DOI: https://doi.org/10.54393/pjhs.v6i1.2701

PAKISTAN JOURNAL OF HEALTH SCIENCES
(LAHORE)
https://thejas.com.pk/index.php/pjhs
ISSN (E): 2790-9352, (P): 2790-9344
Volume 6, Issue 01 (January 2025)



Original Article

OPEN ACCESS

The Frequency of Blood Transfusion Reactions: A Retrospective Study from a Tertiary Care Hospital

Uzma Chohan[1], Sumayya Najam[2], Khushbakhat Khanzada Rajput[3], Maryam Khanzada Rajput[4], Syeda Azka Waqar[5*] and Namra Yunus[5]

[1]Department of Pathology, Shahida Islam Medical College, Lodhran, Pakistan
[2]Department of Hematology, Hematology Diagnostic Center, Lahore, Pakistan
[3]Department of Pathology, Isfand Yar Bukhari District Hospital, Attock, Pakistan
[4]Department of Pathology, Diagnostic and Research Lab, Bilawal Medical College, Jamshoro, Pakistan
[5]Department of Pathology, Fatima Memorial Hospital, Lahore, Pakistan

ARTICLE INFO

Keywords:
Blood Transfusion Reactions, Febrile Non-Hemolytic Transfusion Reactions, Allergic Reactions, Blood Products, Transfusion Safety

How to Cite:
Chohan, U., Najam, S., Rajput, K. K., Rajput, M. K., Waqar, S. A., & Yunus, N. (2025). The Frequency of Blood Transfusion Reactions: A Retrospective Study from a Tertiary Care Hospital: Frequency of Blood Transfusion Reactions. Pakistan Journal of Health Sciences, 6(1), 158-163. https://doi. org/10.54393/pjhs.v6i1. 2701

***Corresponding Author:**
Syeda Azka Waqar
Department of Pathology, Fatima Memorial Hospital, Lahore, Pakistan
azkawaqar06112014@gmail.com

Received date: 27th October, 2024
Acceptance date: 18th January, 2025
Published date: 31st January, 2025

ABSTRACT

Blood Transfusion Reactions (BTRs) are complications that may occur during or after transfusion, in which allergic reactions and Febrile Non-Hemolytic Transfusion Reactions (FNHTRs) being the most common. **Objective:** To assess the frequency and types of transfusion reactions among patients at Shahida Islam Medical College Hospital and a blood transfusion service supplier. **Methods:** This retrospective observational study analyzed transfusion reactions reported between January, 2022, and September, 2024. A total 1936 transfused has done during this time frame. Data were collected using non-probability convenience sampling, covering patient demographics, blood products used, and Incident rate of transfusion reactions. IBM SPSS version 28.0 was utilized for statistical analysis, with categorical variables presented as frequencies and percentages. **Results:** Out of 1936 transfusions a total 12 (0.6%) reported transfusion reactions in which allergic reactions accounted for the majority (50.0%), followed by FNHTRs (33.33%) and none or very limited reactions of other reactions seen both on whole blood and PCV. The overall incidence of transfusion reactions was 0.53%. **Conclusions:** This study highlighted that allergic reactions are the most prevalent Blood Transfusion Reactions, emphasizing the need for premedication protocols for high-risk patients. Future research should focus on identifying predictive markers for allergic reactions, refining transfusion protocols.

INTRODUCTION

Adverse reactions to blood transfusions represent a significant complication in transfusion medicine. Among the various labile blood components, Platelet Concentrates (PCs) are the most frequent contributors to Hypersensitivity Transfusion Reactions (HTRs). These reactions often necessitate the cessation of PC transfusion, prolonging the transfusion process and increasing morbidity. In patients with a history of allergic transfusion reactions, premedication and heightened monitoring are often required. The French hemovigilance database, one of the largest standardized systems for tracking transfusion complications, provides critical insights into HTRs associated with labile blood products [1]. Febrile Non-Hemolytic Transfusion Reactions (FNHTRs) are among the more commonly observed complications in allogenic transfusion. These reactions are often attributed to the presence of White Blood Cells (WBCs) or leukocytes within the transfused product. During storage, these cells actively synthesize pro-inflammatory cytokines, leading to elevated cytokine levels and an

Copyright © 2025. PJHS, Published by Crosslinks International Publishers LLC, USA
This work is licensed under a Creative Commons Attribution 4.0 International License.

DOI: https://doi.org/10.54393/pjhs.v6i1.2701

increased risk of FNHTRs. The removal of leukocytes prior to storage, a process known as leukoreduction, significantly minimizes cytokine accumulation, thereby reducing the incidence of these febrile reactions [2]. Mild allergic transfusion reactions frequently result in the unnecessary discontinuation of transfusion, leading to wastage of blood components and repeated exposure of recipients to additional transfusion products. This repeated exposure increases the risk of alloimmunization. Recent studies have sought to identify the clinical symptoms and parameters that lead transfusionists to prematurely terminate transfusions due to mild ATRs [3]. AHTRs are characterized by a sudden onset of hypotension immediately following the initiation of transfusion, typically resolving upon cessation of the transfusion. Emerging evidence has suggested a correlation between AHTRs and preoperative administration of Angiotensin-Converting Enzyme (ACE) inhibitors. Recent case studies have documented two unrelated instances of AHTR, detailing their clinical presentation, diagnostic processes, and management strategies [4]. TRALI remains the leading cause of transfusion-related mortality in the United States, yet its characteristics in surgical populations are not well-defined. To enhance perioperative transfusion practices and mitigate TRALI risk, researchers have focused on clarifying its epidemiology, particularly in the context of interventions aimed at reducing TRALI incidence. These efforts aim to improve patient safety and refine transfusion protocols in surgical settings [5]. First identified in 1951 and 1957, Transfusion-Related Acute Lung Injury (TRALI) was formally recognized as a distinct clinical condition in 1985 following a study involving 36 patients. Earlier hypotheses in 1970 and 1971 suggested that leukoagglutinins targeting HLA and non-HLA antigens were responsible for TRALI reactions. Over the years, with advances in transfusion practices and heightened awareness, TRALI has emerged as a frequent and significant complication of blood transfusions. In recent reporting periods, it has been identified as the primary cause of transfusion-related mortality in the United States. [6]. Blood transfusion reactions can be broadly categorized into two main types that is Acute or Immediate Reactions and Delayed Reactions. Acute or Immediate Reactions occur shortly after the transfusion and include conditions such as acute hemolytic transfusion reaction, transfusion-associated sepsis, febrile non-hemolytic transfusion reaction, mild to severe allergic reactions, transfusion-associated circulatory overload, and transfusion-related acute lung injury. These reactions typically require prompt recognition and management to prevent serious complications. While Delayed Type Transfusion Reactions, develop over time following the transfusion. Examples include serological hemolytic reactions, iron overload, transfusion-associated graft-versus-host disease, and post-transfusional purpura. These delayed reactions may require long-term monitoring and specific therapeutic interventions. The most common symptoms of AHTRs include fever, chills, itching, or urticaria. These reactions typically manifest within 24 hours of transfusion and are usually self-limiting without requiring specific treatment. However, severe cases may present with symptoms such as dyspnea, hematuria, high fever, or loss of consciousness, potentially indicating a life-threatening reaction. AHTRs occur when the recipient's immune system destroys transfused red blood cells. [6]. Transfusion-Associated Sepsis (TAS) is an acute non-immune reaction caused by the transfusion of bacteria-contaminated blood products. Symptoms include a sudden rise in body temperature exceeding 2°C above baseline, rigors, and hypotension. These symptoms usually appear shortly after transfusion initiation. The risk of TAS is influenced by factors such as the type of bacterial contamination (e.g., gram-negative bacteria), patient demographics, transfused blood volume, and the storage duration of platelets [7]. FNHTRs are common complications of allogeneic red blood cell or platelet transfusions, typically occurring during or within 4–6 hours post-transfusion. These reactions, characterized by fever (>100°C), chills, and rigors, are more frequent in non-leukoreduced blood products. Patients with a history of FNHTRs are at an elevated risk of recurrence, with some cases presenting additional symptoms such as nausea, vomiting, and hypotension [8]. TRALI is characterized by sudden pulmonary insufficiency, manifesting as severe dyspnea, hypoxia, and pulmonary edema with normal cardiac function. The underlying mechanisms include leukocyte antibodies and biologically active lipids or cytokines that prime neutrophils. These processes lead to increased pulmonary microvascular permeability, causing protein-rich fluid accumulation in the lungs [9]. Mild allergic transfusion reactions, including rash, itching, and flushing, occur in 1–3% of all transfusions. Severe allergic reactions, such as anaphylactic shock, are rare but may result from IgE or anti-IgA antibodies. Less severe allergic responses may involve pre-existing antibodies to proteins or other transfused allergens [1]. Anaphylactoid reactions, while clinically similar to anaphylaxis, do not involve IgE antibodies. Instead, they arise from complement activation, bradykinin cascade, or direct activation of mast cells and basophils, leading to symptoms such as dizziness, tingling, and uneasiness. TACO results from pulmonary edema caused by circulatory overload, presenting as an underrecognized but serious complication. This condition often mimics immune-mediated pulmonary edema but arises due to fluid overload rather than immune mechanisms. These potentially life-threatening

Copyright © 2025. PJHS, Published by Crosslinks International Publishers LLC, USA
This work is licensed under a Creative Commons Attribution 4.0 International License.

DOI: https://doi.org/10.54393/pjhs.v6i1.2701

complications are observed in patients with sickle cell disease, presenting with hemolysis days after transfusion. Diagnosis includes monitoring acute pain episodes following transfusion [10]. Primarily seen in immunosuppressed patients, TA-GVHD manifests with fever, rash, and gastrointestinal symptoms. The condition may lead to severe outcomes like generalized erythroderma and bullae formation [11, 12].

Blood transfusion reactions (BTRs) represent a significant clinical challenge in transfusion medicine, contributing to increased morbidity, prolonged hospital stays, and in severe cases, mortality, with allergic reactions and febrile non-hemolytic transfusion reactions (FNHTRs) being the most frequently encountered complications. While hemovigilance data from high-income countries are relatively well-established, comparable surveillance data from lower-middle-income settings like Pakistan remain sparse and inconsistent, creating a critical gap in understanding the local burden and pattern of transfusion reactions across different blood products. Furthermore, limited institutional-level data hinder the development of context-specific premedication protocols and transfusion safety guidelines tailored to regional healthcare infrastructure.The study aimed to evaluate the incidence rate and types of transfusion reactions associated with the administration of different blood components, including whole blood and PCV within the blood transfusion services of a tertiary care hospital.

METHODS

The study population consisted of patients with the symptoms of transfusion reactions. This was a retrospective observational study conducted at Shahida Islam Medical College Hospital; a tertiary care hospital in Lodhran and Hamdard Blood Bank and Transfusion center; a blood transfusion center providing blood bank related services. Data collection was based on the number of transfusion reactions reported in last 2 years and 9 months (15th January 2022 to 11th September 2024) which was total 1936 transfusion done in the both settings. Convenient sample techniques were used after establishing and using digital and latest equipment's in Blood banking. In this study only the incident rate of transfusion reactions was checked from the different type blood components like Whole blood and PCV. The data were collected by the transfusion service provider like Patient transfusion date, type of blood component transfused and patient history. The diagnosis and all reactions were assessed clinically through the experienced haematologist through proper guidelines like donor blood group and Rh factor, re-cross match, Gram stain, Complete blood count, culture sensitivity and specificity and urine analysis, all these parameters are not including in the study. Data on incident were focused on rate of transfusion reaction and which component of blood being transfused. Total 12 blood transfusion reactions out of 1936 that occurred during 15th January 2022 to 11th September 2024. A non-probability convenience sampling technique was used to select samples after approval of Institutional Review Board. (Letter No# SIMC/ET.C/0009/24). This data was analysed to identify different type of blood transfusions reactions and their incident rate. Categorical variables were summarized as frequencies in the form of percentages. Mean and Standard Deviation (SD) were calculated for continuous variables. Statistical analysis was performed using SPSS version 28.0, and significance was also assessed at a 5% level.

RESULTS

Total 12 (0.6%) reactions from all transfusions (1936) were reported in the particular chosen time. Among these, Allergic reactions were 06 (50%), showing the highest frequency. FNHTR were 4 (33.33%), and Anaphylactoid reactions were 2 (16.67%) (Table 1).

Table 1: Frequency of Blood Transfusion Reactions

Reactions	Frequency (%)
Allergic Reaction	6 (50%)
FNHTR	4 (33.33%)
Anaphylactoid reactions	2 (16.67%)
TA-GVHD	0 %
TRALI	0 %
Total	12 (100%)

This figure 1 illustrated the distribution of various types of blood transfusion reactions (BTRs) reported among 1936 transfusions conducted between January 15, 2022, and September 11, 2024. The majority of the reactions were allergic reactions, accounting for 50% of the reported cases, followed by Febrile Non-Hemolytic Transfusion Reactions (FNHTRs) at 33.33%. A minimal number of cases involved other types of reactions, observed in both whole blood and Packed Cell Volume (PCV) transfusions. The figure highlights the overall incidence rate of BTRs at 0.53%, underscoring the predominance of allergic reactions as the primary complication.

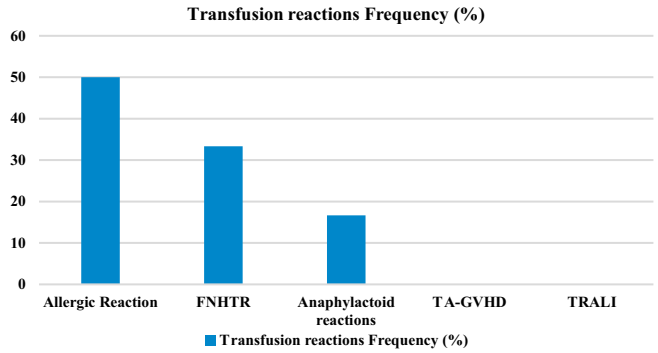


Figure 1: Frequency of Blood Transfusion Reactions

Copyright © 2025. PJHS, Published by Crosslinks International Publishers LLC, USA
This work is licensed under a Creative Commons Attribution 4.0 International License.

DOI: https://doi.org/10.54393/pjhs.v6i1.2701

Out of the total 12 transfusion reactions, 8 were associated with whole blood products, of which 5 (62.5%) were allergic reactions, 2 (25%) were Febrile Non-Hemolytic Transfusion Reactions (FNHTRs), and 1 (12.5%) was an anaphylactoid reaction (Table 2).

Table 2: Frequency of Blood Transfusion Reactions due to Whole Blood

Reactions	Frequency (%)
Allergic Reaction	5 (62.5%)
FNHTR	2 (25.0%)
Anaphylactoid reactions	1 (12.5%)
TA-GVHD	0 %
TRALI	0 %
Total	8 (100%)

The remaining 4 transfusion reactions were associated with packed cell products, including 1 (25%) allergic reaction, 2 (50%) Febrile Non-Hemolytic Transfusion Reactions (FNHTRs), and 1 (25%) anaphylactoid reaction (Table 3).

Table 3: Frequency of Blood Transfusion Reactions due to Pack Cells

Reactions	Frequency (%)
Allergic Reaction	1 (25.0%)
FNHTR	2 (50.0%)
Anaphylactoid reactions	1 (25.0%)
TA-GVHD	0 %
TRALI	0%
Total	4 (100%)

DISCUSSION

Blood transfusion is a common and generally safe procedure in which blood or blood components are administered intravenously to replace lost blood or address conditions that impair the body's ability to produce blood. Each year, approximately 5 million Americans undergo blood transfusions. While most transfusions proceed smoothly, mild complications may occur, and serious reactions, though rare, can develop. Blood transfusions are essential for replacing blood lost during surgeries, treating injuries, and addressing conditions like anemia and blood disorders that affect blood production [14]. In this study, the overall incidence of transfusion reactions was 0.53%, comparable to hemovigilance reports from countries such as India and China. A study in India reported a 0.27% incidence, while another healthcare center in India found a rate of 0.2 [15, 16]. Similarly, a meta-analysis from China identified a rate of 0.4%, but the incidence was markedly higher in Ghana [17]. The variance in rates reflects differences in healthcare systems, blood product screening protocols, and transfusion practices. This study identified 12 acute transfusion reactions, with allergic reactions being the most frequent, accounting for 6 cases (50%). Febrile non-hemolytic transfusion reactions (FNHTR) were the second most common, reported in 4 cases (33.33%), followed by transfusion-associated circulatory overload (Anaphylactoid Reactions) in 2 cases (16.67%). Allergic Reactions (50%): These were the most prevalent, typically presenting as mild allergic responses, such as itching or hives, but they did not escalate to anaphylaxis. FNHTR (33.33%): These reactions, characterized by fever and chills, occurred frequently in recipients of whole blood and packed cell transfusions. Anaphylactoid Reactions (16.67%): Though the risk of Anaphylactoid Reactions is usually higher with whole blood due to the larger volume, it also appeared with packed cells, likely due to multiple units being transfused. Possibly this was due to multiple blood units being transfused to the patient. These findings aligned with previous studies highlighting the predominance of allergic reactions and FNHTR. The reported incidence of allergic reactions in this study (50%) mirrors trends observed in other hemovigilance reports [18, 19]. Whole blood transfusions were more likely to cause reactions than packed red cells, likely due to the higher volume and complexity of the product. Additionally, cases of Anaphylactoid Reactions with packed cells though less common can occur due to cumulative volume overload from multiple transfusions. This underscores the importance of careful monitoring and transfusion protocols to prevent circulatory overload. While Transfusion-Associated Graft-Versus-Host Disease (TA-GVHD) and Transfusion-Related Acute Lung Injury (TRALI) have been reported in other studies, no such cases were observed in the dataset. A UK hemovigilance report documented 13 cases of TA-GVHD between 1996 and 2005, highlighting the need for continued vigilance [20].

This study was limited by its retrospective design, small number of reported reactions (only 12 out of 1,936 transfusions), reliance on convenience sampling, and restriction to only two blood product types, which may have resulted in underreporting and limited the comprehensiveness of reaction profiling. The exclusion of detailed laboratory parameters such as culture sensitivity, CBC, and crossmatch data further constrained the depth of reaction analysis and classification accuracy. Future research should employ prospective, multicenter hemovigilance frameworks with standardized reporting systems to capture a broader spectrum of transfusion reactions across all blood components, including platelets and fresh frozen plasma. Additionally, investigating predictive biomarkers for high-risk patients and evaluating the impact of leukoreduction and premedication protocols on reaction incidence could significantly improve transfusion safety practices in resource-limited settings.

Copyright © 2025. PJHS, Published by Crosslinks International Publishers LLC, USA
This work is licensed under a Creative Commons Attribution 4.0 International License.

DOI: https://doi.org/10.54393/pjhs.v6i1.2701

CONCLUSIONS

This study highlights the incidence and distribution of transfusion reactions in patients receiving whole blood and packed red cell transfusions. Allergic reactions were the most frequently observed, accounting for 50% of all reported reactions, followed by FNHTR (33.33%), Anaphylactoid Reactions (16.67%), and no cases report for TA-GVHD and TRALI (0%). Whole blood transfusion was more frequently associated with allergic reactions, while FNHTR and Anaphylactoid Reactions cases were reported with both whole blood and packed cell transfusions, suggesting that even smaller volumes may carry risks when multiple units are transfused.

Authors' Contribution

Conceptualization: UC
Methodology: SN
Formal analysis: MKR
Writing and Drafting: UC, KKR, SAW, NY
Review and Editing: UC, KKR, SAW, NY

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflicts of Interest

All the authors declare no conflict of interest.

Source of Funding

The authors received no financial support for the research, authorship and/or publication of this article.

REFERENCES

[1] Mertes PM, Tacquard C, Andreu G, Kientz D, Gross S, Malard L *et al.* Hypersensitivity transfusion reactions to platelet concentrate: a retrospective analysis of the French hemovigilance network.Transfusion.2020 Mar; 60(3): 507-12. doi: 10.1111/trf.15275.

[2] Clifford L, Jia Q, Subramanian A, Yadav H, Wilson GA, Murphy SP *et al.* Characterizing the epidemiology of postoperative transfusion-related acute lung injury. Anesthesiology.2015 Jan; 122(1): 12. doi: 10.1097/ALN .0000000000000514.

[3] Yoon U, Abdullah M, Elia E, Herman J. Intraoperative Diagnosis and Management of Acute Hypotensive Blood Transfusion Reaction (AHTR): A Report of Two Cases. The American Journal of Case Reports.2018 Oct; 19: 1283. doi: 10.12659/AJCR.910642.

[4] Demir T, Sahin M, El H, Sezer H. Post-Transfusion Purpura Following Cardiac Surgery. Journal of Cardiac Surgery: Including Mechanical and Biological Support for the Heart and Lungs.2015 Mar; 30(3): 253-5. doi: 10.1111/jocs.12462.

[5] Hatayama Y, Matsumoto S, Hamada E, Kojima N, Hara A, Hino N *et al.* Analysis of acute transfusion reactions and their occurrence times. Yonago Acta Medica.2018 Mar; 61(1): 087-90. doi: 10.33160/yam.2018.03.013.

[6] Adkins BD, Lawicki S, Johnson M, Eichbaum Q. Mild allergic transfusion reactions: impact of associated clinical symptoms?. American Journal of Clinical Pathology.2019Feb;151(3):344-8.doi:10.1093/ajcp/aqy 150.

[7] Fatima S, Rafique A, Tehsin F. Frequency of Acute Blood Transfusion Reactions encountered in patients in a Tertiary Care Hospital. Pakistan Journal of Medical & Health Sciences. 2017 Jan; 11(1): 120-2.

[8] Delaney M, Wendel S, Bercovitz RS, Cid J, Cohn C, Dunbar NM *et al.* Transfusion reactions: prevention, diagnosis, and treatment. The Lancet. 2016 Dec; 388(10061):2825-36. doi:10.1016/S0140-6736(15)01313 - 6.

[9] Habibi A, Mekontso-Dessap A, Guillaud C, Michel M, Razazi K, Khellaf M *et al.* Delayed hemolytic transfusion reaction in adult sickle-cell disease: presentations, outcomes, and treatments of 99 referral center episodes. American Journal of Hematology.2016 Oct; 91(10): 989-94. doi: 10.1002/ajh. 24460.

[10] Hendrickson JE, Roubinian NH, Chowdhury D, Brambilla D, Murphy EL, Wu Y *et al.* Incidence of transfusion reactions: a multicenter study utilizing systematic active surveillance and expert adjudication. Transfusion.2016 Oct; 56(10): 2587-96. doi: 10.1111/trf.13730.

[11] Hong H, Xiao W, Lazarus HM, Good CE, Maitta RW, Jacobs MR. Detection of septic transfusion reactions to platelet transfusions by active and passive surveillance.Blood, the Journal of the American Society of Hematology. 2016 Jan; 127(4): 496-502. doi: 10.1182/blood-2015-07-655944.

[12] Kato H, Nakayama T, Uruma M, Okuyama Y, Handa M, Tomiyama Y *et al.* A retrospective observational study to assess adverse transfusion reactions of patients with and without prior transfusion history.Vox Sanguinis.2015 Apr; 108(3): 243-50. doi: 10.1111/vox. 122 08.

[13] 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, the Journal of the American Society of Hematology.2015 Jul;126(3):406-14.doi:10.1182/blood -2015-01-620872.

[14] Narbey D, Habibi A, Chadebech P, Mekontso-Dessap A, Khellaf M, Lelièvre JD *et al.* Incidence and predictive score for delayed hemolytic transfusion reaction in adult patients with sickle cell disease. American Journal of Hematology. 2017 Dec; 92(12): 1340-8.doi: 10.1002/ajh.24908.

Copyright © 2025. PJHS, Published by Crosslinks International Publishers LLC, USA
This work is licensed under a Creative Commons Attribution 4.0 International License.

DOI: https://doi.org/10.54393/pjhs.v6i1.2701

[15] Oakley FD, Woods M, Arnold S, Young PP. Transfusion reactions in pediatric compared with adult patients: a look at rate, reaction type, and associated products. Transfusion.2015Mar;55(3):563-70.doi:10.1111/trf.12827.

[16] Peters AL, van Hezel ME, Juffermans NP, Vlaar AP. Pathogenesis of non-antibody mediated transfusion-related acute lung injury from bench to bedside. Blood Reviews.2015 Jan; 29(1): 51-61. doi: 10.1016/j.blre. 2014 .09.007.

[17] Rajesh K, Harsh S, Amarjit K. Effects of prestorage leukoreduction on the rate of febrile nonhemolytic transfusion reactions to red blood cells in a tertiary care hospital. Annals of Medical and Health Sciences Research.2015 May; 5(3): 185-8. doi: 10.4103/2141-9248 .157498.

[18] Sirianni G, Perri G, Callum J, Gardner S, Berall A, Selby D. A retrospective chart review of transfusion practices in the palliative care unit setting. American Journal of Hospice and Palliative Medicine®.2019 Mar; 36(3): 185-90. doi: 10.1177/1049909118806456.

[19] Yanagisawa R, Shimodaira S, Sakashita K, Hidaka Y, Kojima S, Nishijima F *et al.* Factors related to allergic transfusion reactions and febrile non-haemolytic transfusion reactions in children. Vox Sanguinis. 2016 May; 110(4): 376-84. doi: 10.1111/vox.12373.

[20] West FB and Silliman CC. Transfusion-related acute lung injury: advances in understanding the role of proinflammatory mediators in its genesis. Expert Review of Hematology. 2013 Jun; 6(3): 265-76. doi: 10.1586/ehm.13.31.

Copyright © 2025. PJHS, Published by Crosslinks International Publishers LLC, USA
This work is licensed under a Creative Commons Attribution 4.0 International License.