ORIGINAL ARTICLE

Impact of Transfusion Practice on the Occurrence of Acute Transfusion Reactions in a Malaysian Hospital: A Single-centre Retrospective Study

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ABSTRACT

Introduction: Acute transfusion reactions (ATR) are commonly reported in clinical transfusion practice, which may result in significant morbidity and mortality. This study aims to explore the impact of transfusion practice on the prevalence, characteristics, and associated factors of ATR at Hospital Sultanah Bahiyah, Kedah, Malaysia. **Methods:** This was a retrospective study using records from haemovigilance forms of reported transfusion reactions, E-Delphyn (blood bank system), and E-His (hospital information system). A total of 118 cases of ATR from January 1, 2015 until December 31, 2017 were selected and analysed. For each case, a control was selected from a patient who did not develop ATR. **Results:** A total of 122,215 units of whole blood and blood component transfusions have been performed and 415 ATR were reported. The prevalence of ATR was 0.34% or one in 294 units transfused. There was a significant association between ATR and red cell concentrate (RCC) stored for more than 14 days (adj OR = 65.29, 95% CI 9.29-458.85). The most common ATR were allergic reactions with 63 cases (53.4%), followed by febrile non-haemolytic transfusion reactions (FNHTR) with 45 cases (38.1%). Allergic reactions were significantly associated with female patients (p = 0.038) and the paediatrics age group (p = 0.038). Multivariate analysis revealed a significant association between FNHTR and RCC stored more than 14 days (p = 0.002). **Conclusion:** The prevalence of ATR in this hospital was low and associated with RCC stored for more than 14 days. Implementation of pre-storage leucoreduction is recommended.

Keywords: Acute transfusion reaction, Allergic reaction, Febrile non-haemolytic transfusion reaction, Stored red blood cell

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INTRODUCTION

Haemovigilance was first developed in France and Japan in 1993 as a reaction to the risks of blood transfusion following the emergence of Human Immunodeficiency Virus (HIV) during that time (1). Haemovigilance consists of procedures during the blood transfusion process, from blood donation and blood component preparation, through to their provision and transfusion to recipients, as well as their follow up. It also involves monitoring, reporting, investigating, and analysing adverse events that occurred during blood donation, processing, and transfusion, which prompted the need to prevent their occurrence or recurrence (2). Quality aspects of blood transfusion, such as appropriate use of blood, can be improved by adhering to haemovigilance systems (3). In Malaysia, all adverse events that occurred during blood collection, processing, testing, transfusion procedures, and the outcome of the transfusion (including near misses) must be reported to the Hospital Transfusion Committee, the State Transfusion Committee, and the National Haemovigilance Coordinating Centre. This study was focused on ATR cases reported from 2015 to 2017 at Hospital Sultanah Bahiyah, a tertiary hospital in Kedah, Malaysia. The Department of Transfusion Medicine at this hospital supplies blood and blood components to various speciality and sub-speciality services. The signs and symptoms of ATR may occur within 24 hours following a blood transfusion (4). ATR are more common nowadays and are more likely to lead to severe morbidity and mortality (5). Previous studies

have revealed that ATR can be associated with red cell concentrates (RCC) transfusion (6), affecting more female (7) and paediatric patients (8), RCC stored more than 14 days and patients with history of pregnancy (9). Continuous quality enhancement of the transfusion process through corrective and preventive actions to boost donor and patient safety, improving transfusion appropriateness, and decreasing wastage are the goals of haemovigilance (2). ATR can result in hospital admission for outpatients or prolonged admission for inpatients, even though most ATR cases are not severe (10). Severe transfusion reactions can lead to significant patient morbidity and mortality, which can be avoided (6). At Hospital Sultanah Bahiyah, most of the reported adverse transfusion reactions were acute. These ATR included allergic reactions, febrile non-haemolytic transfusion reactions (FNHTR), transfusion-related acute lung injury (TRALI), transfusion-associated circulatory overload (TACO), and transfusion-associated dyspnoea (TAD).

FNHTR is often presented with fever (≥ 38 °C oral or equivalent and a change of ≥ 1°C from pre-transfusion temperature), with chills or rigors, while allergic reaction is characterised by mucocutaneous signs or symptoms, which are pruritus, urticaria, localised angioedema, edema of lips/tongue/uvula, periorbital, and conjunctival, which present during or within 4 hours of transfusion (11). TRALI consists of 5 indicators, which are acute onset, hypoxemia ($PaO_2/FiO_2 < 300$ mmHg or oxygen saturation is < 90% on room air or other clinical evidence), bilateral infiltrates on chest X-ray, left arterial hypertension is not present, and no temporal relationship to an alternative risk factor for acute lung injury during or within 6 hours of completion of transfusion (12). On the other hand, TACO is the presence of any four of these signs or symptoms, which are acute respiratory distress, tachycardia, increased blood pressure, acute or worsening pulmonary edema on frontal chest X-ray, and positive fluid balance (12). TAD is largely a diagnosis of exclusion. It is defined as respiratory distress that occurs within 24 hours of transfusion that does not fulfil the criteria of TRALI, TACO or allergic reaction (13).

Prompt recognition and management are crucial, even though both types of ATR often result in little or no morbidity (14). Hence, continuous monitoring of ATR is essential to promote patient care and safety. This study aimed to determine the impact of blood transfusion practice on the prevalence, characteristics, and associated factors of ATR in order to develop appropriate interventions to reduce ATR incidence at Hospital Sultanah Bahiyah.

MATERIALS AND METHODS

Sampling Method

Systematic random sampling was used to select 118 cases of ATR from January 1, 2015 until December 31, 2017 from a total of 415 cases. Given that this was a matched case-control study (matched by the type of blood component transfused), a control for each case with ratio of 1:1 was selected from patients who did not develop ATR during this study period. A subject was taken from every three samples, while a control was taken from every fifth sample until a match for the type of blood component transfused was found.

For ATR cases, the inclusion criterion was transfused patients who developed acute transfusion reactions and the reports were sent to the laboratory during this study period. The exclusion criteria were reported transfusion reaction cases that were not concluded as ATR and incomplete reporting forms.

For non-ATR cases (control), the inclusion criterion was transfused patients who did not develop ATR during this study period, while the exclusion criteria were patients who requested the Group, Screen, and Hold (GSH) test, and patients who requested the Group and Crossmatch (GXM) test, but were not transfused.

Research Tool

Data were collected from the adverse transfusion event reporting form, the report of reaction to blood or plasma form, and the worksheet for investigating transfusion reaction, which are kept at the Immunohaematology Laboratory, Department of Transfusion Medicine, Hospital Sultanah Bahiyah.

The E-His system was used to collect patients' clinical information. The E-His system is a computerised hospital information system at Hospital Sultanah Bahiyah that stores medical records for easy assessments. Additional information related to the patient, such as blood group, transfusion history, and blood component characteristics were traced from the E-Delphyn system, which is a computerised blood bank information system used at Hospital Sultanah Bahiyah.

Data Analysis

Descriptive statistics were conducted to analyse frequencies and percentage distributions for categorical variables, while continuous data were presented as means and standard deviation (SD). The conditional regression analysis for matched data for both univariate and multivariate analyses was performed using the Cox proportional hazard model. The interaction was checked and adjusted for confounding factors. The final model was selected based on the principle of parsimony and best fit using the Hosmer-Lemeshow approach of using -2 log-likelihood ratios. A p-value of less than 0.05 was considered statistically significant. Data were analysed using the IBM SPSS Statistics V24 under IBM Corporation, New York.

Ethical Approval

This study has been approved by the Research and

Ethics Committee, School of Medicine, Universiti Sains Malaysia, Kelantan Health Campus (USM/JEPeM/17120692) and registered with the National Committee for Clinical Research (NMRR-17-2873-38926).

RESULTS

Prevalence

During the study duration, which was from 2015 to 2017, a total of 122, 215 units of whole blood and blood component transfusions were performed. Clinicians reported a total of 415 ATR during this study period. A total of 118 ATR cases were selected using systematic random sampling. The prevalence of ATR in this current study was 0.34%.

Types of ATR

Out of 415 ATR cases identified during the period between 2015 and 2017, 118 ATR cases were randomly selected using systematic random sampling. Descriptively, the most frequently reported ATR types throughout this study period were allergic reactions (53.4%), followed by FNHTR (38.1%), TACO (3.4%), TAD (3.4%), and TRALI (1.7%), as shown in Table I.

Table I: Types of Reported Acute Transfusion Reactions (n=118)

Type of Acute Transfusion Reaction	n (%)
Allergic reaction	63 (53.4)
Febrile non-haemolytic transfusion reaction (FNHTR)	45 (38.1)
Transfusion-related circulatory overload (TACO)	4 (3.4)
Transfusion-associated dyspnoea (TAD)	4 (3.4)
Suspected transfusion-related acute lung injury (TRALI)	2 (1.7)

Association between Patients' Demographics and Characteristics of Blood Components, and ATR

The recipients were categorised as adults (18 years old and more) and paediatrics (less than 18 years old). The adult group showed a higher percentage of ATR at 83.9%, while the percentage of ATR among the paediatrics group was 16.1% (Table II). In the univariate analysis, a significant association was found between the occurrence of ATR and the paediatrics group ($p = 0.005$). The risk of developing ATR was five times higher among paediatrics patients compared to the adults (crude OR 4.74, 95% CI 1.62-13.96) as shown in Table III. As for gender, 65.3% of female patients showed a higher percentage of experiencing ATR, while for male patients, the percentage was 34.7%, which showed three times higher percentage of cases among females (crude OR = 3.13, 95% CI 1.75-5.60) compared to males ($p < 0.001$). However, in the multivariate analysis, age and gender were no longer contribute to the occurrence of ATR.

Patients with blood group O showed the highest percentage at 42.2%, followed by blood group B (28.8%), blood group A (23.7%), and blood group AB (5.1%). However, no significant difference was observed between each ABO blood group. The most common signs or symptoms reported for ATR were fever (21.2%), followed by fever with chills and rigors (16.9%), urticaria or rashes suggestive of allergic reactions (53.4%), and dyspnoea (8.5%).

Table II: Patients' Demographics and Characteristics of Blood Components Among ATR and non-ATR Cases

Variables	ATR Group (n=118) n (%)	Non-ATR Group (n=118) n (%)
Patients' Demographics		
Age group ;		
Adult	99(83.9)	114(96.6)
Paediatrics	19(16.1)	4(3.4)
Gender ;		
Male	41(34.7)	73(61.9)
Female	77(65.3)	45(38.1)
Blood group ;		
A	28(23.7)	35(29.7)
B	34(28.8)	27(22.9)
O	50(42.4)	49(41.5)
AB	6(5.1)	7(5.9)
Signs and symptoms ;		
-Fever	25 (21.2)	-
-Fever/chills/rigors	20 (16.9)	-
-Urticaria/Rashes/Periorbital Oedema	63 (53.4)	-
-Dyspnoea	10 (8.5)	-
History of transfusion	58(49.2)	42(35.6)
History of pregnancy	60(50.8)	26(22.0)
Characteristics of Blood Components		
Type of Blood Component ;		
-Whole blood	17 (14.4)	17 (14.4)
-Red cell concentrate	83 (70.4)	83 (70.4)
-Fresh frozen plasma	13 (11.0)	13 (11.0)
-Random donor platelet concentrate	5 (4.2)	5 (4.2)
-Cryoprecipitate	0 (0)	0 (0)
Days of red cell concentrate storage ;		
-0-14	30 (25.4)	98(83.1)
->14	88 (74.6)	20(16.9)
Blood groups ;		
-A	28 (23.7)	38(32.2)
-B	33 (28.0)	24(20.3)
-O	51 (43.2)	48(40.7)
-AB	6 (5.1)	8(6.8)

ATR = Acute transfusion reaction

The univariate analysis showed that ATR cases were more commonly presented with the history of transfusion compared to non-ATR cases ($p = 0.038$). A significant difference in the occurrence of ATR was also observed among patients with a history of pregnancy (50.8%) compared to those without this attribute in the univariate analysis, with the odds of 3.00 (crude OR = 3.00, 95% CI 1.55-5.79, $p = 0.038$). However multivariate analysis revealed no significant association between ATR and history of pregnancy and history of transfusion.

ATR were mostly seen after the transfusion of RCC (70.4%), followed by whole blood (14.4%), fresh frozen plasma (11.0%), and random donor platelet concentrate (4.2%). During this study period, no ATR cases were

reported from the transfusion of cryoprecipitate. The only blood characteristic factor that can be independently associated with the occurrence of ATR in this study was the number of days blood was in storage. Transfusion of RCC that were in storage for more than 14 days (> 14 days) showed a higher percentage of ATR cases at 74.6%, while RCC that were in storage for less than 14 days (0-14 days) were 25.4% of the ATR cases reported, and this difference was significant ($p < 0.001$) as per Table III. The results showed that patients transfused with RCC stored for more than 14 days have 65 times higher possibility of experiencing ATR compared to those transfused with RCC stored less than 14 days (adj OR = 65.29, 95% CI 9.29-458.85).

Given that allergic reactions and FNHTR were the most commonly reported ATR types in this study, both were selected for a specific analysis to determine their association with patients' demographics and characteristics of blood components.

Association between Allergic Reactions with Patients' Demographics and Characteristics of Blood Components

The analysis results showed that allergic reactions were significantly associated with female patients ($p = 0.038$)

Table III: Association between ATR with Patients' Demographics and Characteristics of Blood Components

Variables	ATR Group (n=118) n (%)	Non-ATR Group (n=118) n (%)	Crude OR (95% CI)	Adjusted OR (95% CI)
Age group;				
Adult	99(83.9)	114(96.6)	Reference	
Paediatrics	19(16.1)	4(3.4)	4.75(1.62-13.96)*	
Gender;				
Male	41(34.7)	73(61.9)	Reference	
Female	77(65.3)	45(38.1)	3.13(1.75-5.60)*	
Blood group;				
A	28(23.7)	35(29.7)	0.93(0.29-3.00)	
B	34(28.8)	27(22.9)	1.37(0.44-4.32)	
O	50(42.4)	49(41.5)	1.14(0.37-3.56)	
AB	6(5.1)	7(5.9)	Reference	
History of transfusion	58(49.2)	42(35.6)	1.76(1.03-3.01)*	
History of pregnancy	60(50.8)	26(22.0)	3.00(1.55-5.79)*	
Days of storage ;				
0-14	30(25.4)	98(83.1)	Reference	
>14	88(74.6)	20(16.9)	65.29(9.29-458.85)*	65.29(9.29-458.85)*
Blood groups ;				
A	28(23.7)	38(32.2)	1.04(0.31-3.52)	
B	33(28.0)	24(20.3)	1.77(0.52-6.00)	
O	51(43.2)	48(40.7)	1.40(0.42-4.61)	
AB	6(5.1)	8(6.8)	Reference	

*significant with *P*-value < 0.05 ATR = Acute transfusion reaction

Table IV: Association between Allergic Reaction with Patients' Demographics and Characteristics of Blood Components

Variables	Allergic group (n=62) n(%)	Non allergic group (n=62) n(%)	Crude OR (95% CI)	Adjusted OR (95% CI)
Age ;				
Adults	45(72.5)	61(98.4)	Reference	
Paediatrics	17(27.5)	1(1.6)	17.00 (2.26-127.74)*	9.35(1.14-76.94)*
Gender ;				
Male	24(38.7)	37(59.7)	Reference	
Female	38(61.3)	25(40.3)	2.44(1.13-5.31)*	3.48(1.07-11.32)*
Blood group ;				
A	13(21.0)	19(30.6)	0.61(0.15-2.52)	
B	20(32.3)	16(25.8)	0.98(0.24-4.01)	
O	24(38.7)	23(37.1)	0.85(0.21-3.45)	
AB	5(8.0)	4(6.5)	Reference	
History of transfusion	28(45.2)	19(30.6)	1.90(0.88-4.09)	
History of pregnancy	19(30.6)	15(24.2)	2.09(0.87-5.00)	
Days of storage ;				
0-14	21(33.9)	46(74.2)	Reference	
>14	41(66.1)	16(25.8)	65.29(2.62-1627.33)*	
Blood groups ;				
A	13(21.0)	23(37.1)	0.676(0.16-2.95)	
B	19(30.6)	14(22.6)	1.304(0.29-5.96)	
O	25(40.3)	20(32.2)	1.236(0.28-5.40)	
AB	5(8.1)	5(8.1)	Reference	

*significant with *P*-value<0.05

and the paediatrics age group (p = 0.038) (Table IV). There was no significant difference in other variables, which were blood group, history of transfusion and history of pregnancy. Allergic reactions were also significantly associated with RCC stored more than 14 days (p = 0.011) in the univariate analysis. However, this effect was no longer observed in multivariate analysis after controlling for patients' age and gender.

Association between FNHTR with Patients' Demographics and Characteristics of Blood Components

The analysis of FNHTR showed that it was significantly associated with the number of days RCC were in storage (more than 14 days) (adj OR = 65.29, 95% CI 4.64-918.05, p = 0.002) as per Table V. There was no significant difference in other variables, which were age, gender, patient's blood group, history of transfusion, history of pregnancy, and ABO blood group.

DISCUSSION

The prevalence of ATR during this study period was 0.34% or one in 294 units transfused, which is lower compared to the results obtained by (6) from Universiti Kebangsaan Malaysia Medical Centre at 0.54% and (7) from India at 0.92%. Local study from Hospital Universiti Sains Malaysia (5), and from Pakistan (14) reported slightly lower prevalence of ATR at 0.23%. Cases of allergic reactions were the highest frequency of ATR followed by FNHTR. These findings are similar to the findings obtained by (5) whereby the most common ATR were allergic reactions, followed by FNHTR. Sharma et al. (2015) reported that allergic reactions and FNHTR were the most common occurrences among all types of ATR in India (7). However a study in Pakistan observed FNHTR as the most frequent reaction, followed by allergic reactions (15). The reported TRALI cases in this study were not further investigated to look for the presence of anti-neutrophil antibodies to confirm TRALI diagnosis as the patients were discharged in good health. No deaths directly attributable to transfusion were reported in this study.

This current study found that adult patients showed a higher frequency of ATR compared to the paediatrics age group. This could be because of the higher demand for blood transfusion for adult patients in the study location. The results of this study also indicated that the frequency of ATR was higher among females than among males. This finding is consistent with the report of a study in India that there was a positive correlation between ATR and female patients (7). However, there was no significant association between ATR and paediatrics and female patients in the current study.

Reported signs and symptoms were analysed in this study, and the most common ones were urticaria and rashes from allergic reactions, followed by fever, and fever with chills and rigors from FNHTR. These results were expected given both allergic reactions and FNHTR were commonly reported ATR during this study period. These results matched those observed by local studies whereby the most common symptom reported for ATR was urticaria and skin rashes (5, 6). There was no association between ATR and ABO blood groups in this current study, as supported by study done in United States (8). It is observed that no significant difference

Table V: Association between Febrile Non-haemolytic Transfusion Reaction (FNHTR) with Patients' Demographics and Characteristics of Blood Components

Variables	FNHTR group (n=45) n(%)	Non FNHTR group (n=45) n(%)	Crude OR (95% CI)	Adjusted OR (95% CI)
Age ;				
Adults	43(95.6)	43(95.6)	Reference	
Paediatrics	2(4.4)	2(4.4)	1.00(0.14-7.10)	
Gender ;				
Male	13(28.9)	29(64.4)	Reference	
Female	32(71.1)	16(35.6)	4.20 (1.58-11.14)*	
Blood group ;				
A	11(24.4)	15(33.3)	Reference	
B	10(22.2)	7(15.6)	1.80(0.50-6.47)	
O	24(53.4)	21(46.7)	1.51(0.57-4.02)	
AB	-(0)	2(4.4)	0.000	
History of transfusion	24(53.3)	20(44.4)	1.44(0.62-3.38)	
History of pregnancy	20(44.4)	9(20.0)	4.93(1.57-15.50)*	
Days of storage ;				
0-14	6(13.3)	43 (95.6)	Reference	
>14	39(86.7)	2(4.4)	65.29(4.64-918.05)*	65.29(4.64-918.05)
Blood groups ;				
A	11(24.4)	14(31.1)	Reference	
B	10(22.2)	6(13.3)	2.00(0.51-7.79)	
O	24(53.4)	23(51.2)	1.33(0.50-3.57)	
AB	-(0)	2(4.4)	0.000	

*significant with *P*-value<0.05

in patients with transfusion history to develop ATR, in agreement with study from Japan, whereby risks of adverse transfusion reactions were found during the first transfusion, as well as during transfusion of patients with transfusion history (10).

This study observed that ATR were seen mostly with the transfusion of RCC. This could be because the majority of blood transfusions during this study period involved RCC. These results are consistent with the local study done by Rabeya et al. (2011), in which most reported ATR were due to RCC (6), as similarly reported by other studies (5, 7–9, 10, 15). RCC that were transfused during the study period were mostly non-leucoreduced RCC, which explained the higher incidence of ATR compared to other blood components.

In general, ATR cases in this study were not significantly associated with history of transfusion and history of pregnancy following the multivariate analysis. This might be due to the low number of multi-transfused patients, such as thalassaemic and cancer patients in this current study. Leucocyte removal from blood components using leucocyte depletion filters is known to prevent or at least delay leucocyte-mediated adverse reactions. In multi-transfused patients, such as thalassaemic patients, alloimmunisation against HLA antigens on donor white cells is prevented by leucodepletion, which also prevents FNHTR (16). A study on red blood cell transfusion was conducted in the United States, in which FHNTR and delayed serologic transfusion reactions were the most frequent adverse events to be reported. It was concluded that the higher rate of ATR could be contributed by the lack of universal leucoreduction of RBC units (1).

There was a significant association between the paediatrics group and female patients, and allergic reactions. Study from United States (8) also reported a significant association between paediatrics group allergic reactions. However report from the same study showed there was no significant association between female patients and allergic reaction (8). This current study found that history of pregnancy and history of transfusion were not significantly associated with allergic reactions, but not in line with previous research (9). Previously transfused patients and multigravida women are at risk of ATR (17). Multigravida women may produce alloantibodies to leucocyte, or platelet antigens as a result of an overt foetal-maternal haemorrhage. Hence, women who develop leucocyte antibodies following a pregnancy or an abortion are more likely to have allergies and FNHTR, if subsequently transfused with leucocyte-containing blood components (17). The observed difference might be due to the different methods of analysis since matched case-control analysis was performed in this study. Furthermore this study did not explore more on the number of pregnancies and abortions as well as number of transfusion received.

All allergic reactions reported in this study were found to be mild. In the case of mild allergic reactions, patients are recommended to take antihistamine as pre-medication prior to undergoing future transfusion to reduce any subsequent reaction (14). This recommendation can be considered for paediatrics group and female patients who would receive transfusion, in view of the discovery of the significant association between allergic reactions, and paediatrics group and female patients. Another effective alternative would be to transfuse patients who have recurrent severe allergic reactions with washed or concentrated blood products (18). The main indication for washed RCC is for patients who reported to have repeated moderate or severe reactions to standard transfusion of RCC. The rationale is that plasma proteins in the supernatant of the red cells, in combination with recipient factors, may be responsible for causing these reactions. Thus, washing can remove the majority of plasma in the RCC. Guidelines recommend transfusing washed RCC to patients who have experienced repeated moderate or severe reactions, regardless of immunoglobulin (Ig) A status. This could also work for patients who are deficient in IgA, who have experienced a similar transfusion reaction, as well as in cases where RCC from IgA deficient donors are unavailable (18). However, this kind of measure is currently unavailable at Hospital Sultanah Bahiyah due to the lack of facility to process washed blood products.

We observed that incidences of FNHTR were only significantly associated with the age of RCC or number of days in storage (more than 14 days). This finding was in the same line with the results obtained by studies done in India and Canada whereby FNHTR cases mostly came from transfusion of blood products of older than 14 days in storage as cytokines are released in the blood components that may cause various reactions (9, 19). In addition to allergic reactions, FNHTR was also one of the most frequently reported ATR cases during this study period. A high incidence of FNHTR at Hospital Sultanah Bahiyah compared to other types of ATR could be due to the lack of pre-storage leucoreduction facilities. The incidence of FNHTR can be reduced by implementing pre-storage leucoreduction of red blood cells (20-22), although it might not have same benefits for allergic reactions (23). This is because allergic reactions are caused by acellular plasma components rather than leucocytes in blood components (24). Pre-storage leucoreduction of RCC or packed red blood cells is aimed to effectively deplete blood components from the white blood cells (WBC). Thus, the burden of HLA antigens to decrease the occurrence of FNHTR will be lightened. However, this might also decrease the cytokines produced during storage by viable WBC, such as lymphocytes (25). Incidence of FNHTR can be reduced by administering antipyretic as pre-medication prior to transfusion. Previous recipients have been reported to benefit from this measure, with no evidence of antipyretic complications or other transfusion

complications (26). Another measure that can be taken into consideration is to issue RCC less than 14 days in storage to a patient who has previous history of FNHTR.

Some of the limitations of this study include this was a single-centre study. Hence, the results of this study should be interpreted with care and cannot be generalised to other settings. The nature of retrospective design opens up the possibility of missing cases and under-reporting of ATR cases by ward staff during this study period. This study did not explore more on the number of pregnancies and abortions. Future study is recommended to separate history of pregnancy into the number of pregnancies and abortions to obtain a significant association. Another study limitation was the high OR for the number of days blood is in storage (more than 14 days), even though it was statistically significant. This study has emphasised the significant impact of the number of days blood is in storage on the occurrence of ATR. However, the findings in this study should be interpreted cautiously because small samples were analysed in a single-centre setting. Multicentre studies, with a higher number of samples, are needed to confirm further findings.

CONCLUSION

In conclusion, the prevalence of ATR at Hospital Sultanah Bahiyah from 2015 to 2017 was low compared to other reported studies. Implementation of pre-storage leucoreduction is significant to reduce the rate of ATR, as the number of multi-transfused patients and multigravida women were not evaluated in this study. Introducing patient blood management (PBM) in a clinical setting is an effective way to ensure optimum and effective usage of blood products for clinical transfusion, and thus, incidences of ATR can be reduced.

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