United International Journal for Research & Technology

Volume 07, Issue 08, 2026 | Open Access | ISSN: 2582-6832

Developing a Blood Supply Management Framework for Provincial Hospitals: A Health Systems Perspective from the Philippines

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***Abstract*—** Blood supply management is still a vital factor in the delivery of healthcare services, especially in the Provincial Hospitals, which depend on external blood suppliers for blood transfusion. The objective of this study was to create a Blood Supply Management Framework for hospitals in the province from a health system perspective. The study specifically analyzed the current blood supply system and capacity of the provincial hospitals, blood utilization patterns, blood component and blood type demand, identified barriers and challenges to blood availability, distribution, and utilization, and evaluated coordination mechanisms among hospitals, blood centers, and public health agencies and identified the key health system factors that influence blood supply management. The research design used was a descriptive cross-sectional study with nine hospitals that provide blood transfusion services in each province. The survey questionnaire was used to collect the data and the data analyzed by frequency counts, percentage, weighted mean and rank analysis. The findings indicated that all hospitals were blood stations and at the main source of blood access was the Local Blood Service Facility networking. The most commonly used blood products were Red Blood Cells, and Type O positive blood. Limited availability of blood during lean season was the biggest challenge, followed by transportation-related challenges, delays in communication and inefficiency in blood utilization. The findings led to a Blood Supply Management Framework that focuses on coordinated governance, inter-facility networking, efficient use of resources and the ongoing involvement of the community. The framework can be used as a tool to enhance blood supply systems and provide timely and safe transfusion service delivery in the provincial health system.

***Keywords*—** blood supply management, blood utilization, provincial hospitals, health systems, blood transfusion services.

I. INTRODUCTION

Blood is an indispensable part of the modern health care systems. It is an important factor in patients with trauma and major surgical procedures, obstetric emergencies, anaemia, cancer, kidney disease and other conditions that require transfusion support. Although medical technology has improved, no artificial blood has yet been found to replace the human blood completely. Therefore, maintaining a secure, sufficient and timely blood supply is an important and widespread public health concern worldwide. The World Health Organization (WHO) strongly states that the availability of safe blood and blood products is essential to the provision of good health services and universal health coverage. But there are still many countries that are struggling with maintaining adequate blood supply because of the growing demand, low blood donation rate, logistical difficulties, and lack of resources.

The complexity of blood supply systems has grown worldwide with the increase in population, demographic changes and the increased occurrence of chronic diseases that need regular blood support. Researchers have previously reported that healthcare systems need to constantly adapt blood collection, storage, distribution, and use to ensure they are never short of blood and do not waste blood (Jacobs et al., 2024; Gadsden, 2024). This is a real problem in developing countries where blood service infrastructure, transport systems, and blood inventory management systems tend to be limited (Barnes et al.,

2022). To ensure sufficient blood flow in these various environments, there needs to be coordination between blood centers, hospitals, government and communities.

Voluntary non-remunerated blood donation is one of the most crucial measures to ensure a safe and sustainable blood supply. Voluntary blood donation is linked to better blood safety, higher donor retention and public trust in blood services and WHO continues to support for 100% voluntary blood donation (WHO, 2019; WHO, 2025). Likewise, the AABB emphasized the need to enhance donor recruitment and retention initiatives to tackle blood supply issues and ensure long-term sustainability of blood services (AABB, 2025). But, if there are fluctuations in donor participation, especially over the holidays, during natural disasters, when handling public health issues, and during times when community engagement is low, it remains a big concern.

The fragility of blood supply systems has been further illustrated by recent events in the world. The COVID-19 pandemic caused a lot of disruptions in the blood collection and distribution activities in many countries, including movement restrictions, a drop in the number of donors and pressures to the health care system (Yap & Fedoc-Minguito, 2023; Denakker et al., 2023). The same challenges have been described in the event of natural disasters and humanitarian emergencies, which underscores the need for robust blood supply systems that are capable of adjusting to unforeseen challenges. Such experiences have highlighted the importance of the continuity of blood services through effective blood inventory management, preparedness for emergencies and coordination between institutions.

In addition to availability, healthcare institutions should also put efforts into the effective use of blood resources. Studies of Patient Blood Management (PBM) and evidence-based transfusion practices have shown benefits in ensuring optimal use of blood to improve patient outcomes, while minimizing unnecessary blood transfusion and blood wastage (Gammon et al. 2023; Wu et al. 2024). Proper patient assessment, following clinical guidelines, accurate demand forecasting and ongoing inventory monitoring are all aspects of effective utilization. Shortages can occur due to poor utilization practices such as over-ordering, delayed communication, and inadequate inventory control, which can lead to higher operational costs (Jadwin et al., 2022; Chien et al., 2025).

Wastage of blood is always a problem in healthcare systems. The causes of blood loss in hospitals have been identified as studies have shown that blood conditions of expiration, improper handling, transportation delay and inefficient inventory management are significant factors that cause blood loss in hospitals (Bashir et al., 2021; Mitra et al., 2025; Tounsi et al., 2025). Due to the ultra-short shelf life of blood products, healthcare institutions have to carefully balance availability and wastage. The challenge is especially important in smaller hospitals where the demand may vary and storage space is limited.

Blood supply management has become more and more discussed in the context of supply chain and health system perspective. Blood supply chains involve a series of activities that include donor recruitment, collection, testing, processing, storage, transportation, distribution, and utilization (Samani et al., 2019; Torrado & Barbosa-Póvoa, 2022). To ensure the quality and safety of blood products whilst delivering when required, then it is necessary to have effective coordination between stakeholders. Likewise, research on health systems has noted the significance of service delivery, workforce capacity, financing, governance, information systems and community involvement for promoting health system effectiveness for health outcomes (Nolte et al., 2022).

In the Philippines, the National Blood Services Act of 1994 (RA 7719) is the law that guides blood services, which includes promoting voluntary blood donation, and creating a coordinated national blood service network. Through the Department of Health (DOH), blood centers are responsible for collecting, processing, and distributing blood products to hospitals and other healthcare institutions. However, many areas of the country continue to face issues regarding blood availability, donor recruitment,

transportation and appropriate distribution (Tamayo, 2024). Blood shortages have been reported repeatedly in the Bicol Region, along with the need for greater promotion of blood donations to address a growing need (Atun, 2024; Bicol Medical Center calls for blood donors to avert supply shortage, 2025).

There are special issues affecting provincial hospitals in the national blood service system. Numerous hospitals only have a 'blood station' and rely on outside blood centers for their blood needs. The timely availability of blood products, including during emergencies, may be impacted by geographic distance from blood centers, transportation constraints, financial considerations, and communication barriers. Moreover, the need for blood is rising as the volume of healthcare services continues to grow, the aging population grows, and the prevalence of chronic diseases that demand transfusion support rises (Lin et al., 2026). These challenges require more effective coordination processes and improved management systems for fair access to blood services.

In other provinces where access to blood products is a challenge, hospitals have to heavily depend on external blood suppliers and informal networks for procuring blood supplies at the times of need. While facility-to-facility coordination is in place, the sharing of blood does not always take place in a coordinated and formalized manner among stakeholders. Hospitals encounter the recurring shortages in the lean periods of donation, transportation issues and optimization of utilization of blood. The lack of a comprehensive framework to incorporate the service provision, coordination mechanisms, governance structures and participation of the community could reduce the efficiency and sustainability of blood supply management in the province. Existing blood supply systems, utilization patterns and coordination mechanisms should be investigated to get the best out of them and enhance the performance of the health systems in the delivery of blood.

In response to these challenges, this study aimed to develop a Blood Supply Management Framework for provincial hospitals using a health systems perspective. Specifically, the study sought to (1) evaluate the existing blood supply system and service capacity of provincial hospitals; (2) assess blood utilization patterns and demand for major blood components and blood types; (3) identify barriers and challenges affecting blood availability, distribution, and utilization; (4) examine the effectiveness of coordination among hospitals, blood centers, and public health agencies; (5) determine key health system factors influencing blood supply management; and (6) develop a proposed Blood Supply Management Framework for provincial hospitals based on the study findings.

II. METHODOLOGY

This study employed a descriptive cross-sectional research design to evaluate the existing blood supply system, utilization patterns, coordination mechanisms, and challenges affecting blood supply management among provincial hospitals in one province in the Philippines. The study involved nine (9) licensed public and private hospitals authorized to provide blood transfusion services. Using purposive sampling, one representative from each hospital's Blood Transfusion Committee or designated personnel directly involved in blood-related services was selected as respondent. Data were collected using a researcher-developed and validated survey questionnaire consisting of sections on hospital characteristics, blood supply sources, blood utilization patterns, coordination mechanisms, and barriers affecting blood availability, distribution, and utilization. The research instrument underwent content validation by experts from the academic institution and the Provincial Health Office to ensure clarity, relevance, and reliability.

Data collection was conducted after securing the necessary approvals and informed consent from participating institutions and respondents. Completed questionnaires were retrieved, reviewed for completeness, and encoded for analysis. Descriptive statistical tools, including frequency counts, percentages, weighted means, and rank analysis, were utilized to summarize and interpret the data. The findings were further analyzed using a health systems perspective focusing on service delivery, access to blood supply, workforce, information systems,

financing, governance, and community participation. Based on the results, a proposed Blood Supply Management Framework was developed to strengthen coordination, accessibility, utilization, and sustainability of blood services among provincial hospitals. Ethical principles of voluntary participation, confidentiality, anonymity, and responsible data management were observed throughout the study.

III. RESULTS

Existing blood supply system and service capacity of provincial hospitals

The findings in Table 1 indicate that the blood supply system in the provincial hospital setting is characterized by a predominantly low-to-mid-level service structure, with most facilities operating as primary hospitals (66.7%) and the remainder classified as secondary hospitals (33.3%). The absence of tertiary-level facilities suggests limited capacity for advanced clinical services, including complex transfusion management and high-volume blood storage. This structural configuration reflects a decentralized but low-capacity hospital network that is highly dependent on external blood supply sources and referral systems for specialized care.

In terms of ownership, the distribution between public (55.6%) and private (44.4%) hospitals shows a relatively balanced mixed-health system. This suggests that both sectors play a significant role in blood utilization and service delivery. However, the reliance on both public and private institutions also introduces variability in operational protocols, coordination efficiency, and access to standardized blood management systems, which may affect consistency in blood supply practices across facilities.

The analysis of bed capacity further highlights the limited scale of hospital infrastructure in the province, with the majority of facilities (66.7%) operating at 1–25 bed capacity and the remaining 33.3% at 51–100 beds.

The absence of large hospitals (>100 beds) indicates constrained inpatient capacity, which directly influences blood demand forecasting, storage capability, and inventory turnover. Smaller facilities are typically less equipped to maintain blood stockpiles, thereby increasing reliance on external blood service facilities and real-time procurement systems.

Table 1. *Characteristics of Provincial Hospitals Involved in Blood Transfusion Services (n = 9)*

Characteristics	f	%
Hospital Level		
Primary	6	66.7
Secondary	3	33.3
Tertiary	0	0.0
Type of Ownership		
Public	5	55.6
Private	4	44.4
Bed Capacity		
1–25 beds	6	66.7
26–50 beds	0	0.0
51–100 beds	3	33.3
More than 100 beds	0	0.0
Blood Service Capability		
Blood Station	9	100.0
Blood Bank	0	0.0
Blood Collecting Unit	0	0.0
Years of Operation		
Less than 5 years	1	11.1

5–10 years	1	11.1
11–20 years	1	11.1
More than 20 years	6	66.7

A key finding is that all participating hospitals (100%) function solely as blood stations, with no blood banks or blood collecting units identified. This indicates a highly dependent system where hospitals do not engage in blood collection or processing activities but instead rely entirely on external blood centers and networking arrangements. While this model aligns with regulatory requirements under national blood service policies, it also exposes the system to vulnerabilities such as delays in procurement, transportation challenges, and supply shortages during peak demand or emergency situations.

The longevity of hospital operations further shows that a majority of facilities (66.7%) have been in service for more than 20 years, suggesting institutional stability and established healthcare service delivery in the province. However, despite this long operational history, the continued absence of in-house blood banking capacity highlights persistent infrastructural and resource limitations rather than maturity of transfusion service development.

Overall, the results suggest that the existing blood supply system in provincial hospitals is characterized by high dependency, limited infrastructural capacity, and strong reliance on external coordination mechanisms. While the current structure ensures compliance with national blood service regulations, it underscores the need for strengthened inter-facility collaboration, improved logistics systems, and enhanced regional coordination to ensure timely and adequate blood availability, particularly in geographically dispersed and resource-constrained settings.

Blood utilization patterns and demand for major blood components and blood types

The findings on blood utilization patterns reveal a clear preference for component-based transfusion practices among provincial hospitals. As shown in Table 2, Red Blood Cells (RBCs) recorded the highest weighted mean (2.66) and were interpreted as highly utilized, indicating that RBC transfusion remains the most critical and frequently required blood component across hospital settings. This pattern is consistent with clinical demand in cases of anemia, surgical blood loss, trauma, and obstetric emergencies, where immediate restoration of oxygen-carrying capacity is essential.

Table 2. *Blood Utilization Patterns by Blood Component (n = 9)*

Blood Component	Weighted Mean	Interpretation	Rank
Red Blood Cells	2.66	Highly Utilized	1
Whole Blood	1.11	Less Utilized	2
Fresh Frozen Plasma	1.00	Less Utilized	3
Cryoprecipitate	1.00	Less Utilized	4

In contrast, Whole Blood (1.11), Fresh Frozen Plasma (1.00), and Cryoprecipitate (1.00) were all categorized as less utilized. This suggests a strong shift toward component therapy practices, where specific blood components are administered based on patient need rather than transfusing whole blood. Such practice reflects improved transfusion efficiency and aligns with modern transfusion medicine principles that emphasize targeted therapy, reduced wastage, and optimized use of limited blood resources.

However, the consistently low utilization of plasma and cryoprecipitate may also indicate limited clinical indications, lack of availability, or restricted access in smaller provincial hospitals. This highlights potential gaps in specialized transfusion capability, particularly in managing coagulopathies, severe bleeding disorders, and critical care cases requiring plasma-based products.

Regarding blood type utilization in Table 3, Type O+ was the most frequently used blood group (weighted mean = 1.89). This is expected given its status as the most commonly transfused type in emergency settings due to its relative compatibility and frequent availability. It is often prioritized in acute care situations where rapid transfusion is required and cross-matching time is limited.

Type A+ (1.66) was moderately utilized, while Type B+ (1.44) and Type AB+ (1.00) were less frequently used. This distribution reflects both population blood group prevalence and clinical transfusion demand patterns. The significantly lower utilization of AB+ may also be attributed to its relative rarity in the population, making demand naturally lower compared to other blood types.

Table 3. *Blood Utilization Patterns by Blood Type (n = 9)*

Blood Type	Weighted Mean	Interpretation	Rank
O+	1.89	Highly Utilized	1
A+	1.66	Moderately Utilized	2
B+	1.44	Less Utilized	3
AB+	1.00	Less Utilized	4

Overall, the results indicate that blood utilization in provincial hospitals is primarily driven by emergency and high-demand clinical conditions, with a strong reliance on RBC transfusion and Type O+ blood.

This pattern underscores the need for robust inventory planning, especially for RBC units and universal donor blood types, to ensure continuous availability during peak demand periods.

At the same time, the low utilization of other components suggests the importance of strengthening clinical guidelines and hospital capacity to optimize appropriate use of all blood products within a comprehensive transfusion strategy.

Barriers and challenges affecting blood availability, distribution, and utilization

Table 4 presents the barriers and challenges affecting blood availability and distribution among provincial hospitals. The findings reveal that insufficient blood supply during lean months emerged as the most common problem, obtaining the lowest sum of ranks (13) and ranking first among all identified challenges. This indicates that maintaining an adequate blood inventory remains a significant concern, particularly during periods when voluntary blood donation activities decline. Seasonal fluctuations in donor turnout may be influenced by factors such as adverse weather conditions, school breaks, holidays, and reduced community mobilization activities, resulting in shortages that can affect the timely provision of blood transfusion services.

Table 4. *Barriers and Challenges Affecting Blood Availability and Distribution (n = 9)*

Challenge	Sum of Ranks	Rank	Interpretation
Insufficient blood supply during lean months	13	1	Most Common Problem
Transportation-related access barriers	23	2	Common Problem
High blood processing fees	25	3	Moderate Problem
Inefficient communication among facilities	29	4	Least Problem

The second most common challenge was transportation-related access barriers (sum of ranks = 23). This finding highlights the logistical difficulties encountered by hospitals, particularly those located far from blood centers and major healthcare facilities. Delays in transporting blood products can compromise timely access to life-saving transfusions during emergencies and may increase operational costs for both healthcare institutions and patients. The geographical distribution of healthcare facilities within the province further emphasizes the importance

of efficient transportation and distribution systems in ensuring equitable access to blood services.

High blood processing fees ranked third (sum of ranks = 25) and were interpreted as a moderate problem. Although blood itself is donated voluntarily, patients often incur expenses related to blood processing, testing, storage, and administrative services. These costs may create financial burdens for patients and their families, particularly those from low-income households, and can potentially affect access to timely transfusion services. The finding suggests the need for continued policy support and financial assistance mechanisms to reduce the economic impact of blood transfusion on patients.

Among the identified barriers, inefficient communication among facilities received the highest sum of ranks (29) and was considered the least common problem. While communication challenges were not perceived as a major issue compared with supply shortages and transportation constraints, effective communication remains essential for coordinating blood requests, inventory monitoring, and inter-facility blood sharing. Strengthening communication systems through standardized reporting procedures and digital information platforms may further improve coordination and responsiveness within the blood supply network.

The findings indicate that the major challenges affecting blood availability and distribution are primarily related to supply adequacy, logistics, and affordability rather than communication processes. These results underscore the need for enhanced donor recruitment initiatives, strengthened transportation and distribution mechanisms, and sustainable financing strategies to ensure a reliable and accessible blood supply system. Addressing these barriers is critical for improving the resilience and efficiency of blood service delivery within provincial healthcare settings.

Table 5 presents the barriers and challenges affecting blood utilization among provincial hospitals. The findings indicate that the delay in notifying the blood station that blood is no longer required was identified as the most common problem, obtaining the lowest sum of ranks (27).

This finding suggests that communication gaps between clinical departments and blood service facilities contribute significantly to inefficiencies in blood utilization. Delayed notification may result in unnecessary reservation of blood units, limiting their availability for other patients and increasing the risk of wastage, particularly given the limited shelf life of blood products.

Table 5. *Barriers and Challenges Affecting Distribution (n = 9)*

Challenge	Sum of Ranks	Rank	Interpretation
Delay in notifying blood station that blood is no longer required	27	1	Most Common Problem
Patient discharged/deceased before transfusion	28	2	Common Problem
Rescheduling/cancellation of procedures	35	3	Moderate Problem
Lack of evidence-based guidelines (MBOS)	36	4	Moderate Problem
Blood received near expiry date	39	5	Moderate Problem
Improper handling/storage of blood	42	6	Minor Problem
Insufficient staffing	45	7	Least Problem

The second most common challenge was patient discharge or death before transfusion (sum of ranks = 28). This situation often occurs when a patient's clinical condition changes after blood has already been reserved or crossmatched. Consequently, blood units allocated for these patients may remain unused, creating inventory management challenges and potentially reducing the availability of blood for other patients requiring urgent transfusion. The finding highlights the importance of continuous patient

assessment and timely communication between clinical and laboratory personnel.

Rescheduling or cancellation of medical and surgical procedures ranked third (sum of ranks = 35) and was interpreted as a moderate problem. Elective procedures frequently require advance blood reservation as a precautionary measure. When procedures are postponed or cancelled, reserved blood units may remain unused, affecting inventory turnover and operational efficiency. Effective scheduling systems and timely updates among healthcare teams are therefore essential to minimize unnecessary blood reservations.

Similarly, the lack of evidence-based guidelines such as the Maximum Blood Ordering Schedule (MBOS) ranked fourth (sum of ranks = 36) and was also considered a moderate problem.

The absence of standardized transfusion guidelines may contribute to over-ordering, excessive blood reservation, and inappropriate utilization practices. Implementing evidence-based transfusion protocols can improve clinical decision-making, optimize blood requests, and reduce unnecessary demand on limited blood resources.

Another moderate challenge identified was receiving blood units near their expiry date (sum of ranks = 39). Blood products with limited remaining shelf life increase the likelihood of wastage if not utilized promptly.

This issue may reflect inventory imbalances within the blood distribution network and underscores the need for improved forecasting, stock rotation, and coordination between blood centers and hospitals.

Improper handling or storage of blood products ranked sixth (sum of ranks = 42) and was interpreted as a minor problem. Although not frequently reported, improper storage conditions can compromise blood quality and patient safety.

The relatively low ranking suggests that participating hospitals generally maintain acceptable blood handling practices, likely due to adherence to established transfusion protocols and regulatory standards.

The least common challenge identified was insufficient staffing to facilitate transfusion services (sum of ranks = 45). While staffing constraints are commonly reported in healthcare settings, respondents perceived this issue as having less impact on blood utilization compared to communication, inventory, and procedural factors. Nevertheless, adequate staffing remains essential for ensuring timely blood administration, monitoring transfusion reactions, and maintaining quality transfusion services.

The primary barriers affecting blood utilization are largely associated with communication delays, changes in patient status, and procedural inefficiencies rather than resource or staffing limitations. These results emphasize the importance of strengthening communication systems, implementing evidence-based transfusion guidelines, improving inventory management practices, and enhancing coordination between clinical departments and blood service facilities. Addressing these challenges can contribute to more efficient blood utilization, reduced wastage, and improved availability of blood products for patients in need.

Effectiveness of coordination among hospitals, blood centers, and public health agencies.

Table 6 presents the coordination mechanisms among hospitals, blood centers, and health agencies in relation to blood supply management and utilization.

The findings indicate that the preferred use of Local Blood Service Facility (LBSF) networking or blood-sharing systems was reported by 77.8% of hospitals, suggesting that inter-facility collaboration is the dominant operational mechanism for securing blood supply in the province.

This highlights the importance of decentralized networking arrangements in ensuring timely access to blood products, particularly in settings where direct access to centralized blood centers may be limited by distance or logistical constraints.

Table 6. Barriers and Challenges Affecting Utilization (n = 9)

Coordination Indicator	f	%
Preferred use of LBSF Networking/Blood Sharing System	7	77.8
Preferred use of Blood Center	2	22.2
Hospitals operating as Blood Stations	9	100.0
Existing reliance on inter-facility networking	7	77.8
Reliance on centralized blood center services	2	22.2

Similarly, reliance on blood centers as a direct source of blood supply was reported by only 22.2% of hospitals. This lower proportion indicates that while blood centers remain the primary regulatory and processing institutions within the national blood service system, their role as a direct supplier to hospitals is relatively limited in the provincial context. Instead, blood distribution is largely facilitated through intermediary networking systems, which may help improve responsiveness but also depend heavily on coordination efficiency among facilities.

All participating hospitals (100%) were identified as blood station facilities, confirming their role as dependent units within the broader blood supply chain rather than independent blood collection or banking centers. This structural arrangement reinforces the centralized nature of blood processing and the reliance of provincial hospitals on external supply systems for transfusion services. As a result, hospitals primarily function as requesting, storing (short-term), and transfusing units rather than full-service blood production centers.

The findings further show that 77.8% of hospitals rely on inter-facility networking, which aligns with the preference for LBSF systems. This reinforces the role of collaborative arrangements among hospitals as a key mechanism for addressing supply shortages and ensuring redistribution of blood products when needed. Such networking systems enhance flexibility in emergency situations and help mitigate the impact of limited blood availability in isolated facilities.

In contrast, reliance on centralized blood center services was reported by only 22.2% of hospitals, indicating that direct utilization of central blood supply pathways is less common. This may be attributed to geographical barriers, transportation delays, and administrative constraints in accessing centralized services. However, reduced direct dependence on blood centers may also introduce variability in supply chain oversight and standardization of distribution processes.

Blood supply coordination in provincial hospitals is largely driven by inter-facility networking rather than direct centralized distribution systems. While this approach enhances accessibility and responsiveness, it also underscores the need for stronger formalized agreements, standardized communication protocols, and improved governance mechanisms to ensure consistency, safety, and efficiency in blood distribution. Strengthening coordination between blood centers, hospitals, and health authorities remains essential to achieving a more resilient and integrated blood supply system.

Health system factors influencing blood supply management.

The factors that affect blood supply management from the health systems perspective in provincial hospitals are presented in Table 6. The results show that the management of blood supply is a complex process and is affected by various factors such as: service delivery capacity, staff availability, information systems, financing mechanisms, governance and participation at the community level. The factors are interrelated and contribute to how well, how accessible and how sustainable blood services are in the province.

In the service delivery domain, all the hospitals are blood stations and rely on outsourcing blood suppliers for blood products. This finding is indicative of the centralized blood service model that involves blood collection, testing and processing by authorized blood centers, and blood storage, distribution and transfusion by hospitals. While this helps meet the national blood

safety standards, it also boosts reliance on outside suppliers, and could cause gaps in blood supplies or logistical problems.

Access to blood supply is achieved by the majority of hospitals through the use of Local Blood Service Facility (LBSF) networking in order to meet the demand of blood products within the required time. The discovery emphasizes the need for inter-facility cooperation to ensure blood availability, especially in remote locations. Networking arrangements help hospitals to obtain blood resources effectively and are an alternative source of blood when the centralized blood center is unable to respond to urgent needs.

The health workforce domain revealed that staffing limitations affect blood utilization efficiency. Although insufficient staffing was not identified as the most significant operational challenge, adequate human resources remain essential for inventory management, transfusion monitoring, documentation, and coordination of blood-related services. Workforce constraints may affect the overall responsiveness and efficiency of blood management systems, particularly during periods of increased demand.

Table 6. *Key Health System Factors Influencing Blood Supply Management*

Health System Domain	Key Findings
Service Delivery	All hospitals operate as blood stations dependent on external blood suppliers
Access to Blood Supply	Majority rely on LBSF networking for timely blood access
Health Workforce	Staffing limitations affect blood utilization efficiency
Health Information Systems	Delays in communication contribute to blood wastage
Medical Products and Technologies	Red Blood Cells and O+ blood are most frequently utilized
Health Financing	Blood processing fees remain a challenge for patients
Leadership and Governance	Need for formalized blood-sharing agreements and coordination mechanisms
Community Participation	Sustained donor recruitment programs are necessary during lean months

Within the health information systems domain, communication delays were found to contribute to blood wastage. Delays in notifying blood stations when blood is no longer required can result in unnecessary reservation of blood units and reduce opportunities for redistribution to other patients. This finding underscores the importance of efficient information-sharing mechanisms, standardized reporting procedures, and digital inventory management systems to improve coordination and optimize blood utilization.

Regarding medical products and technologies, Red Blood Cells and Type O positive blood were identified as the most frequently utilized blood products. This utilization pattern reflects the clinical demand for blood transfusions in managing anemia, trauma, surgical procedures, and obstetric emergencies. The concentration of demand on specific blood components and blood types highlights the need for targeted inventory planning, demand forecasting, and stock management strategies to ensure continuous availability.

The health financing domain revealed that blood processing fees remain a challenge for many patients. Although blood donation is voluntary, patients often incur costs related to blood testing, processing, storage, and administrative services. These financial burdens may affect access to timely transfusion services, particularly among economically disadvantaged populations. The finding suggests the need for financial assistance programs and supportive policies that can reduce out-of-pocket expenditures associated with blood transfusion.

Under leadership and governance, the study identified the need for formalized blood-sharing agreements and stronger coordination mechanisms among hospitals, blood centers, and public health agencies. Clear

governance structures, standardized operating procedures, and formal memoranda of agreement can strengthen accountability, improve communication, and facilitate more efficient blood distribution across healthcare facilities.

Finally, community participation emerged as a critical factor in sustaining the blood supply system. The findings indicate that continued donor recruitment and community-based blood donation programs are necessary, particularly during lean months when blood donations decline. Strengthening partnerships with local government units, educational institutions, civil society organizations, and community groups can help maintain an adequate pool of voluntary blood donors and improve the long-term sustainability of blood services.

Overall, the findings demonstrate that effective blood supply management extends beyond the availability of blood products alone. It requires a coordinated health systems approach that integrates service delivery, workforce capacity, information systems, financing, governance, and community engagement. Strengthening these domains can enhance the resilience, efficiency, and sustainability of blood supply systems and improve access to safe and timely transfusion services in provincial healthcare settings.

Proposed Blood Supply Management Framework for provincial hospitals based on the study findings. The proposed Blood Supply Management Framework illustrates a structured and integrated health systems approach to addressing the persistent challenges in blood availability, distribution, and utilization across provincial hospitals in the Philippines. The framework is anchored on multi-level coordination involving national policy direction, regional implementation, facility-level management, and community participation.

At the apex of the system is the Department of Health (DOH), which provides strategic governance through policy formulation, regulatory enforcement, quality assurance, and capacity-building initiatives.

This central role ensures that national standards for blood safety, adequacy, and accessibility are uniformly implemented across all participating health facilities. The DOH also plays a critical role in strengthening system-wide monitoring and ensuring compliance with established transfusion guidelines.

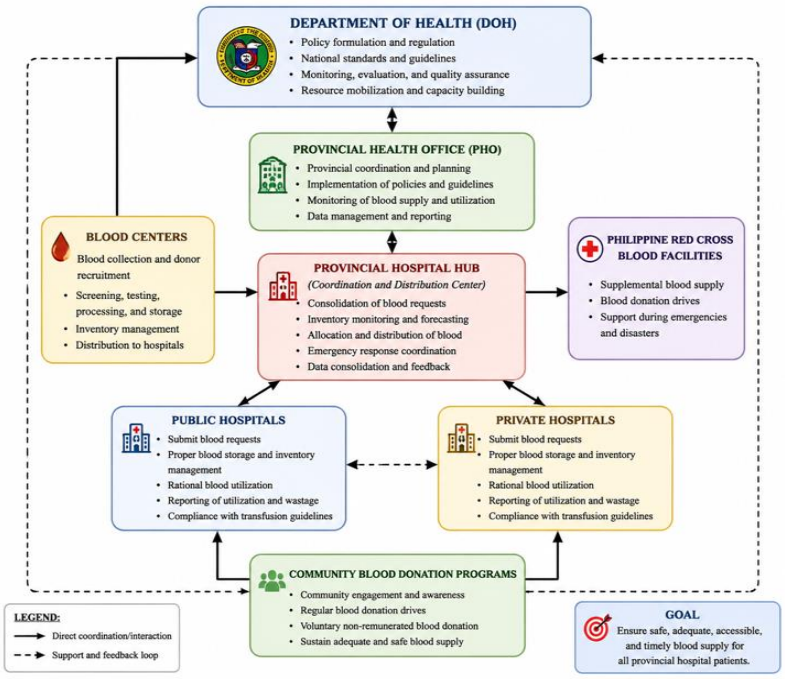

Figure 1. *Proposed Blood Supply Management Framework for Provincial Hospitals Based on the Study's Findings*

Provincial Health Office (PHO) is the operational coordinating body at the subnational level, supporting the DOH. The PHO designs and implements policies at a local level by coordinating their implementation, monitors the use and availability of the blood supply, and manages data and reporting in hospitals. The PHO also supports coordination between public and private health facilities, to ensure that blood is available to meet true demand on a province wide basis.

The Provincial Hospital Hub at service delivery level acts as the hub of the service delivery for coordinating and distributing the services. It brings together blood requests, handles stock forecasting, and helps in allocating and redistributing blood products. It also enhances emergency response coordination, especially when quantities are low, in disaster or when there is a sudden surge in demand. This model is based on the hub to fix the issue of fragmentation in the blood distribution system and also to enable better inter-facility resource sharing.

The framework also incorporates the blood centers, which facilitate donor recruitment, collect blood, screen and test donors, process the blood, store and distribute blood to initial units. These functions make sure that blood products are only added to the blood supply chain that are safe and of good quality. To complement these, the Philippine Red Cross blood facilities serve as complementary providers in emergency situations and when blood supply is reduced, thus increasing system resilience.

At the hospital level, both public and private hospitals are responsible for requesting blood, adopting proper storage conditions, following the rational approach to blood transfusion and reporting the utilization data. This is a two-in-one responsibility that increases accountability and optimizes the use of blood, also following clinical guidelines.

A key element of the framework is the integration of community blood donation programs which are the building blocks of sustainable blood supply. The programs encourage voluntary, unpaid blood donations through awareness creation activities, regular blood drives, and collaborative agreements with local government agencies, educational institutions and civil society organizations. The social element is essential for seasons of scarcity and a consistent supply of donors.

In general, the coordination model of the system was introduced, where each stakeholder has a certain role, which must be coordinated and is interdependent. Horizontal collaboration and cooperation among hospitals and blood service providers, as well as the strong vertical integration between DOH, PHO and hospital systems, increases responsiveness and decreases inefficiencies and delays in blood delivery. The inclusion of community participation further strengthens sustainability and resilience of the blood supply system.

In essence, the framework demonstrates that an effective blood supply system is not solely dependent on infrastructure or supply availability, but on the strength of coordination, governance, communication, and stakeholder collaboration across all levels of the health system.

IV. CONCLUSION & RECOMMENDATION

The study revealed that provincial hospitals are highly dependent on the blood supply chain, which consists of limited service capacity, dependence on external blood suppliers and lack of blood banking. Local Blood Service Facility (LBSF) networking was found to be the key element in achieving timely blood product supply in most hospitals, and Red Blood Cells (RBCs) and type O positive blood were the most commonly used blood component and blood type. The main problems encountered in blood supply management are the limited blood availability during lean periods, access problems due to transportation, delay in communication of blood use and lack of standardized blood use guidelines. These results are indicative of the fact that the coordination mechanisms, information systems, financing, workforce capacities, governance structures and community participation, in addition to blood availability and supply, have a significant impact on effective blood supply management. The proposed Blood Supply Management Framework provides a systems-based approach to strengthening

coordination, accessibility, and utilization of blood resources among provincial hospitals.

Provincial hospitals, blood centers, and public health agencies should establish formalized blood-sharing agreements and strengthen inter-facility networking to improve coordination and ensure timely blood distribution during routine operations and emergencies. The Provincial Health Office should lead the implementation of standardized blood utilization protocols, including evidence-based guidelines such as the Maximum Blood Ordering Schedule (MBOS), while promoting digital communication and inventory monitoring systems to reduce wastage and improve resource allocation. Furthermore, sustained community-based blood donation programs should be intensified through partnerships with local government units, educational institutions, private organizations, and civil society groups, particularly during lean months when blood shortages are most common. These strategies can enhance the efficiency, sustainability, and resilience of the provincial blood supply system and improve access to safe and timely transfusion services.

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