An Observational Study of Intraoperative Transfusion Management in a Cardiac Surgical Unit in Trinidad and Tobago

OJ Harrison[1], NC Rahaman[2]

ABSTRACT

Objective: *To investigate the intraoperative transfusion requirements in off-pump coronary artery bypass grafting (OPCABG) and the cost implication of blood products and cell savers on a background of limited resources.*

Methods: *Prospective data collection identified 60 patients undergoing OPCABG surgery at the Eric Williams Medical Sciences Complex, Trinidad and Tobago. Data relating to these patients (including preoperative haemoglobin (Hb), graft number, presence of diabetes, ejection fraction, preoperative serum creatinine, intraoperative blood use and blood loss) and costing for cell saver disposables and prepared donor (or allogenic) blood were obtained.*

Results: *Twenty units of packed red blood cells (pRBCs) were given in theatre to 27% (16 of 60) of patients. Transfusion requirement was significantly lower in patients with fewer grafts, higher pre-operative Hb level and non-diabetic patients. Cell saver disposables and one unit of pRBCs were estimated to cost TT$5000 and TT$1700, respectively. Each patient's transfusion cost TT$2125.00 per unit.*

Conclusion: *The study demonstrates the financial implications of routine cell saver use in OPCABG in a setting of limited resources. The cost-effectiveness of routine cell saver use remains to be elucidated, but we recommend the selective use of cell savers in patients who are at a higher risk for transfusion.*

Keywords: Cardiac surgery, cell saver, cost, transfusion

Estudio Observacional del Manejo de la Transfusión Intraoperatoria en una Unidad de Cirugía Cardíaca en Trinidad y Tobago

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RESUMEN

Objetivo: *Investigar los requisitos de la transfusión intra-operatoria en el bypass coronario con injerto sin circulación extracorpórea (OPCABG), y la implicación del costo de los hemoderivados y los recuperadores celulares en un contexto de recursos limitados.*

Métodos: *La recopilación de datos prospectivos identificó a 60 pacientes sometidos a cirugía OPCABG en el Complejo de Ciencias Médicas Eric Williams, en Trinidad y Tobago. Se obtuvieron datos en relación con estos pacientes (incluyendo la hemoglobina preoperatoria (Hb), número de injertos, presencia de diabetes, fracción de eyección, creatinina sérica preoperatoria, uso y pérdida de sangre preoperatorios) así como el costo de todos los recuperadores celulares desechables, y la sangre del donante preparada (o alogénica).*

Resultados: *Veinte unidades de glóbulos rojos empaquetados (pRBCs) fueron transfundidas en el salón de operaciones al 27% (16 de 60) de los pacientes. La necesidad de la transfusión fue significativamente más baja en los pacientes con menos injertos, nivel preoperatorio de hemoglobina (Hb) más alto, y en los pacientes no diabéticos. El costo de los recuperadores celulares desechables y una unidad de pRBCs fueron estimados en 5000 TTD y 1700 TTD, respectivamente. La transfusión de cada paciente costó 2125 TTD por unidad.*

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Conclusión: *El estudio demuestra las implicaciones financieras del uso de recuperadores celulares de rutina en el OPCABG en un contexto de recursos limitados. El costo-efectividad del uso de los recuperadores celulares de rutina sigue siendo un asunto que necesita aclaración. No obstante, se recomienda el uso selectivo de recuperadores de células en pacientes con alto riesgo a causa de la transfusión.*

Palabras claves: Cirugía cardíaca, recuperador celular, costo, transfusión

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INTRODUCTION

Patients undergoing cardiac surgery are among the biggest consumers of blood transfusions (including packed red cells, fresh frozen plasma and platelets) of all surgical patients. It is thought that a small proportion of these patients (10–20%) consume over three-quarters of the total blood products used in surgery (1).

In coronary revascularization, off-pump coronary artery bypass grafting (OPCABG) has been demonstrated to reduce blood transfusion requirement when compared to the "on-pump" procedure (2). This is a result of avoiding the complications of coagulopathy and haemodilution associated with cardiopulmonary bypass. This technique is now standard practice in many units including the Eric Williams Medical Sciences Complex (EWMSC), Trinidad and Tobago.

For blood to be used in cardiac surgery, it must first be donated. Trinidad and Tobago is still developing a completely voluntary national blood donation programme. Therefore, patients must find five different persons to donate blood *via* a "chit system" before their operation is scheduled. After giving blood, donors receive confirmation that they have donated blood (*ie* a "chit") which can then be given to the patient. A patient needs five "chits" to be accepted for surgery. This is further complicated by the stringent criteria which donors must fulfil before they can give blood, preventing many prospective donors from giving blood. There is also a potential for the selling of blood by unscrupulous donors to desperate patients. Once suitable donors are found, the collection, preparation and delivery of blood products represents a significant cost burden to the hospital. Preparation is particularly costly because each unit of blood must be screened for numerous infections.

Intraoperative cell salvage is a process where shed anticoagulated blood is washed and centrifuged, resulting in a suspension of red cells in saline that can be autotransfused. However, the cost-effectiveness of routine cell salvage remains to be elucidated for the routine use at the EWMSC.

The present study investigates the intraoperative blood transfusion management during OPCABG and its cost implication as compared to that if the cell saver was used at the EWMSC.

SUBJECTS AND METHODS

Data were collected prospectively from all patients undergoing elective open-heart surgery by the Caribbean Heart Care Medcorp team at the EWMSC between September 7 and December 16, 2009.

Parameters included patient demographics (age and gender), date of operation, operation performed, left ventricular function (percentage ejection fraction), number of grafts (for OPCABG), renal function (as preoperative serum creatinine), the presence of diabetes, the preoperative haemoglobin value and anticoagulation medication being taken prior to surgery. These data were collected preoperatively from the patient's case file. Intraoperative data included the estimated blood loss (including swabs) during the operation and the quantity and type of any blood products transfused during the operation. This information was collected from the anaesthetic charts.

Cost values for blood products were obtained from a senior clinician in the hospital blood bank. Costing for cell saver disposables was obtained from the stock manager within the Caribbean Heart Care unit.

Data analysis was performed using GraphPad Prism version 5.00 for Windows, (GraphPad Software, San Diego, California, USA; www.graphpad.com). *P*-values were calculated using simple *t*-tests, Chi-square analysis and Fisher's exact test.

RESULTS

Within the study period, 60 elective OPCABG procedures were performed. The age range of the patients in the cohort followed a normal distribution (Fig. 1). There was a male (62%) predominance (Fig. 2).

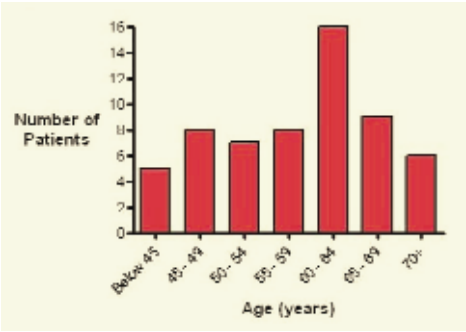

Fig. 1: The age distribution of the study sample.

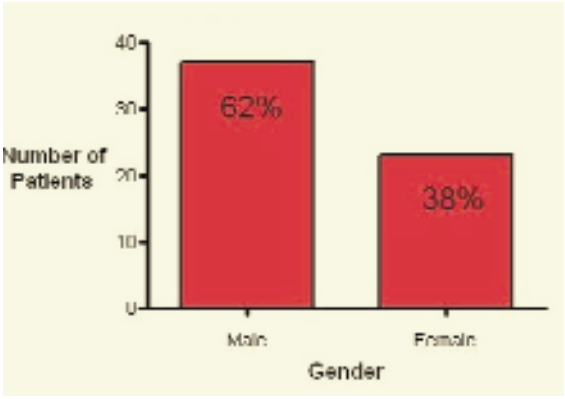

Fig. 2: The proportion of male and female patients in the study sample.

Mean average blood loss was calculated to be 499 millilitres. Sixteen (27%) of the 60 patients received blood transfusion (Fig. 3). All 16 patients had packed red blood

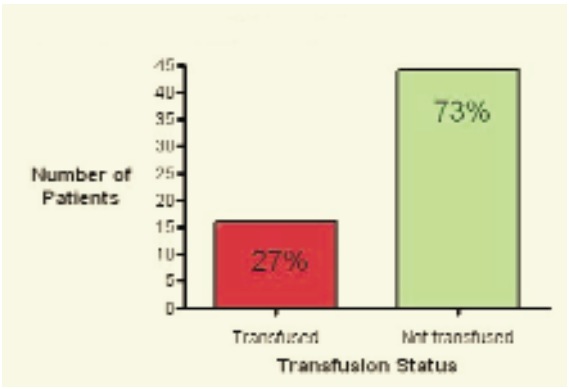

Fig. 3: The proportion of patients requiring blood transfusion in theatre.

cells (pRBC) transfusions totalling 20 units. Thirteen patients received one unit each, two patients received two units and one received three units (Fig. 4).

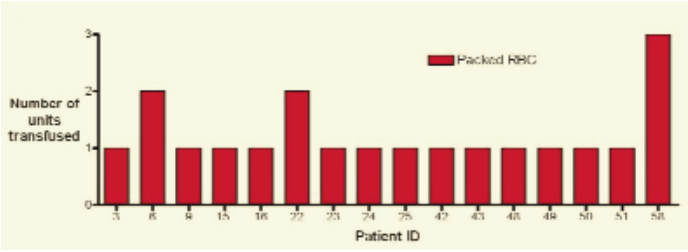

Fig. 4: The nature of transfusions given in theatre.

The data show a statistically significant difference between the proportion of patients receiving transfusions as graft number increased, $p = 0.0378$ (Fig. 5). One of six patients (16%) who had one graft, six of 24 (25%) with two grafts, 15 of 25 (60%) with three grafts and three of five (60%) with four grafts, required transfusion.

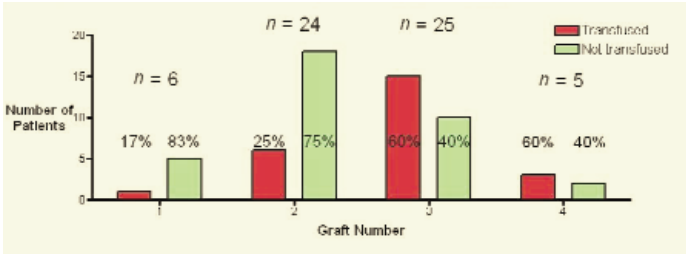

Fig. 5: How transfusion requirement varied with number of grafts performed.

Although no significant difference was found, the data suggest that a greater proportion of diabetic patients received blood transfusion compared to non-diabetic patients (42% *versus* 29%, respectively) [Fig. 6]. Graft number was not a confounding factor since analysis showed no significant difference between the graft number requirements of diabetic *versus* non-diabetic patients (Fig. 7).

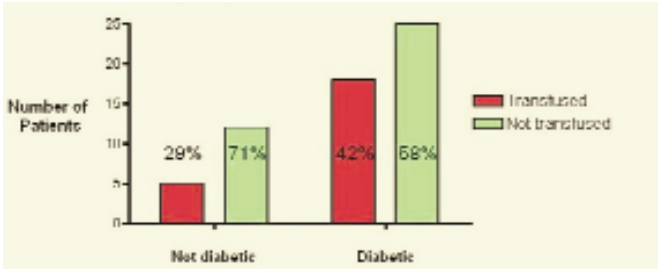

Fig. 6: The difference between transfusion rates in diabetic and non-diabetic patients.

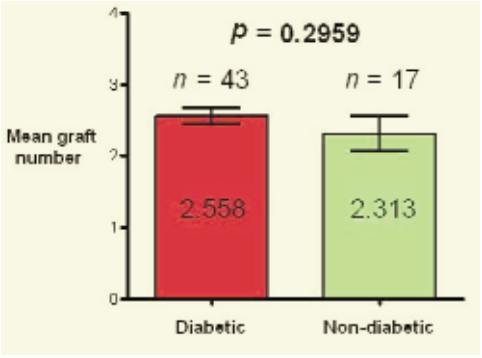

Fig. 7: The mean graft number requirement for diabetic and non-diabetic patients in the study sample.

Preoperative haemoglobin values for patients who received transfusion were significantly lower than those who did not require a transfusion, $p < 0.0001$ (Fig. 8).

There was no significant difference between the ejection fractions of patients that were transfused and not transfused, $p = 0.275$ (Fig. 9).

There was no significant difference between preoperative serum creatinine of patients that were transfused and not transfused, $p = 0.585$ (Fig. 10).

Preparation of whole blood was estimated to cost TT$1600 per unit including the cost of blood collection, pro-

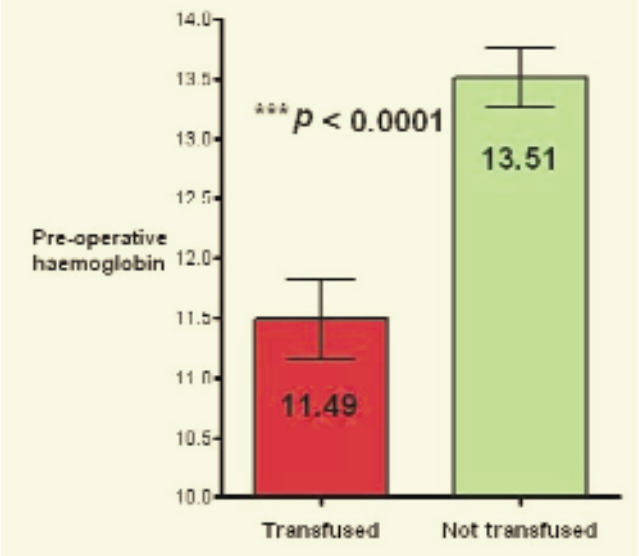

Fig. 8: The difference in preoperative haemoglobin values for patients who were transfused and those who were not transfused. ***$p < 0.0001$ is extremely significant.

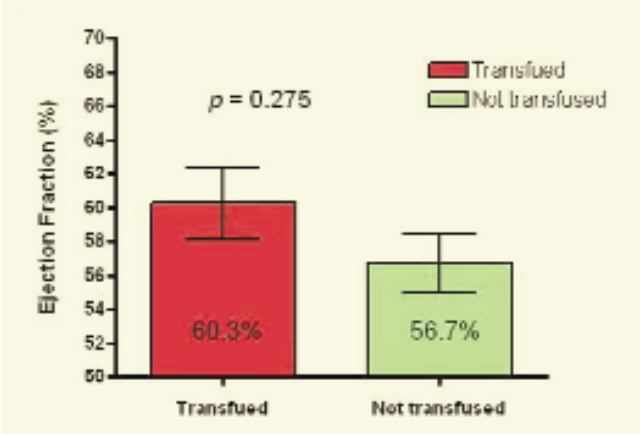

Fig. 9: The difference in ejection fraction between patients who were transfused and those who were not.

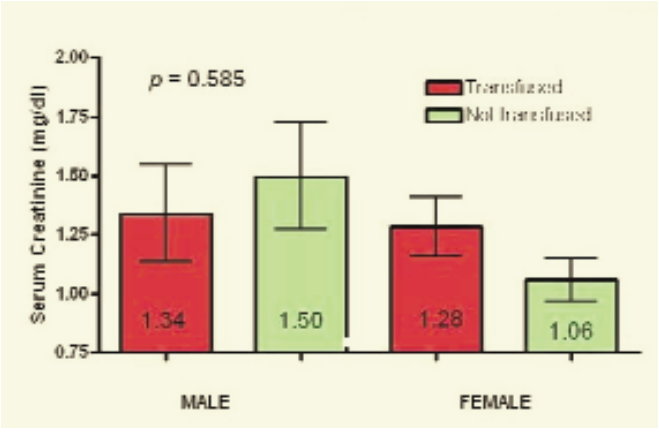

Fig. 10: The difference in preoperative serum creatinine between males and females that were transfused and those that were not.

cessing and serological testing. Conversion to pRBC, fresh frozen plasma or platelets was estimated to cost TT$100, hence a total cost of TT$1700.

In this study, the total cost of packed red blood cells transfused was approximately TT$34000 in 16 patients (TT$2125/patient). Cell saver disposables used at the Eric Williams Medical Sciences Complex are imported from Miami, USA and are estimated to cost TT$5000 per unit. This includes shipping, customs and insurance for importing. All unused blood donated for cardiac surgical patients was stored in the blood bank and used for other patients.

DISCUSSION

Blood transfusion is associated with a small but well recognized risk of blood borne infection transmission such as human immunodeficiency virus (HIV), hepatitis virus and cytomegalovirus. Transfusion has been associated with increased morbidity (ischaemic events and hospital stay), mortality and hospital cost following cardiac surgery (3). Immunological complications such as transfusion reactions and transfusion related acute lung injury (TRALI) can be life-threatening. As a result of these blood transfusion-related problems, policies have been instituted to improve safety which has resulted in decreased donation and hence blood shortage.

In a setting of limited resources and potential transfusion complications, blood conservation in cardiac surgery is indeed critical. Twenty-seven per cent of cardiac surgical patients received an intraoperative blood transfusion. Risk factors for transfusion were identified as low preoperative haemoglobin, increased graft number and diabetes.

The literature supports the use of cell savers to reduce perioperative allogenic transfusion in cardiac surgery. In a meta-analysis by Carless *et al*, cell saver use decreased transfusion requirement by 23% [rate reduction was even higher in other surgical specialities] (4). The authors quote an average reduction in units transfusion of 0.67 (95% CI 0.45, 0.89) per patient when used routinely. The shed blood is washed and all viable platelets and clotting factors associated with haemostasis are removed before the red cells suspended in saline are returned to the patient. Complications of cell salvage have become increasingly rare since their introduction in the 1960s. Air embolism, coagulopathy and bacterial contamination of salvaged blood have been described (5). Cost-effectiveness of cell salvage has come into question previously (6).

In this study, 63.3% of patients did not require a transfusion, and the additional cost of a TT$5000 cell saver would not have been cost-effective in a public system which is strained financially. Although transfused patients received each unit of blood at a cost of TT$2125 compared to using a cell saver at TT$5000, this is too simplistic a calculation, since the hidden costs of transfusion-related complications, morbidity and increased hospital stay has not been taken into consideration.

Whilst this study cannot prove that cell savers are more cost-effective than blood transfusion, it is important to remember the benefit that cell savers offer in eliminating transfusion-related complications and this must be considered when assessing the costing. Indeed, it might be speculated that this risk may be even more significant in a developing country such as Trinidad and Tobago where rates of blood-borne infection such as HIV are higher than in developed countries and the rates of transmission might also be higher (7). The extent and cost implications of this benefit remain to be elucidated.

Simple measures for optimizing patients' preoperative haemoglobin include oral iron supplementation and may reduce perioperative transfusion requirement (8, 9). Unlike elective non-cardiac surgery, the use of erythropoietin is cautioned in severe coronary and peripheral vascular disease since an increase in platelets and packed cell volume can contribute to a prothrombotic state (10).

Selective cell saver use is therefore recommended as best practice. They may be used more cost-effectively if objective measures of increased risk of allogenic transfusion could be identified preoperatively allowing disposables to be made available before selected operations. This study identified three factors which may increase the risk of transfusion: graft number (≥ 2), lower preoperative haemoglobin (≤ 11.5 g/dL), and the presence of diabetes. Other important considerations include emergency cardiac surgery where patients are on antiplatelet therapy and Jehovah Witness patients who refuse allogenic blood transfusions

A limitation of this study was that it was observational and not a controlled prospective trial. No standardized criteria for transfusion were established for this study. Blood was given at the anaesthetist's discretion based on the clinical status (*eg* excessive blood loss, hypovolaemia, hypotension) rather than strict predetermined parameters. The time scale for this study was limited and thus patient numbers are sub-optimal, making reliable conclusions difficult to draw. The patient numbers were too small to assess the cost implications of transfusion related complications. Financial constraints in the public health system did not permit the use of cell savers in this cohort of patients. Cell savers are currently reserved for the Jehovah Witness patients. Continuing data collection will be done to create a larger database.

The present study demonstrates the financial implications for transfusion management in OPCABG surgery in a setting of limited resources. Graft number, presence of diabetes, and preoperative haemoglobin value were identified as factors that are associated with increased blood requirement and operative cost. The benefit of routine cell saver use in reducing transfusion-related complications (and its associated cost-benefit) remains to be fully elucidated. The study recommends that more cell saver disposables be made available in the public healthcare system so that selective use of cell savers can be used in patients identified as having a high risk of being transfused as found in this study.

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