



ORIGINAL ARTICLE

Impact on costs related to inadequate indication of blood transfusion



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Abstract

Introduction: Blood component wastage has become a financial and ethical challenge in everyday hospital practice. Inadequate indication of blood products has been reported in up to 57.3% of cases. This has caused a significant increase in the costs associated with blood transfusion. The aim of this study was to establish the impact of inadequate indication of blood products on costs related to blood transfusion in a university hospital.

Material and methods: A retrospective, descriptive, observational study was conducted to evaluate blood product transfusions performed between January 1 and June 30, 2015, based on the criteria of the American Association of Blood Banks. The direct cost of blood product units was determined and transfusions were classified by type of indication, and the service ordering the transfusion.

Results: Based on the American Association of Blood Banks guidelines, 1028 transfusions were evaluated and 47.8% of these had an inadequate indication, equivalent to an estimated \$38,766.87 USD for direct processing costs. According to the type of blood product transfused, 29.4% of fresh frozen plasma, 38.6% of packed red blood cells, and 68.2% of platelet concentrates had an inadequate indication.

Conclusions: An inadequate blood transfusion indication produces a high impact on costs related to blood transfusion involving an estimated yearly unnecessary expense of \$860,766.64 USD in our hospital.

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Introduction

Preventive strategies are needed for the identification, evaluation and treatment of anemia, to optimizing hemostasis and to establish decision thresholds to minimize inadequate use of blood and its products.¹ According to the American Association of Blood Banks (AABB), approximately 15 million units of packed red blood cells (RBC) are transfused in the United States and almost 85 million are transfused annually worldwide.² In 2013, the National Blood Transfusion Center in Mexico (CNTS, in Spanish) reported that 5,933,405 units were dispensed; however, to date the total number of units transfused at the national level has not been published.³

In the state of Nuevo Leon, in 2014, a total of 235,935 units⁴ were dispensed; of these, according to reports from the State Center for Blood Transfusion (CETS), 162,340 (68.8%) were transfused.⁵ At the University Hospital of the Autonomous University of Nuevo Leon (HU-UANL) during 2014, a total of 22,808 units of blood products were transfused.⁶

The AABB has published guidelines that establish the different criteria for transfusing fresh frozen plasma (FFP),⁷ RBC, and platelet concentrates (PC).⁸ In 2007, The Mexican Association of Transfusion Medicine (AMMTAC, in Spanish) published the Guidelines for the Clinical Use of Blood, which provides clinical and laboratory criteria for the use of blood and blood products.⁹

According to the literature 0.3–57.3% of transfusions are inadequate.¹⁰ Regarding the type of blood product transfused, for RBC, up to 70% of transfusions are inadequate, while for FFP it has reached 87.5%.¹¹ Nationally, the percentage of inadequate transfusions reached 45%.¹² According to a study by González-Villanueva et al. performed from 2009 to 2011 in patients from the Internal Medicine, Orthopedics, Gynecology and Surgery Services of “Dr. José Eleuterio González” University Hospital, in Monterrey, Mexico, 16.2% of transfusion were inadequate based on AMMTAC criteria.¹⁰ However, the percentage of inadequate transfusions in other areas of this hospital is unknown.

The use of methods for risk reduction and the development and implementation of new technologies for donation and transfusion have contributed to a significant increase in the cost of blood transfusion.¹³ Currently, 1% of total hospital costs are attributed to blood transfusion; however, this may vary by disease and procedure. For example, in treatments such as liver and bone marrow transplants, blood transfusion plays an important financial role representing 5% to 9% of total hospital costs, which can easily exceed \$3800 USD per treatment.¹⁴ A study published by Sanchez-Alvarez et al. in 2000, reported a RBC unit cost of \$1750 MXN (equivalent to \$98.59 USD) in a public hospital, while in a private hospital the cost was \$5232.25 MXN, (equivalent to \$294.77 USD), thus establishing a significant difference in costs related to transfusion in the public versus the private sector.¹⁵

In 2004, Juarez-Rangel et al. published a retrospective study from the CNTS, which reported that up to 63.3% of blood products were inadequately transfused, with an estimated impact of \$1,700,000.00 MXN, equivalent to about \$95,775 USD, annually in direct costs.¹²

Numerous studies have established the benefits of implementing restrictive transfusion strategies.^{2,16–20} Since these

strategies are currently being implemented in our hospital, we considered it important to assess proper adherence to international guidelines (AABB) and its impact on costs related to blood transfusion.

Material and methods

This is a retrospective, observational, descriptive study of transfusion of blood products (RBC, FFP and PC) performed at the “Dr. José Eleuterio González” University Hospital in Monterrey, Mexico, from January 1 to June 30, 2015. The study was based on the number of blood products transfused, registered in the CiBank blood bank hospital system during 2014. Using the formula for calculating proportions in finite populations with an expected rate of 50%, an accuracy of 0.03 and a confidence interval of 95%, we obtained a sample size of 1019 transfusions. In order to project with greater adherence the hospital’s transfusion behavior, the sample was randomly distributed over a period of 6 months using Epidat version 4.1.

Transfusions of RBC, FFP and PC in hospitalized patients older than 18 years were included.

Transfusions in pediatric patients were not included in this study, since the indication for transfusion in these patients includes different criteria for transfusion of blood components in adults, cryoprecipitate transfusions were not included because of the special requirements for transfusion, apheresis platelet transfusions were not included, because in our hospital they are performed under the express request of the treating physician and pre-programming of the procedure; records with incomplete data were excluded.

The medical record of each patient was reviewed and the presence of acute bleeding was assessed according to the classification of the AMMTAC.⁹ The indication of transfusion of blood products was evaluated according to the recommendations of the AABB.^{2,7,8}

For cost analysis, an estimate was made considering costs directly related (resources) to the processing of units (blood donor selection, collection, analysis, fractionation, storage, and compatibility testing) according to current market prices without considering the annual inflation rate. Costs were pooled by units transfused in each service and costs per unit transfused with an inadequate indication. Conversion of Mexican pesos (MXN) to United States dollars (USD) was performed according to the Exchange Rate to Settle Liabilities Denominated in United States Dollars Payable in Mexico, published by the Bank of Mexico on March 7, 2016.

Statistical analysis was performed using SPSS version 20.0 for Windows; for categorical variables frequency and percentage tables were used and bar and sectors graphs were created. For numeric variables, measures of central tendency and location, such as median and interquartile ranges was used. Pearson’s Chi square test was used for comparison of categorical variables, considering a value $\leq .05$ as statistically significant.

Results

In total, 1447 units of blood products transfused between January 1 and June 30, 2015 were selected for analysis. Of

Table 1 Inadequate indication of blood product transfusion by medical service at the “Dr. José Eleuterio González” University Hospital, Monterrey, México, from January to June, 2015.

Service	Blood product transfused				
	Inadequate Indication				Total
		RBC	FFP	PC	
	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)
Surgery	25 (65.8)	13 (52)	0 (0)	12 (100)	38 (3.7)
Plastic surgery	2(40)	2 (40)	0 (0)	0 (0)	5 (0.5)
Gynecology	14 (29.8)	9 (21.4)	1 (100)	4 (100)	47 (4.6)
Internal medicine	123 (44.1)	21 (24.1)	8 (28.6)	94 (57.3)	279 (27.1)
Neurosurgery	3 (60)	3 (60)	0 (0)	0 (0)	5 (0.5)
Neurology	4 (40)	0 (0)	0 (0)	4 (80)	10 (1.0)
Obstetrics	7 (70)	2 (40)	2 (100)	3 (100)	10 (1.0)
Oncology	1 (20)	1 (20)	0 (0)	0 (0)	5 (0.5)
Otolaryngology	1 (100)	1 (100)	0 (0)	0 (0)	1 (0.1)
University employee medical services	13 (20.6)	7 (21.9)	0 (0)	6 (21.4)	63 (6.1)
Post-surgical	7 (58.3)	2 (40)	2 (50)	3 (100)	12 (1.2)
Operating room	140 (72.9)	89 (67.4)	9 (50)	42 (100)	192 (18.7)
Delivery	8 (47.1)	6 (60)	0 (0)	2 (33.3)	17 (1.7)
Traumatology	8 (66.7)	8 (66.7)	0 (0)	0 (0)	12 (1.2)
Adult ICU	29 (43.3)	3 (16.7)	7 (25.9)	19 (86.4)	67 (6.5)
Post-surgical ICU	43 (41.3)	2 (9.1)	8 (21.1)	33 (75)	104 (10.1)
Renal unit	0(0)	0 (0)	0 (0)	0 (0)	4 (0.4)
Adult ER	63 (40.1)	28 (29.5)	8 (26.7)	27 (84.4)	157 (15.3)
Total	491 (47.8)	197 (38.6)	45 (29.4)	249 (68.2)	1028 (100)
ER, emergency room.					

ER, emergency room.

these, 419 were excluded for not meeting inclusion criteria, leaving a total of 1028 transfusions.

The highest number of transfusions were recorded in Internal Medicine, the Operating Room and the Adult Emergency Room with 279 (27.1%), 192 (18.7%) and 157 (15.3%) units transfused, respectively, while the services with the lowest number of transfusions were Plastic Surgery, Oncology, the Renal Unit, and Otolaryngology, which comprised 1.5% of the units included in this study.

Evaluation of the indication of transfusion of blood products, based on the guidelines of the AABB, showed that 47.8% of the transfusions were inadequate. Among the services with the greatest number of transfusions, the highest percentage of inadequate indications occurred in the Operating Room (72.9%), while in Internal Medicine and the Adult ER it was 44.1% and 40.1%, respectively.

Regarding the type of units transfused 510 (49.6%) were RBC, 365 (35.5%) were PC and 153 (14.9%) were FFP. PCs had the highest percentage of inadequate transfusions (68.2%), compared to RBC and FFP (Table 1).

A statistically significant difference was found when the service and the indication for RBC and PC transfusion were compared ($P \leq .001$), however, this did not occur with FFP ($P = .120$).

To conduct a cost analysis and evaluation of the impact of inadequate transfusion of blood products, the approximate amount of processing a unit of blood was calculated at a direct cost of \$78.96 USD per unit collected (Table 2).

Based on the results, the estimated cost for processing the 1028 units included in this study was \$81,165.67 USD, of

Table 2 Processing cost per unit, in USD, at the “Dr. José Eleuterio González” University Hospital, Monterrey, México.

Concept	USD
Donor evaluation	\$7.70
Donation	\$11.92
Serology	\$41.35
Pre-transfusion tests	\$17.07
Other	\$0.91
Cost per unit	\$78.96

which \$38,766.87 USD correspond to 491 units transfused with an inadequate indication according to AABB criteria. Extrapolating the results of this study at the hospital level, a one-year total of \$860,766.64 USD would have been expended in the inadequate transfusion of 10,902 units. At the state level, this would represent a total of 77,599 units transfused with an inadequate indication, with an estimated cost of \$6,126,823.58 USD. While at the national level, inferring that the rate of national transfusion in 2013 was the same as that of the state in 2014 (68.8%), approximately 1,951,283 units would have been transfused with an inadequate indication, representing a cost of approximately \$154,063,411.85 USD in 2013.

Discussion

The main objective of this study was to establish the impact of inadequate indication of blood products on costs related

to blood transfusion. Based on the guidelines of the AABB, we found that 47.8% of the transfusion of blood products had an inadequate indication; this places the behavior of our hospital's transfusions within percentages reported both nationally and internationally.^{10,11}

A previous study published by Gonzalez-Villanueva et al.¹⁰ found that 16.2% of the transfusions in our hospital were inadequate. Our report shows approximately a 3-fold increase in the percentage of inadequate transfusions; however, in the previous study only Internal Medicine, General Surgery, Gynecology and Obstetrics, and Orthopedics were evaluated, while our study covered services more involved in transfusion practice such as the Adult Emergency Room, the intensive care unit, the operating room, and the renal unit.

Similarly, this increase in inadequate indications may be because the AABB guidelines have more restrictive figures for transfusion of blood products, primarily for RBC, where hemoglobin levels of 7.0–8.0 g/dL are used in stable patients.² National guidelines (AMMTAC) indicate transfusion of RBC in "anemia with signs and symptoms of tissue hypoxia in normovolemic patients, regardless of hemoglobin levels".⁹

With regard to service indicating transfusion, internal medicine had the highest number of units transfused with a total of 279 (27.1%), followed by the operating rooms with a total of 192 units. According to the type of indication, we observed that surgical areas had the highest percentages of inadequate indication compared to nonsurgical services. This strongly correlates with that reported by González-Villanueva in 2012.¹⁰

The literature has reported up to 74% of inadequate indications for RBC and 96.2% for FFP,¹¹ while for PC, up to 13% of inadequate transfusions have been reported.¹² This places the results of this study in a good position with regard to transfusion of RBC and FFP, but not in transfusion of PC.

A cost per unit transfused ranging from \$118.42 USD²¹ to \$1183 USD has been reported in the literature.²² The estimated cost per unit of transfused blood products in this study was \$78.96 USD, which was slightly less than that reported by Sanchez-Alvarez et al.¹⁵ where the unit cost was estimated at \$98.59 USD; however, they did not include indirect costs related to blood product transfusion. Comparing these results, we found a difference of \$19.63 USD per unit with regard to that reported by Sanchez-Alvarez et al.¹⁵ while when compared with reports in the literature, the difference between the two was \$39.46 USD, with respect to the minimum reported.

In our hospital, during 2014, the total number of transfusions of blood products was 22,808. By applying the annualized cost per unit and extrapolating the percentage of inadequate indications of this study, we found a total of 10,902 units transfused with inadequate indication representing an estimated cost of \$860,766.64 USD. Projecting the results of this study into national figures, 1,951,283 units of transfused blood products were inadequately indicated, equivalent to \$154,063,411.85 USD.

Pereira²³ in 2006 established a mean of \$8.66 million USD as an annual production cost in a sample of blood banks in the United States. If the percentage of inadequate indications obtained in this study were applied, this would be equivalent to a total cost of \$4,139,480 USD. However,

recent studies have reported annual production costs of blood products that vary from \$1.62 million USD²² to \$72 million USD²⁴; therefore, the cost of inadequate indications of blood products could easily reach \$34,416,000 USD. This denotes the high economic impact that inadequate indications of transfused blood product units have on costs related to transfusion.

The results of this study demonstrate the direct relationship between inadequate indication of blood products and increased costs related to transfusion. In the future, it is important to encourage adherence to transfusion guidelines for blood products, training medical personnel involved in transfusion, and making them aware of the expense involved in inadequate indication of blood products in each of the areas of the hospital. For this, a transfusion committee should play a key role in the development and maintenance of guidelines.

Parallel to this study, Alvarado-Navarro conducted research related to medical knowledge of transfusion in physicians from our hospital involved in the use of this therapeutic resource. Their results support the need to implement educational programs,²⁵ which in the long-term could significantly affect costs related to blood transfusion.

This study did not include transfusions of blood products in pediatric patients due to differing criteria for their indication compared to adults. Cryoprecipitate and platelet apheresis were also excluded because of the specific conditions required for transfusion. Limited access to medical records and, in some cases, lack of data regarding the amount of acute bleeding during procedures, could have influenced the assessment of transfusions, especially during surgery.

The fact that this hospital is a teaching institution, in which physicians in training are admitted every year, can lead to changes in criteria for indicating blood products, making it difficult to establish a standardized transfusion practice. Transfusion medicine courses for these residents have the potential to greatly improve every day practice.

Regarding cost analysis, this study included only costs directly related with processing units of blood products, without taking into account indirect costs (labor, equipment depreciation, maintenance costs of facilities, etc.) or annual fluctuation, which could increase unit processing costs.

In conclusion, this report shows that, based on the guidelines of the AABB, almost half of the transfusions were inadequately indicated, involving an estimated unnecessary cost over \$860,000 USD for a total of 10,902 units. Transfusion of blood products has a considerable economic impact for hospitals; therefore, it is necessary to implement guidelines to justify the use of blood products as well as perform periodic audits where transfusion committees play a prominent role.

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Conflict of interest

The authors have no conflicts of interest to declare.

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References

- Goodnough LT, Shieh L, Hadhazy E, et al. Improved blood utilization using real-time clinical decision support. *Transfusion* (Paris). 2014;54:1358–65.
- Carson JL, Grossman BJ, Kleinman S, et al. Red blood cell transfusion: a clinical practice guideline from the AABB. *Ann Intern Med*. 2012;157:49–58.
- Centro Nacional de la Transfusión Sanguínea. Reporte anual de ingresos y egresos de componentes sanguíneos a nivel nacional, in 2013. Information provided by the National Blood Transfusion Center (CNTS) through the National Institute of Transparency. Access to Information and Personal Data Protection [Internet]. <https://www.infomex.org.mx/gobiernofederal/home.action>.
- Centro Nacional de la Transfusión Sanguínea. Reporte anual de ingresos y egresos de componentes sanguíneos del estado de Nuevo León in 2014. Information provided by the National Blood Transfusion Center (CNTS) through the National Institute of Transparency. Access to Information and Personal Data Protection [Internet]. <https://www.infomex.org.mx/gobiernofederal/home.action>.
- Centro Estatal de la Transfusión Sanguínea. Units of blood components transfused in 2014. Information provided by the State Blood Transfusion Center (CETS) of Nuevo León, México.
- Banco de Sangre Hospital Universitario "Dr. José Eleuterio González". Units of blood products transfused in 2014. Information provided by the Blood Bank of the "Dr. José Eleuterio González" University Hospital, Universidad Autónoma de Nuevo León, Monterrey, México.
- Roback JD, Caldwell S, Carson J, et al. Evidence-based practice guidelines for plasma transfusion. *Transfusion* (Paris). 2010;50:1227–39.
- Kaufman MR, Djulbegovic B, Gernsheimer T, et al. Platelet transfusion: a clinical practice guideline from the AABB. *Ann Intern Med*. 2015;162:205–13.
- Malagón-Martínez A, Berges-García A, Bonifaz-Gracias R, et al. Guía para el uso clínico de la sangre. 3rd ed. México: AMMTAC; 2007. p. 26.
- González-Villanueva JI, Cantú-Rodríguez OG, Gallardo-Uribe I, et al. Indicaciones, uso y efecto terapéutico en la administración de hemocomponentes en un hospital de tercer nivel. *Med Univ*. 2012;14:72–9.
- Pérez-Chávez F, Cázares-Tamez R, Jiménez-Morales BE, et al. Evaluación del uso y apego a las indicaciones clínicas de plasma fresco congelado en el hospital universitario Dr. José E. González. *Med Univ*. 2005;7:16–20.
- Juárez-Rangel E, Casanova V, Jezabel MA, et al. Auditoria transfusional retrospectiva en el centro nacional de la transfusión sanguínea. *Rev Invest Clin*. 2004;56:38–42.
- Recardie-Murray J, Stefan CD. Cost and indications of blood transfusions in pediatric oncology in an African hospital. *Open Hematol J*. 2011;5:10–3.
- Kacker S, Frick KD, Tobian AA. The costs of transfusion: economic evaluations in transfusion medicine, part 1. *Transfusion* (Paris). 2013;53:1383–5.
- Sánchez AS, González NP, Alvarez VJC. Costos en la transfusión sanguínea. *Rev Mex Anest*. 2000;23:66–70.
- Boral LI, Bernard A, Hjorth T, et al. How do I implement a more restrictive transfusion trigger of hemoglobin level of 7 g/dL at my hospital? *Transfusion* (Paris). 2015;55:937–45.
- Valencia-Arango W, Villada I, Calero SM, et al. Analisis de la practica transfusional en un hospital de Segundo nivel en Cali. Colombia entre junio y noviembre de 2010. *Med UIS*. 2012;25:107–12.
- Radwan ZA, Bai Y, Matijevic N, et al. An emergency department thawed plasma protocol for severely injured patients. *JAMA Surg*. 2013;148:170–5.
- Mirski MA, Frank SM, Kor DJ, et al. Restrictive and liberal red cell transfusion strategies in adult patients: reconciling clinical data with best practice. *Crit Care*. 2015;19:202.
- Holst LB, Petersen MW, Haase N, et al. Restrictive versus liberal transfusion strategy for red blood cell transfusion: systematic review of randomized trials with meta-analysis and trial sequential analysis. *BJM*. 2015;350:h1354.
- Mafirakureva N, Nyoni H, Nkomo SZ, et al. The costs of producing a unit of blood in Zimbabwe. *Transfusion* (Paris). 2016;56:628–36.
- Shander A, Hofmann A, Ozawa S, et al. Activity-based costs of blood transfusions in surgical patients at four hospitals. *Transfusion* (Paris). 2010;50:753–65.
- Pereira A. Economies of scale in blood banking: a study based on data envelopment analysis. *Vox Sang*. 2006;90:308–15.
- Trentino KM, Farmer SL, Swain SG, et al. Increased hospital costs associated with red blood cell transfusion. *Transfusion* (Paris). 2015;55:1082–9.
- Alvarado-Navarro D. Conocimientos de medicina transfusional en residentes de un hospital universitario [thesis]. Monterrey: Universidad Autónoma de Nuevo León; 2016, 23 p.