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Predictive factors associated with packed red cell transfusions in patients submitted to elective surgery of the digestive tract: an inter-institutional analysis

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The objective of this study was to understand the determinative factors for packed red cell transfusions in elective digestive tract surgeries in four hospital units in Montes Claros, Minas Gerais, Brazil. Retrospective analyses were performed by collecting data from the clinical records of patients submitted to elective digestive tract surgeries from June 2007 to December 2008 at these four hospital units. Eighty-one cases (42% females and 58% males) were included in this study. The average age was 55.5 years old (Standard deviation \pm 19.11 years). The commonest reported underlying disease was neoplasia (42%). Of these patients, 38 (47%) were transfused in the immediate preoperative period, 28 (34.6%) during the surgery and 37 (45.7%) in the immediate postoperative period. In the univariate analysis, there was an association between the data of transfusions and the different institutions. In the surgical phase, there were correlations between transfusion and the reason for transfusion, RH factor (Rhesus), institutional policy and the underlying disease. In the postoperative phase, no association was identified. In all phases, there were not correlations between the type of surgical procedures, ASA index (American Society of Anesthesiology), and hemoglobin and hematocrit values. Therefore, this study demonstrated that the blood transfusions in elective digestive tract surgeries were heterogeneous between hospitals and were not related to specific laboratorial values; they were associated to the underlying pathology, but not with the type of surgical procedure and generally followed the criteria of the healthcare specialist.

Key words: Digestive system surgical procedures; Erythrocyte transfusion; Blood component transfusion

Introduction

The main consequence of the significant blood loss that occurs during surgery is acute anemia, which in turn, results in an inadequate delivery of oxygen to tissues, causing tissue hypoxia. The usual approach in acutely anemic patients is packed red blood cell transfusions (RBCT) to increase the oxygen transport capacity.⁽¹⁾ However, more restrictive strategies have been employed in order to minimize

transfusion practices, to reduce the morbidity and mortality arising from their use and costs.⁽²⁾ There are several studies that try to establish a risk-benefit ratio for RBCT, its judicious and rational use, and its real need in many surgical procedures. Hematologic values that serve as the "transfusion trigger" are not consensual and the use of RBCT is remarkably variable.⁽²⁻⁵⁾

These data seem to support the plasticity that the human body has to compensate for blood loss and overcome

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difficulties in oxygen transportation and suggest that lower hemoglobin and hematocrit levels than those used in transfusion decision making are perfectly acceptable without using RBCT.^(6,7) In addition, the use of alternative transfusion procedures in the pre- and intraoperative periods including red cell recovery, hemodilution with crystalloids, an increased oxygen supply, use of erythropoietin, iron and vitamin B12 supplements, has reduced the effect of blood loss and does not result in changes related to hypoxia, hypotension or arrhythmia.⁽⁶⁻¹⁰⁾

It has also been noted that there are great intra- and inter-institutional variations in RBCT protocols when performing procedures such as coronary artery bypass, acute coronary syndrome and orthopedic surgeries.⁽¹¹⁻¹⁴⁾ Furthermore, the documentation in medical records in respect to requests for transfusions and the monitoring of side effects of RBCT is often scarce.^(4,14)

Given the paucity of published studies that deal with the variability in indication of RBCT use for elective surgeries of the digestive tract in different Brazilian institutions and the need to understand predictive factors for RBCT in these surgeries, the aim of this study was to understand factors that determine RBCT in elective surgeries of the digestive system in four hospitals in Montes Claros, Minas Gerais.

Methods

A descriptive, analytic retrospective study was performed collecting data from the clinical records of transfusion units of four hospitals in the city of Montes Claros. This city, situated in the north of the state of Minas Gerais, has a population of 350,000. The data of patients, who underwent elective surgeries of the digestive tract between June 2007 and December 2008 and received RBCT during the preoperative, intraoperative and postoperative periods, were collected using specific forms.

The records of patients undergoing multisystem surgical procedures were excluded. The variables included information about the hospital, patient status before surgery [age, gender, American Society of Anesthesiology (ASA) index, medical history and coagulation disorders], surgery data [underlying pathology, type of intervention, laboratory examinations, hemorrhagic status, instability and complications in the intraoperative and postoperative], transfusion characteristics [indication, ABO and RH (Rhesus) factors and informed consent]. Data were input in two databases using the SPSS 15.0 computer program (Statistical Package for the Social Sciences, Chicago, USA) and were analyzed using descriptive statistics and the chi-square, Likelihood and linear univariate analysis of variance (ANOVA) tests.

This study was conducted in accordance with the precepts established by resolution number 196/88 of the

National Health Council, Brazilian Ministry of Health. The directors of the participating health institutions understood the importance of this study and signed informed consent forms. The research project was submitted for evaluation and approved by the Research Ethics Committee of the Universidade Estadual de Montes Claros (# 1033/08).

Results

Thirty-four female (42%) and 47 male (58%) patients operated in the period from June 2007 to December 2008 fulfilled the inclusion criteria of this study. The mean age of these patients was 55.5 years (± 19.11 years). The underlying diseases were 34 (42%) tumors, 18 (22.2%) infectious and inflammatory processes, 11 (13.6%) stenoses, obstructions or protrusions, nine (11.1%) vascular diseases and nine (11.1%) other pathological diseases. The mean 'lowest hemoglobin concentrations' presented by patients in the immediate preoperative period was 9.77 g/dL (± 2.07 g/dL) and the median, minimum and maximum hemoglobin concentrations were 9.7 g/dL, 6.10 g/dL and 15 g/dL, respectively. The mean 'lowest hematocrit levels' of patients in the preoperative period was 0.31% ($\pm 0.059\%$) and the median, minimum and maximum hematocrit levels were 0.30%, 0.21% and 0.40%, respectively. The preoperative hemoglobin and hematocrit levels were recorded in writing or as test results in 50 (61.72%) and 58 (71.6%) of the 81 patients' records, respectively. The ASA index was reported for 60 (74%) cases with a mean value of 2.3 (± 0.81). Coagulation disorders were reported in five cases. Of the 81 patients, 38 (47%) received pre-operative RBCT; of these, seven (18%) were re-transfused in the intraoperative period and 12 (31.6%) in the immediate postoperative period. There was no justification documented in the medical records for the transfusions of 27 patients in the preoperative period. Justifications for RBCT included 12 patients with anemia [mean hemoglobin = 9.38 g/dL (± 2.08 g/dL)], one in hypovolemic shock and another with upper gastrointestinal bleeding. An analysis by linear univariate ANOVA of the associations of hemoglobin and hematocrit with preoperative RBCT gave p-values of 0.076 and 0.164, respectively. There were no significant associations of RBCT with hemoglobin levels of 8 g/dL or less or with hematocrit less than 0.30%. The relationships between preoperative RBCT and other correlated categorical preoperative variables are listed in Table 1. Of the preoperative variables studied, only the hospital and reasons given for transfusions were associated to RBCT ($p = 0.009$ and $p = 0.008$, respectively).

The surgical procedures used were 51 (63%) resections and enucleations, 16 (19.2%) repairs, reconstruction, derivations and disconnections, nine (11.1%) exploratory surgeries and five (6.2%) cauterization and sclerosis. During the intraoperative period, 28 (34.6%)

patients received RBCT. Five intraoperative complications were reported that would justify transfusions; three hemorrhages or hypovolemic shock and two technical difficulties during surgery were reported. There was no statistical association of RBCT with hemoglobin of 8 g/dL

Table 1. Preoperative red blood cell transfusions and related categorical variables (n = 81)

Variable	Preoperative transfusion		p-value
	Yes n (%)	No n (%)	
Gender			
Female	14 (36.8)	20 (46.5)	0.379
Male	24 (63.2)	23 (53.5)	
Age			
Up to 43 years	9 (23.7)	11 (25.6)	0.980
from 44 to 56 years	11 (28.9)	12 (27.9)	
More than 56 years	18 (47.4)	20 (46.5)	
Blood type			
A	10 (26.3)	20 (46.5)	0.306
B	4 (10.5)	3 (7.0)	
AB	1 (2.7)	1 (2.3)	
O	23 (60.5)	19 (44.2)	
RH factor			
Positive	34 (89.5)	38 (88.4)	0.875
Negative	4 (10.5)	5 (11.6)	
ASA			
1 and 2	16 (42.1)	24 (55.8)	0.109
3 and 4	8 (21.1)	12 (27.9)	
Not informed	14 (36.8)	7 (16.3)	
Institution			
1	11 (28.9)	2 (4.7)	0.009*
2	14 (36.8)	23 (53.5)	
3	6 (15.8)	4 (9.3)	
4	7 (18.5)	14 (32.5)	
Underlying disease			
Tumors	12 (31.6)	22 (51.2)	0.308
Inflammatory/infectious processes	9 (23.7)	9 (20.9)	
Stenosis/obstructions/protrusions	6 (15.8)	6 (13.9)	
Vascular processes	6 (15.8)	3 (7.0)	
Other pathologic processes	5 (13.1)	3 (7.0)	
Lowest hemoglobin levels			
Less than or equal to 0.3%	6 (15.8)	3 (7.0)	0.379
Greater than 0.3%	19 (50)	21 (49.0)	
Data missing	13 (34.2)	19 (44.0)	
Lowest Hematocrit levels			
Less than or equal to 0.3%	17 (44.8)	10 (23.3)	0.094
Greater than 0.3%	13 (34.2)	17 (39.5)	
Data missing	8 (21.1)	16 (37.2)	
Coagulation disorders			
No	36 (94.7)	11 (26.3)	0.748
Yes	2 (5.3)	27 (73.7)	
Preoperative reason mentioned			
Yes	11 (26.3)	3 (7.0)	0.008*
No	27 (73.7)	40 (93.0)	
Consent			
No	32 (84.2)	38 (88.4)	0.586
Yes	6 (15.8)	5 (11.6)	

* significant - p-value ≤ 0.05

or less or with hematocrit of 0.30% or less in the immediately preoperative period. Table 2 illustrates the relationship between intraoperative RBCT and correlated categorical variables. Of the variables studied during the surgery, the Rh factor (p = 0.037), the institution (p = 0.001), underlying disease (cancer) (p = 0.001) and reasons given for transfusion (p = 0.031) were correlated to RBCT.

Table 2. Intraoperative red blood cell transfusions and related categorical variables (n = 81)

Variable	Intraoperative transfusion		p-value
	Yes n (%)	No n (%)	
Gender			
Female	11 (39.3)	23 (43.4)	721
Male	17 (60.7)	30 (56.6)	
Age			
Up to 43 years	4 (14.3)	16 (30.2)	0.142
from 44 to 56 years	7 (25.0)	16 (30.2)	
More than 56 years	17 (60.7)	21 (39.6)	
Blood type			
A	8 (28.6)	22 (41.5)	0.287
B	1 (3.6)	6 (11.3)	
AB	1 (3.6)	1 (1.9)	
O	18 (64.2)	24 (45.3)	
RH factor			
Positive	22 (78.6)	50 (94.3)	0.037*
Negative	6 (21.4)	3 (5.7)	
Institution			
1	1 (3.6)	12 (22.7)	0.001*
2	9 (32.1)	28 (52.8)	
3	4 (14.3)	6 (11.3)	
4	14 (50.0)	7 (13.2)	
Underlying disease			
Tumors	20 (71.4)	14 (26.4)	0.001*
Inflammatory/infectious processes	5 (17.9)	13 (24.5)	
Stenosis/obstructions/protrusions	0 (0)	11 (20.8)	
Vascular processes	2 (7.1)	7 (13.2)	
Other pathologic processes	1 (3.6)	8 (15.1)	
Lowest hemoglobin levels			
Less than or equal to 8 g/dL	1 (3.6)	8 (15.1)	0.234
Greater than 8 g/dL	15 (53.6)	25 (47.2)	
Data missing	12 (42.8)	20 (37.7)	
Lowest Hematocrit levels			
Less than or equal to 0.3%	7 (25.0)	20 (37.7)	0.323
Greater than 0.3%	10 (35.7)	20 (37.7)	
Data missing	11 (39.3)	13 (24.6)	
Type of surgery			
Resections/Enucleations	22 (78.6)	29 (54.7)	0.143
Plasties/Reconstructions/Disconnections/Derivations	4 (14.3)	12 (22.6)	
Exploratory surgeries	1 (3.6)	8 (15.1)	
Cauterizations/scleroses	1 (3.6)	4 (7.5)	
Intraoperative reason mentioned			
Yes	4 (14.3)	1 (1.9)	0.031*
No	24 (85.7)	52 (98.1)	

* significant - p-value ≤ 0.05

Thirty-seven (45.7%) patients received packed red blood cells in the postoperative period. The mean values of the lowest hemoglobin and hematocrit levels in the postoperative period were 9.39 g/dL (\pm 2.25 g/dL) and 0.28% (\pm 0.06%), respectively. The median, minimum and maximum hemoglobin concentrations were 9.8 g/dL, 4.60 g/dL and 14.10 g/dL, respectively.

The median, minimum and maximum hematocrit levels were 0.28%, 0.15% and 0.45%, respectively. Of the 81 patients' records, only 48 (59.2%) and 60 (74.1%) reported the postoperative hemoglobin and hematocrit values, respectively.

Table 3: Postoperative red blood cell transfusions and related categorical variables (n = 81)

Variable	Postoperative transfusion		p-value	
	Yes n (%)	No n (%)		
Gender				
Female	15 (40.5)	19 (43.2)	0.810	
Male	22 (59.5)	25 (56.8)		
Age				
Up to 43 years	13 (35.1)	7 (15.9)	0.119	
from 44 to 56 years	10 (27.1)	13 (29.6)		
More than 56 years	14 (37.8)	24 (54.5)		
Blood type				
A	17 (46.0)	13 (29.5)	0.057	
B	5 (13.5)	2 (4.5)		
AB	0 (0)	2 (4.5)		
O	15 (40.5)	27 (61.4)		
RH factor				
Positive	35 (94.6)	37 (84.1)	0.122	
Negative	2 (5.4)	7 (15.9)		
Institution				
1	5 (13.5)	8 (18.1)	0.908	
2	18 (48.7)	19 (43.2)		
3	5 (13.5)	5 (11.4)		
4	9 (24.3)	12 (27.3)		
Underlying disease				
Tumors	11 (29.7)	23 (52.2)	0.288	
Inflammatory/infectious processes	10 (27)	8 (18.2)		
Stenosis/obstructions/protrusions	7 (18.9)	4 (9.1)		
Vascular processes	4 (10.8)	5 (11.4)		
Other pathologic processes	5 (13.5)	4 (9.1)		
Type of surgery				
Resections/Enucleations	19 (51.4)	32 (72.7)	0.147	
Plasties/Reconstructions/Disconnections/Derivations	11 (29.7)	5 (11.4)		
Exploratory surgeries	5 (13.5)	4 (9.1)		
Cauterizations/scleroses	2 (5.4)	3 (6.8)		
Lowest Hematocrit levels				
Less than or equal to 0.3%	21 (56.8)	16 (36.4)		0.172
Greater than 0.3%	9 (24.3)	14 (31.8)		
Data missing	7 (18.9)	14 (31.8)		
Postoperative reason mentioned				
Yes	14 (37.8)	11 (25.0)	0.213	
No	23 (62.2)	33 (75.0)		

In the postoperative period, three patients suffered hemorrhages, 15 needed to be transferred to intensive care units and 11 patients died. An analysis by linear univariate ANOVA of the associations of hemoglobin and hematocrit with postoperative RBCT gave p-values of 0.801 and 0.83, respectively.

No post-transfusion complications were reported in the patients' records. There were associations of RBCT with hemoglobin concentrations of less than 8 g/dL due to the lack of documentation in most cases. There was no statistical association of RBCT with postoperative hematocrit values of 0.30% or less.

Table 3 describes the relationship between RBCT in the postoperative period and correlated categorical variables. No statistically significant association was identified between the variables and RBCT.

Discussion

RBCT is widely used; in elective procedures its indication may be more restricted.⁽¹²⁻¹⁴⁾ In this study, even in elective surgeries of the digestive tract, 47%, 34.6% and 45.7% of patients received RBCT in the preoperative, intraoperative and postoperative periods, respectively. Although the nature of this study does not allow the identification of cause-effect relationships, the postoperative mortality rate was high (11 cases). There is clear evidence that RBCT can result in poor prognosis for critically ill patients and that the loss of effectiveness of red blood cells is related to storage time, nitric acid levels linked to free hemoglobin, leukocytes present in donor blood components, inflammatory response of the recipient and reduced cell plasticity that influences motility and gas exchange.⁽¹⁵⁾

It is well known, for example, that surgical trauma and stress may have an important impact on the immunomodulation of patients with comorbidities such as tumors and that allogeneic transfusions may enhance the weaknesses of the immune response.⁽¹⁶⁾

Similarly, a study involving 179 patients submitted to gastric surgery for tumors demonstrated, by univariate analysis, that a large volume of blood was transfused and that the transfusion practice was associated with a worse prognosis.⁽¹⁷⁾ Another study that examined the impact of RBCT on 154 patients who were submitted to radical gastrectomy showed, by multivariate analysis, that transfusion was directly associated to reduced survival.⁽¹⁸⁾

The use of recombinant human erythropoietin associated with iron supplementation may significantly reduce the need for perioperative RBCT, by elevating the hematocrit in anemic patients suffering from gastrointestinal tumors.⁽¹⁹⁾

Certain techniques minimize blood loss during surgical

procedures such as hypotensive anesthesia, maintenance of normothermia, care during dissections, the use of fibrin glue, electrocoagulation, intraoperative blood recovery and hemodilution.^(6,18) Careful monitoring of oxygenation, restricted phlebotomy for diagnostic tests, postoperative blood recovery, improvement of hemostasis using drugs, monitoring of blood pressure, tolerance of normovolemic anemia, the careful use of anticoagulants and antiplatelet agents are postoperative strategies to detect possible hemorrhages.⁽⁶⁾

As is seen by the great variability in protocols between different hospitals, the parameters to indicate transfusion are not universal. The current study shows that the hematologic values, status of the patient and the type of surgical procedure did not serve as parameters to indicate RBCT and that the professional's choice essentially guided transfusions.

A Canadian study⁽²⁰⁾ of 5,298 patients treated in intensive care units found that 25% received RBCT. Independent variables predictive of transfusions were assessed and included age, APACHE II (Acute Physiology and Chronic Health Evaluation), type of surgery and the healthcare institution.

After multivariate analysis it was evident that the variable institution was the most relevant, thereby corroborating our perioperative findings. It was found that 35% of blood transfusions (202 of 576 cases) were performed in patients with pre-transfusion hemoglobin levels ranging from 9.5 g/dL to 10 g/dL and 80% of these cases were transfused more than two units. The most common reason to transfuse blood was acute bleeding (35%) and to improve oxygen supply (25%). A large variability in transfusion protocols between institutions was observed in this study as was the adoption of an old fashioned marker, the 10 g/dL threshold for hemoglobin, by many intensivists.^(20,21) These data were corroborated by another study carried out by the same group, that show the high inter- and intra-institutional variability of blood transfusions in patients undergoing coronary artery bypass surgery.⁽⁵⁾

Other interinstitutional studies conducted by European groups have also shown great variability in the transfusion practice in patients undergoing orthopedic and other types of surgeries.^(4,13,14) Interestingly, publications have shown an association between RBCT and management of gastric tumors with poor prognosis and shorter survival different to the practices adopted by professionals during surgery in this study.^(17,18)

Even with anemia being an indication for transfusion in the preoperative period and reports of postoperative bleeding, transfusions in the vast majority of the patients of this study were not justified. Furthermore, there was no significant correlation between the hemoglobin and hematocrit levels and transfusions. Indications for transfusion procedures are often based on objective and subjective

criteria, such as "trigger" variables, semiotic criteria, the hospital itself, professional experience, medical conditions and low hemoglobin levels, often without associated clinical symptoms.^(11,22-24) Hemoglobin levels were actually used as a trigger variable for the indication of transfusions for years, however the optimal hemoglobin levels vary considerably from one patient to another depending on multiple variables such as age, chronic diseases (especially coronary artery disease), current diagnosis, cause of anemia and anemia tolerance.^(15,25,26) There are studies that clearly demonstrate the good tolerability that some patients with low hemoglobin levels have of anemia and the effectiveness of blood conservation strategies and autologous red blood cell production stimulating procedures, which maximize the final hematocrit without RBCT.^(27,28) Another aspect to consider is that in gastrointestinal procedures, blood loss can be greatly minimized through minimally invasive surgical techniques, reduced surgical time and surgical planning with the conservation of the patient's blood by avoiding iatrogenic hemorrhages.⁽¹⁸⁾

Essential data related to hemoglobin and hematocrit levels, the ASA index and the signature of patients consenting to transfusion were often absent from medical records. Previous studies have demonstrated the same deficiency in data logging, such as one analysis which reported there was a notation of the reason for transfusion in only 23% of cases.^(4,14) A study in an obstetric service in the UK revealed that, on knowing about the potential risks of the procedure, only 9% of patients consented to transfusions. At the same time, patients were transfused without reporting a reason on their records, probably suggesting that the indication criteria are essentially personal rather than by measurable parameters.⁽²²⁾

Conclusions

In conclusion, the study revealed that RBCT in elective surgery of the digestive tract was heterogeneous among the different participating hospitals, lacked specific laboratory values to guide the indication of transfusions and was related to the underlying pathology but not with the type of intervention performed. These elements highlight the need to revisit the practice of RBCT of surgical patients and to develop programs of continuing education among healthcare professionals in respect to the indications of blood component transfusions.

Resumo

O objetivo desse estudo foi compreender os fatores determinantes da prática transfusional de concentrado de hemácias em cirurgias eletivas do aparelho digestivo em quatro unidades hospitalares em Montes Claros, Minas Gerais, Brasil. Foi realizado um estudo descritivo, analítico e retrospectivo através do

levantamento de dados em prontuários clínicos de quatro unidades hospitalares de onde foram catalogados os dados de pacientes a partir de junho de 2007 a dezembro de 2008, referentes às cirurgias citadas. Os resultados evidenciaram 81 casos, sendo 42% do gênero feminino e 58% do masculino. A idade média foi de 55,5 anos ($\pm 19,11$ anos). As enfermidades de base reportadas mais comuns foram os processos neoplásicos (42%). Desses 81 pacientes, 38 (47%) foram hemotransfundidos no pré-operatório imediato, 28 (18%) foram transfundidos no transcirúrgico e 37 (45,7%) no pós-operatório imediato. Na análise univariada houve diferenças entre a prática transfusional pré-cirúrgica interinstitucional. Na fase cirúrgica houve relação entre a prática transfusional com a citação de motivos, fator RH (Rhesus), prática institucional e doença de base. Na fase pós-cirúrgica não foram demonstradas relações. Em todas as fases, não houve associação da prática transfusional com os tipos de procedimentos cirúrgicos, com o índice ASA (American Society of Anesthesiology) e valores de hemoglobina e hematócrito. Concluindo, esse estudo revelou que a prática transfusional foi heterogênea entre instituições hospitalares, careceu de valores laboratoriais específicos, relacionou-se com a patologia de base mas não com o tipo de procedimento cirúrgico e foi norteada pelo critério de escolha do profissional.

Descritores: Procedimentos cirúrgicos do sistema digestório; Transfusão de eritrócitos; Transfusão de componentes sanguíneos

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