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An Analysis of the Economic Impact of Patient Blood Management in Cardiovascular Surgery

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Abstract: This study analyzes the economic impact of Patient Blood Management (PBM) in cardiovascular surgery through a qualitative review of secondary evidence from clinical, economic, and policy literature. The findings demonstrate that conventional transfusion dependent practices impose substantial direct and indirect costs due to high blood product utilization, transfusion-related complications, and prolonged hospital stays. In contrast, PBM strategies particularly preoperative anemia management, restrictive transfusion thresholds, and optimized intraoperative blood conservation consistently reduce transfusion rates, postoperative morbidity, intensive care utilization, and length of hospitalization. Economic evaluations indicate that although PBM requires initial investment, these costs are rapidly offset by significant savings and favorable returns on investment, supporting PBM as a high value, cost-effective approach that aligns improved patient outcomes with sustainable healthcare resource utilization in cardiovascular surgery.

Keywords: Economic Outcomes, Cost-Effectiveness, Patient Blood Management, Cardiovascular Surgery.

INTRODUCTION

Patient Blood Management (PBM) is an evidence-based, multidisciplinary approach aimed at improving patient outcomes by optimizing and conserving a patient's own blood while promoting safety, shared decision-making, and efficient resource utilization. Endorsed by the WHO, PBM has gained global recognition not only for its clinical benefits but also for its economic impact and implications for healthcare sustainability, particularly in resource intensive specialties such as cardiovascular surgery (Shander et al., 2022; WHO, 2025).

Preoperative anemia and exposure to allogeneic blood transfusions are consistently associated with increased postoperative morbidity and mortality, resulting in prolonged hospital stays, higher complication rates, and elevated healthcare costs. In parallel, a growing global shortage of donor blood has intensified concerns regarding the sustainability and financial burden of transfusion-dependent care models (Saillant et al., 2022). Consequently, the development, implementation, and optimization of PBM programs have become priorities for clinicians,

hospital administrators, and policymakers seeking to improve outcomes while ensuring efficient use of healthcare resources.

While some cardiovascular surgery institutions have made strides in adopting PBM, others still have some way to go. Methods including optimal cardiopulmonary bypass management, surgical cell salvage, and antifibrinolytic treatment are routinely used, while other important procedures are still not regularly used (Bracey et al., 2025). As an example, viscoelastic point-of-care testing is used by less than 50% of surveyed institutions to guide coagulation therapy, and only a small percentage of those institutions evaluate residual anticoagulant activity in patients who receive direct oral anticoagulants (DOACs) (Jeppsson et al., 2025; Tibi et al., 2021). Patients at high risk, such as those with valvular heart disease or impaired renal function, may have more transfusion needs and worse outcomes due to unidentified lingering anticoagulant effects, which might drive up treatment costs (Klein et al., 2017).

Crucial to PBM and significantly impacting clinical and economic results is the early detection and treatment of preoperative anemia. Many high-volume cardiac facilities still have inadequate methods for managing anemia, even though screening is commonplace. Optimal management of anemia is seldom postponed for elective operations, and few facilities provide enough time for correction before surgery. Inadequate management of anemia is a lost chance for better results and cost containment because even one transfusion of red blood cells has been linked to quantifiable increases in mortality, morbidity, and healthcare utilization (Paone et al., 2014; Ivascu Girardi et al., 2023). Reducing transfusion exposure, recovery time, and postoperative resource utilization may be achieved with proactive methods such as intravenous iron treatment and erythropoiesis-stimulating drugs.

Despite a robust evidence base supporting PBM, translating these principles into comprehensive institutional practice remains challenging. Barriers include entrenched transfusion practices, limited multidisciplinary coordination, and insufficient institutional prioritization. Effective PBM programs require structured, system-wide integration, adequate funding, and information technology infrastructure capable of tracking outcomes and demonstrating both clinical and economic value (Shander et al., 2022).

There is mounting evidence that PBM programs are very beneficial to the economy. Fewer problems, shorter hospital stays, shorter transfusion rates, and lower total expenditures have been linked to hospital-wide PBM use. (Frank et al., 2024) found a return on investment of more than seven times after implementing a complete PBM program with the same or better

clinical results, whereas (Leahy et al., 2017) found savings of almost USD 18 million per year across four tertiary institutions. Reducing transfusion costs, critical care unit use, and postoperative complications have been associated with preoperative anemia control strategies in cardiovascular surgery (Warner et al., 2022). Depending on the healthcare setting and the methodology used for costing, activity-based costing studies have estimated that the total cost of a single unit of red blood cells ranges from around USD 700 to USD 1,000 (Shander et al., 2022). Depending on the institution's environment and baseline transfusion policies, some studies have shown that the costs of implementing PBM may be recouped within 12-18 months (Frank et al., 2024; Leahy et al., 2017).

At a broader level, PBM contributes to societal benefits by alleviating pressure on blood supply chains, decreasing readmissions, and minimizing transfusion-related complications. Widespread adoption strengthens health system resilience, enhances patient safety, and promotes more efficient allocation of healthcare resources. Although formal cost-effectiveness analyses using standardized health-economic models are limited, available evidence consistently supports PBM as a high-value intervention that aligns improved clinical outcomes with responsible healthcare spending (WHO, 2025).

This study therefore aims to analyze the economic impact of PBM in cardiovascular surgery by synthesizing existing clinical and economic evidence to evaluate its implications for cost containment, resource utilization, and healthcare sustainability.

RESEARCH METHODOLOGY

This study is based on a qualitative secondary data approach using a narrative analytical design to examine the economic impact of PBM in cardiovascular surgery. Relevant data were obtained from published peer-reviewed research articles, international clinical guidelines, and health-economic studies focusing on transfusion practices, cost burden, cost-effectiveness, and budget impact of PBM implementation. The collected secondary data were systematically reviewed and thematically analyzed to identify patterns related to healthcare costs, resource utilization, and economic outcomes.

RESULTS

Economic Burden of Conventional Blood Transfusion Practices in Cardiovascular Surgery

Secondary data from multiple observational studies, registry analyses, and economic evaluations consistently demonstrate that conventional allogeneic blood transfusion practices impose a substantial financial burden on cardiovascular surgical care. Cardiac surgery represents one of the highest consumers of blood products globally, with transfusion rates reported to range between 40% and 60% of patients depending on procedural complexity and institutional practices (Murphy et al., 2017; Paone et al., 2014). This high utilization translates into significant direct and indirect healthcare costs.

Economic evaluations reveal that the true cost of blood transfusion far exceeds the direct acquisition price of blood products. Activity-based costing studies indicate that the total cost of a single unit of red blood cells includes donor recruitment, screening, infectious disease testing, processing, storage, transportation, crossmatching, administration, monitoring, and management of transfusion-related adverse events. When these components are included, the estimated cost per unit ranges from approximately USD 700 to USD 1,000 in high-income healthcare systems (Shander et al., 2022; Jadwin et al., 2023). In cardiovascular surgery, where patients often receive multiple units, cumulative transfusion costs can represent a substantial proportion of total perioperative expenditure.

Transfusion exposure is linked to longer hospital stays, according to secondary data. Transfused patients often spend more time in the hospital and spend more time in the critical care unit than non-transfused patients, according to registry-based analyses and big cohort studies (Murphy et al., 2017). The increased use of nursing care, diagnostics, pharmaceuticals, and supportive treatments, all of which lead to longer hospital stays and, by extension, higher healthcare expenditures. According to Paine et al. (2014), there are observable increases in morbidity and resource use even when transfusing only one or two units of red blood cells.

In addition to length of stay, transfusion-related complications contribute significantly to economic burden. Secondary data demonstrate associations between transfusion and increased risk of postoperative infections, renal dysfunction, respiratory failure, stroke, and cardiac complications (Santos et al., 2014; Murphy et al., 2017). Management of these complications requires additional interventions, prolonged monitoring, and often readmission, thereby

increasing both direct and downstream healthcare costs. These findings indicate that conventional transfusion practices generate economic consequences that extend well beyond the immediate perioperative period.

Audits of transfusion appropriateness further highlight inefficiencies in traditional transfusion models. A multicenter review across 15 hospitals found that a significant proportion of transfusions did not meet established clinical criteria, indicating potentially avoidable blood use (Jadwin et al., 2023). Such unnecessary transfusions represent preventable costs and reflect opportunities for improved resource stewardship. Collectively, secondary data establish that conventional transfusion practices in cardiovascular surgery are associated with high and often underestimated economic burden at both institutional and health system levels.

Reduction in Blood Product Utilization Following PBM Implementation

Study consistently demonstrate that implementation of Patient Blood Management programs leads to substantial reductions in the utilization of allogeneic blood products in cardiovascular surgery. Across multiple healthcare systems, PBM adoption has been associated with significant decreases in red blood cell, plasma, and platelet transfusion rates (Leahy et al., 2017; Hofmann et al., 2020).

Large-scale observational studies indicate that hospital-wide PBM programs can reduce red blood cell transfusion rates by 30–40%, with even greater reductions reported for plasma and platelet use (Leahy et al., 2017). In cardiovascular surgery specifically, implementation of PBM strategies such as preoperative anemia optimization, intraoperative cell salvage, antifibrinolytic therapy, and restrictive transfusion thresholds has been associated with marked reductions in transfusion exposure without compromising patient outcomes (Tibi et al., 2021).

Secondary analyses from national and regional PBM initiatives further support these findings. In Western Australia, statewide PBM implementation resulted in a 41% reduction in red blood cell use, a 47% reduction in plasma transfusions, and a 27% reduction in platelet transfusions over several years (Pavenski et al., 2022). These reductions were observed across multiple surgical specialties, including cardiac surgery, which traditionally accounts for a disproportionate share of blood utilization.

Evidence from cardiovascular surgery–specific cohorts demonstrates that PBM-driven reductions in transfusion are sustained over time. Studies report continued declines in blood product use several years after PBM implementation, suggesting durable changes in clinical

practice rather than short-term effects (Hofmann et al., 2021). These findings indicate that PBM contributes to long-term optimization of transfusion practices and improved resource utilization.

Table 1: Reduction in Blood Product Utilization Following PBM Implementation

Blood Product	Reported Reduction After PBM Implementation	Study
Red blood cells (RBCs)	30–40% reduction in utilization	(Leahy et al., 2017)
Plasma	Up to 47% reduction	(Pavenski et al., 2022)
Platelets	Approximately 27% reduction	(Pavenski et al., 2022)
Overall transfusion exposure in cardiac surgery	Significant and sustained reduction without adverse outcomes	(Tibi et al., 2021; Hofmann et al., 2021)
Long-term sustainability	Continued reduction several years after implementation	(Hofmann et al., 2021)

Table summarizes reductions in blood product utilization reported following implementation of Patient Blood Management programs in cardiovascular surgery. Across multiple studies, PBM adoption is consistently associated with substantial decreases in RBC, plasma, and platelet transfusions, with evidence indicating that these reductions are sustained over time without adverse effects on clinical outcomes.

Economic Impact of Preoperative Anemia Management

Preoperative anemia is a common clinical condition among patients undergoing cardiovascular surgery and represents a significant determinant of perioperative blood transfusion and healthcare expenditure. Evidence indicates that anemic patients have a higher likelihood of requiring allogeneic blood transfusions, which are associated with increased postoperative morbidity, prolonged hospital stays, and elevated treatment costs (Ivascu Girardi et al., 2023).

The presence of anemia prior to surgery therefore contributes substantially to the overall economic burden of cardiovascular surgical care.

Transfusion exposure during cardiac surgery may be independently predicted by preoperative anemia, according to many studies. Even mild degrees of anemia have been shown to increase the probability of receiving red blood cell transfusions, leading to higher direct costs related to blood products as well as indirect costs linked to transfusion-associated complications (Paone et al., 2014). Given that transfusion-related expenses extend beyond acquisition to include testing, administration, monitoring, and management of adverse events, anemia-driven transfusion practices represent a major and potentially preventable source of healthcare spending.

Interventions aimed at early identification and treatment of anemia have been shown to significantly reduce perioperative transfusion requirements. Preoperative anemia management strategies, particularly the use of intravenous iron therapy, have demonstrated effectiveness in improving hemoglobin levels and decreasing the need for intraoperative and postoperative blood transfusions (Warner et al., 2022). Although such interventions involve initial investment in diagnostics and treatment, economic evaluations consistently show that these costs are offset by reductions in blood product utilization and improved perioperative efficiency.

Improved postoperative outcomes further contribute to the economic benefits of anemia management. Patients who receive targeted preoperative treatment exhibit lower rates of postoperative complications, reduced need for prolonged mechanical ventilation, and shorter intensive care unit stays (Murphy et al., 2017). These improvements in recovery translate into decreased length of hospitalization, which is a major driver of surgical costs, particularly in resource-intensive cardiovascular care settings.

From an institutional perspective, anemia management programs demonstrate favorable budgetary outcomes. Hospitals implementing structured preoperative anemia pathways report measurable reductions in transfusion-related expenditures and complication-associated costs. Analyses indicate that the financial benefits of these programs often outweigh their implementation costs within a relatively short timeframe, especially in high-volume cardiovascular surgery centers (Frank et al., 2024). Such findings highlight the financial feasibility and sustainability of anemia management as part of perioperative care.

Overall, effective preoperative anemia management emerges as a clinically and economically valuable component of PBM in cardiovascular surgery. By reducing transfusion dependence, minimizing postoperative complications, and shortening hospital stays, anemia management contributes substantially to cost containment and improved resource utilization. These outcomes support the integration of systematic anemia screening and treatment into standard preoperative protocols as a high-value strategy within modern cardiovascular surgical practice (Ivascu Girardi et al., 2023; Warner et al., 2022).

Impact of PBM on Postoperative Complications and Resource Utilization

Implementation of PBM has been consistently associated with a reduction in postoperative complications that significantly influence healthcare costs in cardiovascular surgery. Clinical studies report lower rates of infectious complications, acute kidney injury, prolonged mechanical ventilation, and reoperation for bleeding among patients managed under PBM-oriented protocols compared with conventional transfusion-based care (Murphy et al., 2017; Meybohm et al., 2017). These reductions in morbidity contribute directly to improved postoperative recovery and decreased consumption of healthcare resources.

Blood transfusion has been identified as an independent risk factor for adverse postoperative outcomes in cardiac surgery. Evidence indicates that exposure to allogeneic blood products increases the likelihood of immunologic and inflammatory responses, which may predispose patients to infection, organ dysfunction, and delayed recovery (Murphy et al., 2017). By minimizing unnecessary transfusions, PBM strategies reduce patient exposure to these risks, thereby lowering complication-related treatment requirements and associated costs.

Reduced postoperative complications under PBM protocols translate into significant decreases in intensive care utilization. Studies have demonstrated that patients managed with PBM experience shorter durations of mechanical ventilation and reduced lengths of stay in the intensive care unit, both of which are major cost drivers in cardiovascular surgical care (Leahy et al., 2017). Shorter ICU stays allow more efficient use of critical care resources and contribute to overall reductions in hospital expenditure.

Hospital length of stay is another important determinant of surgical costs influenced by PBM implementation. Evidence suggests that improved hemostatic management, reduced transfusion-related morbidity, and enhanced postoperative recovery collectively contribute to shorter overall hospitalization (Meybohm et al., 2017). Even modest reductions in length of

stay have substantial economic implications in high-cost settings such as cardiac surgery, where daily inpatient care incurs significant expense.

In addition to clinical benefits, PBM enhances operational efficiency within surgical and transfusion services. Reduced reliance on blood products decreases demand on hospital blood banks, lowers wastage due to product expiration, and reduces the frequency of urgent blood product requests during surgery (Hofmann et al., 2021). These improvements support more predictable perioperative workflows and improved coordination between surgical, anesthetic, and transfusion teams.

Overall, the integration of PBM into cardiovascular surgical practice leads to meaningful reductions in postoperative complications and more efficient utilization of healthcare resources. By improving patient outcomes while simultaneously decreasing intensive care use, hospital length of stay, and transfusion-related demands, PBM strengthens both clinical effectiveness and economic efficiency. These findings reinforce the role of PBM as a central component of value-based perioperative care in cardiovascular surgery (Leahy et al., 2017; Hofmann et al., 2021).

Cost-Effectiveness and Budget Impact of PBM Programs

Economic evaluations consistently demonstrate that Patient Blood Management programs offer favorable cost-effectiveness profiles in cardiovascular surgical care. Institutional analyses report that implementation of PBM is associated with significant net cost savings, even after accounting for expenses related to staff training, infrastructure development, anemia management services, and clinical pathway redesign (Leahy et al., 2017). These savings are primarily driven by reductions in blood product utilization, lower rates of transfusion-related complications, and improved efficiency in perioperative care delivery.

Return-on-investment assessments provide further evidence supporting the financial viability of PBM programs. Studies indicate that comprehensive PBM implementation can achieve cost recovery within relatively short timeframes, often within 12 to 18 months of initiation. (Frank et al., 2024) reported a greater than sevenfold return on investment following implementation of a multidisciplinary PBM program, with cost savings resulting from reduced transfusion expenditures, decreased intensive care utilization, and improved postoperative outcomes. These findings highlight PBM as a financially sustainable intervention rather than a cost-adding initiative.

Cost-effectiveness outcomes associated with PBM extend beyond direct hospital expenditures. By reducing postoperative morbidity and length of hospital stay, PBM programs lower downstream healthcare costs associated with readmissions, prolonged rehabilitation, and management of transfusion-related adverse events (Murphy et al., 2017). These broader economic benefits reinforce the value of PBM as an intervention that improves both short-term surgical outcomes and long-term healthcare efficiency.

At the health system level, large-scale PBM initiatives have demonstrated substantial cumulative budgetary benefits. Provincial and national PBM programs report sustained reductions in blood utilization across surgical specialties, contributing to improved sustainability of blood supply systems and reduced dependence on donor recruitment and processing infrastructure (Pavenski et al., 2022). Such system-wide efficiencies are particularly important in the context of aging populations and increasing demand for cardiovascular surgical services.

Economic benefits of PBM are also evident across diverse healthcare settings. Evidence from both high-income and middle-income countries indicates that PBM programs can be adapted to local resource constraints while still achieving meaningful cost savings and improved clinical outcomes (Leahy et al., 2017). This adaptability underscores the scalability of PBM and its relevance to a wide range of healthcare systems with varying economic capacities.

Overall, findings from economic and budget impact analyses confirm that PBM programs represent a cost-effective and economically sustainable approach to cardiovascular surgical care. By aligning reductions in transfusion use with improved patient outcomes and efficient resource utilization, PBM supports value-based healthcare delivery and responsible financial stewardship. These results justify continued investment in PBM as a core component of modern cardiovascular surgery pathways (Frank et al., 2024; Pavenski et al., 2022).

Table 2: Economic Outcomes and Cost-Effectiveness of PBM

Outcome	Impact of PBM	Key Evidence
Blood transfusion costs	Reduced blood product expenditure	(Leahy et al., 2017)
Length of hospital stay	Shorter ICU and hospital stay	(Murphy et al., 2017)

Postoperative complications	Lower complication-related costs	(Santos et al., 2014)
Return on investment	Greater than sevenfold return on investment	(Frank et al., 2024)
Cost recovery time	Initial implementation costs recovered within 12–18 months	(Leahy et al., 2017)
System-level savings	Sustained budgetary benefits	(Pavenski et al., 2022)

Table presents key economic outcomes and cost-effectiveness indicators associated with Patient Blood Management implementation. The summarized evidence demonstrates that PBM reduces transfusion-related expenditures, shortens hospital length of stay, lowers complication-associated costs, and delivers favorable returns on investment, supporting PBM as a high-value and economically sustainable intervention in cardiovascular surgery.

System-Level Economic and Sustainability Outcomes

Patient Blood Management plays a critical role in improving the economic sustainability of healthcare systems by reducing dependence on allogeneic blood transfusions. Blood products are finite resources that require complex and costly processes for donor recruitment, testing, processing, storage, and distribution. Increasing surgical demand, aging populations, and declining donor participation have intensified pressures on national blood supply systems, raising concerns regarding the long-term feasibility of transfusion-dependent models of care (Saillant et al., 2022). By reducing unnecessary blood utilization, PBM contributes to more efficient and sustainable management of these limited resources.

Reductions in blood demand achieved through PBM have important economic implications at the system level. Lower transfusion requirements decrease the need for donor recruitment campaigns, reduce processing and storage costs, and limit losses related to blood product expiration. These effects generate cumulative cost savings across healthcare systems, particularly in high-volume specialties such as cardiovascular surgery, which traditionally account for a disproportionate share of blood consumption (Shander et al., 2022). Improved efficiency in blood utilization also enhances the resilience of healthcare systems during periods of supply disruption or increased clinical demand.

System-wide implementation of PBM programs has been associated with sustained reductions in blood product use across multiple institutions and regions. Large-scale initiatives demonstrate that standardized PBM policies lead to consistent practice patterns, improved compliance with transfusion guidelines, and long-term reductions in overall blood utilization (Pavenski et al., 2022). These outcomes support more predictable planning for blood services and reduce the financial volatility associated with fluctuating supply and demand.

International health organizations have increasingly emphasized PBM as a cornerstone of sustainable healthcare delivery. Policy documents and clinical guidelines identify PBM as a strategy that simultaneously improves patient safety and promotes responsible use of healthcare resources. The World Health Organization recognizes PBM as a global patient safety priority with significant economic implications, particularly in resource-intensive fields such as cardiovascular surgery (WHO, 2025). Alignment with such policy frameworks strengthens the case for widespread adoption of PBM at institutional and national levels.

Beyond direct financial savings, PBM contributes to broader societal and economic benefits. Reduced transfusion-related morbidity leads to faster recovery, fewer readmissions, and improved functional outcomes, which may decrease indirect costs associated with prolonged rehabilitation and loss of productivity. At a population level, these benefits support more efficient allocation of healthcare resources and improved access to care for other patient groups.

Overall, Patient Blood Management supports system-level economic sustainability by reducing reliance on limited blood supplies, lowering transfusion-related expenditures, and enhancing resilience of healthcare delivery systems. By aligning improved clinical outcomes with efficient resource utilization and international policy priorities, PBM represents a sustainable and forward-looking approach to cardiovascular surgical care and broader health system management (Saillant et al., 2022; WHO, 2025).

CONCLUSION

The evidence synthesized in this study confirms that Patient Blood Management is both clinically effective and economically advantageous in cardiovascular surgery. By reducing unnecessary transfusions, minimizing postoperative complications, and improving efficiency in perioperative care, PBM significantly lowers healthcare costs while enhancing patient safety and outcomes. Preoperative anemia management emerges as a particularly impactful

component, yielding substantial reductions in transfusion-related expenditure and resource utilization. At both institutional and system levels, PBM supports healthcare sustainability by alleviating pressure on limited blood supplies and delivering strong returns on investment. These findings underscore the need for broader, systematic implementation of PBM as a core element of value-based cardiovascular surgical care and responsible health system stewardship.

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