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The Analysis of the Characteristics of 182 Transfusion Reactions Cases and the Effect of Preventive Medication

Ping Hu[1,2], Minghui Chen[1,2], Peng Wei[1,2]*

[1]Department of Blood Transfusion, The Sixth Affiliated Hospital, Sun Yat-sen University, Guangzhou 510000, Guangdong, China
[2]Biomedical Innovation Center, The Sixth Affiliated Hospital, Sun Yat-sen University, Guangzhou 510000, Guangdong, China

***Corresponding author**: *Peng Wei, weipeng3@mail.sysu.edu.cn*

Abstract: *Objective*: To analyze the characteristics of 182 cases of transfusion reactions and explore the effect of preventive medication. *Methods*: A retrospective analysis was conducted on 182 cases of transfusion reactions reported at the Sixth Affiliated Hospital, Sun Yat-sen University, from February 2022 to January 2025. Non-transfusion reaction cases were selected by random sampling as the control group, and the characteristics and high-risk factors of transfusion reactions were analyzed based on their basic clinical features and medical history data. *Results*: The incidence of platelet transfusion reactions was higher than that of red blood cells and plasma transfusions. The incidence of transfusion reactions and the febrile non-hemolytic transfusion reaction (FNHTR) ratio in women was higher than that in men. The incidence of transfusion reactions and FNHTR ratio in patients with a history of pregnancy was higher than in those without. The incidence of transfusion reactions and FNHTR ratio in patients with a history of prophylactic drug was significantly higher than those without. The FNHTR ratio in type A and O blood recipients was higher than that in type B blood recipients. The FNHTR ratio of red blood cell transfusion was higher than that of plasma and platelet transfusion. The above differences were statistically significant ($p < 0.05$). There was no statistically significant difference ($p > 0.05$) in the reaction types and incidence of transfusion reactions among the age, transfusion history, transfusion reaction history, and chemotherapy/immunotherapy/targeted drug use history of the recipients. There was also no statistically significant difference ($p > 0.05$) in the preventive effects of dexamethasone, promethazine, chlorpheniramine, loratadine, and diphenhydramine on transfusion reactions. *Conclusion*: Women's and pregnancy history are important influencing factors for the occurrence and type of transfusion reactions. The blood type of the recipient and the composition of the transfusion blood can affect the type of transfusion reactions. The effectiveness of prophylactic medication in reducing transfusion reactions is controversial.

Keywords: Transfusion reactions; Febrile non-haemolytic trans-fusion reaction (FNHTR); Allergic reaction; Prophylactic medication

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1. Introduction

Blood transfusion is an indispensable clinical treatment, especially for acute blood loss and hematopoietic disorders. Transfusion reactions are complications occurring during or after transfusion, often hindering treatment, reducing efficacy, and in severe cases threatening life [1,2]. Historically, the incidence of transfusion reactions ranged from 1% to 10% [3]. With advances in testing and blood processing, transfusion-transmitted infections have been somewhat controlled. A study reported a transfusion reaction incidence of 2‰ in China during 2019–2020 [4]. However, non-infectious transfusion reactions, which are largely influenced by recipient factors, remain difficult to prevent. Allergic reactions and febrile non-hemolytic transfusion reactions (FNHTR) account for 97.55% of all transfusion reactions [4]. Currently, prophylactic use of glucocorticoids and antihistamines before transfusion is recommended to prevent non-infectious reactions, but whether this approach is effective and which drugs are preferable remain unresolved [2]. This retrospective study analyzed transfusion reaction cases reported in our hospital from February 2022 to January 2025, aiming to identify characteristics and risk factors and to discuss the necessity and choice of prophylactic medication, so as to inform individualized prevention strategies.

2. Subjects and methods

2.1. Study subjects

2.1.1. Experimental group

Clinical data of 182 reported transfusion reaction episodes at The Sixth Affiliated Hospital, Sun Yat-sen University, from February 2022 to January 2025 were collected.

Inclusion criteria: (1) met diagnostic criteria for transfusion reactions; (2) had complete clinical data.

Diagnostic criteria for transfusion reactions [4,5]: (1) Febrile non-hemolytic transfusion reaction (FNHTR): an increase in body temperature of ≥ 1 ℃ during or within 1–2 hours after transfusion of whole blood or components, with fever and chills as main manifestations, not explainable by other causes. (2) Allergic reaction: within 4 hours of transfusion, patients developed facial flushing, pruritus, erythema, urticaria, angioedema (frequently on the face, lips, or periorbital region), dyspnea, hypotension, bronchospasm, or laryngeal edema; some may also have fever, chills, nausea, vomiting, diarrhea, or abdominal pain. (3) Other reactions: atypical symptoms, but with other causes excluded.

2.1.2. Control group

182 transfusion episodes without any reported reaction were randomly sampled from patients receiving transfusion therapy in the same hospital during the same period, and corresponding clinical data were collected.

2.2. Methods

2.2.1. Data collection

Electronic medical records were reviewed to collect data on age, sex, blood type, blood component transfused, type of transfusion reaction, irregular antibody screening results, history of previous transfusion, history of previous transfusion reactions, pregnancy history, history of bone marrow transplantation, history of chemotherapy/immunotherapy/targeted therapy, and use of prophylactic medication before transfusion.

Total transfusion episodes: 41,207. After excluding 174 episodes with transfusion reactions (8 cases had

both FNHTR and allergic reaction), 182 episodes were included in the experimental group. Using random sampling, 182 non-reaction episodes were selected from the remaining cases as controls, and their data were collected.

2.2.2. Statistical analysis

SPSS 22.0 was used. Continuous data are expressed as mean ± SD; comparisons between groups used *t* tests. Categorical data are described as rates and proportions; comparisons are made using χ^2 or Fisher's exact test. $p < 0.05$ was considered statistically significant.

3. Results

3.1. Baseline characteristics of transfusion reaction cases

From February 2022 to January 2025, 174 transfusion reaction episodes were reported (age range 1–88 years, mean 59.93 ± 17.21 years). The largest age group was 60–69 years (28.18%), followed by 50–59 years (22.42%), then 40–49, 70–79, 30–39, 18–29, ≥ 80, and ≤ 17 years. There were 90 cases of isolated FNHTR, 68 of isolated allergic reaction, and 8 cases with both FNHTR and allergic reaction. All were acute, mild reactions that resolved after symptomatic treatment; no severe adverse events occurred. Only one case had a positive antibody screening test.

3.2. Factors influencing the composition of FNHTR and allergic reactions

The proportion of FNHTR was higher in female recipients than in males ($p < 0.05$). FNHTR proportion was higher for red blood cell transfusion than for plasma, while allergic reaction proportion was higher for plasma than for red blood cells ($\chi^2 = 47.042$, $p = 0.000 < 0.05$). FNHTR proportion was higher for red blood cells than for platelets, and allergic reaction proportion was higher for platelets than for red blood cells ($\chi^2 = 34.024$, $p = 0.000 < 0.05$). No significant difference was found between plasma and platelets regarding FNHTR and allergic reaction proportions ($\chi^2 = 0.070$, $p = 0.791 > 0.05$). Recipients with a history of pregnancy had a higher FNHTR proportion than those without ($p < 0.05$). Recipients receiving prophylactic medication had a higher FNHTR proportion than those without ($p < 0.05$). Blood type B had a higher proportion of allergic reactions than types A and O, while types A and O had a higher FNHTR proportion than type B ($p < 0.05$). No significant differences in reaction type were observed across age groups, transfusion history, history of previous transfusion reactions, or chemotherapy/immunotherapy/targeted drug use ($p > 0.05$). (see **Table 1**)

Table 1. The analysis of the proportion of 182 patients with transfusion reactions (n, %)

Category	Subcategory	FNHTR n(%)	Allergic reaction n(%)	χ^2	*p*
Sex	Male	29 (40.85)	42 (59.15)	12.601	0.000 (< 0.05)
	Female	69 (66.99)	34 (33.01)		
Age	< 60 years	48 (50.53)	47 (49.47)	2.857	0.091 (> 0.05)
	≥ 60 years	50 (63.29)	29 (36.71)		
Blood type	Type A	37 (67.27)	18 (32.73)	8.794	0.032 (< 0.05)
	Type B	15 (37.50)	25 (62.50)		
	Type O	35 (58.33)	25 (41.67)		
	Type AB	11 (57.89)	8 (42.11)		

Category	Subcategory	FNHTR n(%)	Allergic reaction n(%)	χ^2	*p*
Blood component	Red blood cells	76 (83.52)	15 (16.48)	55.388	0.000 (< 0.05)
	Plasma	13 (25.49)	38 (74.51)		
	Platelets	9 (28.13)	23 (71.87)		
Transfusion history	Yes	66 (57.39)	49 (42.61)	0.063	0.801 (> 0.05)
	No	31 (55.36)	25 (44.64)		
History of transfusion reaction	Yes	33 (55.93)	26 (44.07)	0.007	0.934 (> 0.05)
	No	60 (56.60)	46 (43.40)		
Pregnancy history	Yes	63 (67.74)	30 (32.26)	11.834	0.001 (< 0.05)
	No	35 (43.21)	46 (56.79)		
History of chemotherapy/ immunotherapy/targeted therapy	Yes	28 (53.85)	24 (46.15)	0.038	0.845 (> 0.05)
	No	70 (57.38)	52 (46.62)		
Prophylactic medication	Yes	75 (70.09)	32 (29.91)	22.627	0.000 (< 0.05)
	No	23 (34.33)	44 (65.67)		

3.3. Incidence of transfusion reactions by blood component

A total of 41,207 transfusions were administered: 14,808 red blood cell units, 20,516 plasma units, 3,427 platelet units, and 2,456 cryoprecipitate units. The overall transfusion reaction incidence was 4.223‰. Platelets had the highest incidence (9.629‰), followed by red blood cells (6.483‰) and plasma (2.583‰). No reactions occurred with cryoprecipitate. The incidence for platelets was significantly higher than for red blood cells and for plasma ($\chi^2 = 47.547$, $p = 0.000 < 0.05$). (see **Table 2**)

Table 2. The occurrence of transfusion reactions with different blood components

Blood component	Number of FNHTR (N)	Number of allergic reactions (N)	Number of other reactions (N)	Total number of transfusion reactions (N)	Total units transfused (N)	Incidence (‰)
Red blood cells	76	15	5	96	14808	6.483
Plasma	13	38	2	53	20516	2.583
Platelets	9	23	1	33	3427	9.629
Cryoprecipitate	0	0	0	0	2456	0
Total	98	76	8	174 (8 with fever + allergy)	41207	4.223

3.4. Analysis of factors associated with transfusion reactions

The incidence of transfusion reactions was significantly higher in females than in males ($p < 0.05$). The incidence was higher for red blood cells than for plasma ($\chi^2 = 14.570$, $p = 0.000 < 0.05$), and higher for platelets than for plasma ($\chi^2 = 15.403$, $p = 0.000 < 0.05$). No significant difference was found between red blood cells and platelets ($\chi^2 = 1.850$, $p = 0.174 > 0.05$). Recipients with a history of pregnancy had a significantly higher incidence than those without ($p < 0.05$). Prophylactic medication users had a significantly higher incidence than non-users ($p < 0.05$). No significant differences in incidence were found by age, blood type, transfusion history, history of previous transfusion reactions, or history of chemotherapy/targeted/ immunotherapy ($p > 0.05$). (see **Table 3**) No significant differences were observed among the preventive

effects of dexamethasone, promethazine, chlorpheniramine, and others (loratadine, diphenhydramine) (χ^2 = 2.718, p = 0.437 > 0.05).

Table 3. The analysis of influencing factors related to transfusion reactions

Factor		Case group n (%)	Control group n (%)	χ^2	p
Sex	Male	77 (42.31)	113 (62.09)	14.269	0.000 < 0.05
	Female	105 (57.69)	69 (37.91)		
Age	≤ 17 years	6 (3.30)	7 (3.85)	0.105	0.949 > 0.05
	18–59 years	93 (51.10)	91 (50.00)		
	≥ 60 years	83 (45.60)	84(46.15)		
Blood type	Type A	58 (31.87)	39 (21.43)	5.517	0.138 > 0.05
	Type B	40 (21.98)	49 (26.92)		
	Type O	65 (35.71)	76 (41.76)		
	Type AB	19 (10.44)	18 (9.89)		
Blood component	Red blood cells	96 (52.75)	66 (36.27)	35.363	0.000 < 0.05
	Plasma	53 (29.12)	89 (48.90)		
	Platelets	33 (18.13)	14 (7.69)		
	Cryoprecipitate	0 (0.00)	13 (7.14)		
Transfusion history	Yes	117 (64.28)	130 (71.43)	2.737	0.098 > 0.05
	No	62 (34.07)	47 (25.82)		
History of transfusion reaction	Yes	60 (32.97)	50 (27.47)	1.336	0.513 > 0.05
	No	112 (61.54)	122 (67.03)		
	Unknown	10 (5.49)	10 (5.50)		
Pregnancy history	Yes	95 (52.20)	60 (32.97)	12.279	0.000 < 0.05
	No	87 (47.80)	122 (67.03)		
History of chemotherapy/ immunotherapy/ targeted therapy	Yes	55 (30.22)	39 (21.43)	3.672	0.055 > 0.05
	No	127 (69.78)	143 (78.57)		
Prophylactic medication	Yes	112 (61.54)	50 (27.17)	42.758	0.000 < 0.05
	No	70 (38.46)	132 (71.73)		

4. Discussion

Transfusion reactions are classified by timing into acute and delayed. Delayed reactions are often subtle and may be masked by the underlying disease. In this study, the reported incidence of transfusion reactions was 4.223‰, all acute, predominantly FNHTR (2.378‰) and allergic reactions (1.844‰), consistent with Xia et al., but higher than the 2‰ reported by Huang et al. [4,6]. This difference may be due to the upgraded transfusion information management system implemented in our hospital since January 2022, which assists clinical staff and transfusion department personnel in managing transfusion reactions. Moreover, the transfusion department staff conduct telephone follow-ups with all patients within 24 hours after transfusion to further monitor reporting, management, and outcomes, resulting in high recognition and low underreporting, thus making the data reliable.

Females had a significantly higher proportion of transfusion reactions than males, and patients with a

history of pregnancy had a higher proportion than those without, consistent with Wu et al. [7]. Additionally, females and those with a pregnancy history were more prone to FNHTR, whereas males and those without a pregnancy history were relatively more prone to allergic reactions. This is likely because females often have a history of pregnancy, and repeated immune stimulation can produce HLA, HNA, or HPA antibodies, leading to FNHTR [8].

In our study, platelets had the highest reaction incidence (9.629‰), followed by red blood cells (6.483‰) and plasma (2.583‰), with no reactions to cryoprecipitate, similar to Xia et al. [6]. Further analysis showed that red blood cell transfusion was more likely to cause FNHTR than plasma or platelet transfusion, mainly because red blood cell products may contain residual white blood cells that, in antigen-antibody reactions in the recipient, can agglutinate, and after destruction in the mononuclear-phagocyte system, they release endogenous pyrogens, resulting in FNHTR [9]. Current consensus is that a leukocyte content $< 5 \times 10^6$ in blood products can effectively prevent FNHTR [2]. Therefore, improving leukoreduction technology, reducing costs, and expanding the use of leukoreduced products are important for reducing clinical FNHTR. Plasma and platelet transfusions were more likely to cause allergic reactions because they contain abundant plasma proteins that can induce antigen-antibody reactions or directly trigger allergic responses, which are related to both donor and recipient constitution [10]. For patients at high risk of allergy, it is advisable to use products with reduced plasma content.

Domestic guidelines recommend antipyretics (e.g., acetaminophen, aspirin) for preventing FNHTR, and glucocorticoids or antihistamines for preventing allergic reactions [2]. However, the 18th edition of the AABB Technical Manual only recommends acetaminophen for FNHTR prevention and treatment, and does not recommend routine antihistamine prophylaxis for allergic reactions because it may mask early clinical signs of severe reactions such as AHTR, TACO, and TRALI, thereby delaying diagnosis [11]. Studies by Lai and Jiang et al. both indicated that prophylactic use of hormones or antihistamines before transfusion does not reduce the incidence of transfusion reactions [12,13]. In our study, the prophylactic drugs used were glucocorticoids (dexamethasone) and antihistamines (promethazine, chlorpheniramine, loratadine, diphenhydramine). The results showed that recipients pretreated with antiallergic drugs had a significantly higher incidence of transfusion reactions than untreated ones, and no significant difference was found among the different drugs. This may be because clinicians proactively administer prophylaxis to patients at high risk of transfusion reactions, but the efficacy of these drugs is limited, failing to reduce the incidence to the level of the control group. Given that the overall reaction incidence in our hospital was 4.223% and all were mild, with full recovery after symptomatic management and no sequelae, we do not recommend routine prophylactic medication before transfusion, considering patient cost, safety, and limited drug efficacy.

It should be noted that patients with a history of chemotherapy/immunotherapy/targeted therapy had a slightly higher incidence of transfusion reactions than those without, but the difference was not statistically significant ($p = 0.055 > 0.05$). Given the large number of patients receiving antineoplastic agents in our hospital, both the drugs and the patients' immune status may influence the occurrence of transfusion reactions; thus, caution is needed when transfusing such patients. Although the incidence of transfusion reactions increased with age up to the 60–69 year group and then decreased, age itself was not a significant factor. While blood type did not affect overall incidence, type B recipients were more prone to allergic reactions, and types A and O to FNHTR, possibly because ABO antibodies participate in regulating inflammation, infection, and immune responses [14]. No significant differences in incidence were found based

on prior transfusion history or prior reaction history. This may be because the number of prior transfusions was not stratified; generally, two or more prior transfusions have an impact, and the effect increases with the number of transfusions [13–15]. Data on prior transfusion reaction history were mainly obtained from blood requisition forms and rarely from medical records, which may introduce bias. Moreover, the occurrence of transfusion reactions is related to the patient's immune status at a given time. Since a large proportion of our patients have cancer or undergo surgery, a previous transfusion reaction does not guarantee a reaction in subsequent transfusions.

5. Conclusion

In summary, female sex and pregnancy history are important factors influencing both the occurrence and type of transfusion reactions. The recipient's blood type and the blood component transfused may affect the type of reaction. For female, pregnant, type A or type O recipients receiving red blood cells or platelets, leukoreduced products are recommended. Patients with recurrent FNHTR may appropriately use antipyretics for prophylaxis. For male, type B recipients receiving plasma-rich products (plasma, platelets, cryoprecipitate), it is advisable to avoid transfusions during periods of heightened sensitivity and to choose products with reduced plasma protein content. Prophylactic use of glucocorticoids and antihistamines before transfusion is not recommended. The most important measures to reduce transfusion reactions are prevention at the source: rational and appropriate use of blood to avoid unnecessary transfusions, promotion of autologous and component transfusion, and selection of suitable products based on patient condition. Additionally, improving blood processing technologies (e.g., pathogen inactivation, leukoreduction, plasma protein reduction), enhancing component purity, reducing costs, and developing blood substitutes are essential.

Disclosure statement

The authors declare no conflict of interest.

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