CODEN [USA]: IAJPBB ISSN : 2349-7750

INDO AMERICAN JOURNAL OF
PHARMACEUTICAL SCIENCES

SJIF Impact Factor: 7.187

https://zenodo.org/records/10041229

https://www.iajps.com/volumes/volume10-october-2023/06-issue-10-october-23/

Available online at: http://www.iajps.com *Review Article*

IRRADIATED BLOOD PRODUCTS, INDICATIONS AND COMPLICATIONS - REVIEW

[1]Majed Fisal Doobi , [2]Waheed Ayidh Mohammed AlQurashi, [3] Majed Abdullah Saeed Alghamdi, [4]Abdullah Siddiq Saeed Mahdi, [5]Saad Fawaz Bin Khatim Alghufayri, [6] Abdulhaleem Abdulrazaq Shahbahai, [7]Maher Mohammed Rashed Alsubhi, [8]Ahmad abdulghaffar abdulghafour, [9]Abdullah Ali Saad AlQarni, [10] Fuad Abdulhamed Abdulsabor Bokhary

[1]Laboratories and medical technology , Blood bank, Maternity and Children's Hospital
[2]Medical Laboratory Technician, Blood bank, Maternity and Children's Hospital
Mecca Saudi Arabia
[3]Specialist Clinical Biochemistry - Clinical Toxicology, Laboratory and blood bank, maternity and children's hospitals. Mecca Saudi Arabia
[4]Speciality:senior specialist Clinical biochemistry, Maternity and children hospital , Makkah health cluster , Makkah . Saudi Arabia
[5]Medical Laboratory Technician, Laboratory and blood bank, Maternity and children hospital , Makkah health cluster , Makkah . Saudi Arabia
[6]Medical Laboratory Technician, Laboratory and blood bank, Maternity and children hospital , Makkah health cluster , Makkah . Saudi Arabia
[7]Lab specialist, Blood Bank, Maternity and children hospital , Makkah health cluster , Makkah . Saudi Arabia
[8]Lab specialist, Blood Bank, Maternity and children hospital. Mecca . Saudi Arabia
[9]Speciality: senior specialist Clinical parasitology, Department: parasitology, Maternity and children hospital, Mecca.saudi Arabia
[10] LABORATORY TECHNICIAN, LABORATORY & blod bank, Maternity and Children's Hospital, Mecca Saudi Arabia

Abstract:

Red blood cell transfusions are administered as a therapeutic intervention for the management of hemorrhage and to enhance the delivery of oxygen to bodily tissues. The administration of red blood cell transfusions should be determined by the patient's clinical status. Narrative review conducted throughout the databases such as PubMed, for all relevant studies that were published up to the end of 2022.

Transfusions of blood products ought to be administered in accordance with established protocols and clinical evaluation, while endeavors should be made to prevent the unnecessary administration of transfusions. Over the past few decades, the safety of transfusions has significantly improved due to advancements in component preparation methods. One notable example is the application of leukoreduction to red blood cells (RBC) or platelets, which has been found to considerably decrease the incidence of febrile non-hemolytic transfusion reactions (FNHTR) and human leukocyte antigen (HLA) alloimmunization-related problems. The implementation of these product adjustments is primarily observed in affluent nations, although remains universally absent in the poor world. Specific modifications that should be implemented for patients with particular blood product requirements include irradiation, washing of red blood cells and platelets, and depletion of platelets from plasma.

Corresponding author:
Majed Fisal Doobi,
Laboratories and medical technology ,
Blood bank, Maternity and Children's Hospital

Please cite this article in Majed Fisal Doobi et al . ***Irradiated Blood Products, Indications And Complications - Review****, Indo Am. J. P. Sci, 2023; 10 (10).*

INTRODUCTION:

The process of blood transfusion has undergone significant breakthroughs in safety throughout the centuries. The blood component that is administered through transfusion may consist of cellular elements, such as red blood cells (RBCs), platelets, or white blood cells (WBCs), as well as non-cellular components, such as plasma or plasma-derived products. The absence of a viable alternative necessitates the utilization of these components in patients requiring these goods. When administered through transfusion, these components are considered exogenous substances that carry the potential for eliciting an immune response [1].

The safety of blood transfusion has significantly improved in recent times, yet it is not entirely devoid of potential complications. The progression of technology in blood testing and the increased focus on screening donors have effectively decreased the occurrence of adverse events connected to transfusions, particularly the transmission of infectious pathogens. Nevertheless, the danger of non-infectious consequences remains a significant concern [2]. The comprehensive assessment of transfusion-related adverse events was facilitated by the surveillance done by the Serious Hazards of Transfusion (SHOT) haemovigilance scheme in the United Kingdom [3]. In the United States, it has been stated that the incidence of adverse responses resulting from blood transfusion is estimated to be 0.2%. Among these events, over 80% are attributed to either allergic reactions or febrile nonhemolytic reactions [4].

Transfusion-associated graft-versus-host disease (TA-GvHD) is an infrequent but typically lethal complication that can arise from the transfusion of blood components that contain lymphocytes. The absence of published clinical trials necessitates reliance on case reports, haemovigilance data, and laboratory techniques focused on the inactivation or elimination of lymphocytes in transfused components for evidence on prophylaxis. Previous studies in the academic literature have made efforts to comprehend the vulnerability of recipients by analyzing retrospective epidemiological data and considering the degree of immunosuppression, without focusing on the particular pathophysiology of TA-GvHD [4,5].

The understanding of the clinical and laboratory characteristics of TA-GvHD, as well as the extent to which recipient and component factors contribute to its development, is currently lacking.

The aforementioned syndrome was initially identified in individuals with weakened immune systems who had received transfusions of cellular blood components that contained live lymphocytes [6]. It became apparent thereafter that individuals who were not immunosuppressed might also manifest the illness, especially when the transfused blood components originated from a human leukocyte antigen (HLA)-haploidentical unrelated donor or a family member [7,8].

DISCUSSION:

The process of blood component preparation was established in 1960 with the objective of isolating blood components from a single unit of whole blood using a specialized apparatus known as a chilled centrifuge [3]. The preparation of packed red blood cells (PRBC) and fresh frozen plasma (FFP) involves a single-step heavy spin centrifugation process. On the other hand, the preparation of platelet concentrates (PLTCs), PRBC concentrates, and FFP requires a two-step centrifugation process. There are two primary methodologies for creating platelet-leukocyte- and thrombin-rich concentrate (PLTC), namely the platelet-rich plasma (PRP) method and the BC method. The algorithm for the separation using the two ways is presented as Algorithm depicted in [Figure 1]. The PRP method is characterized by its simplicity, ease of manual execution, and relatively lower cost. However, it is important to note that the yield of platelets and plasma is significantly lower in this method. The BC approach is considered superior,

while its manual execution can be complex, necessitating the implementation of automation [9].

A comprehensive analysis [10] of the global body of literature pertaining to TA-GvHD was conducted, focusing on various characteristics associated with TA-GvHD. The most significant risk factor for the development of the syndrome (reported in 71% of instances with known HLA data) among recipients who did not exhibit other common indications for component irradiation was the sharing of HLA antigens between the donor and recipient. The analysis encompassed a total of 348 cases and indicated that the occurrence of the condition in recipients aligns more closely with transfusion rates rather than with individual patient characteristics. The authors' findings suggest that the role of immunological incompetence as a risk factor for TA-GvHD may be less substantial than previously hypothesized.

The constituents generally consisted of whole blood and red blood cells. The review indicated the storage time of components in 158 cases (45.4%) that were reviewed. In 148 instances (93.7%), the component in question was identified as either being fresh or having a maximum age of 10 days. A total of ten instances, accounting for 6.3% of the sample, indicated a storage duration ranging from 11 to 14 days. None of the reported cases were associated with components held for more than two weeks. The Japanese Red Cross reported similar findings in two series of transfusion-associated graft-versus-host disease (TA-GvHD), with no instances of the condition observed in cases involving components held for more than 14 days [11].

The implementation of leucocyte depletion has been seen as a preventative measure. Nevertheless, despite the use of leucocyte depletion, cases of TA-GvHD have nevertheless been documented. Specifically, between 2000 and 2013, 66 out of the total 348 cases (18.9%) were recorded [10,12]. In few cases, individuals received transfusions of blood components that had undergone leucocyte depletion (LD), although comprehensive information regarding the efficacy of the leucocyte depletion process was not provided.

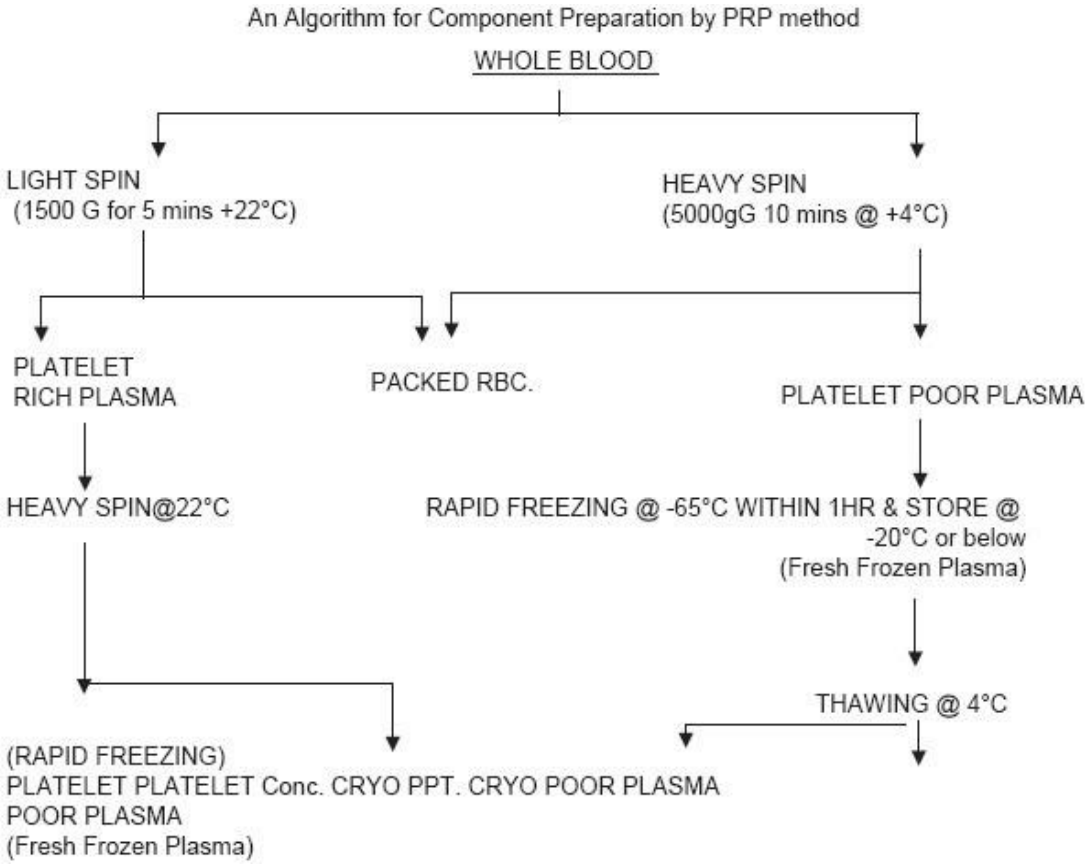

Figure1. Algorithm for blood component preparation

Irradiated blood products

The blood products commonly subjected to irradiation include packed red blood cells (PRBC), platelets, and granulocyte concentrations. Irradiation is deemed required and obligatory under the following circumstances:

Gamma radiation is utilized to inhibit the occurrence of transfusion-associated graft vs host illness in cellular blood components [13]. For instance, individuals who are immunosuppressed or have impaired immune systems, with the exception of patients with AIDS, neonates undergoing exchange transfusions, intrauterine transfusions, donations from first or second-degree relatives, and HLA-selected components.

In the context of aplastic anemia patients undergoing immunosuppressive medication with anti-thymocyte globulin, Platelets can undergo irradiation at any point during the storage process, without affecting their shelf life.

It is recommended that all granulocyte components undergo irradiation prior to being issued and transfused without unnecessary delay [14]. According to reference [15], it is recommended that the minimum dose administered to the irradiated unit should be 25 Gy, ensuring that no portion of the unit is exposed to a radiation exceeding 50 Gy.

Packed red blood cell or platelet concentrate, saline washed& Photopheresis:

Saline-washed red blood cells are a specialized component that is exclusively generated upon request for patients who possess antibodies to plasma proteins, such as anti-IgA, and for individuals who experience severe allergic reactions when administered with blood products [16]. This procedure is more cost-effective compared to both Leuco and Plasma depletion techniques. The aforementioned product can also be derived from packed red blood cells (PRBC) following the process of leukocyte reduction or removal of blood components (BC). The saline washing procedure is typically performed three to four times using either manual or automated methods. The ultimate outcome entails the suspension of packed red blood cells (PRBC) in a saline solution containing less than 0.5 grams of protein per unit. The aforementioned idea of washing PLTC is applicable to the management of newborn alloimmune thrombocytopenia [16].

Photopheresis is a distinct form of apheresis wherein the white cell component is subjected to UV radiation outside of the body. This method involves the oral administration of a photoactive dye, such as psoralen (specifically 8-methoxypsoralen or 8 MOP). The apheresis operation is conducted after a span of many hours. In an ex vivo setting, the isolated white cell component is subjected to ultraviolet radiation, which leads to the activation of drugs. Photopheresis is primarily utilized as a therapeutic modality for cutaneous T-cell lymphoma, as it has demonstrated significant efficacy in inducing dramatic remissions of skin lesions [17].

The process of filtering, specifically employing filters with suitable particle size (known as nanofiltration), effectively eliminates viruses that possess a protein membrane, while viruses with a lipid envelope remain unaffected. Aseptic membrane filtration, with a pore size of 0.22 nm, is employed as a means of eliminating microorganisms and achieving sterilization of large quantities of products before they are filled into ampoules or final product containers [18].

Psoralen or Riboflavin, in conjunction with ultraviolet light treatment, are additional chemicals employed for the purpose of pathogen inactivation in platelets and plasma. The inactivation of pathogens in components that comprise red blood cells poses a complex dilemma. In similar circumstances, the efficacy of S303 (Helinx), a specifically engineered small molecule for the purpose of pathogen inactivation, has been demonstrated with positive outcomes [19].

A wide array of pharmaceutical substances are currently employed as alternatives to blood, including haemoglobin preparations, haemostatic agents, and plasma expanders. In recent times, advancements in culture techniques and preliminary research conducted on animal models have facilitated the proposition of cultured red blood cells (cRBCs) as a promising and innovative alternative to traditional blood replacements [20].

Currently, containers made from polyolefin or polyvinyl chloride (PVC) are utilized for the collection of whole blood. These containers may have a thinner structure or may be plasticized using various chemicals, such as triethyl hexyl trimellitate and butyryl-tri-hexyl citrate. The bags under consideration exhibit an oxygen permeability that is almost double that of initial-generation PVC containers plasticized with Di ethyl hexyl phthalate. Additionally, they are capable of sustaining a pH level above 6, which contributes to enhanced platelet viability and functionality [20]. The importance of appropriate component storage lies in its ability to maintain the biological functionality of the constituents, mitigate their metabolic processes, and minimize bacterial proliferation in the blood components.

According to established protocols, the recommended storage temperature for red blood cells falls within the range of +2°C to +6°C. For platelets and leukocytes, the appropriate storage temperature is between +20°C and +24°C. As for plasma products, it is advised to store them below −18°C [20].

The storage of components is divided into three compartments or equipment units: the Untested components, the Tested and approved components ready for issuance, and the Tested but dangerous or quarantined components designated for disposal [21].

Furthermore, it is necessary to utilize distinct equipment for the purpose of safely storing cross-matched units, if they are accessible. During the transportation process, it is recommended that the components be stored at the indicated temperatures for a maximum duration of 24 hours. It is imperative to ensure that the temperature range for preserving packed red blood cells (PRBC) remains within the limits of +2°C to +10°C. The components are consistently stored and transported within a temperature range of +20°C to +24°C. In order to preserve the frozen state of all components, it is important to transport them in a manner that ensures their continued frozen condition (21).

The monitoring and documentation of temperature fluctuations can be accomplished by employing indicators affixed to the units or by conducting physical inspections of each component to identify any signs of degradation. It is imperative to ensure the maintenance of the cold chain for all blood components until the moment of transfusion (22).

Plasma transfusion is recommended in patients with active bleeding and an Interna- tional Normalized Ratio (INR) greater than 1.6, or before an invasive procedure or sur- gery if a patient has been anticoagulated [20,22]. Plasma is often inappropriately transfused for correction of a high INR when there is no bleeding. Supportive care can decrease high- normal to slightly elevated INRs (1.3 to 1.6) platelets in these conditions can result in further throm- bosis. One unit of apheresis platelets should increase the platelet count in adults by 30 to 60×10^3 per μL (30 to 60 × 10^9 per L).[3] In neonates, transfusing 5 to 10 mL per kg of platelets should increase the platelet count by $50to100\times10^3$ per$\mu L(50to100\times10^9$ perL). One apheresis platelet collection is equivalent to six pooled random donor platelet concentrates [22].

CONCLUSION:

The practice of haemovigilance, which aims to ensure the safety of blood transfusions, involves implementing various measures to maintain quality assurance throughout the entire process. These measures include employing well-trained technical personnel, adhering to proper collection and storage protocols, utilizing high-quality blood products, using properly calibrated equipment, employing quality reagents and kits, and maintaining thorough documentation. The presence of blood components that are not native to a patient's body can result in a spectrum of undesirable effects, ranging from mild allergy symptoms to potentially lethal reactions. Typically, the aforementioned reactions are induced by plasma proteins, leukocytes, red cell antigens, plasma, and other infections. In order to mitigate and minimize such issues, blood products are subjected to several modifications, including leukoreduction, irradiation, volume reduction, saline washing, and pathogen inactivation. The management of blood inventory is a significant issue in the field of blood banking, with particular emphasis on uncommon blood groups under regular circumstances and common blood groups at times of calamities.

REFERENCES:

1. Hardwick J. Blood processing: Introduction to blood transfusion technology. *ISBT Sci Ser*. 2008;3:148–76.
2. New Delhi: National Aids Control Organization, Ministry of Health and Family welfare Government of India; 2007. Standards for Blood Banks and Blood Transfusion Services; pp. 47–50.
3. Moog R. A new technology in blood collection: Multicomponent apheresis. In: Peterson BR, editor. *New Developments in Blood Transfusion Research*. New York: Nova Science Publishers, Inc; 2006. pp. 141–6.
4. Lotens A, Najdovski T, Cellier N, Ernotte B, Lambermont M, Rapaille A. New approach to ‘top-and-bottom’ whole blood separation using the multiunit TACSI WB system: Quality of blood components. *Vox Sang.* 2014;107:261–8.
5. Agbaht K, Altintas ND, Topeli A, Gokoz O, Ozcebe O. Transfusion-associated graft-versus-host disease in immunocompetent patients: case series and review of the literature. Transfusion. 2007; 47: 1405–11.
6. Aoun E, Shamseddine A, Chehal A, Obei M, Taher A. Transfusion-associated GVHD: 10 years’ experience at the American University of Beirut-Medical Center. Transfusion. 2003; 43: 1672–6.

7. Maitta RW, Vasovic LV, Mohandas K, Music-Aplenc L, Bonzon-Adelson A, Uehlinger J. A safe therapeutic apheresis protocol in paediatric patients weighing 11 to 25 kg. *Vox Sang.* 2014
8. Matthes G, Ingilizov M, Dobao ML, Marques S, Callaert M. Red cell apheresis with automated in-line filtration. *Transfus Med Hemother.* 2014;41:107–13.
9. Klein HG, Anstee DJ, editors. 11th ed. Massachusetts: Blackwell Publishing Ltd; 2005. Mollison's Blood Transfusion in Clinical Medicine; p. 27.
10. Kopolovic I, Ostro J, Tsubota H, Lin Y, Cserti-Gazdewich CM, Messner HA, et al. A systematic review of transfusion-associated graft-versus-host disease. Blood. 2015; 126: 406–14.
11. Uchida S, Tadokoro K, Takahashi M, Yahagi H, Satake M, Juji T. Analysis of 66 patients with definitive transfusion-associated graft-versus-host disease and the effect of universal irradiation of blood. Transfus Med. 2013; 23: 416–22.
12. Williamson LM, Stainsby D, Jones H, Love E, Chapman CE, Navarrete C, et al. The impact of universal leukodepletion of the blood supply on hemovigilance reports of posttransfusion purpura and transfusion-associated graft-versus-host disease. Transfusion. 2007; 47: 1455–67.
13. Garraud O, Tariket S, Sut C, Haddad A, Aloui C, Chakroun T, Laradi S, Cognasse F. Transfusion as an Inflammation Hit: Knowns and Unknowns. Front Immunol. 2016;7:534.
14. Uhlmann EJ, Isgriggs E, Wallhermfechtel M, Goodnough LT. Prestorage universal WBC reduction of RBC units does not affect the incidence of transfusion reactions. Transfusion. 2001 Aug;41(8):997-1000.
15. Pineda AA, Taswell HF. Transfusion reactions associated with anti-IgA antibodies: report of four cases and review of the literature. Transfusion. 1975 Jan-Feb;15(1):10-5.
16. Sandler SG, Mallory D, Malamut D, Eckrich R. IgA anaphylactic transfusion reactions. Transfus Med Rev. 1995 Jan;9(1):1-8.
17. Toy P, Popovsky MA, Abraham E, Ambruso DR, Holness LG, Kopko PM, McFarland JG, Nathens AB, Silliman CC, Stroncek D., National Heart, Lung and Blood Institute Working Group on TRALI. Transfusion-related acute lung injury: definition and review. Crit Care Med. 2005 Apr;33(4):721-6.
18. Kopko PM, Popovsky MA, MacKenzie MR, Paglieroni TG, Muto KN, Holland PV. HLA class II antibodies in transfusion-related acute lung injury. Transfusion. 2001 Oct;41(10):1244-8.
19. Zhou L, Giacherio D, Cooling L, Davenport RD. Use of B-natriuretic peptide as a diagnostic marker in the differential diagnosis of transfusion-associated circulatory overload. Transfusion. 2005 Jul;45(7):1056-63.
20. Popovsky MA. Transfusion and the lung: circulatory overload and acute lung injury. Vox Sang. 2004 Jul;87 Suppl 2:62-5.
21. Savage SA, Sumislawski JJ, Zarzaur BL, Dutton WP, Croce MA, Fabian TC. The new metric to define large-volume hemorrhage: results of a prospective study of the critical administration threshold. J Trauma Acute Care Surg. 2015 Feb;78(2):224-9; discussion 229-30.
22. Khan AI, Patidar GK, Lakshmy R, Makhija N, Talwar S, Hazarika A. Effect of leukoreduction on transfusion-related immunomodulation in patients undergoing cardiac surgery. Transfus Med. 2020 Dec;30(6):497-504.