Blood Use in Neurosurgical Cases at the University Hospital of the West Indies

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ABSTRACT

Objective: *Many neurosurgical cases are done without the need for blood transfusion, yet blood is unnecessarily cross-matched, resulting in wasted resources. This study was undertaken to document and compare the number of units of blood components requested, cross-matched and transfused in neurosurgical cases at the University Hospital of the West Indies (UHWI).*

Methods: *A prospective, observational study was undertaken over one year. Data collected for each patient included demographic information, relevant perioperative data, and blood banking data including blood components requested, cross-matched and transfused. Data were analysed using SPSS version 16.*

Results: *Data were analysed on 152 patients, 71 females (46.7%) and 81 males (53.3%). The mean age was 48.7 ± 19.6 years and 100 of the procedures were done electively (65.8%). Blood components were ordered in 114 (75%) cases, red cells more commonly in 113 (74.3%) patients, and plasma in 19 (12.5%) patients. Overall, 20 patients (13.2%) were transfused. Most patients (90.9%) needed one to two units of blood. Of the 236 units of blood components that were cross-matched or prepared, only 62 were transfused. The cross-match/preparation to transfusion ratio (CTR/PTR) was 6.00 for red cells and 1.31 for plasma. Preoperative haemoglobin ≤ 10.0 g/dL ($p = 0.001$), estimated blood loss of ≥ 1 litre ($p < 0.001$), higher American Society of Anesthesiologists (ASA) physical status score ($p < 0.03$) and a resident as lead surgeon ($p < 0.05$), were significant predictors of blood transfusion.*

Conclusion: *The transfusion rate was low with a high cross-match to transfusion ratio, suggesting that less cross-matching is needed. A new approach to blood ordering for neurosurgical cases is recommended.*

Keywords: Blood transfusion, cross-match to transfusion ratio, neurosurgery

El Uso de la Sangre en los Casos de Neurocirugía en el Hospital Universitario de West Indies

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RESUMEN

Objetivo: *Muchos casos neuroquirúrgicos se realizan sin necesidad de transfusión de sangre. Sin embargo, la sangre es innecesariamente sometida a pruebas cruzadas, lo cual resulta en un malgasto de recursos. Este estudio fue emprendido con el propósito de documentar y comparar el número de unidades de los componentes sanguíneos requeridos, cotejados, y transfundidos en los casos de neurocirugía en el Hospital Universitario de West Indies (HUWI).*

Métodos: *Se realizó un estudio prospectivo observacional por espacio de más de un año. Los datos recopilados de cada paciente incluían información demográfica, datos relevantes perioperatorios, y datos de bancos de sangre, incluyendo los componentes sanguíneos solicitados, cotejados, y transfundidos. Los datos fueron analizados utilizando SPSS versión 16.*

Resultados: *Los datos se analizaron en 152 pacientes: 71 mujeres (46.7%) y 81 varones (53.3%). La edad promedio fue de 48.7 ± 19.6 años y 100 de los procedimientos se realizaron de manera electiva (65.8%). Se ordenaron componentes de la sangre en 114 casos (75%), siendo los glóbulos rojos los más comúnmente requeridos en 113 pacientes (74,3%) y el plasma en 19 pacientes (12.5%). En general, 20 pacientes (13.2%) fueron transfundidos. La mayoría de los pacientes (90.9%) necesitó una o dos unidades*

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de sangre. De las 236 unidades de componentes sanguíneos que fueron preparados o sometidos a pruebas cruzadas, sólo 62 fueron transfundidos. La proporción de la preparación/prueba cruzada en relación con la transfusión (CTR/PTR por sus siglas en inglés) fue 6.00 para los glóbulos rojos y 1.31 para el plasma. La hemoglobina preoperatoria ≤ 10.0 g/dL ($p = 0.001$*), la pérdida estimada de sangre de ≥ 1 litro (*$p < 0.001$*), la mayor puntuación del estado físico (*$p < 0.03$*) según los criterios de la Sociedad Americana de Anestesiólogos (ASA), y un residente como principal cirujano (*$p < 0.05$*), fueron predictores significativos de la transfusión de sangre.*

Conclusión: *La tasa de transfusión fue baja, con una alta proporción de la prueba cruzada frente a la transfusión, sugiriendo que se necesitan menos pruebas cruzadas. Se recomienda un nuevo enfoque a la hora de hacer pedidos de sangre para los casos neuroquirúrgicos.*

Palabras claves: Transfusión de sangre, proporción prueba cruzada:transfusión, neurocirugía

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INTRODUCTION

Many neurosurgical procedures involve a significant risk of bleeding. Bleeding, when it occurs, can be rapid and may lead to patient instability with unfavourable operating conditions resulting in serious morbidity and mortality. Thus allogeneic blood is usually cross-matched to ensure that if it becomes necessary, blood and blood components are available (1). However, many procedures are done without blood transfusion (2, 3) and there is a significant disparity between cross-match requests and actual transfusion (1, 2, 4).

A cost is incurred for each unit of blood that is processed (2). Cross-matching renders units unavailable to other patients and thus increases the risk of them becoming outdated (5). Elective surgical procedures have been postponed in cases where blood is absent and this increases the costs to both patient and institution. A high cross-match to transfusion ratio (CTR) suggests that most requests are not translated to actual need for transfusion and indicates a waste of resources. Therefore it would be more cost-effective to have a more streamlined approach to blood ordering which should result in significant savings (6−8).

The objective of this study was to document the difference, if any, in the number of units of blood components requested and cross-matched/prepared *versus* the number that was actually transfused, and therefore to suggest a maximum blood ordering schedule for neurosurgical procedures done at the University Hospital of the West Indies (UHWI).

SUBJECTS AND METHODS

The study was approved by the UHWI/University of the West Indies/Faculty of Medical Sciences Ethics Committee. It was a prospective observational study. All patients presenting for neurosurgical procedures at the UHWI, Kingston, Jamaica from July 1, 2007–June 30, 2008 were eligible for the study. This 500-bed hospital is a university-affiliated, multidisciplinary institution which serves as a referral centre for the entire island of Jamaica. Data collected for each patient included demographic information, American Society of Anesthesiologists (ASA) physical status, preoperative haemoglobin, surgical procedure, blood loss, and transfusions, as well as blood banking data – number and component of units requested, cross-matched and transfused. Data collection did not require any patient/investigator interaction and did not in any way impact the study participant, thus patient consent was not deemed necessary.

The Statistical Package for Social Sciences (SPSS) version 16.0 was used for data entry and analysis. All parametric data were analysed and presented using descriptive statistics. Preoperative, intra-operative and postoperative variables (*eg* age, ASA class, surgery, blood loss, *etc*) were cross-tabulated against number of blood units transfused and tested for statistical significance using the Chi-squared test. Ratio and interval data are presented as mean ± standard deviation.

RESULTS

Data were collected for 260 patients. The group for data analysis comprised 152 as 108 had missing data in some variables of interest. Blood loss accounted for the largest group of missing data (n = 94). A further 14 were excluded due to missing preoperative haemoglobin (n = 11) and ASA status (n = 3).

There were 71 females (46.7%) and 81 males (53.3%). The mean age was 48.7 ± 19.6 years, ranging from one day to 85 years. Most patients were ASA I (36.2%) and II (50.0%). There were 100 elective procedures (65.8%) while 52 (34.2%) were emergency procedures. Most of the surgeries were spinal procedures (55.3%) and craniotomies (22.4%). Burr holes for haematoma evacuation and transphenoidal resection of pituitary tumours were the next largest groups [7.2% each] (Table 1).

Blood and blood components were ordered in 114 [75%] cases. Type and screen only was requested in 24 patients (15.8%), and no requests were made in 14 patients (9.2%). Red cells (packed or whole blood) were requested in 113 (74.3%) patients and plasma with red cells in 18 of those patients. One patient had a request for plasma alone.

Of the patients for whom red cells were requested, 75.2% were for one or two units. There were equal requests for one to two units and three to four units of plasma (47.4%).

Red cells were cross-matched for 113 (74.3%) patients and plasma prepared for 12 (7.9%) patients. Thus, red cells

Table 1: Predictors of transfusion

	Transfusion	No transfusion	*p*-value
Age			
0−59 years	11	87	$p = 0.3$
≥ 60 years	9	45	
ASA physical status			
I	3	52	$p < 0.05$
II	11	65	
III	6	14	
IV	0	1	
Type of surgery			
Spine:	15	69	$p < 0.30$
Cervical	8	30	
Thoracic	1	2	
Lumbar	6	37	
Craniotomy:	4	30	
Tumour	2	13	
Aneurysm	2	6	
Trauma	0	11	
Burr hole	0	11	
TSR	1	10	
Other	0	12	
Urgency of surgery			
Elective	11	89	$p < 0.3$
Emergency	9	43	
Preoperative Hb			
> 10 gm/dL	14	123	$p = 0.001$
≤ 10 gm/dL	6	9	
Lead surgeon			
Resident	20	109	$p = 0.04$
Consultant	0	23	
Blood loss			
< 1000 mls	10	123	$p < 0.001$
> 1000 mls	10	9	

ASA − American Society of Anesthesiologists, TSR − transphenoidal resection of pituitary, Hb − haemoglobin

were cross-matched in 100% and plasma was prepared in 63.2% of the respective requests.

Of the patients cross-matched, 104 (92.0%) were cross-matched for one to two units, seven patients (6.2%) for three to four units and two patients (1.7%) for > 4 units.

Three patients (2.1%) were transfused in the preoperative period. One patient had plasma, one had packed red cells and another had both. The patients transfused with red cells each had haemoglobin of 8.0 g/dL and got one to two units. Thirteen patients (8.6%) were transfused intra-operatively: eight (5.3%) had red cells alone, three (2.0%) had plasma and red cells and two (1.3%) had plasma only. Most patients (90.9%) who had red cell transfusions had one to two units and 80% of those receiving plasma got three to four units. Eleven patients (7.2%) were transfused postoperatively, six having been already transfused intra-operatively. Six patients had red cells, three had red cells and plasma, and two had plasma only. All nine patients who had red cells were transfused one to two units. Transfusions were done for anaemia and incompletely replaced intra-operative blood loss.

Some patients were transfused in more than one phase of their perioperative care (*eg* intra-operatively and postoperatively). When a patient transfused in any part of the perioperative period was counted only once, 20 patients (13.2%) were transfused. Of the 236 units of blood components cross-matched or prepared, 62 were used. The cross-match/preparation to transfusion ratios (CTR/PTR) for blood components are shown in Table 2.

Table 2: Cross-match/Preparation to transfusion ratios (CTR/PTR) for blood components

	Red cells	Plasma	Total
Number of units cross-matched/ prepared	198	38	236
Number of units transfused	33	29	62
CTR/ PTR	**6.00**	**1.31**	**3.81**

Age ($p = 0.3$), urgency of surgery ($p < 0.3$) and type of surgery ($p = 0.20$) were not significant predictors of transfusion. A preoperative haemoglobin ≤ 10 gm/dL ($p = 0.001$) and estimated blood loss of over one litre ($p < 0.001$) were significant predictors of blood transfusion. A higher ASA physical status score ($p < 0.03$), and a resident as lead surgeon ($p < 0.05$) were also associated with an increased risk of transfusion (Table 1).

DISCUSSION

Over the past two decades there has been a decrease in the amount of blood components transfused in the perioperative period due to a combination of factors: recognition of transfusion-associated risk (9), use of microsurgical techniques (10) and acceptance of lower haemoglobin (11). Donations have also decreased (9). Therefore there has been some emphasis on looking at blood ordering and transfusion practices in many groups of patients in order to better utilize blood resources (12).

The overall transfusion rate in neurosurgical patients in this study was only 13.2%, with 8.6% transfused intra-operatively and 7.9% postoperatively. Couture *et al,* in their study of 301 patients having cerebrovascular procedures at the University of Virginia, also recorded a low intra-operative transfusion rate (0−7.4%) for all procedures. The recorded postoperative transfusion rates were 17.0%–66.7%, which made their overall transfusion rate higher than ours except in the patients for carotid endarterectomy [4%] (4). In a study of patients in the United Kingdom (UK) undergoing clipping or coiling of intracranial aneurysms (2), the transfusion rate was 32%, the majority requiring transfusion intra-operatively. Le Roux *et al* documented an intra-operative transfusion rate of 24.5% and a postoperative rate of 44.6% in patients with intracranial aneurysms treated surgically (1). Perhaps as these studies included solely patients with cerebrovascular surgical disease it could be argued that these patients would be at higher risk of bleeding and thus would have a higher transfusion rate compared to our study. Bhatnagar *et al* had a heterogenous mix of patients similar to this study, exclusive of emergencies (13). Their transfusion rate was recorded as 31%. Thus our transfusion rate was low especially as emergencies were included in our patient population.

For reporting purposes, patients who got one or two units of blood were grouped together, the majority getting two units. A transfusion of one unit of blood is considered unnecessary; however, availability may have been a determining factor when this occurred. For two patients, further units were transfused in the postoperative period, strengthening the theory that insufficient blood supply was dictating transfusion practice. Two patients had whole blood, again probably determined by accessibility, and one received an autologous unit.

A low preoperative haemoglobin [≤ 10.0 gm/dL] was a highly significant predictor of transfusion in our population ($p = 0.001$). LeRoux *et al* and de Gray and Matta also found this to be a significant predictor of intra-operative transfusion (1, 2). It would seem intuitive, as a low starting haemoglobin requires less blood loss in order for the haemoglobin to drop to tissue hypoxic threshold, and acute anaemia is associated with cerebral injury (14).

A high ASA status indicates a more ill patient and this was also associated with an increased chance of transfusion. A resident as lead surgeon on a case increased the likelihood of a transfusion being needed. This could be explained by the lower level of experience and skill of the junior [resident] surgeon.

Estimated blood loss ≥ 1000 mls was a significant predictor for intra-operative transfusion in our study. Bhatnagar *et a*l also found a significant difference in blood loss between transfused and non-transfused patients (13). Le Roux *et al* did not quantify the blood loss in their study but intra-operative rupture of aneurysm, evacuation of intracerebral haematoma, large aneurysm and treatment of multiple aneurysms were all significant predictors of intra-operative transfusion, and all are usually associated with greater blood loss (1).

There has been a trend to accept a lower haemoglobin for transfusion and to incorporate other factors apart from haemoglobin level as a transfusion trigger (11), however, in neurosurgical patients, higher haemoglobin has been shown to be associated with better neurological outcome. The use of transfusion though, as a means of raising the haemoglobin, might not necessarily improve the outcome (15−17).

Exclusion of the 108 patients with incomplete data did not change the outcome of the study as the same factors significantly affected the likelihood of transfusion in analyses done with or without the 108. However, the magnitude of the effect might have been larger (10% transfusion rate with 108 included *versus* 13.2% with them excluded).

As a result of the low transfusion rate in our population, there was a perioperative CTR of 6.00 for red cells. This suggests that many units were being unnecessarily cross-matched. A figure of 2.0 has been proposed as indicating good utilization of blood resources (8). The high CTR implies a waste of personnel's time, reagents and funds. The blood bank is compelled to have more units in storage as cross-matching renders a unit unavailable for 24−48 hours and an apparent shortage of blood can result. Transfer of a unit to the operating room increases the risk of poor storage outside the blood bank, outdating, if the unused unit is not returned promptly, and thus wastage (18). In the Jamaican setting where blood can be difficult to access, unavailability is more the problem than outdating. A high CTR, however, may just reflect a practice of ordering standby blood as a precautionary measure. In other settings, where blood supply is more reliable, a type and screen would suffice, making such behaviour unnecessary. However, international studies (2, 4, 19−21) have also demonstrated higher than the recommended CTR, some in reliable blood supply jurisdictions, hence the practice of over ordering of blood components seems widespread.

The ratio of the number of units of plasma prepared to those transfused (PTR) was much lower (1.31). Plasma was prepared in 63.2% of requests. This better ratio suggests that most of the prepared plasma was used. It is unclear whether decision-making by blood bank personnel about whether or not to issue plasma, or product shortage contributed to the better ratio.

An immediate way to increase efficiency in the use of blood components is to implement a maximum surgical blood order schedule (MSBOS). This is a list of common elective surgeries and the maximum number of blood units to be cross-matched for each preoperatively. It can be derived from retrospective data analysing actual blood usage in individual surgical procedures (22). The MSBOS would increase blood availability by decreasing the time each unit spends in an assigned or cross-matched status. Several studies have demonstrated that significant advantages accrue from instituting an MSBOS (5, 7, 8): a decrease in the CTR, increased accessibility of blood and significant savings in staff time, reagents and money. Recently, it has been suggested that the blood order should be personalized for each patient in order to increase efficiency further (23).

However, there are some elements that must be present for the MSBOS to work. A multidisciplinary approach with the involvement of surgeons, anaesthetists and blood bank staff is pivotal for success. Proper completion of the request form for blood products would enhance the ability of the blood bank to handle the requests made. Patients who are likely to need transfusion (those with coagulopathies or low preoperative haemoglobin) and those who may be difficult to cross-match (unusual antibodies) should be identified preoperatively and appropriate blood allocation made regardless of the MSBOS for the specific procedure (2). The ability to access suitable quantities of blood in a timely manner in case of unexpectedly severe blood loss is imperative. However, streamlining of blood ordering with a significant decrease in excessive ordering should increase the availability of blood for just such instance. In discussion with the haematologist, the surgeon should be able to vary the MSBOS for a particular patient, if difficulties increasing the patient's likelihood of bleeding, are anticipated.

The numbers in our study were small and the population was diverse, which made detailed analysis by procedure difficult. The greatest transfusion rates were in spinal surgery and in craniotomies for tumours (Table 1). A longer study time or inclusion of other centres would allow a clearer view of which procedures exhibited greatest propensity for blood loss and therefore guide the number of units to be cross-matched/prepared. From this study, the literature, combined with clinical experience, we recommend a type and screen for all neurosurgical patients with cross-matching for those patients with low preoperative haemoglobin, coagulopathies and antibodies. If the case is completely elective, then elevation of the preoperative haemoglobin to normal should be achieved by non-transfusion methods. As the majority of transfused patients in this study required only one to two units of blood components, we recommend that two units be cross-matched where cross-matching is necessary. If more is required, the two units plus crystalloids should suffice while further cross-matching is ensuing. For these recommendations to be widely accepted, the blood bank will need to have blood available to be cross-matched when it becomes necessary.

In conclusion, our varied neurosurgical population had a low transfusion rate, mainly done intra-operatively. Higher ASA status, low preoperative haemoglobin, a resident lead surgeon, and blood loss were significant predictors of perioperative transfusions. Most transfused patients were given one to two units. The CTR was high, suggesting over cross-matching of units. We recommend that all patients have a type and screen, and that cross-matching be reserved for patients who have anaemia, coagulopathies or antibodies. Our study suggests that in most cases two units of red cells will be adequate and we also recommend that the blood bank should have blood available for cross-matching if blood becomes urgently required.

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