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Budget Impact Analysis of Implementing Patient Blood Management in the Cardiovascular Surgery Department of a Turkish Private Hospital

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Purpose: In cardiovascular surgeries, iron deficiency anemia and transfusion of blood products are associated with mortality and morbidity, prolonged hospital stay and poor patient outcomes. Patient blood management (PBM) is a patient-centered approach based on a 'three pillar' model that promotes optimum use of blood and blood products to improve outcomes. This study assessed the potential budget impact of implementing PBM in patients undergoing elective cardiovascular surgery in a private hospital in Turkey.
Methods: Two models were developed to estimate the hospital budget impact of PBM. The first model encompassed implementation of the first pillar of PBM, which proposes treatment of iron deficiency anemia before a surgical procedure. The second covered implementation of all three pillars of PBM. Budget impact was estimated from the number of avoided complications after treating iron deficiency anemia and reducing blood transfusions. Rates of complication (sepsis, myocardial infarction, renal failure and stroke) with and without PBM were taken from published meta-analyses. Data on 882 cardiovascular operations performed during 2020–2022 were taken from the Florence Nightingale Istanbul Hospital. The costs of treating complications were estimated by applying Turkish Social Security Institution prices to a healthcare resource utilization tool for each complication completed by experts.
Results: Results from the budget impact analysis showed that, by implementing the first pillar of PBM, the department could have avoided 30 complications and saved 4,189,802 TRY. For the second model based on implementing all three pillars of PBM, 29 complications could have been avoided by reducing the number of transfusions, with budget savings of 6,174,434 TRY. Reducing the length of hospital stay could have enabled 137 additional operations in the given period.
Conclusion: Implementation of PBM in patients undergoing elective cardiovascular surgery in private hospitals could be a budget-saving strategy in Turkey and may provide an opportunity to increase revenue.
Keywords: patient blood management, budget impact, anemia, cardiovascular surgery, healthcare resource utilization, Turkey

Introduction

The practice of patient blood management (PBM), which enforces optimum use of blood and blood products to improve patient outcomes, has been developed since the early 2000s. The three pillars of PBM are (i) optimizing erythropoiesis and correction of anemia; (ii) optimizing hemostasis and minimizing blood loss; and (iii) harnessing patient-specific physiological reserves to avoid anemia.[1–3] Relying on a patient's own blood and reducing the need for transfusion during the perioperative period are considered key components of PBM.[4]

PBM can be adopted as a national policy and can also be adopted at the institutional level. The World Health Organization (WHO) urged its member states to embark on PBM initiatives as a new standard of care in 2010.[5] However, although there are good examples of PBM implementation at an institutional level, uptake of the WHO recommendation at a national level has been slow. The Australian PBM initiative[6] is often cited as a good example of PBM implementation at this level. Although there are only a few national PBM initiatives, the institutional examples have already provided sufficient evidence that PBM improves patient outcomes by decreasing the need for transfusion and reducing

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morbidity and mortality.[7] It has also been shown to contribute to improvements in the financial outlook of a healthcare system or an institution by reducing length of hospital stay and costs.[8]

The first pillar of PBM entails optimizing erythropoiesis. Preoperative iron deficiency anemia before a planned surgery is considered an important risk factor for complications and increased transfusion rates. Several studies have shown the negative impact of preoperative iron deficiency anemia on patient outcomes and other measures related to their care (for example, length of hospital stay), both at the national and institutional levels.[9–17] Preoperative anemia also increases the risk of blood transfusion in the perioperative period which itself is considered to be an important determinant of morbidity and mortality.[14–16,18–27] The second and third pillars of PBM focus on minimizing blood loss and bleeding during the operation, and harnessing and optimizing patient-specific reserve to reduce the risk of anemia during treatment. Strategies that can be adapted for the second and third pillar of PBM include optimizing coagulopathy with treatment options such as anticoagulant reversal, clotting factor concentrates, antifibrinolytic agents and minimizing blood loss, allogenic blood transfusion by blood-sparing surgical techniques or cell salvage, and implementing a patient-specific blood management plan.[2,28]

In addition to its negative impact on clinical outcomes, iron deficiency anemia and transfusion can increase the cost burden. Iron deficiency anemia can cause complications in the postoperative period, and treatment costs of these complications can be substantial. As well as the cost of the blood products and transfusions, transfusion-related complications and prolonged length of stay can also contribute to unnecessary and avoidable costs.

Cardiovascular surgery is an area of special interest for PBM for two main reasons. First, preoperative iron deficiency anemia is highly prevalent among adult cardiac surgery patients, with an estimated prevalence of 20–30% using the WHO's definition of anemia.[8] Second, blood loss in cardiac surgery is typically higher than in other types of surgery. For instance, about 10% of cardiovascular surgery patients experience excessive bleeding,[29] leading to higher demand for red blood cell (RBC) transfusions.[11,30–32]

To the best of our knowledge, this is the third study to investigate the budget impact of PBM in the Turkish healthcare context. In the first study,[33] the potential cost-saving of implementing the first pillar of PBM in the Turkish healthcare system was assessed. An evidence-based hypothetical model, focused on potential savings from avoiding postoperative complications via implementation of preoperative treatment of iron deficiency anemia, was developed. In this analysis, complication probabilities were derived from a published meta-analysis.[34] The second study assessed the potential cost savings from both RBC transfusions and transfusion-related complications by using pre- and post-PBM data from a Turkish public hospital.[35] This third study aims to assess the potential budget impact of implementing PBM in all patients undergoing elective cardiovascular surgery at a Turkish private hospital without a standardized PBM program.

Materials and Methods

The potential budget impact of implementing PBM in the Florence Nightingale Istanbul Hospital was assessed using overall hospital data from the cardiovascular surgery department. Thereafter, two budget impact models based on the overall hospital data were designed. In the first model, the budget impact of implementing the first pillar of PBM in the cardiovascular surgery department was estimated on the basis of the number of avoided complications based on postoperative complication rates (sepsis with and without pneumonia, renal failure, myocardial infarction and stroke) reported in the meta-analysis by Kleinerüschkamp et al (Table S1).[34] These rates were applied to data from the cardiovascular surgery department to calculate the number of complications that could have been avoided if the first pillar of PBM had been implemented in all patients undergoing elective cardiovascular surgery.

The second budget impact model incorporated the potential impact of implementing all three pillars of PBM in all cardiovascular surgery patients on the number of RBC transfusions and complications. Transfusion rates following cardiac surgery were taken from the Althoff et al meta-analysis, which identified rates of 55.2% for the no-PBM group and 39.1% for the PBM group.[36] These rates were used to calculate the number of patients who could be exposed to RBC transfusion in the department. Complication rates caused by RBC transfusion were taken from the meta-analysis results by Ferraris et al (Table S2).[37]

Data Sets

Two data sets were used from the hospital. The data were analyzed at the aggregate level rather than patient level; consequently, no association with patients was made and therefore average values were used. The first data set comprised a random sample of 302 patients who underwent operations in the cardiovascular department during the period 2018–2021. These data cover 22.3% of all cardiovascular surgeries from 2018 to 2021 and were used to estimate hospital-specific data (eg, percentage of patients with iron deficiency anemia, number of transfused RBC units, length of stay). The second data set comprised the total number of cardiovascular surgeries in the period 2020–2022 and their occurrence in Social Security Institution (SSI) patients. This period was specifically chosen because the hospital signed an agreement with the SSI in 2020. There were 882 cardiovascular operations in the hospital during this period, of whom 280 were SSI patients. Figure 1 presents the budget impact models used in the analysis of the second data set.

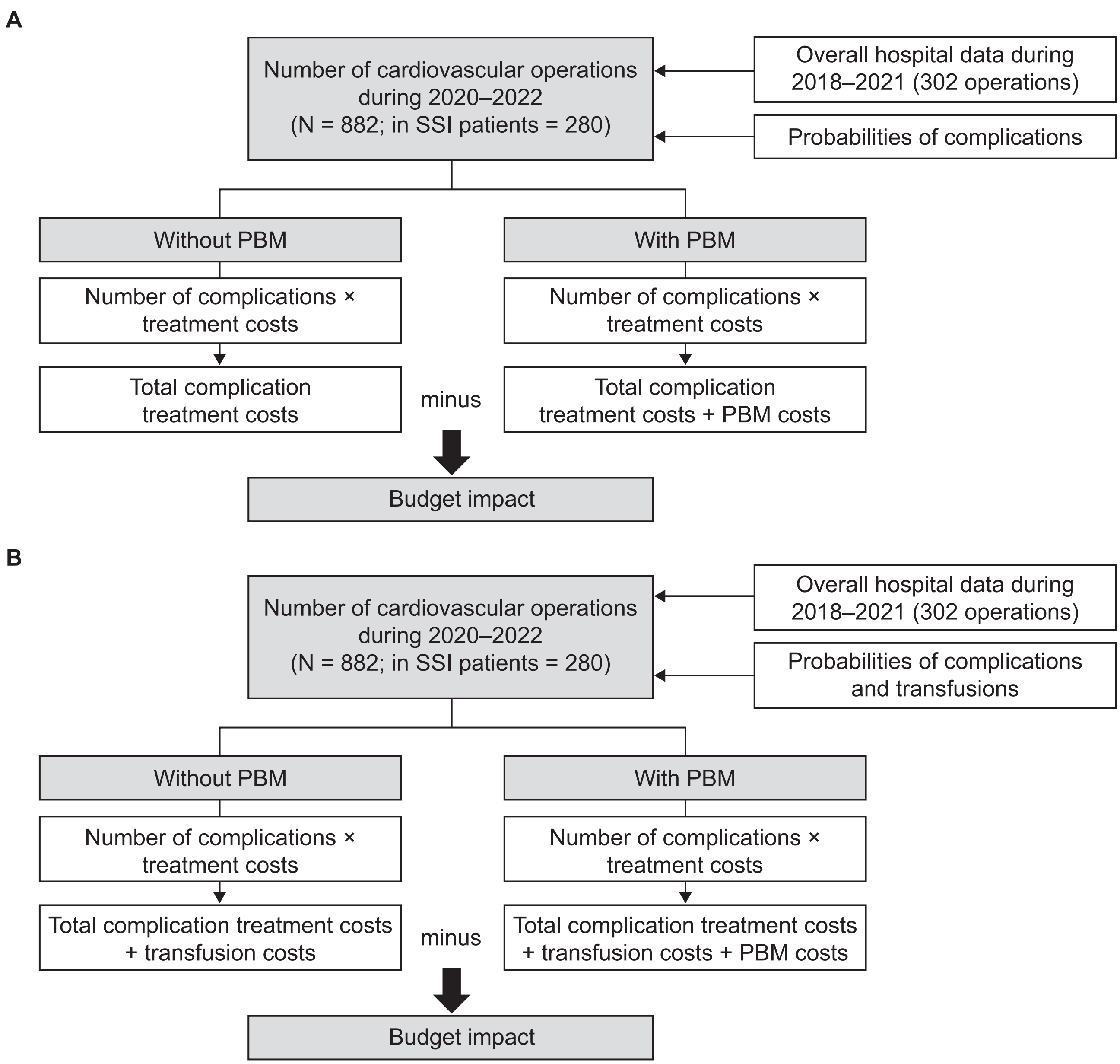

Figure 1 Budget impact model for implementing (**A**) the first pillar of PBM and (**B**) all pillars of PBM according to transfusion data during 2020–2022.
Abbreviations: PBM, patient blood management; SSI, Social Security Institution.

Cost Estimation

The SSI prices were used to estimate cost components of the model because the hospital micro-costing data were not available. The SSI is the main public payer organization in Turkey, covering 90% of the population, and sets reimbursement prices; as private hospital costs are higher, they are permitted to charge SSI patients up to 200% of the SSI prices. The major cost parameters were the following: (i) cost of treating iron deficiency anemia; (ii) cost of treating complications; and (iii) cost of transfusion. A healthcare resource utilization tool was developed for each complication. The tool for each complication was completed by experts, and the resources used to treat these events were identified. After identifying the type, duration and frequency of resources used in the treatment of complications, the SSI guidelines and price tariffs were used to calculate the overall cost of treating complications (Table S3). Iron deficiency anemia was assumed to be treated with 1000 mg (2 × 500 mg vials) of intravenous ferric carboxymaltose (FCM; Inferject, Vifor Pharma). The public price of the product was 1181.89 TRY/vial as of May 7, 2023.

Results

Hospital Data from the Cardiovascular Surgery Department During 2018–2021

During 2018–2021, 1354 operations were undertaken in the cardiovascular surgery department. Patient data obtained from the hospital included information from 302 patients (22.3% of all cardiovascular surgery patients) (Table 1). Of these, 70% were male and 30% were female, and the mean age was 60.9 years (males: 60.4 years; females: 62.0 years). Coronary artery bypass grafting (CABG) was the most commonly performed procedure (48%), followed by cardiac valve operations (33%) and CABG plus cardiac valve operations (9%).

Overall, 55.6% (168/302) of patients underwent RBC transfusion, with a mean of 2.26 RBC units transfused per patient. Based on the WHO criteria (hemoglobin <12 g/dL for women and <13 g/dL for men), 82 patients (27.2%) had iron deficiency anemia in the preoperative period, of whom 58.5% (48/82) underwent RBC transfusion. The data in Table 1 provide the inputs for hospital-specific data, which were applied to the total number of cardiovascular operations during 2020–2022.

Budget Impact of Implementing the First Pillar of PBM

Complication rates of preoperative iron deficiency anemia were taken from the meta-analysis by Kleinerüschkamp et al,[34] who identified rates of 18.7% without PBM and 6.3% with PBM (Table S1). There were 882 cardiovascular operations in the hospital during 2020–2022 and, according to the aforementioned hospital patient data, 27% of these were assumed to be anemic (238 patients). Tables 2 and 3 present the estimated complication rates and budget impact of implementing the first pillar of PBM for this time period. If the first pillar of PBM had been implemented in the hospital in all cardiovascular surgery patients, 30 complications could have been avoided in the given period (Table 2). The total

Table 1 Comparison of Patient Data for Preoperatively Anemic and Non-Anemic Patients Undergoing Cardiovascular Operations in the Florence Nightingale Istanbul Hospital During 2018–2021

	Anemic Patients (n = 82)	Non-Anemic Patients (n = 220)	All Patients (N = 302)
RBC transfusions, n (%)	48 (58.5)	120 (54.5)	168 (55.6)
RBC units per patient, n, mean	2.79	2.03	2.26
Length of stay for all patients, days, mean	12.27	9.22	9.98
Length of stay for patients with transfusions, days, mean	11.1	9.50	9.95
ICU length of stay for all patients, days, mean	2.52	2.15	2.29
ICU length of stay for patients with transfusions, days, mean	1.98	2.50	2.45

Abbreviations: ICU, intensive care unit; RBC, red blood cell.

Table 2 Estimated Complication Rates with and without Implementation of the First Pillar of PBM for Cardiovascular Operations in the Florence Nightingale Istanbul Hospital During 2020–2022 (n = 882)

Complication	Without PBM (n = 882)	With PBM (n = 882)
Sepsis with pneumonia, n (%)	15 (1.7)	6 (0.7)
Sepsis without pneumonia, n (%)	11 (1.2)	5 (0.6)
Acute renal failure, n (%)	6 (0.7)	2 (0.2)
Acute myocardial infarction, n (%)	7 (0.8)	0
Acute stroke, n (%)	5 (0.6)	2 (0.2)
Total (any complication), n (%)	45 (5.1)	15 (1.7)

Note: Values may not sum to total due to rounding.
Abbreviation: PBM, patient blood management.

Table 3 Budget Impact of Implementing the First Pillar of PBM for Cardiovascular Operations in the Florence Nightingale Istanbul Hospital During 2020–2022 (n = 882)

	Cost of Treatment without PBM, TRY	Cost of Treatment with PBM, TRY	Budget Impact of Complications, TRY
Sepsis with pneumonia, n	420,202	171,842	−248,360
Sepsis without pneumonia, n	258,031	105,461	−152,570
Acute renal failure, n	5,627,740	2,116,030	−3,511,710
Acute myocardial infarction, n	406,897	9400	−397,497
Acute stroke, n	678,140	235,564	−442,576
Total (any complication), n	7,391,011	2,638,298	−4,752,713
Cost of PBM, TRY			562,911
Total budget saving with PBM, TRY			4,189,802
Total budget saving with PBM, €			194,460

Note: Turkish Central Bank exchange rate on May 5, 2023: €1 = 21.5459 TRY.
Abbreviation: PBM, patient blood management.

savings with SSI prices would have amounted to 4,189,802 TRY (€194,460) (Table 3). In the given period, 28% of the patients undergoing a cardiovascular operation were SSI patients.

Budget Impact of Implementing All Pillars of PBM According to Transfusion Data

In the second budget impact model, complications caused by RBC transfusion were used in calculations. Transfusion rates associated with and without PBM were taken from Althoff et al[36] and complication rates after transfusion were taken from Ferraris et al (Table S2).[37] In the Althoff et al meta-analysis, 55.2% of patients undergoing cardiac surgery required transfusion without implementation of PBM,[36] which aligns with the current data set (57%). This analysis found that 29 complications caused by RBC transfusions could have been avoided with the implementation of PBM in all cardiovascular surgery patients (Table 4).

Table 5 presents the budget impact of implementing PBM in the Florence Nightingale Istanbul Hospital after applying the treatment costs of complications for all cardiovascular surgery patients. If PBM had been implemented, thus reducing the need for RBC transfusions, the savings could have reached 6,174,434 TRY (€286,571). As was the case for the previous analysis, this is an underestimation of savings because the analysis is based on SSI prices which were set up to be below hospital prices.

Table 4 Estimated Transfusion and Complication Rates with and without PBM for Cardiovascular Operations in the Florence Nightingale Istanbul Hospital During 2020–2022

	Without PBM (n = 882)	With PBM (n = 882)
Transfusion, n (%)	488 (55.3)	345 (39.1)
No transfusion, n (%)	394 (44.7)	537 (60.9)
Complication, n (%)		
Sepsis	53 (6.0)	37 (4.2)
Renal failure	19 (2.2)	13 (1.5)
Myocardial infarction	18 (2.0)	13 (1.5)
Stroke	7 (0.8)	5 (0.6)
Total (any complication)	97 (11.0)	68 (7.7)

Abbreviation: PBM, patient blood management.

Table 5 Budget Impact of Implementing PBM for Cardiovascular Operations in the Florence Nightingale Istanbul Hospital During 2020–2022 (n = 882)

	Cost of treatment without PBM, TRY	Cost of treatment with PBM, TRY
Sepsis	1,184,588	837,691
Renal failure	17,987,759	12,720,194
Myocardial infarction	1,018,033	719,911
Stroke	1,023,793	723,984
Total complication costs	21,214,173	15,001,780
Total cost of transfusion	1,471,232	1,509,191
Total	22,685,405	16,510,971
Total budget saving, TRY		6,174,434
Total budget saving, €		286,571

Note: Turkish Central Bank exchange rate on May 5, 2023: €1 = 21.5459 TRY.
Abbreviation: PBM, patient blood management.

Impact of Implementing PBM on Length of Stay

Table 6 presents the potential number of additional patients who could have been treated with the implementation of PBM in the hospital. The length of stay following cardiovascular surgery was 9.98 days from the hospital data. Althoff et al[36] concluded that PBM could save 1.34 days for cardiovascular patients. Therefore, length of stay with PBM was

Table 6 Expected Impact of Implementing PBM for Cardiovascular Operations on Length of Stay in the Florence Nightingale Istanbul Hospital

	Estimate
Time for each operation	
Length of stay from hospital data, days, mean	9.98
Number of days saved with PBM, days, mean[a]	1.34
Length of stay with PBM, days, mean[b]	8.64
Expected impact if PBM had been implemented for all patients during 2020–2022	
Number of days that could have been saved in all patients, days, mean[c]	1181.9
Number of additional patients who could have had an operation[d]	137

Notes: [a]From Althoff et al, 2019. [b]Calculated as 9.98 − 1.34. [c]Calculated as 882 operations × 1.34. [d]Calculated as 1181.9 ÷ 8.64.

calculated to be 8.64 days, and a further 137 patients could have potentially had an operation during 2020–2022 if PBM had been implemented for all cardiovascular surgery patients. The SSI makes a package payment for cardiovascular operations and the mean price for a cardiovascular operation is 24,239 TRY. Therefore, using SSI prices, the hospital could have earned an additional 3,320,743 TRY with the implementation of PBM. The hospital can charge the patient up to 200% of the SSI bill, which is paid directly by the patient as an out-of-pocket expense. When this additional 200% patient contribution (6,641,486 TRY) is added to this, the potential additional income would have reached 9,962,229 TRY. However, even with this additional patient contribution, this value is an underestimation because SSI prices are used in the analysis, and for non-SSI patients the fees can be even higher.

Discussion

There is already sufficient evidence to claim that PBM is a cost-saving option at the institutional level.[7,38–41] A decrease in use of blood and blood products and in costs after implementing a PBM program has also been observed in Turkish state hospitals.[42–44] Although PBM itself involves costs associated with acquisition of drugs and introduction of organizational changes, the cost savings to the healthcare system and hospitals can more than offset these additional costs.

Froessler et al estimated the economic consequences of perioperative administration using FCM versus usual care in patients with iron deficiency anemia undergoing elective abdominal surgery and concluded that FCM resulted in cost savings to hospitals.[45] According to their estimations, the mean costs per patient treated with FCM and usual care were €2461 and €3246, respectively, which translated to potential savings of €786 per patient.[45] The result was achieved with shorter length of stay for FCM patients. Mehra et al, in their prospective interventional cohort study with 101,794 patients, concluded that there was a 27% decrease in allogeneic blood transfusion after the implementation of a PBM program; this resulted in savings of direct transfusion costs totaling more than US$2,000,000 in 1 year.[39] Even a modest decrease in transfusion can lead to substantial budget savings.[46] A meta-analysis for PBM demonstrated both the clinical and economic value of the program. Meybohm et al, on the basis of the findings of Althoff et al,[36] performed a cost–benefit analysis to assess the economic impact of a PBM program and concluded that implementation of PBM in 235,779 surgical patients resulted in decreased RBC utilization and length of stay: the mean cost of transfusion per patient was reduced from €68.62 to €32.41, and there was a decrease in length of stay by 0.45 days, which resulted in cost savings of €114.43 per patient.[8] Taking the cost of PBM implementation into account, the overall benefit was found to be €21.60 per patient. In a similar approach by Drabinski et al, the researchers aimed to quantify the epidemiological and economic benefits of implementing the first pillar of PBM in the German healthcare system.[47] Their analysis was also based on treating preoperative iron deficiency anemia and avoiding RBC transfusions. They concluded that the hypothetical implementation of PBM would have resulted in estimated annual net hospital direct cost savings of €1029 million in the German healthcare system.[47]

This study shows the potential budget impact of implementing either the first pillar or all pillars of PBM in all elective cardiovascular surgery patients of a Turkish private hospital. In line with the current study, previous studies applying the same methodology in different settings have demonstrated the budget-saving impact of PBM in the Turkish healthcare system.[33,35] The first of these studies used a budget impact model to evaluate implementation of the first pillar of PBM in both cardiac and non-cardiac surgeries within the Turkish healthcare system, and found that PBM implementation was cost-effective for both types of surgery.[33] The second study evaluated cost-effectiveness of PBM in cardiovascular surgeries in a state hospital in Turkey following introduction of a new PBM system, demonstrating substantial savings over 20 months in the cardiovascular surgery department following PBM implementation.[35] In this analysis, the proportion of patients estimated to require blood transfusion were taken from the Althoff et al meta-analysis which found that 55.2% of patients undergoing cardiac surgery without PBM required transfusion;[36] this aligns with the current hospital data set (57%), indicating that this meta-analysis was an appropriate choice on which to base estimations.

Length of stay is an important throughput indicator in both assessing hospital efficiency and forecasting the number of patients to be treated in the hospital since it determines patient turnover. It is also more important for private hospitals because the number of patients impacts their income. The hospital has a contract with the Turkish SSI based on the prices of the institution to provide healthcare services to SSI patients, but the hospital can also charge patients up to 200% of the SSI bill as an out-of-pocket expense. Private hospitals can also charge SSI patients for accommodation facilities (up to three times the daily bed price of the SSI for rooms with one bed). For these reasons, patient turnover is important in financial terms.

PBM implementation can also result in substantial benefits for patients, by enabling them to avoid adverse outcomes associated with preoperative anemia and blood transfusion, such as hospital-acquired infections.[11,48] Avoidance of postoperative complications and good quality of recovery has also been associated with improved health-related quality of life following cardiac surgery.[49,50]

The results from this analysis show that the hospital could have saved about 4 million TRY by implementing the first pillar of PBM and about 6 million TRY by reducing RBC transfusions. In addition to this, 137 additional patients could have had an operation if PBM had been implemented in all cardiovascular surgery patients, generating a potential revenue of 3–9 million TRY. These figures are from only one surgical department of one private hospital. There were 571 private hospitals with 53,805 beds in Turkey in 2021,[51] indicating that introducing PBM in private hospitals could generate substantial savings to Turkish private hospitals. Moreover, all these cost savings are likely to be an underestimation since they are based on SSI tariffs, but only 28% of the patients undergoing a cardiovascular operation in the given period were SSI patients.

There are certain limitations to this study. First, the probabilities for complications with and without PBM are taken from published meta-analysis results, so any limitations applicable to those studies are also relevant to this study. Second, the costs associated with treating complications were estimated using expert opinion. In the absence of cost data, expert opinion is widely used in literature;[52–55] however, it has its own limitations. Third, the costs of treating complications were estimated using the SSI tariff because the private hospital data were not available; however, SSI prices are lower than the actual market prices for private hospitals, so all budget impact estimations are underestimations of real cost savings. Fourth, it was not possible to match patients in terms of demographic and clinical characteristics since all comparisons, with and without PBM, were made in the same cohort.

Conclusion

The results of the study have revealed that implementation of PBM in private hospitals is a budget-saving strategy in Turkey and could additionally provide an opportunity to increase revenue. For patients, PBM implementation can improve clinical outcomes and limit the risks associated with blood loss and transfusion of blood products.

Abbreviations

CABG, coronary artery bypass grafting; FCM, ferric carboxymaltose; PBM, patient blood management; RBC, red blood cell; SSI, Social Security Institution; WHO, World Health Organization.

Data Sharing Statement

All data generated or analyzed during this study are available within the main manuscript and supplementary materials.

Ethics Approval and Consent to Participate

Research guidelines for Turkey indicate that no ethics approval was required for the study design employed here. The study used an economic modelling approach with aggregate figures, not patient level data. The statistical data used presented no interference, and therefore ethics committee approval was waived. Appropriate permissions to use aggregate data from the hospital were obtained from the rector of Demiroğlu Bilim University, Prof. Dr. Çavlan Çiftçi, who is among the authors.

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Author Contributions

All authors made a significant contribution to the work reported, whether in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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