ORIGINAL RESEARCH PAPER

Volume-8 | Issue-2 | February-2019 | PRINT ISSN No 2277 - 8179

INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

AN EVALUATION OF NON-INFECTIOUS ADVERSE REACTIONS FOLLOWING BLOOD TRANSFUSION AT A TERTIARY CARE REFERRAL TEACHING HOSPITAL IN SOUTHERN INDIA.

Immunohematology

Sindhuja K Senior Resident, Department of Transfusion Medicine, SVIMS, Tirupati

SreedharBabu KV* Professor & Head, Department of Transfusion Medicine,SVIMS,Tirupati *Corresponding Author

Anitha M Senior Resident,Department of Transfusion Medicine,SVIMS,Tirupati

Praveen MD Senior Resident,Department of Transfusion Medicine,SVIMS,Tirupati

Sriranjitha TVN Junior Resident,Department of Transfusion Medicine,SVIMS,Tirupati

ABSTRACT

Background: Though blood transfusion is life saving, it can also lead to certain adverse reactions which can be fatal rarely. Identification of the adverse reactions will help in taking appropriate steps to reduce their incidence and make blood transfusion process as safe as possible and this study has been undertaken to assess the frequency of adverse reactions occurring following whole blood or blood component transfusion in patients admitted at a tertiary care referral teaching hospital in Southern India.

Material and Methods: During the period of one year all the adverse reactions related to transfusion of blood and blood components in patients admitted at our hospital were recorded. They were analyzed and classified using standard definitions, based on their clinical features and laboratory tests.

Results: During the study period, a total of 13,532 whole blood and blood components were issued from our blood bank to 4,155 patients. Among them 23 (0.16%) adverse reactions were noted. The most common type of reaction observed was allergic (n = 9; 39.13%), followed by delayed hemolytic transfusion reaction (DHTR) (n = 4; 17.39%).Other reactions observed were febrile non hemolytic transfusion reactions (FNHTRs) (n=3, 13.04%), hypotension (n=3, 13.04%),transfusion associated circulatory overload (TACO) (n = 1, 4.35%), transfusion related acute lung injury (TRALI) (n = 1, 4.35%) and delayed serological transfusion reaction (DSTR)(n = 2, 8.70%).

Conclusion: Frequency of transfusion reactions in the present study was 0.16%.This can be an underestimation of the true incidence because of underreporting which can be improved by hemovigilance system and one should consider for rationale use of whole blood and blood components.

KEYWORDS

Adverse transfusion reactions, blood transfusion, hemovigilance.

INTRODUCTION:

Dramatic changes in medical practice like replacement surgeries and chemotherapies have resulted in tremendous increase in the usage of blood and blood components. Recently, there has been a concern regarding the appropriate use of blood products because of the associated adverse events [1].Though blood transfusion is often life saving, it can also lead to certain adverse reactions which can be fatal rarely. Of the transfusion associated fatalities reported to the FDA during 2005 to 2009, 3% were caused by anaphylaxis which cannot be predicted; 8% TACO which can be prevented [2].

Any transfusion-related adverse events occurring within 24 Hrs were considered as acute while those occurring after were considered as delayed transfusion reactions. Errors in transfusion are well documented in literature and are preventable, provided they are reported and promptly analyzed at the earliest [3]. Such errors can result in mismatched ABO incompatible transfusions [4]. Hence, there is a need for personal monitoring of the recipient of blood/blood components, documentation of the transfusions and to minimize the potential adverse events. Hence, this prospective evaluation of the adverse reactions following the transfusion of blood and blood components admitted at the tertiary care referral teaching hospital in Andhra Pradesh, South India was undertaken.

MATERIAL AND METHODS:

This prospective study was conducted in the department of Transfusion Medicine of a tertiary care referral teaching hospital, Andhra Pradesh for a period of one year. During the issue of each unit of whole blood/blood component a transfusion reaction form was issued to the concerned that is taking care of the patient/transfusion, containing written guidelines regarding bedside monitoring of transfusion events and the procedure of the reporting of the transfusion related adverse events. To the extent possible, efforts have been made to monitor the recipient personally. Instructions were given to the healthcare personnel to monitor for any signs of reaction and to report to the blood bank. On receipt of any information regarding any adverse reaction, personal attention was initiated and necessary investigations such as blood grouping and typing for both pre and post transfusion samples of patient and blood bag, repeat compatibility testing(Ortho BioVue, Ortho-Clinical Dignostics,High Wycombe,UK),direct and indirect anti globulin tests (DAT and IAT), antibody screening (ID-Dia Cell I-II-III.Bio Rad,Diamed GmbH,Switzerland) and identification (ID-Dia Panel; BioRad, Diamed GmbH, Switzerland) were performed on pre and post transfusion sample of recipient by gel technology(BioRad, Diamed, GmbH Switzerland). Recipient blood sample was analyzed for post transfusion complete blood counts, peripheral blood smears for schistocytes and spherocytes, reticulocyte count, serum bilirubin, plasma haemoglobin, liver function tests (LFT), renal function tests (RFT) and lactate dehydrogenase (LDH) levels were done. Fresh urine sample was collected to test for the presence of haemoglobinuria and urobilinogen and blood samples from the bag and the recipient were subjected for bacterial culture. Bacterial sepsis is confirmed if the blood culture of the patient and transfused component is same. If there is suspicion of TRALI, X-ray Chest AP view was requested. At the time of discharge patient was advised to report back if he/she develops any fever or jaundice in a span of one week.

As outlined in the departmental standard operating procedure prepared in accordance with the guidelines laid down by the Directorate General of Health Services (DGHS), Ministry of Health &Family Welfare, Government of India [5] and as a part of transfusion reaction work up the patient's name, identification number both on the vial and requisition form were rechecked and blood grouping and Rh typing were verified in the patient file and requisition form on the bedside. Relevant clinical history regarding indications of blood transfusion, history of any previous similar episodes of adverse events, any previous history of transfusions and in the case of female patients history of pregnancy were collected. Donor unit was checked for any abnormal mass or clot, any peculiar odour coming from the blood bag to rule out any abnormal delay in transfusion and improper storage after release of the unit from the blood bank, any leakage / breakage, number of ports broken from the blood bag and the condition of transfusion set filter was observed.

RESULTS:

During the period of study, a total of 13,532 units of whole blood and blood components were transfused to 4,155 patients, admitted at our hospital. Among them 2300 (55.36%) were males and 1855 (44.64%) were females. Out of 13,532 units issued during the study period 2185 (16%) were of whole blood, 4305 (32%) packed red blood cells, 3729

(27.5%) fresh frozen plasma (FFPs) and 3121(23%), 67(0.5%) and 125(1%) were random donor platelets, single donor platelets (SDP), and cryoprecipitates respectively (Table 1).A total of 23(0.16%) transfusion reactions were observed during the study period. Among them 12 (52%) were seen in males and 11(48%) in females. Majority of the patients belonged to blood group O Positive

Table 1: Type of blood /blood components transfused.

Type of component	No. of units transfused	Percentage
Whole blood	2,185	16%
Packed red cells	4,305	32%
Fresh frozen plasma	3,729	27.5%
Random Platelets	3,121	23%
Single donor platelets(SDP)	67	0.5%
Cryo precipitate	125	1%
Total	13,532	100%

(n=9; 39%) followed by A Positive (n=7; 30%), B Positive (n= 5; 22%) and O Negative (n=2; 9%) (Table2).

Table 2: Demographic characteristics of the transfusion recipients reporting with adverse reactions.

Variable	Value
Gender	
Males	12(52%)
Females	11(48%)
Blood Group	
O Positive	9(39%)
A Positive	7(30%)
B Positive	5(22%)
O Negative	2(9%)

Out of 23(0.16%) transfusion reactions reported 17 (74 %) were of acute and 6(26 %) were delayed type. Most common reaction reported was allergic reaction (n=9; 39.13%) followed by DHTR (n= 4; 17.39%). In the present study 9 allergic reactions were noted and their overall incidence is 0.066%, each of three FNHTRs and hypotension reactions were noted and their overall incidence is 0.022%. Each of 1 case of TRALI and TACO were noted and their overall incidence is 0.007%. Four DHTRs and 2 DSTRs were noted and their overall incidence is 0.029% and 0.014% respectively (Table 3).

Table 3:Relative frequency & over all incidence of transfusion reactions in the present study.

Type of reaction	Number (n=23)	frequency	Over all incidence (%)
Allergic reactions	9	39.13%	0.066%
FNHTR	3	13.04%	0.022%
Hypotension	3	13.04%	0.022%
TRALI	1	4.35%	0.007%
TACO	1	4.35%	0.007%
DHTR	4	17.39%	0.029%
DSTR	2	8.70%	0.014%
Total	23	0.16%	0.16%

FNHTR-febrile non hemolytic transfusion reactions, TRALI-transfusion related acute lung injury,TACO-transfusion associated circulatory overload, DHTR- delayed hemolytic transfusion reactions,DSTR- delayed serologic transfusion reactions.

Majority of the reactions were due to transfusion of packed red blood cells (PRBC) (n=13;57%), followed by fresh frozen plasma (FFP) (n=5;22%) , whole blood(n=4;17%) and with random donor platelets (RDPs) (n=1; 4%).Overall 0.30% of PRBCs, 0.18% of whole blood, 0.03% of platelets and 0.13 % of FFP issued from the blood bank during the study period were implicated in causing transfusion reactions (Table 4).

The most common signs and symptoms were rashes in 7 (30%), chills in 7 (30%) followed by fever in 6 patients (26.08%) (Table 5).

Allergic reactions were the commonest acute reactions reported and comprised of 39.13% (9/ 23).Among this, signs and symptoms were rashes in 6 (66.7%), chills in 4 (44.4%), itching in 4 (44.4%), hypertension in 2(22.2%), urticaria and headache in 1 patient (n=1;11.1%).FFP was implicated in, 5(56%) ,packed red cells in 3 (33%) and Whole blood in 1 (11%) patients (Table 4).

FNHTR was found in 13.04% (3/23) patients. The most common signs and symptoms were fever in 3 (100%) patients, chills in 2 (67%),rigors in 2 (67%), tachycardia (33%) and vomiting in 1 (33%) patient. Packed red cells was implicated in 2 (67%) and platelets in 1(33%) patient (Table 4).

Hypotension was found in 13.04% (3/23) patients. A decrease of systolic blood pressure of about 20 mm of Hg was observed and pulse was feeble. Whole blood was implicated in 2(67%) and packed red cells in 1(33%) patients (Table 4).

A single case of TRALI was reported and the recipient was 48 year old male with carcinoma of rectum who developed fever, hypotension, hypoxia, tachycardia and bilateral crepitations after packed red cells transfusion. Diagnosis was confirmed by chest X-ray AP view showing bilateral perihilar opacity suggestive of non cardiogenic pulmonary edema and other relevant investigations.

A single case of TACO was observed in a female patient with nephrotic syndrome after packed red cell transfusion.She developed dyspnea, chest discomfort,myalgia,sweating and tachycardia. Her post transfusion X-ray chest AP view showed cephalisation of pulmonary vasculature, haziness at bilateral perihilar regions and lower lung zones and prominent end on vessels in perihilar region and cardiomegaly. The symptoms were relieved after diuretic therapy.

In the present study we noticed 4 cases of DHTR in which fever and anemia were the presenting symptoms after 7 to 10 days of transfusion. During the period of study in one case of DHTR, DAT was found to be positive even after 1 year and her post transfusion malaria was ruled out by Quantitative Buffy Coat (QBC) method and thick peripheral blood smear examination but she was seroreactive for HbsAg. In view of the low haemoglobin (4.2gm/dL) and the associated symptoms, the least incompatible blood was transfused under steroid coverage.DSTR was observed in 2 patients. Upon antibody screening (ID-Dia cell I-II-III. BioRad,Diamed, GmbH Switzerland) and identification(ID-DiaPanel;BioRad,Diamed, GmbH Switzerland) anti-N was identified in one patient and anti-JK^a antibody in another patient.

Out of the total 23 patients , 7 (30.4%) patients belongs to Oncology specialities,5(22%) to Neurosurgery , 3 (13%) patients to Nephrology , 2(8.7%) patients each in RICU and Urology respectively and 4 (4.3%) patients belongs to Medicine, SGE, Medical gastroenterology and Haematology departments (Table 6).

DISCUSSION:

The overall frequency of adverse reactions during the present study period was 0.16 % (23/13,532 blood components) (Table 1) which is almost similar to a study conducted by Bhattacharya et al in North India at PGIMER (0.18%) [6].The overall frequency of adverse reactions in different studies is shown in the Table 7 [7-14].

In the present study, out of 23 patients, 12 patients (52%) were males and 11 (48%) were females(Table 2) which is similar to a study conducted by Praveen Kumar et al. from North India where he reported adverse reactions in 54.3% of males and 45.7% of females [11].In the present study 9 (39 %) of the patients belongs to O positive group (n=9/23;39%) followed by A positive (n=7/23;30%) (Table 2).Similar study conducted by Dhruva Kumar Sharma et al.[13] reported majority of the reactions in A Positive blood group patients(n=15/32;47%) followed by O positive patients(n=9/32;28%). As O blood group is the predominant group in South India, it may be the reason for majority of the patients belonging to this group in the present study. In our study majority of the reactions were due to transfusion of 13 (57%) units of packed red blood cells which is similar to a study by Dhruva Kumar Sharma et al. where 30.2% of packed red cells were implicated in transfusion reactions [13] (Table 4).

Table 4:Categorization of transfusion reactions according to the type of Whole blood/blood component transfused.

S. No	Transfusion Reactions	Frequency n(%)	Whole blood n(%)	Packed red blood cells n(%)	Fresh frozen plasma n(%)	Platelets n(%)
1.	Allergic reactions	9(39.13)	1(11)	3(33)	5(56%)	NR
2.	FNHTR	3(13.04)	NR	2(67)	NR	1(33%)

3.	TRALI	1(4.35)	NR	1(100)	NR	NR
4.	TACO	1(4.35)	NR	1(100)	NR	NR
5.	Hypotension	3(13.04)	2(67)	1(33)	NR	NR
6.	DHTR	4(17.39)	1(25)	3(75)	NR	NR
7.	DSTR	2(8.70)	NR	2(100)	NR	NR
	Total	23	4	13	5	1

FNHTR-febrile non hemolytic transfusion reactions, TRALI-transfusion related acute lung injury,TACO-transfusion associated circulatory overload, DHTR- delayed hemolytic transfusion reactions,DSTR- delayed serologic transfusion reactions,NR-not reported

In the present study most common reaction reported was allergic reaction (39.13%) and its overall incidence was 0.066 %(Table 3). FFP (5/3729 units; 0.13%) is the most commonly implicated blood component followed by packed red cells (3/4305; 0.06%) and whole blood (1/ 2185;0.04%)(Table 4).According to a recent study carried out at AIIMS, New Delhi also the majority of the type of reactions observed were allergic and its overall incidence was 0.028% [11] which is lower than the incidence of allergic reactions in our study. The blood component most commonly implicated in allergic reactions in their study was platelet rich plasma (PRP) (0.053%) followed by packed red blood cells (PRBC).Another report from North India also states that allergic reactions was the commonest form of transfusion reactions [12]. In allergic reactions the signs and symptoms according to the decreasing order of frequency were rashes in 6/ 9 patients (66.7%) ,chills in 4/9 patients (44.4%),itching in 4/9 patients(44.4%), hypertension in 2/9 patients(22.2%), urticaria and headache in one patient (11.1%). Rashes (66.7%) followed by chills (44.4%) were the predominant signs and symptoms of allergic reactions in the present study(Table 5). Bhattacharya et al also observed rash as the most frequent sign, in 76% of their allergic reactions[6]. Other reported symptoms like periorbital odema, vomiting were not observed in the present study.

The frequency of FNHTR in the present study was 13.04%(Table 3) which was lower than the study by Praveen kumar et al. where he reported 35.7% [11].They are reported to be more common with platelet transfusions than PRBCs because platelets require storage temperature of between 20°C –24°C, which results in donor leukocyte activation and pro-inflammatory cytokine accumulation .However, in the present study FNHTRs were found to be more with PRBCs

(2/4305 PRBC transfusions;0.04%,) than with platelets,(1/3121 platelet transfusions;0.03%).The relatively fewer number of platelet transfusions (*n* = 3121;23%) as compared to packed red blood cells*(n* =4305;32%) could be a reason for low reactions with platelets(Table 14) . A greater incidence of FNHTRs with PRBCs was also observed in a study done by Praveen Kumar *et al* [11].The most common signs and symptoms of FNHTR according to the decreasing order of frequency were fever in 3 (100%), chills in 2 (67%), rigors in 2 (67%), tachycardia in 1 (33%), vomiting in 1(33%) (Table 5). Study by Meena siddhu et al. also reported chills and rigors (100%) as common symptom followed by fever (35.1%) (12) (Table 5).

Table 5: Signs and symptoms of transfusion reactions.

Symptoms	n(%)
Rashes	7(30%)
Utricaria	1(4.34%)
Itching	4(17.4%)
Fever	6(26.08%)
Chills	7(30%)
Rigors	2(8.7%)
Tachycardia	3(13.04%)
Vomitings	1(4.34%)
Dyspnea	1(4.34%)
Myalgia	1(4.34%)
Sweating	1(4.34%)
Chest discomfort	1(4.34%)
Hypertension	2(8.7%)
Hypotension	4(17.4%)
Hypoxia	1(4.34%)
Post transfusion fall in Hb levels	4(17.4%)

The frequency of hypotension in the present study was 13.04% (n=3) (Table 3). One patient had hypotension after transfusing packed red cells which is preserved in additive solution – saline adenine glucose mannitol (SAGM). Some authors reported that mannitol may act as an acetylcholine esterase (ACE) inhibitor there by slowing down catabolism of bradykinin and leading to its accumulation in the stored RBCs [15]. There have been several case reports of severe hypotension, occasionally accompanied by flushing of skin and loss of consciousness, developing in patients who received components by bed side leukofiltration [16].But no such bed side filters were used for our patients.

The frequency of TRALI in the present study was low (4.35%)(Table 3).It has been reported that TRALI probably occurs about 1 in 2500 to 4000 units of female donor plasma transfused. In our blood bank the female donors are much less (3% during the study period) particularly the donors for component preparation. This could be one of the reasons for the decreased frequency of TRALI observed. However, the donor sample could not be evaluated for anti-HLA or anti-HNA antibodies which suggest susceptible host factors. Careful selection of donors can decrease incidence of TRALI.

Table 6: Department wise categorization of adverse reactions.

Departments	No. of adverse reactions n (%)
Oncology specialities(Medical, Surgical & Radiation oncology)	7(30.4%)
Neurosurgery	5(22%)
Nephrology	3(13%)
Respiratory Intensive Care Unit (RICU).	2(8.7%)

In the present study a single case of TACO was observed which has occurred following the isolated transfusion of RBC that too only 30 mL. Agnihotri et al. reported a case of TACO following single blood unit transfusion[17].Here, it occurred with only one episode of RBC transfusion showing that it can occur even with small volume of the RBC transfusion of 1 unit or less as reported by Li G et al. [18]. The rationale of transfusion and rate of transfusion were not appropriate in this recipient in spite of the diuretic cover.

Table 7: Comparative study of overall frequency of adverse reactions in different studies

S. no	Author	Place of study	Year	Overall frequency
1.	Callera et al [7]	Sau Paulo, Brazil	2004	0.54%
2.	Shil et al [8]	Dhaka, Bangladesh	2005	7.90%
3.	Khalid et al[9]	Karachi ,Pakistan	2010	0.082%
4.	Bhattacharya et al [6]	PGIMER,Chandigarh	2011	0.18%
5.	Venkatachalapathy et al[10]	IGGGH&PGI Pondicherry	2012	3.30%
6.	Praveen Kumar et al [11]	AIIMS,New Delhi	2012	0.05%
7.	Meena Siddhu et al[12]	Shri Maharaja Gulab SinghHospital,Jammu.	2015	0.27%
8.	Dhruva Kumar Sharma et al [13]	Sikkim	2015	0.92%
9.	Gupta et al[14]	Ludhiana,Punjab	2015	0.42%
10.	Present study	SVIMS,Tirupati, Andhra Pradesh.	2017	0.16%

PGIMER –Post Graduate Institute of Medical Education and Research,, IGGGH&PGI- Indira Gandhi Govt General Hospital and Post Graduate Institute. AIIMS-All India Institute of Medical Sciences.

The frequency of DHTR and DSTR in the present study was 17.39% and 8.70 %(Table 3) respectively which was very high than a study by Praveen Kumar et al. where he reported frequency of 0.5% [11].

Majority of the patients belonged to Oncology specialty (7/23; 30.4%) followed by neurosurgery (5/23; 22%) (Table 6). A possible explanation is these patients were that they undergo a temporary inability to produce blood cells and may use multiple transfusions increasing their susceptibility to transfusion reactions. This is similar to a study by Callera et al where majority of the transfusion reactions were found in oncology departments [7].

To conclude, frequency of transfusion reactions in present study was

0.16%, majority of these were due to transfusion of packed red cells. This can be an underestimation of the true incidence because of underreporting which can be improved by hemovigilance system. Adverse reaction following blood transfusion is a common complication which should be kept in mind and blood transfusion should be given when necessary. Fully functional hospital blood transfusion committee with continuous education to medical and paramedical staff will help in improving hemovigilance system and reducing the incidence of transfusion reactions.

REFERENCES:

1. Sharma S, Sharma P, Tyler LN. Transfusion of blood and blood products: Indications and complications. Am Fam Physician 2011; 83:719-24.
2. Fatalities reported to FDA following blood collection and transfusion: Annual summary forfiscal year 2009. Rockville, MD: Office of Communication, Outreach, and Development, 2010.
3. Jain A,Kumari S,Marwaha N,Sharma RR.The Role of comprehensive check at the blood bank reception on blood requisitions in detecting potential transfusion errors. Indian J Hematol Blood Transfus 2015;31:269-74.
4. Sazama K.Reports of 355 transfusion –associated deaths: 1976 through 1985.Transfusion 30:583-90.
5. Saran RK. Adverse effects of blood transfusion. Transfusion Medicine Technical Manual. 2nd ed. New Delhi: Directorate General of Health Services; 2003. p. 127-9.
6. Bhattacharya P, Marwaha N ,Dhawan H, Roy P, Sharma R R.Transfusion related adverse events at the tertiary care center in North India:An Institutional hemovigilance effort.Asian J Transfus Sci.2011;5:164-70.
7. Callera F,Silva ACO,Moura AF,Melo DB,Melo CMT.Descriptions of acute transfusion reactions in a Brazilian Transfusion Service.Rev bras.hematol.hemoter.2004;26:78-3.
8. Shil N,Biswas J,Islam A,Khatun A. Day care transfusion therapy—One year experience in a day care transfusion unit of Transfusion Medicine department in a tertiary care hospital. Bangladesh J Med 2005;16:83–6
9. Khalid S, Usman M, Khurshid M. Acute transfusion reactions encountered in patients at a tertiary care center. J Pak Med Assoc2010; 60:832-6.
10. Venkatachalapathy TS .A Prospective audit of blood transfusion reactions in tertiary care hospital for the use of Blood and Blood Components. J Blood Disord Transfus 2012 ;3:118.
11. Kumar P, Thapliyal R, Coshic P, Chatterjee K. Retrospective evaluation of adverse transfusion reactions following blood product transfusion from a tertiary care hospital: A preliminary step towards hemovigilance. Asian J Transfus Sci 2013; 7:109-15.
12. Sidhu M,Meenia R,Yasmeen I,Akthar N.A study of transfusion related adverse events at a tertiary care centre in North India:an initiative towards hemovigilance.Int J Adv Med.2015;2:206-10.
13. Sharma DK,Datta S,Gupta A.Study of acute transfusion reactions in a teaching hospital of Sikkim:A hemovigilance initiative.Indian J Pharmacol 2015;47:370-4.
14. Gupta M,Kumar R,Gupta S,Kaur A.Acute transfusion reactions encountered in patients at a tertiary care centre in Punjab. Natl Med J India.2015:28:8-11.
15. Shiba M, Tadokoro K, Sawanobori M, Nakajima K, Suzuki K, Juji T. Activation of the contact system by filtration of platelet concentrates with a negatively charged white cell-removal filter and measurement of venous blood bradykinin level in patients who received filtered platelets. Transfusion 1997; 37:457–62.
16. Sweeney JD, Dupuis M, Mega AP. Hypotensive reactions to red cells filtered at the bedside, but not to those filtered before storage, in patients taking ACE inhibitors. Transfusion 1998;38:410–1.
17. Agnihotri N,Agnihotri A.Transfusion associated circulatory overload.Indian J Crit Care Med.2014:18;396-8.
18. Li G, Rachmale S, Kojicic M, Shahjehan K, Malinchoc M, Kor DJ et al. Incidence and transfusion risk factors for transfusion-associated circulatory overload among medical intensive care unit patients. Transfusion. 2011; 51:338–43.