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Research Article

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Blood Transfusion during Neurological Surgery in a Sub-Saharan Tertiary Teaching Hospital- A Prospective Study

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Abstract

Introduction: *Neurological surgeries are often associated with significant blood loss and high intraoperative and/ or subsequent blood transfusion requirements. This has led to high rate of routine preoperative blood grouping and cross-matching. More often, this translates to a high cross-match/transfusion ratio (CTR) and the consequent blood wastage, hence the need for this study.*

Objective: *We sought to determine the scale of blood transfusion needs and associated factors during neurosurgical procedures.*

Methods: *This was a prospective study of patients who had elective and emergency neurological surgeries at the University of Benin Teaching Hospital. The significance of the relationship between intra-operative blood transfusion and pre-operative diagnosis, ASA physical status and preoperative haemoglobin concentration was determined using chi-square test.*

Results: *About 63.4% of the total patients who underwent neurological surgery had blood grouping and cross matching while 23.7% had intra-operative transfusions, giving a cross-match/ transfusion ratio (CTR) of 2.7:1. Intra-operative blood transfusion was significantly associated with the type and duration of surgery (P <0.001 each) and not with the preoperative haemoglobin concentration (P=1.000).*

Conclusion: *The routine cross-matching of blood may not be mandatory in the pre-operative preparation of all patients for neurological surgery. Rather, the type and duration of the procedure planned could be a useful guide.*

Introduction

Blood and blood products are scarce and costly, especially in our environment [1,2]. Also, the cross-matching of blood in anticipation of possible need may render it unavailable to other patients in need, thus leading to both wastage and relative scarcity. This scenario may not be rare in neurosurgical practice.

Neurosurgeries often involve the anticipatory cross-matching of several units of allogenic blood, probably due to the propensity for massive blood loss and the associated haemodynamic effects [3]. However, many of the cross-matched units of blood are often eventually not transfused during or after surgery, and this leads to gross disparities between cross-matching and transfusion requirements [2,4]. Transfusion rates vary in neurosurgery depending on the type of surgery and the surgeon. For instance, Bhatnager et al. and Crawford-Sykes and co-workers6 report transfusion rates of 31% and 13.2%, respectively [5,6].

Recently, there has been a decrease in perioperative blood transfusion due to the use of blood conservative and microsurgical techniques and the acceptance of lower haemoglobin concentrations [7, 8]. However, in many centers including ours, the practice of routine grouping and cross-matching of blood for many neurosurgical interventions has continued. We therefore sought to determine the scale of blood transfusion and its contributory factors and the cross-match to transfusion ratio (CTR) among neurosurgical patients as a first step in addressing this gap.

Materials and Method

This was a prospective study of all patients who had neurological surgery at the University of Benin Teaching Hospital over a six-month period. The hospital serves as a referral center within a 200-300km radius [9]. The Departments of Neurosurgery and Anaesthesiology are run by a team of consultants assisted by specialist registrars.

All elective and emergency cases done within the six-month period were included in the study. Data were obtained prospectively from each patient using a proforma. The data included age and sex, preoperative haemoglobin concentration, American Society of Anaesthesiologists (ASA) classification, diagnosis, indications for surgery, the surgeries done and data relating to blood transfusion. The latter included blood grouping and cross-matching, the number of units cross-matched, and the number of units transfused.

For the purpose of this study, blood transfusion was defined as transfusion of blood during the intra-operative period. Blood transfusion was commenced in the operating theatre when blood loss exceeded the calculated Maximum Allowable Blood Loss (MABL) [10]. The relationship between blood transfusion and preoperative diagnosis, ASA physical status and preoperative haemoglobin concentration was analyzed. The cross-match to transfusion ratio (CTR), which describes the ratio of blood cross-matched to actual transfusion, obtained by dividing the number of units of blood cross matched by the number of units transfused intra operatively.

Data analysis was carried out using the Statistical Package for the Social Sciences (SPSS) version 20. The frequencies of discrete variables were compared between groups using chi-square test. A p <0.05 was considered statistically significant.

Results

Ninety-three (93) patients underwent different neurosurgical procedures under anaesthesia during the six months period of study. The mean age ± standard deviation of the patients was 33.7 ± 22.8 years and the age range was 3months to 80 years. There were 65 males and 28 females, giving a Male to Female ratio of 2.3:1. Twenty-one patients (22.2%) were ASA I, 28 (30.2%) ASA II, 22 (23.8%) ASA III, 19 (20.6%) ASA IV and 3 (3.2%) ASA V.

Fifty-six (60.3%) patients had elective surgeries while 37 (39.7%) were done as emergency. The operations in descending order included craniotomy/burr hole for subdural haematoma and traumatic brain injury in 38.1%, ventriculo-peritoneal shunt 17.5%, tumour excision 14.1%, wound debridement 11.1%, laminectomy 9.5%, meningeal repair 6.3% and Adeolu procedure 3.2%.

In 74.2% of cases, the Lead Surgeon was a Consultant neurosurgeon while only 25.8% were done by specialist residents under the supervision of a consultant. A majority of the more delicate surgeries such as craniotomy/burr hole (60%), laminectomy (100%), ventriculo-peritoneal shunt (88.2%) and tumour excision (100%) were performed by a consultant neurosurgeon.

The mean duration of surgery ± standard deviation was 170 ± 68 minutes with a range of between 30minutes to 585 minutes (9 hours 45 minutes). The duration of surgery was < 1 hour in 9.5% patients, 1-3 hours in 63.5%, >3-8 hours in 22.5%, and >8 hours in 5.4%. The mean estimated intra-operative blood loss ± standard deviation was 360 ± 183 ml. The volume of blood loss ranged from 5ml to 2000 ml and was <100 ml in 42 (45.1%) patients, 100-500 ml in 30 (32.6%), 501-1000 ml in 12 (12.8%), and >1000 ml in 9 (9.5%).

Fifty-eight (62.4%) patients were fully awake on arrival at the post-anaesthetic care unit (PACU), 22 (23.6%) were drowsy and 13 (14.0%) unconscious. The mean length of stay in PACU ± standard deviation was 156 ± 47minutes while the range was 30 minutes to 8 hours. Twenty-five (26.9%) patients spent <60 minutes at the PACU, 47 (50.5%) spent 1-3 hours and 21 (22.6%) >3 hours.

Fifty-nine (63.4%) had their blood grouped and cross-matched against donor blood while only 22 (23.2%) were transfused, giving a cross-match to transfusion ratio (CTR) of approximately 3:1. Twenty-two (31.9%) of the 69 cases in which the Consultant was the Lead Surgeon received blood transfusion while none of the 24 patients operated on by the specialist registrars had blood transfusion, p = 0.002.

The relationship between transfusion and the characteristics of the patients and the nature of surgery is shown in Tables 1-VI. Patients with ASA class II-IV had the highest frequencies of blood transfusion but the relationship between transfusion and ASA classification was not statistically significant (p = 0.841) (Table 1). The association between the frequency of transfusion and the type of neurosurgery was highly significant statistically (p <0.001) (Table I). The frequency of transfusion was highest in cases of tumour excision (Table 1).

Feature	N	No. (%) transfused	p (χ^2/df)*
ASA classification status			
I	21	3 (14.3)	0.713 (1.37/3)**
II	28	7 (25.0)	
III	22	6 (27.3)	
IV	19	6 (21.6)	
V	3	0	
Type of surgery			
Craniotomy/burrhole	35	10 (28.6)	<<0.001 (38.66/2)
Tumour excision	13	11 (84.6)	
Others***	45	1 (2.2)	

Table 1: Frequency of blood transfusion in relation to ASA classification status and type of surgery. *p (χ^2/degrees of freedom) for group chi-square test. **ASA class IV merged with V. ***Ventriculo-peritoneal shunt 17, wound debridement 10, laminectomy 9, meningeal repair 6, Adeolu procedure 3.

Table 2 shows the association between the frequency of transfusion and the duration of surgery and frequency of transfusion versus estimated blood loss during surgery with p values of 0.031 and 0.008 respectively. Transfusion frequency was highest among patients with duration of surgery >3 hours and estimated blood losses of 100-500 ml.

The haemoglobin (Hb) concentration was > 10g/dl in 95.6% of our patients with 4.4% having an Hb <10g/dl. Less than half (30.4%) of patients with Hb > 10g/dl received blood transfusion while none of the patients with Hb < 10g/dl had blood transfused. There was no statistical relationship between pre-operative Hb concentration and intra-operative blood transfusion in our patients p = 1.000.

Feature	N	No. (%) transfused	p (χ^2/df)*
Duration of surgery			
≥1 hour	9	0	<<0.001 (41.71/3)**
>1-3 hours	58	4 (6.9)	
>3-8 hours	21	14 (66.7)	
>8 hours	5	4 (80.0)	
Estimated blood loss			
<100 ml	42	0	<<0.001 (39.55/2)***
100-500 ml	30	7 (23.3)	
501-1,000 ml	12	6 (50.0)	
>1,000 ml	9	9 (100.0)	

Table 2: Association between frequency of blood transfusion and duration of surgery and estimated blood loss. **p* (degrees of freedom) for group chi-square test. ***>3-8 hours merged with >8 hours. ***501-1000 ml merged with >1000 ml.

There was a statistically significant association between the frequency of transfusion and the level of consciousness on arrival at PACU (p = 0.003) and the duration of stay at PACU (p = 0.002) (Table 3). The frequency was lowest in patients who were awake on discharge from PACU and highest in those who were unconscious. The frequency of transfusion was higher with durations of stay <1 hour or >3 hours.

Feature	N	No. (%) transfused	*p* (df)*
Level of consciousness on arrival at PACU			
Awake	58	6 (10.3)	<0.001 (17.99/2)
Drowsy	22	8 (36.4)	
Unconscious	13	8 (61.5)	
Duration of stay at PACU			
<1 hour	25	9 (36.0)	0.002 (12.37/2)
1-3 hours	47	4 (8.5)	
>3 hours	21	9 (42.9)	

Table 3: Association between level of consciousness on arrival, and duration of stay at PACU and the frequency of blood transfusion. *p (degrees of freedom) for group chi-square test.

Discussion

The study revealed a CTR of approximately 3:1 and a transfusion rate of 37.3% among cross-matched patients. This is, however, higher than the transfusion rates reported by both Bhatnager et al5 and Crawford-Sykes and co-workers6 (31% and 13.2%, respectively). As far as four decades ago, Mintz and colleagues had proposed that a CTR of 2:1 was indicative of the appropriate use of blood [11]. Higher CTR values like the one we observed, therefore, mean inefficient use and/or wastage of blood. The blood thus wasted could have been made available for other patients with dire emergencies who would require blood transfusion [12].

According to the American Association of Neurological Surgeons (AANS), the type of neurosurgeries performed has a significant influence on the frequency of blood transfusion [13]. This stands to reason as craniotomy and tumour excision surgeries would involve more blood loss than burr-holes and shunt insertions. Most neurosurgical procedures in our environment such as tumour excisions are often times associated with significant blood loss, which is attributable to difficulty with securing haemostasis. However, the majority of our procedures were associated with minimal blood loss, probably due to the fact that tumour excision accounted for only 14.1% of the cases done.

Furthermore, the longer the duration of a surgical procedure, the higher the likelihood of significant blood loss and consequently the need for blood transfusion [14]. This may be attributed to more tissue handling and higher duration of anaesthesia-induced vasodilatation and consequent blood loss. Our observation that only 19.5% of procedures lasting less than six hours required transfusion as against 92.3% of cases lasting greater than six hours is a testimony to this fact.

Most neurosurgical procedures involving the brain and the spine are prolonged, and measures should be taken to reduce the length of the procedure. The above must, however, be implemented with the patient's safety in mind which must not be sacrificed for speed. The use of microsurgical techniques and increased level of expertise and training become relevant in this regard. In addition, the most experienced member of the team should ideally be the lead surgeon as this may reduce the duration of surgical procedures and possible complications that may require blood transfusion.

The result of this study shows that consultant-led surgeries are more associated with blood transfusion. This may sound contradictory but it is because the surgeries performed by the consultant were the most delicate ones, with a greater propensity for blood loss and blood transfusion requirements. However, Crawford-Sykes and co-workers found that resident doctor-led surgeries were more associated with blood transfusion and attributed it to limited experience on the part of the residents [6].

The need for blood transfusion was not significantly related to the ASA physical status of the patients in this study. This is in contrast with the results of an earlier study, which showed that the more ill patients and therefore those with a higher ASA physical status had a greater frequency of transfusion [6]. The contrast with the findings in our study may be difficult to explain. However, it is expedient to consider intraoperative events and findings vis-à-vis blood loss and transfusion triggers in deciding the need or otherwise for blood transfusion.

The frequency of blood transfusion was independent of the preoperative haemoglobin (Hb) concentration in this study. This raises a pertinent question as to the need to use preoperative Hb. concentration as a guide to blood grouping and /or transfusion intra-operatively. Despite the fact that we did not measure Hb. concentration intra-operatively, blood transfusion was commenced when blood loss exceeded the allowable blood loss or with the presence of cardiovascular compromise.

Conclusion

The cross-match to transfusion ratio (CTR) among neurosurgical patients at the UBTH is higher than the recommended level and the main associated factors are the type and duration of surgery. Therefore, preoperative grouping and cross-matching of blood should be reserved for patients on the basis of the type and duration of the planned procedure. Also, the adoption of more modern operative techniques aimed at reducing duration of neurosurgical procedures and efforts at blood conservation techniques in the intra-operative period are recommended.

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