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Maximum surgical blood ordering schedule for common Orthopaedic surgical procedures at Birrd hospital (Tertiary orthopaedic hospital)

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Abstract
Background: Blood transfusion is an important part of management of patients undergoing orthopaedics surgeries. However frequently perioperative anticipated blood requirements overshoot the actual need resulting in unnecessary cross matching of blood. Therefore, it is important to formulate a maximum surgical blood ordering schedule (MSBOS) for common orthopaedics surgeries.
Objective: To evaluate our blood utilization in various orthopaedic surgeries and to develop a blood ordering schedule for various orthopaedic surgeries.
Methodology: A 16-month (March 2022 -august 2023) retrospective study was carried out on patients undergoing orthopaedic procedures. Data collected included number of patients transfused, number of units cross-matched and number of units transfused.
Results: A total of 2955 units of blood were cross matched for 2298 patients out of which only 1790 units of blood was transfused to 1274 patients. 3 out of 7 surgical procedures had CTR higher than 2. The mean CTR was 1.65,
Mean transfusion probability (%) was 55.43, Mean Transfusion index was 1.67 and Mean Blood Utilization (%) was 60.57.
Conclusion: The overall CTR was high with moderate percentage blood utilization and resultant significant blood wastage. To prevent unnecessary blood wastage, we suggest the implementation of the recommended MSBOS schedule.

Keywords: Blood transfusion, orthopaedic surgeries, cross-matched to transfusion ratio (CTR), MSBOS

Introduction
Patients undergoing orthopaedic surgeries as an elective procedure or emergency orthopaedic surgery for trauma often experience excessive blood loss- requiring transfusions. Orthopaedic surgeries alone consume a considerable proportion of blood available to the National Health Services, which has been reported to be in the range of 10% - 15% [1]. However, it has been observed that the preoperative placement of blood requests frequently overshoots the actual need resulting in unnecessary crossmatching [2].
The consequences of unnecessary crossmatching results in outdating of blood, overburdening of blood bank personnel, depletion of blood. Bank resources, wastage of time and financial loss to the patients [3, 4].
The cross-match to transfusion ratio (CTR), the transfusion index (TI), transfusion probability and blood utilization when considered together are simple and reliable indicators of the accuracy of preoperative assessment of expected transfusions for an individual patient undergoing a particular surgical procedure. These TI's are helpful in formulating the maximum surgical blood ordering schedule (MSBOS). MSBOS is a table of elective surgical procedures, which lists the number of units of blood routinely cross-matched pre-operatively. Another term, surgical blood ordering equation which is an extended MSBOS incorporates patient and surgical variables, such as pre and post- operative haemoglobin levels of the patient and the amount of surgical blood loss during each surgical procedure [5]. They are intended only as a guide to the ordering of blood and blood products and are interpreted according to individual circumstances, including the clinical condition of the patients [6].

The ratio of the number of units cross matched to the number of units actually transfused, i.e., CTR should not exceed 2:1 [7]. Lower CTR also reduces the overall consumption of blood bank resources, workforce and time. To limit the number of units held out of the circulation and outdating of blood units, MSBOS recommends that for patients likely to be transfused during surgery, the number of cross-matched units should be twice the median requirement for that surgical procedure [8]. According to the International Red Cross, appropriate use of blood had cut down the number of transfusions by 30% [9]. Implementation of MSBOS by Chawla *et al*. resulted in about 60% reduction of cost to the patients [4]. Similarly, Hardy *et al*. found 33% reduction in the number of blood units cross-matched for an elective surgical procedures after introducing MSBOS at their hospital [10]. Keeping in view the previous literature, this study was initiated to improve the efficacy of ordering and utilization of blood by the formulation of MSBOS for common orthopaedics procedures. Our primary objective was to audit the blood utilization in orthopaedics surgeries both elective and emergency trauma so that unnecessary cross matching, wastage of blood bank resources, and financial losses to the patients could be reduced.

Materials and Methods: A 16-month (March 2022 -august 2023) retrospective study was carried out on patients undergoing orthopaedic procedures at BIRRD Hospital. Data collected included number of patients transfused, number of units cross-matched and number of units transfused.
The cross-matched to transfusion ratio (CTR), transfusion probability (%T) and transfusion index (TI), Blood Utilization (BU) and MSBOS were calculated as:

The formula for CTR

$$CTR = \frac{\text{Number of units cross} - \text{matched}}{\text{Number of units transfused}}$$

A ratio of > 2.5 indicates excessive cross-matching of blood for a specific procedure and a ratio of >2 is considered indicative of significant blood wastage.

Formula for transfusion probability (%)

$$TP = \frac{\text{Number of patients transfused}}{\text{Number of patients cross matched}} \times 100$$

A value of < 30 was considered indicative of significant blood wastage

Transfusion Index

$$\text{Where TI} = \frac{\text{Number of units transfused}}{\text{Number of patient's transfused}}$$

A value of < 0.5 signifies no need for cross-match

Blood Utilization (%)

$$BU = \frac{\text{Number of units transfused}}{\text{Number of units cross} - \text{matched}} \text{ x } 100$$

A value of < 50% indicates excessive cross-matching for the procedure.

MSBOS = 1.5 × TI

$$\text{Where TI} = \frac{\text{Number of units transfused}}{\text{Number of patient's transfused}}$$

The MSBOS was formulated using Mead's criterion which states that the number of red blood cells calculated was one and half times the TI for each surgical procedure. Thus, using the Mead's criteria and clinical experience, the MSBOS was recommended for each surgical procedure.

Results: A total of 2298 patients had seven common orthopedic surgical procedures, for which requests for grouping and cross-matching were made. Fifty-eight (58.2%) were males while forty-two (41.8%) were females with ages ranging between 4-92 years. Eighty-four (85%) of the surgical procedures were done as elective while (15%) were emergencies.
A total of 2955 units of blood were cross-matched for these patients but only 1790 units (60.57%) were transfused. Table 1 shows the types of surgery with the number of cases, number of units cross-matched, number of patients cross-matched, number of units transfused, and number of patients transfused. Table 2 however, shows 6 indices that were calculated which are; CTR, Transfusion probability (%), Transfusion index, Blood utilization (%), MSBOS calculated using the Mead's criteria and the Recommended MSBOS.
The CTR was >2 in 3 of the surgical procedures *viz*. total knee replacement, total hip replacement and spine surgeries. The Transfusion probability (%) was > 30 in all of the surgical procedures. The Transfusion index (TI) was > 0.5 in all surgical procedures. While percentage blood utilization was > 50% in only 4 surgical procedures *viz*.; long bone of upper limb fractures, pelvis and acetabulum fracture, lower limb long bone fractures and hemiarthroplasty surgery. Mead's criteria and the Recommended MSBOS was calculated for all the seven surgical procedures using the Mead's criteria and the MSBOS for our hospital was recommended keeping in view clinical experience of the orthopaedic surgeon and the patient's variables. The type and screen (T&S) policy i.e., blood group and screening were recommended for forearm fracture, spine surgery, TKR, tibiofibular fracture and ankle fracture.

Table 1: Number of patients, unit cross matched, patient's cross matched, unit transfused, and patient transfused for the various orthopaedic surgeries

Type of surgery	Unit cross matched	Patients Cross matched	Unit Transfused	Patient Transfused
TKR	804	567	314	240
THR	574	421	259	174
Hemiarthroplasty	204	194	148	107
Spine	334	312	166	152
Pelvis and acetabulum	130	63	109	54
Upper limb long bones	310	251	250	173
Lower limb long bones	600	490	544	374

Total	2955	2298	2298	1274
TKR – Total knee replacement; THR – Total hip replacement				

Table 2: Cross-match to transfusion ratio, transfusion probability, transfusion index, blood utilization, calculated MSBOS by Mead´s criteria and recommended MSBOS for orthopaedic surgeries

Type of surgery	CT R	T (%)	TI	Blood Utilization (%)	MSBOS (M)	Recommended MSBOS
TKR	2.56	42.3	1.30	39.05	1.95	T&S
THR	2.21	41.3	1.48	45.20	2.22	2
Hemiarthroplasty	1.37	55.1	1.38	72.54	2.07	2
Spine	2.01	48.7	1.09	49.70	1.63	T&S
Pelvis and acetabulum	1.19	92.0	2.01	83.84	3.01	3
Upper limb long bones	1.24	68.9	1.44	80.64	2.16	T&S
Lower limb long bones	1.10	76.3	1.45	90.66	2.22	2
Total (mean)	1.65	55.4	1.40	60.57		
CTR: Cross-match Transfusion Ratio, T (%): Transfusion Probability, MSBOS (M): Maximum Blood Ordering Schedule By Mead´S Criteria, TI: TransfusionIndex, TKR: Total Knee Replacement, THR: Total Hip Replacement, T&S: Type And Screen						

Discussion

Although the risk of transfusion transmitted infections is declining, zero risk could not be achieved; moreover, the non-infectious serious hazards of transfusion (immune as well as nonimmune) significantly contribute to the morbidity and mortality associated with transfusion which can rarely be fatal. Provision of adequate and safe blood is challenging in developing countries due to the paucity of voluntary blood donors, poor facilities for storage and blood component preparation as well as inappropriate blood ordering and utilization [11]. Limited availability and supply of blood and the associated risks of transfusion necessitates the rational use of blood and avoidance of unnecessary transfusions [6]. Chawla *et al*., in their study found that both the public and private hospitals were not rational in the use of blood. In the public Hospitals, appropriate use of blood was only 60.57% (n = 2955) compared to the private hospitals where appropriateness was 69.4% [4]. Even in developed countries, inappropriate transfusion is in the range of 18% - 35%, while in India the range varied from 30% to 60% [12].

One of the best methods of evaluating transfusion practices is to determine the ratio of units cross matched to units transfused (CTR). The more accurately the clinicians predict patient's blood needs, the closer the CTR will approach 1:1. A CTR ≥2.5, % T ≥50 and TI ≥0.5 are considered indicative of significant blood utilization [3, 7, 19].

In this study, the overall CTR was 1.65:1, which better than other studies to (2.4:1) reported by Olawumi and Bolaji [13] CTR 2:1 each Kumari *et al*. [14] and Thimmaiah *et al*. [1] with CTR 2:1 each.

Where TI = Number of units transfused Number of patient's transfused our overall CTR is indicative of significant blood wastage and therefore, the need for efforts to reduce the CTR to 1:1 [15].

Total knee replacement was the most common performed surgery. Open or closed reduction and internal fixation (ORIF) for fracture of the long bones of lower limb was the second most common orthopaedic surgery performed in our study, which was less than to that of the study conducted by Kumari *et al*. [14] and Thabah *et al*. [6].

The CTR for femoral fracture in this present study was 1.10: 1 with Transfusion Probability of 76.32% and blood utilization of 90.66%. This was in keeping with that of Kumari *et al*. [14] with a CTR of 2.1, Tp of 53% and percentage blood utilization of 46.7% as against the CTR of 3.5 by Thabah *et al*. [6]. Of all the surgical procedures, total knee replacement had the highest CTR value of 2.56, a Tp of 42.32% and insignificant blood utilization of 39.5%. This is significantly higher to that of Thimmaiah *et al*. [1] with 5% and Kumari *et al*. [14] with 20% and thus informed our recommendation of type and screen policy. All the TKR cases done at our centre were majorly primary and unilateral and the probability for blood transfusion should be zero percent.

In this study, THR had a CTR of 2.21, a Tp of 41.33% and a recommended MSBOS of 2 units of blood which was the same as recommended by Challand *et al*. [17] and Kumari *et al*. [14].

The patient's pre-operative condition affects the CTR because the MSBOS algorithm uses the surgical procedure alone [8]. Blood wastage also depends on the surgeon's expertise for a particular surgery as well as the anaesthetists preset higher transfusion triggers. Despite much studies and evidence-based guidelines for transfusion, inappropriate transfusion still occurs [15, 20].

In establishment of a schedule of MSBOS, emphasis should be laid on local circumstances, clinical practice and patient's variables. The schedule should to be reviewed regularly and adjustments made as necessary for the recommended MSBOS schedule to be effective [6, 16].

Conclusion

The overall CTR in this study was high with a low percentage blood utilization and resultant significant blood wastage. Implementation of the recommended MSBOS schedule in this will prevent unnecessary blood wastage, help standardize the blood ordering schedule, reduce workload on blood-bank personnel as well as reduce cost of treatment to the patient in our resource constrained environment.

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Declaration of Conflicting Interests There are no other conflicts of interest.

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Ethical Review and hospital Consent

The study was approved by the local hospital institutional review board.

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