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ORIGINAL ARTICLE

An Analysis of Blood Utilization for Stem Cell Transplant Patients in a Tertiary Care Hospital

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Background and Objective: Haematopoietic stem cell transplant is a potentially curative treatment option in various benign and malignant haematological diseases. Patients undergoing stem cell transplant procedure require blood transfusion on a daily basis. Currently, there is paucity of data from developing countries on transfusion practices. This audit was undertaken to determine the consumption of packed red blood cells (PRBCs) transfusion in the bone marrow transplant unit of the Aga Khan University Hospital.

Subjects and Methods: A retrospective audit was conducted for packed red cell transfusion ordering practice over a period from June 2014～June 2015. All consecutive patients, admitted for stem cell transplant procedure for various underlying diseases were included. Outcome measures used in this study were (i) cross match to transfusion (C: T) ratio and (ii) transfusion trigger.

Results: During the study period, n=25 patients underwent haematopoietic stem cell transplant. There were n=19 males and n=6 females. One patient was less than 15 years of age while rests were adults. Median age±SD was 26.5±14.5 years (12～54 years). The underlying diagnosis included Aplastic anemia (n=8), Thalassemia major (n=3), Multiple Myeloma (n=4), Acute leukemia (n=5), Hodgkin's lymphoma (n=4), PRCA (n=1). Grand total consumption of PRBCs during the study period was 204 while 258 products were crossmatch. The C:T ratio was 1.26. The transfusion trigger was Hb level of less than 8 gms/dl.

Conclusion: The results of our BMT unit indicate that the C:T ratio and transfusion trigger is comparable to the international benchmark.

Keywords: C:T ratio, Blood utilisation, Stem cell transplant, PRBCs

Introduction

In the last two decades, the numbers of haematopoietic transplant procedures have increased significantly due to improved clinical outcomes. The common indications in developing countries include β Thalassemia Major, Aplastic Anemia and Acute Myeloid Leukemia (1). The stem cell transplant programme's sustainability depends upon a well-equipped transfusion service (2, 3). Because of prolonged myelosuppression, haematopoietic stem cell transplant (HSCT) recipients require packed red blood cell transfusions frequently. It has been established in various studies that roughly, one unit of packed red cell concentrate increases the haemoglobin (Hb) by 1gm/dl and the haematocrit by 3% (4). Randomized control trials done on patients admitted in high dependency areas e.g. intensive care units, have established that there is no difference between a "restrictive" (i.e. maintaining Hb between 7～8

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gm/dl) and "liberal" (i.e. maintaining Hb at 10 gm/dl) strategy (5). The same applies to patients admitted for haematopoietic stem cell transplant. For stable patients, though myelosuppressed, the transfusion trigger of Hb is usually set at 8 gms/dl.

For blood transfusion services, the crossmatch to transfusion ratio (CTR) is an important quality indicator used to audit practices of physicians. The CTR value is obtained by dividing the total number of cross matched red cell units to actual red cells transfused (6). Increased CTR indicates that cross matches were done unnecessarily when simple group and screen would have sufficed. Excessive blood units crossmatched not only leads to wastage of resources but also results in adverse outcome of blood bank inventory.

In Pakistan annually, 1.5 million bags are transfused. However, there is a huge gap between supply and demand (7). Approximately 90% of donations are based on exchange donors; remaining are voluntary, non-remunerated. Therefore, in the current scenario, blood becomes a very precious commodity. The ideal CTR is 1. However, the British Committee for Standards in Haematology recommends a range of 2～2.5 (8). A previous study from our center reported the results of a clinical audit. The audit showed that there was a significant reduction in the maximum surgical blood ordering schedule after intervention (9). The CTR in this study after intervention was between 0 and 1. Novis et al., in 2002 (10) reported CTR across 1639 hospitals which were part of three Q-probes study by College of American Pathologists. The CTR at 50th percentile (median) for the three studies was 1.9, 1.9 and 1.8. In addition to this, the CTR was 1.5 or less in the top 10% of the participating institutions.

A patient undergoing stem cell transplant procedure is admitted in the transplant unit for approximately three to four weeks. The transfusion requests are sent preemptively depending on the laboratory results performed daily. The transfusion trigger is set at 8 gms/dl. With respect to allogeneic stem cell transplant, Xenocostas et al. (11) reported that average requirement was 6.8±6.4 units of red cells between 0～60 days after transplant and thereafter the frequency decreases. In patients undergoing autologous transplants, anemia prior to transfusion was associated with an increased requirement of PRBCs by Kasbia G et al. (12).

Based on this, our objective was to determine the cross match to transfusion ratio and transfusion trigger in our bone marrow transplant (BMT) unit. The rationale was to audit our current practices and to find out a baseline consumption of packed red blood cells exclusively in the transplant unit. As per the literature search, this is the first study from Pakistan to report CTR and transfusion trigger in BMT unit.

Subjects and Methods

This was retrospective audit conducted at the bone marrow transplant unit of the Aga Khan University Hospital, Karachi after receiving institutional ethical review committee's (ERC) exemption (3733-Pat-ERC-15) from June 2014 till June 2015. The study included consecutive patients admitted in the transplant unit planned to undergo allogeneic or autologous stem cell transplant procedure for various benign and malignant haematological disorders. Male and female as well as paediatric (≤15 years) and adult (≥15 years) patients were included.

Stem cell transplant unit

We have a four bedded unit equipped with HEPA filters, positive pressure and laminar air flow ventilation. Double lumen Hickman or peripherally inserted catheters are used for blood±blood product transfusions. These lines are dressed once a week from insertion till discharge by a trained nursing staff. In haemodynamically stable patients, blood±blood product transfusion request is sent to the blood bank according to the laboratory results performed daily. The transfusion trigger has been set at 8gms/dl. A haemoglobin level below this trigger requires transfusion of two units of irradiated packed red blood cells.

Processing in Blood Bank

The Aga Khan University Hospital's blood bank caters to the entire 700 bedded hospital, since a centralized blood banking system is non-existent in Pakistan. Once a request is received in blood bank, ABO and Rh blood grouping along with serological compatibility testing is performed at 37^{o}C on Classic DiaMed-ID (Cressier, Switzerland). The compatible blood tagged with patient's name and medical record number is stored at 2～6^{o}C. To ensure that the chances of clerical error are decreased, we perform ABO grouping at least twice for every patient requiring transfusion of blood±blood product. The crossmatched unit is released for transportation after the identity checks which include patient's name, medical record number, age, gender and blood group by two house staff.

Blood Utilization Committee (BUC)

The hospital's blood utilization committee was established with a main purpose of monitoring proper usage

of blood products and the adherence to Maximum Surgical Blood Ordering Schedule (MSBOS). The representation of members is from Haematology, Obstetrics and Gynaecology (OB/GYN), Surgery, Anesthesia, Internal Medicine, Oncology, Blood Bank and Nursing. The members meet monthly to update on the ongoing practices of blood utilization. The committee also monitors frequency of transfusion reactions occurring in the hospital. The data on both these parameters is analyzed on quarterly basis.

A review of patient's medical records was carried out on each request for packed red blood cell transfusion. The records were analyzed for age, gender, diagnosis, the level of haemoglobin at which transfusion was requested, the number of requested packed red blood cell units and number of transfused packed red blood cells. The crossmatch to transfusion ratio was calculated as: number of number of PRBCs requested /PRBCs transfused. Our institutional CTR is 2.5. Therefore, our measurable acceptable CTR standard for bone marrow transplant (BMT) unit was considered a value less than 2.5. The red cell transfusion trigger was set at 8 gms/dl. Discretion based on physician's decision was allowed based on the patient's clinical condition

Results

During the study period, n=25 patients were admitted in the transplant unit of which n=16 underwent allogeneic stem cell transplant procedure. In remaining patients, autologous transplant was performed. There were n=19 males and n=6 females. One patient was in the pediatric age group (≤15 years), rest were adults. Median age±SD was 26.5±14.5 years (12～54 years). The indications for stem cell transplant included Aplastic anemia (n=8), Thalassemia major (n=3), Multiple Myeloma (n=4), Acute leukemia (n=5), Hodgkin's lymphoma (n=4) and pure red cell aplasia (n=1).

A total of n=258 units of packed red blood cells were requested for crossmatch. Out of these, the grand consumption was n=204. The calculated CTR was 1.26. Comparison of this CTR was made with institutional CTR. The BMT unit's CTR was found to be the most stringent in all four quarters (Fig. 1: comparison of appropriate use of PRBCs by various departments).

The mean±SD haemoglobin trigger was 8.2 gms/dl±0.5 (Range: 6.5～8.8 gms/dl) (Fig. 2). In two patients more than ten units of PRBCs were required during their stay due to transplant related complications which included transplant related thrombotic microangiopathy in one patient and *aspergillus* infection in one patient.

In both these patients, transfusion outside the red cell transfusion strategy was done by the physician when it was clinically indicated based on the patient's condition.

Discussion

The aim of this study was to audit transfusion compliance of the bone marrow transplant unit of the hospital. In developed countries, many hospitals have adapted a type and screen policy to dispense blood±blood products. In a report published by Dexter et al. in 2012, the authors validated an approach to define an appropriate MSBOS,

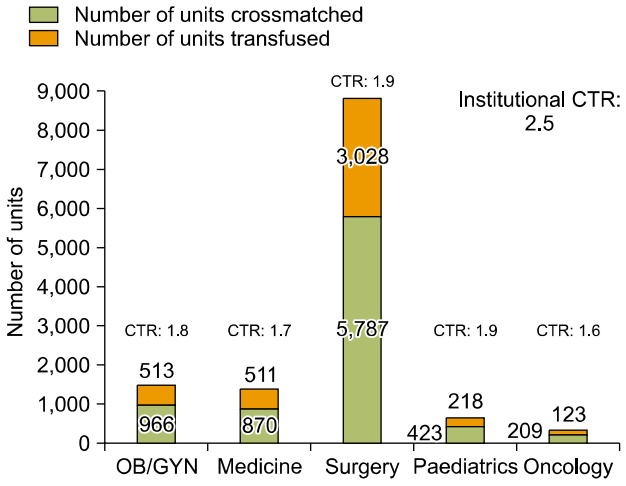

Fig. 1. Comparison of appropriate use of PRBCs by various departments. Fig. 1 shows the CTR of different departments across the hospital. The CTR has been calculated using number of units crossmatched/number of units transfused.

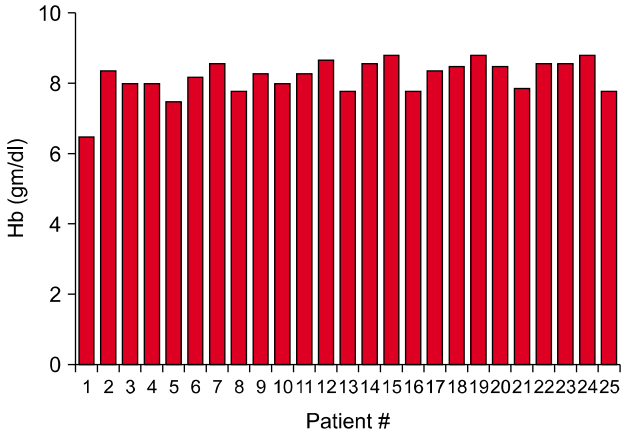

Fig. 2. Transfusion trigger of n=25 patients. Fig. 2 shows transfusion of PRBCs in individual patient during the study period. The mean±SD haemoglobin trigger was 8.2 gms/dl±0.5 (Range: 6.5～8.8 gms/dl).

by reviewing more 160,000 noncardiac surgical cases from more than 1,250 procedures (13). The outcomes have been cost effective with no compromise on patient safety. However, the best methodology to evaluate a clinician's transfusion practice is based on calculating the crossmatch to transfusion ratio (14). Therefore, the more accurate is the prediction of blood loss in a patient by the physician, the lower is the CTR. Since the introduction of MSBOS, hospitals all over the world have implemented strategies to reduce wastage of blood products and manage storage appropriately (15). Our hospital's MSBOS is also based on the type of procedure being performed. Our crossmatch to transfusion ratio was 1.26, which is well below the target CTR of the hospital. When compared to other departments across the hospital, the CTR ranged from 1.6 to 1.9. These departments included: Obstetrics and Gynaecology, Internal Medicine, Surgery, Paediatrics and Oncology (Fig. 1). Although the CTR of all these departments was within the range according to the institutional C: T ratio, the CTR of the bone marrow transplant unit was the most stringent.

We used a restrictive transfusion strategy in our patients i.e. the red cell transfusion trigger was set at 8 gms/dl and patients received two units of irradiated PRBCs when haemoglobin was below this level. The controversy of single unit transfusion still exists. Makroo et al. and Paone et al. have recently published that there is no statistical difference between one unit and two units of PRBCs in relation with acute surgical complications (odds ratio: 1.12, 95% confidence interval) (16, 17).

Our physicians followed judicious use of PRBCs transfusion, maintaining the transfusion trigger and no patient was transfused inappropriately (Fig. 2). One of our patient, aged 42 years with Aplastic Anaemia, developed transplant associated thrombotic thrombocytopenic purpura (TTP) and required daily plasma exchange. We performed 12 sessions of plasma exchange. Her condition did improve initially but later she developed cardiac tamponade and succumbed to her illness. The other patient was a 32 year old male with Hodgkin's lymphoma, who required over 10 units of PRBCs transfusion. He had developed *Aspergillus* infection. Complete resolution of infection was documented and currently he is alive and in remission.

Our way forward will be to lower the CTR to 1, in order to reduce the wastage further and decrease the transfusion threshold to 7 gms/dl in clinically stable, afebrile patients. This will be achieved by education of house staff and physicians. On the university's web portal is an intranet website dedicated to blood bank information. This information contains the guidelines and triggers for blood±blood products. We plan to encourage the use of this portal through continuous education. The blood bank has now introduced online ordering of blood±blood products. In collaboration with the information technology (IT) department we plan to introduce trigger prompts whenever a product is ordered online which will further help in educating the staff. Once these strategies are implemented, our final step will be to close the audit loop by revisiting the CTR and transfusion trigger.

In a developing country like Pakistan, performing stem cell transplant is a challenge. We strive every day to maintain international standards and provide best quality care to our patients. Amidst of this, we have maintained a CTR of 1.26 and a restrictive transfusion strategy.

Potential conflict of interest

The author has no conflict of interest.

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