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Changes in the Transfusion Practice in Cerebral Aneurysm Clipping Surgery: A Center Experience

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Abstract

Objective: Blood use in the perioperative period has been changing over time. The increasing costs of transfusions led to a transformation in the clinical practice.

In our institution until April 2012 all patients who underwent cerebral aneurysm clipping surgery had at least 2 units of RBCs (red blood cells) cross-matched before surgery and from then on only type and screen is performed.

This study assesses the policy changes and the costs associated with blood use in cerebral aneurysm clipping surgery.

Methods: Records of 206 patients who underwent cerebral aneurysm clipping surgery at Centro Hospitalar do Porto in Portugal were retrospectively reviewed between January 2011 and July 2014.

Results: A total of 206 patients underwent cerebral aneurysm clipping surgery during the reviewed period. The patients were separated in two groups: cross-match group and type and screen group.104 patients had its blood cross-matched and 102 had it typed and screened. There was a trend to transfuse less when the blood was typed and screened (6% vs 13%). The cross-match group presented average losses of 1,8 units of blood per surgery which represented 188 units of blood that were not used. In this group all the 104 patients had blood prepared, and only 13 (12,5%) used the blood. In the type and screen group the blood was prepared in 13 cases and used only in 6 cases (46%).

The financial analyses revealed that typing and screening cost about 48% less than cross-matching. This means that if the type and screen method was used since the beginning of the period under analysis, the hospital would have had a saving of 1022€.

Conclusion: Routine type and screen should be made for every patients proposed for aneurysm clipping surgery. Financial benefits with the reduction of transfusion costs would lead to a better management of our blood products.

Keywords: Cerebral aneurysm; Blood transfusion; Neurosurgery; Subarachnoid hemorrhage; Economics; Surgery

Introduction

The cerebral aneurysm clipping surgery is one of the surgical treatments for patients with cerebral aneurysms with or without subarachnoid hemorrhage (SAH). For many years the standard model for aneurysm surgery included the ready availability of blood [1].

However, blood transfusion in the perioperative period has changed significantly, largely because of increased awareness of transfusion-associated risks and increasing costs of transfusions [2,3]. The number of red blood cells (RBC) units ordered in the past may not be now an appropriate standard of practice [2]. Furthermore, intraoperative transfusion of RBC is a risk factor of poor outcome in cerebrovascular surgery [4,5].

Many times the number of RBCs ordered is based on the physician's transfusion experiences with previous patients. New guidelines are being proposed to direct future blood ordering in cerebrovascular surgery [2].

Due to shortage of blood availability and costs, in a single Portuguese tertiary center until April 2012 all patients who underwent cerebral aneurysm clipping surgery had at least 2 units of RBCs cross-matched before surgery and from then on and after a multidisciplinary meeting between the Neurosurgery, Neuroanaesthesia and Hematology departments, only type and screen is done in this type of surgery.

To assess outcomes of these policies changes and to study the costs associated with blood use, we carried out a retrospective analysis of 206 patients who underwent cerebral aneurysm clipping surgery in our institution between January 2011 and July 2014.

Methods and Assumptions

Records of 206 patients who underwent cerebral aneurysm clipping surgery at Centro Hospitalar do Porto in Portugal were retrospectively reviewed over a period of 43 months, between January 2011 and July 2014. We obtained data from the patient's anesthetic chart, blood transfusion documents as well as perioperative notes.

Determination of RBCs use was undertaken in within 4 days of surgery (preoperative, intraoperative and postoperative periods).

The decision to transfuse RBCs was made when there was a documented need to increase oxygen delivery in a patient unable to meet demands. Transfusion was rarely indicated when hemoglobin was greater than 10 g/dL and indicated when the level was less than 8 g/dL. Between these two parameters, the decision to transfuse RBCs was based on the patient´s clinical status and the rate and magnitude of blood loss.

A comparative study was made between the cross-matched group and the group with only type and screen. A cost analysis was also made between the cross-match and the type and screen group.

Assumptions

The cost of blood typing and screening was calculated to be of 9.48€ and the cost of blood preparation to be of 5.42€ per unit. These costs are independent of the blood preparation method (cross-match and type and screen).

The difference between the two methods lies on the fact that the first always prepares 2 units of blood beforehand.

Therefore, the total costs are given by the following formulas:

Cross-match: Cost=9.48€+(2+n) × 5.42 €

Type and screen: Cost=9.48€+n × 5.42€

Being the number of additional blood units to be prepared if needed.

Additionally, for financial costs calculation it was assumed that blood units prepared but not used have no residual value.

Statistical analysis

Data are summarized as the mean ± standard deviation. Differences between groups where the samples were normally distributed were tested using a Student's t test. When the samples were not normally distributed, differences were tested using Mann-Whitney U test. Regression analysis was also used to relate variables to one another. Statistical significance is assumed for comparisons in which $p < 0.05$. All statistical analyses were performed using commercially available software, such as Microsoft Excel.

Results

Out of the 206 patients who underwent cerebral aneurysm clipping surgery between January 2011 and July 2014, 104 had its blood cross-matched and 102 had it typed and screened. The main characteristics of the two groups are illustrated in Table 1.

Both groups are not statistically different, demographics wise.

Those who transfused blood presented barely any differences in the number of units used between the two groups (1.7 vs 1.7).

However, overall it seems that there is a trend to transfuse less when the blood is typed and screened (6% vs 13%). This is not significant at a 95% confidence level, but the p value is relatively close (p=0.101).

Clinical characteristics	Cross-match (n=104)	Type and screen (n=102)	P-Value
Male (n=58)	25	33	
Female (n=148)	79	69	P=0.85
Median ± SD age (yrs)	58 ± 16	60 ± 15	P=0.43
Median ± SD weight (kgs)	68 ± 12	68 ± 13	P=0.53
Median ± SD height (cms)	161 ± 8	162 ± 8	P=0.76
Median ± SD BMI* (kg/m^2)	26 ± 4	26 ± 4	P=0.84
Median ± SD ASA classification†	2 ± 1	2 ± 1	P=0.87
Median ± SD GCS$^{\Delta}$	14 ± 3	14 ± 3	P=0.86

*BMI=body mass index; †ASA=American Society of Anesthesiologists; $^{\Delta}$GCS=Glasgow Coma Scale

Table 1: Patients' characteristics.

Preparation wise, there are considerable differences. Since the cross-match group had blood prepared before knowing whether it was needed, it consistently showed a higher number of units prepared than the type and screen group, who prepared it only when needed. The cross-match group has an average of 2 units prepared in each surgery and the type and screen has an average of only 0,2 units, as illustrated in Figure 1. The difference is statistically relevant with a confidence level of nearly 100% (p<0.001).

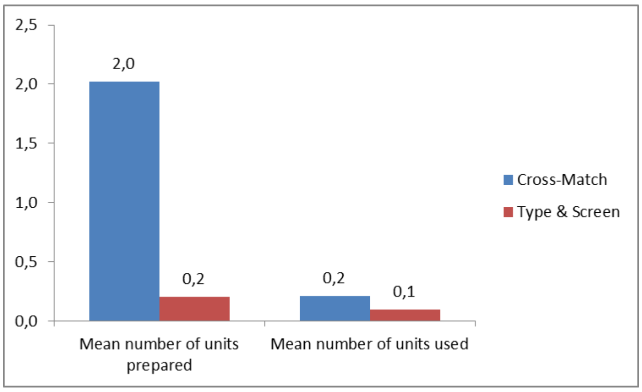

Figure 1: Mean number of units prepared: the cross-match group has an average of 2 units prepared in each surgery and the type and screen has an average of only 0.2 units.

As a result, the cross-match group presented average losses of 1.8 units of blood per surgery. In real terms, this represented 188 units of blood that were cross-matched routinely and not used.

In fact, in the cross-match group all the 104 patients had blood prepared, and only 13 (12.5%) used the blood. Within these 13 surgeries, in 38% of the cases the blood prepared was not entirely used. In contrast, in the type and screen group the blood was prepared in 13 cases and used only in 6 cases (46%). In these 6 cases all the units prepared were used.

Costs wise, an average aneurysm clipping surgery presents costs of 20,4€ in the cross-match group, given that a compatibility testing (ABO and Rh typing of the patient´s RBCs, an antibody screen and a cross-match) is needed for all patients in order to prepare 2 units of blood beforehand, independently of its need and use. In the type and screen group, it costs on average 10.6€ (about 48% less than the cross-match group). In this case, there is a fixed cost of typing all patients, plus the cost of units to be prepared, but only when they are needed. The difference in the groups' mean is statistically relevant, with nearly 100% confidence level (p<0.001).

As mentioned before, some costs are assumed without a real need, therefore there are quantifiable losses in both procedures. The cross-match group presents higher losses, as can be seen in Figure 2.

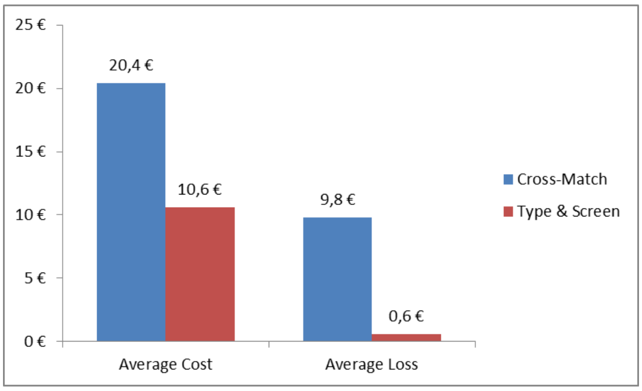

Figure 2: Average cost and loss of both procedures: an average aneurysm clipping surgery presents costs of 20.4€ in the cross-match group, while the type and screen group, it costs on average 10.6€. Losses were on average 9.8€ in the cross-match group and only of 0.6€ in the type and screen group.

In theory, and assuming that there would be no losses apart from those derived from the fact the cross-match procedure always prepares 2 units of blood independently of the need, the only scenario where applying the cross-match procedure is indifferent, costs wise, is when a hospital only has cerebral aneurysm clipping surgeries that always need 2 or more blood units, as illustrated in Figure 3.

There was a strong correlation between patients with SAH and transfusion (p=0,003). The correlation between blood losses and SAH is not statistically significant at 95% confidence level, but would be with a lower confidence level (p=0.09). Other variables combined would eventually strengthen the regression as the adjusted R^2 of both were on the low side (0.04 and 0.01).

Those who were transfused had no statistical difference in the time of the transfusion (day 0 and 1st, 2nd, 3rd and 4th days after surgery). In both groups the majority of patients were transfused intraoperatively (84.6% in the cross-match group and 66.7% in the type and screen group).

There was also no correlation between transfusion and mortality rate at 30 days after surgery (p=0.64 and R^2=0.001).

Those who died, however, showed, on average, a lower initial GCS and a higher SAH incidence, relative to those who didn't die.

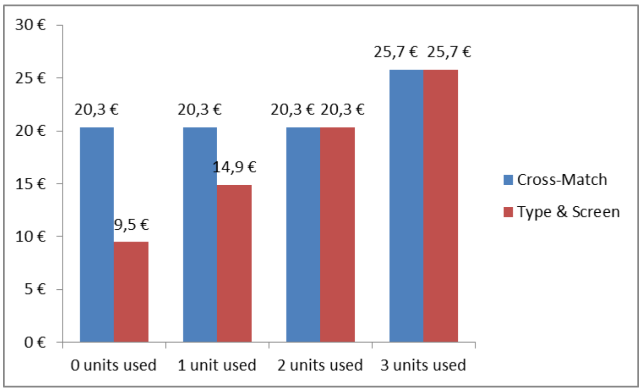

Figure 3: Theoretical comparison of costs between blood preparation types: the costs of applying the cross-match procedure to all patients would only be the same as of type and screen if all aneurysm clipping surgeries needed 2 or more units of blood.

Discussion

The surgical treatment of patients presenting with a cerebrovascular aneurysm leakage or rupture, involves the clipping of the aneurysm [6,7]. The standard model for aneurysm surgery includes the ready availability of blood [8,9]. This involves the routine cross-matching of a variable number of units of blood determined mainly by the anticipated degree of difficulty the case may present as well as the preoperative haemoglobin level [1] and also based on the physician's transfusion experiences with previous patients [2]. While there is evidence [10] of the importance of maintaining the red cell volume perioperatively to decrease the risk of neurological deterioration, the advent of the operating microscope and angiography has done much to decrease the incidence of perioperative bleeding [11].

The healthcare system has been through several changes and the cost of transfusions and the adequacy of the blood supply have become a critical issue.

Given the growing concerns over safety, cost, and adequacy of the blood supply, much effort has focused on examining the blood ordering and transfusion practices in cerebrovascular surgery [2].

The number of units of RBCs cross-matched for surgery is always greater than the number of units actually transfused [12,13].

Several authors have studied the problem of excessive cross-matching using the ratio cross-match to transfusion (C/T ratio). A high C/T ratio means that blood bank must keep more blood in its storage, which increases hospital costs and the likelihood of outdated blood products. Therefore the problems with blood supply occur when products that have a short shelf life are prepared and sent to the operating room but are not used.

RBCs can be stored for 35 days when stored in citrate phosphate dextrose adenine [14] which can be extended to 42 days when AS-1 (Adsol) or AS-3 (Nutricel) is used [12,13]. However, evidence suggests that the oxygen delivery capacity of the RBCs decreases with time in storage and that patients have worse outcomes after receiving blood stored during long periods of time [2].

It is clear that is necessary to develop a preoperative blood ordering protocol based, not only on the experience of the facility, but also in audits and reviews that analyze outcomes and costs.

From our study it seems that an ABO Rh type and antibody screen is a safe preoperative approach for intracranial aneurysm clipping surgery in our institution. With the implementation of these changes in our daily practice it was possible not only to reduce costs associated with blood preparation and transfusion but also allowed a more efficient use of the blood supply available.

The costs of type and screen are clearly different from the cross-matching costs. The financial analyses carried out in this study revealed that typing and screening cost about 48% less than cross-matching. This means that if the type and screen method was used since the beginning of the period under analysis, the hospital would have had a saving of 1022€ in only one type of surgery. These results indicate that if the policy instituted in neurovascular surgery was adopted by all the departments this would have serious repercussions in the total hospital costs.

In other countries like in the United Kingdom these figures are much higher. In 2005 de Gray et al [1] published an economic review of the blood use in cerebrovascular aneurysm surgery, which reported a saving of £4815.72 if their group of patients had been type and screened instead of cross-matched. A more efficient use of the blood supply in this case would lead to even more dramatic changes in transfusion costs.

Conclusion

From this retrospective review, we conclude that routine ABO Rh type and antibody screen should be made for every patients proposed for aneurysm clipping surgery and formal cross-match be restricted to patients with low haemoglobin level preoperatively, abnormal clotting diseases or with abnormal antibodies.

The implementation of this strategy would contribute greatly to reduce blood usage thus maintaining the national blood supply. Financial benefits with the reduction of transfusion costs would lead to a better management of our blood products.

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