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Effectiveness of blood utilization across departments in a tertiary health institution

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Abstract

Introduction: The limited availability of blood makes it imperative that hospitals and transfusion centers employ blood utilization indicators to ensure effective and efficient use. This study is a review of the transfusion practices and blood utilization indicators in the largest tertiary health center in South East Nigeria.

Material and methods: This study was a retrospective cross-sectional hospital-based type. Bio-demographic data, clinical diagnosis, and blood bank information such as patient and donor blood types from a 3-year period (January 2018 to January 2021) was reviewed. The total number of units crossmatched, issued, transfused, or returned was extracted. Utilization indicators such as crossmatch-to-transfusion ratio (C/T ratio), transfusion probability (TP), and transfusion index (TI) were calculated, and our findings were compared to those of similar studies performed in centers in India, Ethiopia and Saudi Arabia.

Results: A total of 2,919 blood units were cross-matched, of which 2,212 units were transfused to 1,953 patients. The study reported an overall C/T ratio of 1.3, a TP of 71%, and a TI of 1.1. These figures compare favorably with findings reported from studies done in other low and middle income countries. The department of medicine, with a C/T ratio of 1.1, had the most efficient blood ordering practices.

Conclusion: Our study shows that the quality indicators on the utilization of blood in our tertiary health institution are in keeping with international best practice. The implementation of policies like the maximum surgical blood ordering schedule could further strengthen the practice and improve the results of the surgical disciplines.

Key words: blood utilization indicators, crossmatch-to-transfusion ratio, transfusion probability, transfusion index, South East Nigeria

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Introduction

Blood utilization refers to the relationship between the number of units of blood requested and the quantity used or transfused as this relates to the different departments and units in a hospital. Blood is the most frequently transferred body tissue in clinical practice, and it requires significant input in terms of human and material resources for the provision of safe blood. Ensuring an adequate supply of blood demands that the available blood be properly dispensed to avoid wastage. The basic aim of an effective blood utilization program is to ensure a rational use of blood [1].

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Blood transfusion, despite being a life-saving procedure, is well known to be associated with risks that can result in morbidity and mortality.

Blood utilization audits guarantee the appropriateness of blood use, reduce wastage and unnecessary transfusions, and subsequently improve quality outcomes. Effective blood utilization can help reduce transfusion risk as unnecessary transfusion is avoided, and the risk-to-benefit outcome of every single unit of blood is properly determined for an individual patient [1]. Overall quality is improved by effective blood utilization as the burden on blood supply is lessened because unnecessary blood units are not transfused, and the improvement of the stability of blood supply is a quality indicator. Reducing non-beneficial transfusions means less is spent on reagents and consumables, and more time is made available for other blood bank processes [1, 2].

The efficiency of blood utilization is calculated using the crossmatch-to-transfusion (C/T) ratio, the probability of transfusion (TP), and the transfusion index (TI) [3]. Effective blood utilization has been used as a term to describe the C/T ratio whose target should be 1.0, implying that all crossmatched blood is actually used. Different studies have shown the C/T ratio to be 2.3 in Ethiopia [3], 1.08 in Turkey [4], and an average of 1.85 in the United States of America [5]. Boral and Henry et al. [6], in coining this term, noted that the desired value is <2.5. This ratio is useful in estimating the over-ordering of blood, but it does not actually assess whether the number of units of blood crossmatched was appropriate for the procedures to be carried out, nor the probability that a transfusion will be required for a particular procedure. Many surgical units demand more than is in fact needed for a surgical procedure to allow a safety margin for transfusions, which may be needed if and when emergencies occur.

Other transfusion indicators include TP and TI. The TP is calculated as the number of patients transfused/number of patients cross matched × 100 (values of more than 30% being thought to be appropriate) [7]. TPs of 20%, 36.9% and 47% have been reported in Zambia, Egypt, and Ethiopia respectively [8–10]. The TI is the average number of units of blood used per patient who was crossmatched. Here, more than 0.5 is regarded as optimal. Various studies have shown the TI to be 0.4, 0.69, and 0.77 in Zambia, Egypt, and Ethiopia respectively [8–10]. These findings are relevant as these are countries with significant similarities in terms of their cultural, political and socioeconomic experiences to Nigeria.

An assessment of these transfusion parameters to determine the efficacy of blood utilization across the different departments of our tertiary health institution will provide information to target intervention and changes in policy aimed at limiting the wastage of this highly valuable resource.

These transfusion parameters provide reliable measures for the efficient and effective management of blood transfusion. Assessing these measures across various departments and sections in clinical practice will enable targeted intervention in terms of awareness campaigns and continued medical education for clinicians to reduce wastage with regard to blood transfusion. This study serves to showcase these utilization measures across the clinical departments of our hospital.

Materials and methods

This was a retrospective study of blood donation and blood bank data from the University of Nigeria Teaching Hospital (a 500-bed multi-specialty hospital located at Ituku-Ozalla, Enugu state) over three years (January 2018 to January 2021). The data was extracted from Excel and analyzed using IBM SPSS version 25.0. Inferential statistics are presented in figures and tables. Statistical analysis included the estimation of median values, frequencies, cross-tabulation, and Chi-Square (Fishers exact test) to estimate statistical differences across various groups. All calculations were done without assuming equal variance, and any *p*-value of less than 0.05 was assumed to be significant.

The overall effectiveness of blood utilization was determined using these blood product utilization quality indicators.

Packed red cells were the most common red cell preparation issued, and is subsequently used interchangeably with the word "blood" in this work.

Crossmatch-to-transfusion ratio

This was calculated using the formula: the total number of units of blood crossmatched/total number of units of blood transfused.

Transfusion probability

This was calculated using the formula: the number of patients transfused/number of patients cross-matched × 100.

Transfusion index

This was calculated using the formula: the number of units of blood transfused/total number of patients crossmatched.

Results

With respect to the various departments, the numbers of recipients were: internal medicine department — 304 (12.8%); surgical departments — 536 (22.6%); obstetrics and gynecology — 434 (18.3%); pediatrics — 238 (10%); emergency (adult and pediatric) — 508 (21.4%); oncology — 153 (6.5%); and others [including intensive care unit (ICU), hematology, special care ward, and radiotherapy/

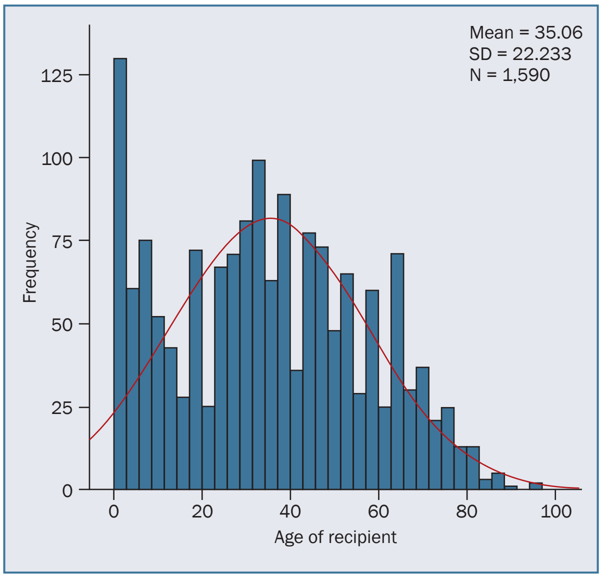

Figure 1. Histogram showing age distribution of blood recipients; SD — standard deviation

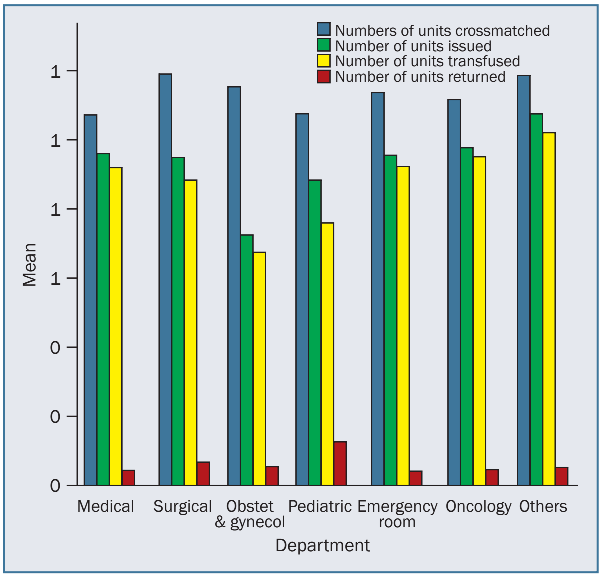

Figure 2. Numbers of units crossmatched, issued, transfused, and returned across various departments; Obstet & gynecol — obstetrics & gynecology

Table I. Transfusion parameters across various departments

Department	Crossmatch-to-transfusion ratio[a]	Transfusion probability[b]	Transfusion index[c]
All departments	2,919/2,212 (**1.32**)	1,953/2,565 (**76.1%**)	2,212/1,953 (**1.13**)
Internal medicine	326/292 (**1.12**)	274/304 (**90.1%**)	292/274 (**1.07**)
Surgery	638/474 (**1.35**)	399/536 (**74.4%**)	474/399 (**1.19**)
Obstetrics and gynecology	502/292 (**1.72**)	242/433 (**55.9%**)	292/242 (**1.21**)
Pediatrics	255/179 (**1.42**)	170/238 (**71.4%**)	179/170 (**1.05**)
Emergency (adults and children)	577/470 (**1.23**)	415/508 (**81.7%**)	470/415 (**1.13**)
Oncology	171/146 (**1.17**)	133/155 (**88.1%**)	146/133 (**1.10**)
Others*	235/207 (**1.14**)	171/198 (**86.4%**)	207/171 (**1.21**)

[a]Crossmatch-to-transfusion ratio (C/T ratio) — number of units crossmatched/number of units transfused; [b]transfusion probability (TP) — number of patients transfused/number of patients crossmatched × 100; [c]transfusion index (TI) — number of units transfused/number of patients crossmatched; *radiotherapy, hematology, special care ward, intensive care unit, eye ward

radio-oncology] — 198 (8.4%). The average age of the recipients was 34 years (range 0–96). Figure 1 shows the age distribution of recipients. The CT ratio, TP, and TI are shown in Table I, while Figure 2 shows a histogram of the various departments with regard to the number of units of blood crossmatched, issued, transfused, and returned.

Figure 1 shows two peaks, with the pediatric and the 30–40 age groups showing the highest frequencies of transfusions.

Cumulatively, the adult patient population had higher numbers of transfusions. There were 1,213 individuals (588 females and 625 males) presenting at different clinical specialties (age range 18 to 96 years, median age 42) who were booked for possible transfusion during this period. A total of 946 units of blood was transfused out of the 1,213 units of blood initially crossmatched. The overall adult blood utilization indices were therefore estimated to be a C/T ratio of 1.28, a transfusion probability (TP) of 77.9%, and a TI of 1.15.

The surgical departments had the highest blood usage, with 638 units being crossmatched while 474 units were transfused. While the medical departments had the most efficient blood utilization parameters, with a C/T ratio of 1.12, a TP of 90.1%, and a TI of 1.07, the department with the lowest tendency to transfuse blood that had already been crossmatched was obstetrics & gynecology, with a C/T ratio of 1.72, a TP of 55.9%, and a TI of 1.21. The Chi-square value showed a significant difference across the departments with regards to the numbers of units crossmatched (r = 22.52, p = 0.001), the number of units issued (r = = 21.569, p = 0.001), the number of units transfused (r = 18.809, p = 0.004), and the number of units returned (r = 30.752, p = 0.0001).

The results presented above are mainly for packed red cells and the occasional whole blood transfusions, representing the most common type of blood products requested in our center. Furthermore, whole blood centrifugation at room temperature (an initial light spin followed by a heavy spin) produces platelet concentrate and fresh plasma, which are issued.

Discussion

Blood is indispensable for life and is thus listed in the World Health Organization (WHO) list of essential medications [11]. Research has shown that transfusion therapy is associated with one in ten hospital admissions [12] and is ranked among the top five most commonly used therapies [13].

Juxtaposing this fact with that of the scarcity and limited blood supply often encountered especially in Sub-Saharan Africa [14] creates a need for the implementation of transfusion programs that will promote effective and efficient utilization of blood products. These programs require periodic audits to further strengthen existing patient blood management (PBM) programs by revealing deficiencies in blood transfusion practice and areas that require improvement.

In the University of Nigeria Teaching Hospital, PBM programs are improving clinical outcomes while discouraging unnecessary use of blood products. Adherence to PBM practices varies across the different specialties of the hospital, with obstetrics & gynecology, other surgical units, and the hemostasis units usually the most compliant. Representatives from these specialties are active members of the Hospital's Transfusion Committee which serves as a 'think tank' on blood transfusion practices.

Analysis of the bio-demographic data from our work reveals a median age of 34 years. Most (63.7%) recipients of the transfused blood components were female. This aligns with studies done in Northern India [15] and Ethiopia [16]. This imbalance can be explained by the high transfusion demand for labour and other particular hemorrhagic conditions, both in the antepartum and post-partum periods. Conversely, some other researchers have reported a preponderance of male recipients [17]. This could be explained by greater occupational exposure, as well as the higher possibility of trauma requiring surgery or transfusion in males.

The C/T ratio is greatest in operative (surgical) disciplines relative to other departments in the hospital. This is predominantly in the departments of general surgery and obstetrics & gynecology. this may be ascribed to vestiges of the age-old surgical practice of estimated blood ordering done to forestall any peri-operative eventualities. Unchecked, this readily leads to material and financial waste, with increased work hours [18, 19]. This also highlights the need for hospital transfusion committees to implement the maximum surgical blood ordering schedule (MSBOS) as a means of limiting wastage. This is a program where the average agreed maximum quantity of blood units required for each specific surgical procedure is documented and consistently used, with no allowances made for individual preferences. This negates the tendency of some surgical teams to request far more blood than they actually require.

Transfusion practice has devised various quality indicators over the years to encourage efficient and effective patient blood management practices by preventing excessive ordering and inappropriate use of blood and blood products [6, 7, 20]. In interpreting the C/T ratio as a blood utilization quality indicator, a ratio of 1:1 is deemed ideal, meaning that all crossmatched units are actually transfused. In practice, a C/T ratio of less than 2:1 [21] is most desirable and portrays efficient and appropriate blood usage, while a C/T ratio of >2.5 indicates inappropriate blood usage.

This study has reported an overall C/T ratio of 1.3. This implies an appropriate and efficient blood ordering practice, and is similar to the C/T ratio of 1.5 reported for Saudi Arabia [2] and of 1.5 and 1.4 respectively for two centers in India [15, 20]. Our reported values are significantly lower than the C/T ratios of 7.6, 3.9, and 3.7 respectively noted in studies performed in Ethiopia [3], Egypt [10], and Tanzania [22].

In our study, the different hospital specialties all had a C/T ratio of <2; the department of internal medicine with a C/T ratio of 1.14:1 had the most efficient blood ordering practices, followed closely by the oncology department. This may be explained by the chronicity of the diseases managed in these departments. Reversal of blood transfusion orders there is unlikely. Relatively, surgical patients with surgical emergencies are more prone to preemptive blood ordering with extra units requested. This practice of requesting blood as 'back up' in case it is needed may explain why most surgical units have higher C/T ratios, as demonstrated in previous studies.

Another quality indicator, the TP, was initially traditionally applied to surgical disciplines [3, 7]. It refers to the probability of the use of transfusion therapy for a particular surgical procedure or the definite number of transfusions done out of all that were crossmatched for such procedures. A value of 30% and above indicates efficient blood usage. Our study found an overall TP of 74.1%. internal medicine had a TP of 90.1%, oncology 88.1%, and surgery 71.1%.

The TI is a reflection of how appropriate is the number of units of blood crossmatched for a particular clinical condition [3, 23]. It is mathematically derived by calculating the average number of units used per patient crossmatched. A value of greater than 0.5 indicates efficient blood usage. The overall TI in our study was 1.1 and this is in keeping with the results of Yasmeen et al. [15] with a value of 1.1, and Trisal et al. [20] with a value of 1.2. A higher value of 2.5 was reported by Shash et al. [2] in Saudi Arabia.

By inference, our reported overall study TI, and the TI values for the various departments, indicate blood ordering policy and transfusion practices that are within acceptable standards.

Our findings thus compare favorably with reported TP and other utilization indicators seen in low and middle income countries (LMIC) as mentioned above. This implies that most units in our hospital are very intentional when ordering blood or have been adequately trained with respect to the use of clinically relevant 'transfusion triggers'.

In contrast, significant differences exist between transfusion practices in LMIC and high-income countries (HIC). These include differences in transfusion indicators, donor rates, the availability and use of components therapy, transfusion rates, and the capacity for comprehensive testing for infectious markers [24]. Also, high income countries use computerized medical records and electronic transfusion requests with automated decision systems on the appropriateness of blood transfusion. Consequently, audits of blood utilization in HIC are based on these systems, making it difficult to compare our work to findings in these areas. Although Zachee and Vanderkerckhove [25] reported a TI of 2.72, significantly greater than values in this study and in other LMICs, there is a shortage of reports on other blood utilization indicators in HIC.

Conclusions

The quality indicators on utilization of blood noted in this study are all within acceptable reference limits. However, it is important to further interrogate the increased C/T ratios noted in the surgical disciplines when compared to other departments in our Hospital.

To that effect, policies such as MSBOS should be implemented for specific surgical procedures that are associated with excessive ordering, so as to further improve our indices and overall patient blood management.

Article information and declarations

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Author contributions

IOA participated in conceptualization, study design, and drafting, also data collection, interpretation and manuscript reviews. AM participated in conceptualization, study design and drafting, in aaddition to data interpretation and statistical analysis. EM participated in conceptualization, study design, and drafting, also data collection, interpretation and manuscript reviews. CN, HO, AU, AD, CE participated in the study design, data collection and Interpretation. All authors participated in the final approval of the manuscript.

Conflict of interests

The authors declare no conflict of interest.

Data availability statement

Data sets and other study documents are appropriately secured and will be made available on request.

Ethics statement

Ethical approval for our study was obtained from the University of Nigeria Teaching Hospital Health Research and Ethical Review Board.

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