerable information regarding the nature of institutions, the nature of clinical work, and the allocation of resources. The result shows that there is a tremendous effect on the consumption of surrogates among the network members, whereby the total utilization among the five years of research indicate a significant 81% increase in aggregate utilization.

The statistics demonstrate that there is also apparent institutional chain of command and specializations in the network. Prince Rashid Ben Al-Hasan Military Hospital is the main referral center and it always consumes 35-40 per cent of total network surfactant supplies. This focus shows its centrality in attending to high-risk cases of neonatal care and indicates the facility value in healthcare provision in the regions.

The dramatic rise of 2024 in various hospitals suggests a huge increase of neonatal service or amendment of the clinical practice in the network. Such a trend and especially the 74 percent year-over-year growth at King Hussein Medical Hospital and the further outstanding performance at Prince Rashid Hospital indicate the effective growth in clinical capacities and possibly, the reduction of adverse clinical outcomes in high-risk neonatal patients.

The dynamics that have been witnessed over time, especially the volatility experienced in 2021 as a result of COVID-19 influences, show how the network is resilient and adaptive to difficult times. The following years show quick recovery and growth, which is a sign of successfully handling the disruption caused by the pandemic and reinstate clinical services.

Variability analysis is used to identify the unique institutional features, where in some hospitals the pattern of utilization is constant whereas in others there is flexibility in adjusting to a varying clinical need and this disparity is most likely representative of diverse positions in such a network and an approach to delivering care to children through different approaches.

The conclusions hold significant implications to the study of regional provision of neonatal care in the military systems since the presence of high-acuity cases in particular centers, as well as the consistent increase in cases throughout the network which is an indication of the effective expansion of special capabilities without losing distributed access to care.

Regarding the resource management viewpoint, the patterns observed offer useful information in the inventory management, budget forecasting and strategic resource deployment since that the large variability in consumption in the referral centers will require that the operations of the inventory be flexible such that they are able to meet the demand that vary with time without also compromising the constant supply of this vital medication.

This work also proves that the continuous examination of the pharmaceutical distribution data is helpful in analyzing clinical practice and institutional features in the healthcare networks and that these analyses can also be used when developing a strategic plan on how to allocate resources, to develop clinical protocols and also to implement quality improvement programs.

6. RECOMMENDATIONS:

Resting on the overall investigation of the surfactant distributions in the entire JRMS hospital network, there are a number of strategic suggestions to streamline the resources allocation, increase clinical results, and improve the functioning efficiency.

Strategic Resource Allocation: The JRMS must contemplate adopting a tiered approach to inventory management system which identifies the unique role of various hospitals in the network. As the high-volume center, Prince Rashid Ben Al-Hasan Military Hospital must have a better inventory buffer to balance the variability in consumption and be a regional referral hospital. Such variability in consumption (SD -19.9) places a high value on flexibility in inventory management which can be adjusted as surge demand occurs avoiding excessive wastage of unused inventory.

In hospitals with rapid growth rates especially King Hussein Medical Hospital and Princess Haya Bint Al Hussein Military Hospital, inventory allocation would include the projected growth trends. The growth of 74% in year-over-year at King Hussein Hospital and 208% percent in Princess Haya Hospital throughout the study period implies that these institutions need a stronger supply chain to handle the growing clinical needs.

Clinical Protocol Standardization: The high levels of heterogeneity in the consumption patterns occurring among the various hospitals implies that there are considerable possibilities of standardization of clinical protocols. Introduction of

network-wide requirements that will regulate the use of the surfactants including both precise admission levels and dosing schedule and time of intervention can not only enhance the consistency of the care but also optimise the utilization of the resources.

This would be provided through a quality-improvement initiative which will encourage the sharing of best practice across the network and this would also allow sharing of the practices throughout the system. It is expected that with the help of structured case-review meetings and systematic reviews on the clinical outcomes, the continuous improvement of providing neonatal care can be supported.

Enhanced Monitoring and Forecasting: The high growth rate witnessed in 2024 supports the importance of having advanced forecasting skills that have the potential of predicting and preparing the significant changes in utilization. Installation of predictive analytics, which consider both demographic tendencies and changes in clinical practices and scheduled expansion of services, should become more likely to enhance the accuracy of demand forecasts.

REFERENCES:

1. Soll, R. and Özek, E., 2009. Multiple versus single doses of exogenous surfactant for the prevention or treatment of neonatal respiratory distress syndrome. *Cochrane database of systematic reviews*, (1).
2. Sweet, D.G., Carnielli, V., Greisen, G., Hallman, M., Ozek, E., Te Pas, A., Plavka, R., Roehr, C.C., Saugstad, O.D., Simeoni, U. and Speer, C.P., 2019. European consensus guidelines on the management of respiratory distress syndrome–2019 update. *Neonatology*, *115*(4), pp.432-450.
3. Ramanathan, R., Rasmussen, M.R., Gerstmann, D.R., Finer, N., Sekar, K. and null The North American Study Group, 2004. A randomized, multicenter masked comparison trial of poractant alfa (Curosurf) versus beractant (Survanta) in the treatment of respiratory distress syndrome in preterm infants. *American journal of perinatology*, *21*(03), pp.109-119.
4. Halliday, H.L., 2008. Surfactants: past, present and future. *Journal of perinatology*, *28*(1), pp.S47-S56.
5. Singh, N., Halliday, H.L., Stevens, T.P., Suresh, G., Soll, R. and Rojas-Reyes, M.X., 2015. Comparison of animal-derived surfactants for the prevention and treatment of respiratory distress syndrome in preterm infants. *Cochrane Database of Systematic Reviews*, (12).
6. Aldana-Aguirre, J.C., Pinto, M., Featherstone, R.M. and Kumar, M., 2017. Less invasive surfactant administration versus intubation for surfactant delivery in preterm infants with respiratory distress syndrome: a systematic review and meta-analysis. *Archives of Disease in Childhood-Fetal and Neonatal Edition*, *102*(1), pp.F17-F23.
7. Abell, B., Naicker, S., Rodwell, D., Donovan, T., Tariq, A., Baysari, M., Blythe, R., Parsons, R. and McPhail, S.M., 2023. Identifying barriers and facilitators to successful implementation of computerized clinical decision support systems in hospitals: a NASSS framework-informed scoping review. *Implementation Science*, *18*(1), p.32.
8. Schnipper, J.L., Kirwin, J.L., Cotugno, M.C., Wahlstrom, S.A., Brown, B.A., Tarvin, E., Kachalia, A., Horng, M., Roy, C.L., McKean, S.C. and Bates, D.W., 2006. Role of pharmacist counseling in preventing adverse drug events after hospitalization. *Archives of internal medicine*, *166*(5), pp.565-571.
9. Bates, D.W., Boyle, D.L., Vliet, M.B.V., Schneider, J. and Leape, L., 1995. Relationship between medication errors and adverse drug events. *Journal of general internal medicine*, *10*(4), pp.199-205.
10. Franklin, B.D., Vincent, C., Schachter, M. and Barber, N., 2005. The incidence of prescribing errors in hospital inpatients: an overview of the research methods. *Drug safety*, *28*(10), pp.891-900.
11. Vaccaro, C., Mahmoud, F., Aboulatta, L., Aloud, B. and Eltonsy, S., 2021. The impact of COVID-19 first wave national lockdowns on perinatal outcomes: a rapid review and meta-analysis. *BMC Pregnancy and Childbirth*, *21*(1), p.676.
12. Handley, S.C., Mullin, A.M., Elovitz, M.A., Gerson, K.D., Montoya-Williams, D., Lorch, S.A. and Burris, H.H., 2021. Changes in preterm birth phenotypes and stillbirth at 2 Philadelphia hospitals during the SARS-

CoV-2 pandemic, March-June 2020. *Jama*, *325*(1), pp.87-89.

13. Armed Forces Health Surveillance Branch. Medical Surveillance Monthly Report (MSMR). Volume 28, Number 12, December 2021. Military Health System.

14. Richard, S.A., Pollett, S.D., Lanteri, C.A., Millar, E.V., Fries, A.C., Maves, R.C., Utz, G.C., Lalani, T., Smith, A., Mody, R.M. and Ganesan, A., 2021, December. COVID-19 outcomes among US Military Health System beneficiaries include complications across multiple organ systems and substantial functional impairment. In *Open Forum Infectious Diseases* (Vol. 8, No. 12, p. ofab556). US: Oxford University Press.

15. Dargaville, P.A., Gerber, A., Johansson, S., De Paoli, A.G., Kamlin, C.O.F., Orsini, F., Davis, P.G. and Australian and New Zealand Neonatal Network, 2016. Incidence and outcome of CPAP failure in preterm infants. *Pediatrics*, *138*(1), p.e20153985.

16. Roberts, K.D., Brown, R., Lampland, A.L., Leone, T.A., Rudser, K.D., Finer, N.N., Rich, W.D., Merritt, T.A., Czynski, A.J., Kessel, J.M. and Tipnis, S.M., 2018. Laryngeal mask airway for surfactant administration in neonates: a randomized, controlled trial. *The journal of pediatrics*, *193*, pp.40-46.

17. Shepherd, E.G., Knupp, A.M., Welty, S.E., Susey, K.M., Gardner, W.P. and Gest, A.L., 2012. An interdisciplinary bronchopulmonary dysplasia program is associated with improved neurodevelopmental outcomes and fewer rehospitalizations. *Journal of Perinatology*, *32*(1), pp.33-38.

18. Phibbs, C.S., Bronstein, J.M., Buxton, E. and Phibbs, R.H., 1996. The effects of patient volume and level of care at the hospital of birth on neonatal mortality. *Jama*, *276*(13), pp.1054-1059.

19. Horbar, J.D., Soll, R.F. and Edwards, W.H., 2010. The Vermont Oxford Network: a community of practice. *Clinics in perinatology*, *37*(1), pp.29-47.

20. Lee, S.K., Aziz, K., Singhal, N., Cronin, C.M., James, A., Lee, D.S., Matthew, D., Ohlsson, A., Sankaran, K., Seshia, M. and Synnes, A., 2009. Improving the quality of care for infants: a cluster randomized controlled trial. *Cmaj*, *181*(8), pp.469-476.

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