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Original Research Article

Evaluating the appropriateness of blood component utilization in burns patients

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ABSTRACT

Background: Blood transfusion is a common intervention in critically ill surgical patients, especially Burns patients. But transfusions have potentially life threatening risks. The aim of the study was to evaluate the appropriateness of various blood components, utilized in Burns patients.
Methods: Burns patient who were admitted at Burns ward, Government Kilpauk Medical College, Chennai, India with age more than 16 years, with 15-40% Total body surface area burns and had survived treatment were included for a period of one year (September 2014-August 2015). New York State health guidelines for RBC transfusion in Burns, Baxter's original Parkland formula and platelet transfusion thresholds given by AABB were used to categorize appropriate transfusions from inappropriate transfusions.
Results: A total of 122 burns patients who fulfilled the inclusion criteria were followed. 85 patients received 308 red cell units of which 64% were appropriate. 114 patients were transfused with 441 fresh frozen plasma units of which 47% were appropriate. One patient was transfused with platelet concentrate and all patients, who had their platelet count more than 10,000/µL, were not transfused.
Conclusions: In our study, 64% of red blood cell transfusions and 47% of FFP transfusions were appropriate. Successful outcome of burns patients purely depends on proper wound care, along with appropriate use of fluids and blood components.

Keywords: Appropriateness, Burns, Blood transfusion

INTRODUCTION

Burns are caused by overheating of body tissues above the critical temperature, leading to tissue damage.[1] Burns are a major cause of morbidity and mortality worldwide which rises with increasing burnt surface area and age. Even small burns can become fatal in the elderly.[2]

Burns are classified as first, second and third degree but it is common to find all three types within the same burn wound, where depth changes with time, especially if infection occurs. Red blood cell transfusion is a common intervention in intensive care units with approximately one third of critically ill patients receiving a blood transfusion at one time or another during their stay.[3] While India has an estimated annual blood requirement of 12 million, the annual collection stands at 9.8 million, of which 84 % are collected from voluntary donors.[4] So, adequate inventory of blood is still a significant and chronic concern which further compounds liberal transfusion practice.[5] The cost effective approach to reduce the use of allogeneic blood transfusion is to

improve appropriateness of transfusions, as new guidelines recommend that decisions to transfuse be based primarily on clinical assessment of individual patients rather than arbitrary hematocrit thresholds. The rates of inappropriate transfusions have varied from 0.3 to 49.6% because of the differences in criteria used to define appropriate and inappropriate transfusions.[6] Burn patients suffer possibly the greatest initial hemodynamic and metabolic stress of all the surgical critically ill patients with the duration of illness lasting for weeks and months. Conditions that necessitate transfusions related to anemia in burn patients are not well defined.[7]

This study was undertaken to find out the appropriateness of blood usage pattern in Burns patients which will help the Burns treatment team to utilize the invaluable resource appropriately, predict future blood demand and help maintain transfusion inventory for specialized burn units.

Magnitude of the burns problem

India, with over a billion populations, has an estimated annual burn incidence of 6-7 million, thus accounting as the second commonest cause of injuries after road traffic accidents. Even though 90% of burns are preventable, 10% of these burn injuries are life-threatening and 50% of the hospitalized patients die of their injuries. Nearly 70% of burn victims are in the 15 to 40 age group who are most productive but belong to poor socioeconomic status. National data on burns are scarce as it is not a notifiable disease and central registry is nonexistent.[8] According to National Crime Records Bureau (NCRB) reports, total accidental deaths in 2013 were 4,00,517 of which total deaths due to accidental fires are 22,177 (6.6%) with electrocution adding another 10,218 (2.6%) of accidental deaths. Tamilnadu accounts for 8.3% and thus shares a larger percentage of accidental deaths, at third place in India.[9]

Deaths due to Fire/Self-immolation account for 7.4 % of all suicides (1,34,799) in India, being the third prominent means of committing suicides. Tamilnadu accounts for 12.3% of all suicides in India, the second highest after Maharashtra. The share of female victims was higher (63.1%) in suicides by Fire/Self-immolation.[10] Children and their parents should be educated about fire safety, storage and safe handling of flammable fluids and gases (especially cooking stoves) and first aid for flame burns and scalds.[11]

Burns and transfusion

Blood transfusion has become ubiquitous in treating major burn injury (>20% TBSA burn), as red cell transfusion is one of the few treatments that adequately restore tissue oxygenation especially when oxygen demand exceeds supply.[12,13] Burn patients, not receiving blood transfusion, had fewer complications than patients receiving transfusion due to the fact that those not receiving transfusion have smaller burn injury and less inhalation injury. Survivors required fewer escharatomies and fasciotomies.[12] The specific level of hemoglobin or hematocrit which dictates when to transfuse red cells is known as the 'Trigger'. But there is no one 'common trigger' with values ranging from 6 gm% to 8 gm% in different centers.[14] Historically, the transfusion threshold for RBCs was hemoglobin below 10.0 gm/dL or hematocrit below 30%, which was first proposed by Adams and Lundy. After 1988, when the National Institutes of Health consensus conference in the United States did not find evidence to support a single criterion for transfusion, several guidelines were published, recommending a range of hemoglobin values between 6.0 to 10.0 gm/dL.[13]

Despite modifications to transfusion thresholds over the past 20 years, transfusion thresholds still differ between various burn centers.[7] In patients without cardiac compromise, blood transfusion can be withheld to hemoglobin levels as low as 7.0 to 8.0 gm/dL as long as there is no active bleeding.[13] Blood transfusions are necessary in burn patients losing more than 700 ml at any one time or have a fall in Hemoglobin to 8 gm%.[15] There is neither an optimal transfusion protocol nor a discrete transfusion trigger.

An important consideration for blood transfusion is acute blood loss with signs of hemodynamic instability. Bedside clinical signs like blood pressure, heart rate, and fall in urine output and change in mental status have been proven to be insensitive and nonspecific.[14] Younger patients and less ill patients were harmed by Red cell transfusion while older and more ill patients benefited. Thus, Universal transfusion protocols may be harmful, but RBC transfusion should not be viewed as uniformly hazardous.[6]

Appropriateness of red cell transfusion

The appropriateness to transfuse blood include not only the pre-transfusion hemoglobin levels, but also events like ongoing blood loss followed by symptoms and signs in the patient like changes in blood pressure and heart rate. Post-transfusion hemoglobin and documentation of informed consent for transfusion also signify appropriateness.[5] However, decision is made taking other factors into consideration: type of surgery, extent of blood loss, presence of adverse clinical conditions like age of patient and presence of cardiopulmonary compromise).[16-20] Among patients in intensive care, restrictive transfusion threshold with Hb values between 7-8 gm/dL does not increase mortality, morbidity or duration of hospitalization. Exceptions to restrictive threshold include patients with cardiovascular disease. Inappropriate uses of Red cell transfusion include a) Anemia with Hb above 10 gm/dL, b) to expand circulatory volume, c) to replace hematinics and d) to accelerate wound healing. Monitoring indices for clinical auditing include use of red cell transfusion in anemia

with Hb > 10 gm/dL and to expand circulatory volume.[18] Various studies show appropriateness of RBC transfusions varying from 97% to 54.1%.[6,21,22]

Appropriateness of plasma transfusion

The typical adult dose of plasma is 10 ml -15 ml per kilogram of body weight. According to the Transfusion Medicine Advisory Group (TMAG) of British Columbia, inappropriate uses of Fresh Frozen Plasma include use in hypovolemia (intravascular volume expander), to enhance or promote wound healing, as a nutritional support, protein losing states or in Burns.[22] Inappropriate indications for Fresh Frozen Plasma include expansion of circulatory volume, hypoproteinemia and for nutritional purposes.[18] Other inappropriate use is insufficient volume transfused.[23] Monitoring indices for clinical auditing are; a) use of FFP in situations like expansion of circulatory volume, hypoproteinemia and for nutritional purposes and b) evaluating the appropriateness of the dose of FFP.[18]

Appropriateness of platelet transfusions

The current recommendations for platelet transfusion is 10,000 platelets/μL in clinically stable patients while, in the presence of clinical instability, the recommended threshold is 20,000 platelets/μL. The surgical patient with active bleeding usually require platelet transfusion if the count is < 50,000/μL. During massive transfusions, the suggested transfusion threshold is 75,000/μL in those with active bleeding.[18,24] Monitoring indices for clinical auditing include prophylaxis at a transfusion threshold, which was higher than recommended.[18]

Aim and objectives

To evaluate the appropriateness of blood component utilization in Burns patients admitted at the Burns ward, Kilpauk Medical College and Hospital, Chennai, Tamilnadu, India.

METHODS

This was a prospective observational study conducted in patients admitted and treated in Burns ward/ Burns Intensive Care unit of Government Kilpauk Medical College, Chennai, Tamilnadu, India. Burns patients admitted and treated between September 2014 and August 2015, who fulfilled the inclusion criteria (purposive sampling) were included in the study. This study was approved by the University Ethical Committee of The Tamilnadu Dr MGR Medical University and the Institutional Ethical Committee of Kilpauk Medical College, Chennai, Tamilnadu, India. The inclusion criteria included i) Age more than 16 years, ii) TBSA 15 – 40% and iii) patients who survived treatment. Burns patients treated previously and admitted later for reconstructive surgeries and those not willing to participate in the study were excluded. Informed consent was obtained from patients/ patients' relatives for willingness to participate in the study. Data entry and analysis were done using SPSS software version 21.0. Descriptive details were given in summary statistics.

Operational definition

To study the appropriate use of blood and blood components in burns patients following guidelines were used.

Whole blood

Whole blood with storage age less than 24 hours if available is the best source for replacing all blood components in massive blood transfusion. Beyond 24 hours of storage, 80-90% of platelets lose their viability and labile coagulation factors' activity would be reduced by 30-40%.[25,26]

Packed red cells

Guidelines for Transfusion of Red Blood Cells – Adults: Third Edition 2012 for Burns Patients.[27] The following criteria are recommended for RBC transfusion of stable burn patients without active bleeding:

- For patients not critically ill and without cardiopulmonary compromise, RBCs may be transfused for hemoglobin of ≤8 g/dL.
- For critically ill patients and/or those with cardiopulmonary compromise, RBCs may be transfused for hemoglobin of ≤10 g/dL.

Fresh frozen plasma

Baxter's original Parkland formula[28]

- Initial 24 hours: Ringer's lactate (RL) solution 4 ml/kg/% burn for adults and 3 ml/kg/% burn for children. This formula recommends no colloid in the initial 24 hours.
- Next 24 hours: Fresh frozen plasma given as 20–60% of calculated plasma volume (0.5 ml/kg/%TBSA). No crystalloids. Glucose in water is added in amounts required to maintain a urinary output of 0.5–1 ml/hour in adults and 1 ml/hour in children.

If FFP was given in inadequate doses, it was considered inappropriate transfusions. Transfusion of FFP in the initial 24 hours of burn injury was also considered inappropriate.

Platelet concentrates

Thrombocytopenia in Burns patients.[25]

- Thrombocytopenia requiring platelet transfusions is rare in burns patients.

- Burns patients with thrombocytopenia can be managed similarly to any other critically ill patient with sepsis.
- Although platelet transfusions are not common in burns patients, it is necessary to limit its use

Platelet transfusion thresholds[29]

The thresholds given by AABB (American Association of Blood Banks) were followed to evaluate appropriateness. Transfusion of platelet concentrates for a platelet count of more than 10000/µL in clinically stable patients and more than 50000/µL in surgical patient with active bleeding constituted inappropriateness.

RESULTS

A total of 143 patients with age more than 16 years and suffering from 15% - 40% TBSA were followed from time of admission to time of discharge. The data of 21 patients who expired during treatment were excluded from analysis.

The data collected from 122 patients who fulfilled the inclusion criteria and gave informed consent were taken to analyze for appropriateness of blood component utilization. The statistics of blood components utilized are given in Table 1, Figure 1 and Figure 2.

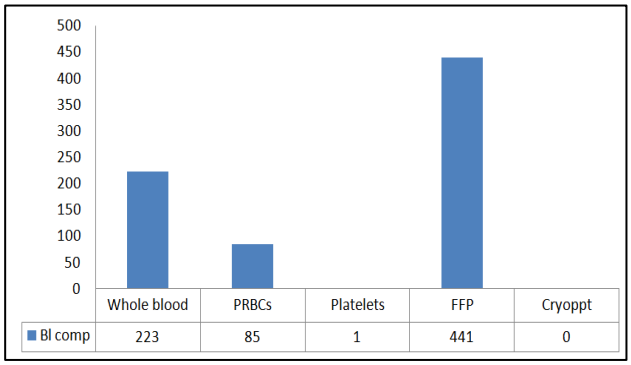

Figure 1: Blood components utilized in Burns patients.

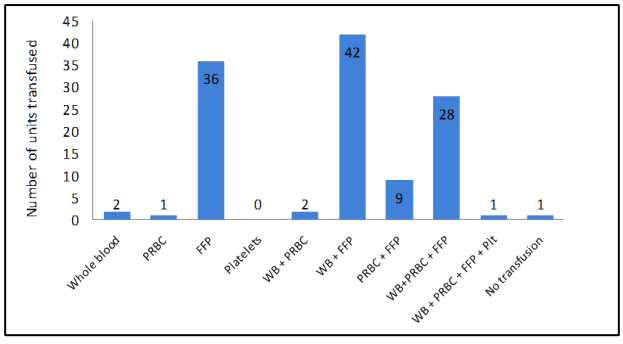

Figure 2: Blood components received by patients in combination.

Appropriateness of red cell transfusion

In this study population (n = 122), 85 patients were transfused with 308 red cell units. When a restricted hemoglobin trigger of 8 gm/dL is applied, only 16% of red blood cell transfusions (n = 49) can be considered as appropriate transfusions. But when a liberal hemoglobin trigger of 10 gm/dL is applied, 64% of all red blood cell transfusions (n = 198) can be considered appropriate transfusions (Figure 3).

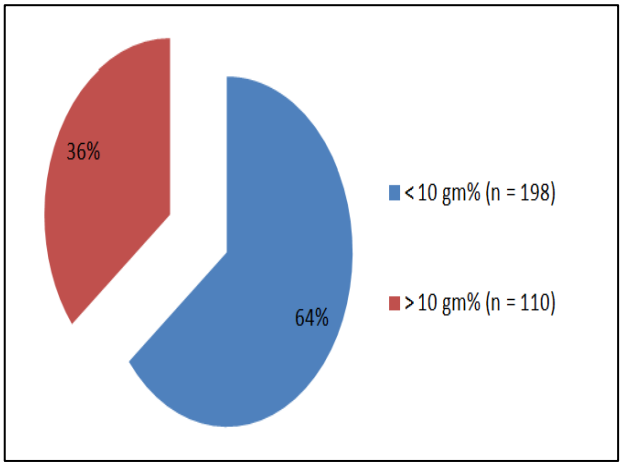

Figure 3: Appropriate red cell transfusions with liberal transfusion trigger of 10 gm/Dl.

Appropriateness of fresh frozen plasma transfusions

When following Baxter's original Parkland formula, in this study population (n = 122), no FFP was transfused in the initial 24 hours of burn injury. 206 units were transfused, at least, as double units (400 – 440 ml) in the second 24 hours after burn injury and were considered appropriate. 235 units of FFP transfusions were considered inappropriate (Figure 4). The reasons for inappropriate transfusions were i) inadequate doses (less than 0.5 mL/kg/% TBSA and as single doses), ii) non-availability of 5% albumin, iii) for treating hypoproteinemia and iv) to promote wound healing.

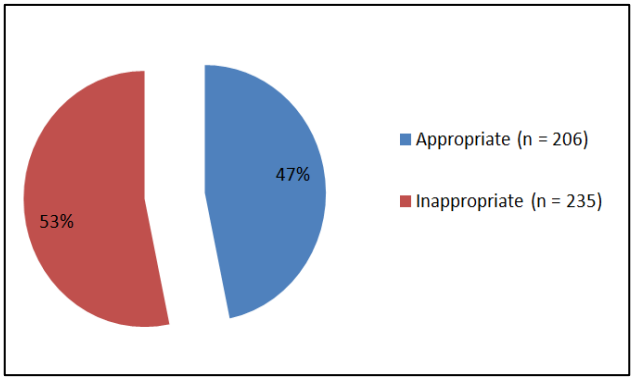

Figure 4: Appropriateness of fresh frozen plasma as colloid in treating burns.

Appropriateness of platelet transfusions

In this study population (n = 122), only one of the Burns patient was transfused with one unit of random donor platelets. (An electrical burns patient undergoing amputation of both upper limbs up to elbow, for which 4 units of red blood cells and 4 units of FFP were given followed by platelet transfusion, with a platelet count of 49,000/cu. mm.). All the burn patients had their platelet counts more than 10,000/cu.mm during their stay at hospital and all platelet transfusions can be considered appropriate.

Table 1: Summary statistics of various blood components used.

Component	Minimum (in number of units per patient)	Maximum (in number of units per patient)	Mean (in number of units per patient)	SD
All components (whole blood, PRBC, FFP & PC (n = 121 patients)	1	33	5.75	4.80
Total red blood cells (Whole blood and PRBC) (n = 85 patients)	1	25	3.41	3.19
Whole blood (n = 76 patients)	1	17	2.93	2.39
Packed red cells (n = 41 patients)	1	8	2.08	1.46
Fresh frozen plasma (n = 114 patients)	1	11	3.61	2.51
Platelets Concentrate (n = 1)	0	1	-	-

Table 2: Difference in mean LOS between patients transfused with whole blood and PRBC.

Variable Red blood cell transfusion	Length of stay (in days) Mean (SD)	P value
Patients transfused with only whole blood (n = 44/122)	22.70 (12.06)	
Patients transfused with only packed red blood cells (n = 9/122)	21.67 (5.21)	> 0.05

DISCUSSION

Appropriateness of red blood cell transfusions

In the present study, 85 patients were transfused with 308 red cell units of which nearly 50% of the burns patients (n = 43) were transfused with a hemoglobin level below 10 gm/dL. The mean pre-transfusion hemoglobin level was 9.67 gm/dL for all transfused patients. This was higher than the mean pre-transfusion hemoglobin level of 8.4 gm/dL in the study by Vincent et al but even in their study, pre-transfusion hemoglobin level was greater than 9 gm/dL in more than 30% of the ICU patients.[30] The mean blood units transfused in Burns patients in this present study (3.41 units) was comparable to study by Vincent et al (4.8 units).[30] But other studies by Posluzny et al (16.6 units), Palmieri et al (13.7 units) and Gupta et al (8 units) showed a higher mean number of blood units transfused.[7,12,31] Most of the red cells transfused in burn patients in this present study belonged to second and third week of storage, which was similar to mean storage age of 16.2 days in the study by Vincent et al. and 16-21 days by Aubron et al.[30,32] The patient profiles in the present study had varied, from a patient who was conservatively managed without any blood component transfusion to an electrical burns patient, who was transfused with 25 units of red cells, 7 units of fresh frozen plasma and 1 unit of platelets and underwent 4 surgical procedures. Use of blood components when are they are not necessary, for example patients with minor or partial thickness burns, who can be managed with fluids only, constitutes inappropriateness. As literatures suggest, burns up to 25% TBSA can be managed with only fluids (oral/intravenous) unless the precarious condition of the burns patient warrants transfusions.[33]

This is true especially in patients with electrical burns who may need amputation to save limb or life, and transfusions are inevitable. Burns patients can have a fall in haemoglobin levels not only during surgical procedures but also later due to anemia of critical illness. Hemoglobin levels in burns can be spuriously high, due to the profound fluid loss leading to hemoconcentration, which may mask the underlying anemia. Adequate hydration will show the true picture, at which time the anemia can lead to complications. Various studies have shown the efficacy of restricted hemoglobin triggers (Hb between 7-9 gm/dL and maintaining hemoglobin of 8-10 gm/dL) when compared to liberal transfusion triggers (Hb around 10 gm/dL and maintaining hemoglobin levels between 10-12 gm/dL) in critically ill patients. Patients are usually transfused with single red cell units with frequent monitoring in-between transfusions. According to recommendations, when hemoglobin trigger of 8

gm/dL is applied, only 16% of all red cell transfusions can be considered appropriate.[16,17] When a hemoglobin trigger of 10 gm/dL is applied, 64% of all red cell transfusions can be considered appropriate. This shows that a liberal hemoglobin trigger of 10 gm/dL was followed for this study group of burns patients.

The reasons for the inappropriate red cell transfusions included, blood loss during surgical procedures, bleeding burns patients and other co-morbid conditions like ischemic heart disease and diabetes mellitus. In the present study, 47 red blood cell units were transfused to burns patients with a hemoglobin level greater than 10 gm/dL, during surgical procedures. The reasons for red blood cell transfusion in burns patients with hemoglobin level of 10 gm/dL (Liberal transfusion trigger) included the patient's anemia masked by hemoconcentration, surgeon's helplessness in estimating the rate and amount of bleeding during burns surgery and the anesthetist's reluctance to wait till Hb reaches below 8 gm/dL. French et al in their study with hemoglobin trigger of 10 gm/dL found only 3% inappropriate transfusions, while Afzal et al by their study in patients with hemoglobin less than 10 gm/dL, found 54.1% appropriate transfusions.[21,22]

In the present study, most of the red blood cell transfusions were whole blood (n = 223). Whole blood is transfused in the belief that it will provide all components of blood and thus will aid in wound healing. As the present study shows, the mean hospital length of stay was not significantly shorter for patients transfused only with whole blood, when compared to those patients who were transfused only with packed red blood cells (Table 2). So, the use of whole blood should be curbed with rational use of blood as components.

Fluid management in burns patients and role of Fresh frozen plasma

Till the 1950s, burns involving even 10-20% TBSA were associated with high mortality. It was then the importance of fluid management in burns was understood and in 1974, Charles Baxter gave the widely acclaimed Parkland formula for fluid resuscitation in burns patients. This formula holds good even today, and is followed all over the world with minor modifications.[34]

The original Parkland formula had incorporated fluid management with only crystalloids during the initial 24 hours after burn injury and management with colloids (Fresh frozen plasma) during the second 24 hours after burns. When a consensus was explored, the initial 24 hours fluid resuscitation with crystalloids was accepted but the next 24 hour resuscitation with colloids was not considered. But fresh frozen plasma was still used in burn resuscitation as a colloid till the end of 1980s when the HIV epidemic shook the world with a high risk of transmission by transfusion. So, rational use of blood and blood products was advocated and use of FFP for volume resuscitation was held inappropriate.[35]

5% Human albumin is the most commonly advocated and used colloid for late fluid management in burns. It is iso-oncotic and has a half-life of about 20 days.[36] Even though effective in hypovolemia and hypoproteinemia (25%), the multiple indications for which Human albumin was supposed to be helpful have been questioned in recent trials and observations. The recent meta-analysis by Cochrane review group had found that use of albumin had not reduced mortality when compared to crystalloids but rather suggested an increased risk of mortality in burns patients. These effects were attributed to the prolonged heat treatment of albumin (10 hours at 60°C) which made the molecules more permeable with loss of electronegative charge. Thus albumin inhibits platelet aggregation and enhances inhibition of factor Xa by Anti-Thrombin III.[37] In India, the price of 20% human albumin was 4904 rupees. But ever since the Indian Drug Price Control Order (DPCO) 2013 by National Pharmaceutical Pricing Authority (NPPA) brought it under essential drug list, there has been a shortage for human albumin solutions.[38]

In such a scenario, the limited availability of albumin and its prohibitive cost has made the clinicians turn back to fresh frozen plasma as a colloid. FFP contains 0.025 g of albumin/ mL, 36 while 5% albumin contains 0.05 g of albumin/ mL. The adequate dosage of FFP is 0.5 ml/kg/% TBSA, which is necessary to derive the desired effects of FFP as a colloid. In the present study, FFP was mostly given as two units, which was equivalent to a dose of 200 ml of 5% albumin. But it is prudent to emphasize that FFP is not suitable for treating hypoalbuminemia.

FFP replenishes fibrinogen and other coagulant factors in burns patients. It also contains fibronectin, shown to be decreased in burns patients, which has opsonic activity and reinforces leukocyte activity in burns. Fibronectin in FFP transfused to burns patients has been shown to decrease incidence of sepsis for about 24 hours after transfusion.[36] But FFP has its own demerits in risk of transfusion transmitted infections and transfusion related immunomodulation.

If the FFP appropriate transfusion guidelines were applied, all the transfusions used for burns as in the present study would seem inappropriate. But on applying the Baxter's original Parkland formula for late fluid resuscitation in burns which advocates FFP as the colloid, we found 53% of the transfusions to be inappropriate. This is similar to the 52% inappropriate FFP transfusion results obtained by Kulkarni et al. in 945 patients with 1884 FFP transfusions.[39] The reasons for inappropriate transfusions were high cost and non-availability of 5% albumin, use for hypoproteinemia and to aid wound healing.

If risks are minimized, fresh frozen plasma can be more beneficial than detrimental in burns management as shown by Fodor et al Thus, in managing 15-40% burns crystalloids are the mainstay of treatment.[40] Colloids are

used only when crystalloids are inadequate in maintaining fluid volume or when complicated by fluid creep. In a resource limited country like India, use of FFP as a colloid replacement is still indispensable, until other colloids (5% albumin) become freely available in market at an affordable cost. Even then, colloids are advised only when the benefits outweigh risks.

Appropriateness of platelet transfusions

It is well known fact that thrombocytopenia is encountered in the first week of burns injury but it reaches normal levels in the second week. Platelet transfusions are not usually indicated in surgical patients till the platelet count falls below 50,000/cu.mm of blood.[18] In the present study, only one patient was transfused with one unit of platelet concentrate during limb amputation surgery for electrical burns along with 4 units of RBCs and 4 units of FFP (with a platelet count of 49,000/cu. mm).

The minimum platelet count encountered in this present study was 33,000/cu. mm. for which no platelet transfusion was given. Hence all transfusions regarding platelet requirements can be considered appropriate. Schofield et al showed a 67% appropriate platelet transfusions in 1147 patients from 14 public hospitals in New South Wales.[41]

CONCLUSION

In present study, by following liberal hemoglobin trigger of 10 gm/dL for burns patients, use of red cell concentrate in 64% transfusions were considered appropriate. The remaining 36% were considered inappropriate because they were transfused for higher hemoglobin values and with an aim to achieve faster wound healing. Considering the cost and paucity of 5% albumin in a country like India, FFP is still indispensible as a colloid and following the original parkland formula, 47% of FFP transfusions were considered appropriate.

The remaining 53% were considered inappropriate because most of the units were transfused after 48 hours of burn injury and number of units transfused was inadequate for the expected dose of albumin to be replaced. Successful outcome of burns patients purely depend on proper wound care, along with appropriate use of fluids and blood components. JR conceptualized and designed the study, collected and analyzed the data. SYJ analyzed and interpreted data. PA revised and approved the manuscript. MC drafted article and analyzed data.

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