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Monitoring and reporting transfusion reactions as a quality indicator – a clinical audit

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ABSTRACT

Background and Objective: This audit was conducted as a part of a quality assurance activity to assess the frequency of receiving completely filled out blood transfusion reaction forms which were accompanied by the required samples. Once this information is known, we will elevate the bar each year to achieve 100% compliance. The sub-aim was to evaluate the frequency of the reported transfusion reactions.
Materials and Methods: The study was conducted from 1st April 2010 to 30th April 2011. The information was evaluated and the frequency of receiving completely filled blood transfusion reaction forms was assessed. The variables identified were the type of transfusion reaction, the blood component transfused, the health care personnel filling the form, and whether there was legible handwriting and a completely filled form. Transfusion reactions were reported as a percentage of the total number of units transfused.
Results: During the study period, 17,880 packed red cells, 13,200 platelets, 13,620 fresh frozen plasma and 2256 cryoprecipitate were transfused and 106 transfusion reactions (0.23%) were reported. Of these, febrile non hemolytic transfusion reaction was the most common (47%), the majority caused by packed red cells.
Conclusion: Eighty-four percent of the transfusion reaction forms were completely filled as per our criteria. Febrile non hemolytic transfusion reactions were the most common reactions reported.

1. Introduction

Hemovigilance is a system of surveillance procedures covering the entire transfusion chain from collection to transfusion of blood components designed to avoid untoward effects of transfusion therapy [1]. The reporting of adverse transfusion reactions is an essential component of hemovigilance allowing rapid and complete investigation of problems, preventing their occurrence and re-occurrence.

The implementation of hemovigilance varies around the globe. Among the pioneers was the European vigilance network created in 1998 that links several hemovigilance systems [2]. For example, France has a very robust hemovigilance system and any incident related to blood transfusion is reported nationwide [3]. In the UK, hospitals voluntarily report only serious adverse reactions including an incorrect blood component transfused (IBCT) and near misses to their national organization called SHOT (Serious Hazards of Transfusion) [4,5]. In the US, morbidity and mortality associated with transfusion is reported [6]. Similar to SHOT, a voluntary reporting system exists in Canada, known as the Transfusion Transmitted Injuries Surveillance System (TTISS) which was implemented in 2001 [4]. In Japan, hemovigilance is observed via the Japanese Red Cross, set up in 1992 [4]. Australia and New Zealand are also working on their hemovigilance systems [4]. In developing nations like Africa, hemovigilance exists in some

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countries such as Zimbabwe, Uganda and the republic of South Africa, while it is sporadic in other countries [4]. Similar initiatives have been taken in Asian countries like China and India to improve their blood banking systems [7,8].

Recently, steps were taken by the Government of Pakistan to improve blood safety. In this direction, the National Blood Transfusion Program (NBTP) made a strategic framework for transfusion practices in 2008–2012 funded by the Health Ministry of Germany. It has financial and technical components and is striving for establishing hospital transfusion committees and a comprehensive hemovigilance system in the country. It is anticipated that in the near future, a national hemovigilance system will be operative with the efforts of the NBTP.

To begin with, hemovigilance will become operational in 22 teaching hospital-associated blood banks in Pakistan. Situated in Southern Pakistan, the Aga Khan University and hospital blood bank is a tertiary care hospital which was established in 1985. From its conception, the hospital was focused on an internal system of hemovigilance which is governed by a hospital transfusion committee called the blood utilization committee (BUC). It started working in 1999 to monitor various quality indicators, including the frequency of transfusion reactions. Accordingly, a wrong blood transfusion is considered as a sentinel event with prompt root cause analysis [9].

Annually, around 46,956 blood and blood products are transfused. Though a number of clinical practices for transfusion are monitored by the BUC, the details provided by clinicians for a transfusion reaction were never audited in our setting. It is important to observe the practices of health care personnel because transfusion reactions can be adequately monitored only if clinical information is provided by them. This audit was conducted as a part of a quality assurance activity to assess a minor but important aspect of hemovigilance, regarding the practices of health care personnel for sending completely filled blood transfusion reaction forms with the required samples.

2. Materials and methods

2.1. Setting

The Aga Khan University (AKU) is a 700 bed tertiary care academic institute with a large oncology and trauma units as well as a fully functional bone marrow transplant unit. The blood bank at AKUH is responsible for catering to the entire needs of the hospital as centralized blood banking is non-existent.

2.2. Collection/transfusion of blood products

The average monthly blood component usage for packed red cell, platelet, fresh frozen plasma (FFP) and cryoprecipitate were 1490, 1100, 1135 and 188 respectively in the study year. Ninety percent of our donor population is comprised of males. Blood is collected in a closed system in CPDA1 and the standard inventory is non-leukoreduced. However, bedside filtration is routinely provided to all chronically transfused patients, and patients with a history of febrile non hemolytic transfusion reactions qualify for pre-medication.

2.3. Evaluation of transfusion reactions

In our institute, nurses are credentialed for blood transfusion. Each patient is monitored regularly for vital signs and the patient is advised to report any untoward symptoms during transfusion. If a blood transfusion reaction is suspected, the nursing staff stops the transfusion immediately, seeks medical advice and sends 4 ml of EDTA blood, any voided urine sample, the used blood bag with tubes to the blood bank along with a completely filled transfusion reaction form (see Fig. 1). The time is noted by the blood bank personnel after receiving the required samples for further work. The standard laboratory evaluation (including re-typing, re-crossmatching, direct–indirect globulin test and blood count) is performed for every febrile transfusion reaction following red cell transfusion. Each evaluation is reported by the technologist to the hematology resident who checks the medical record of the patient, verifies the findings and documents the details after consulting the attending in Blood bank. In case of transfusion of the wrong component, a thorough investigation is done to identify the weak links and measures are taken to bridge the gaps.

The clinical diagnosis of transfusion reactions is made according to the American Association of Blood Banks (AABB) guidelines [10]. A febrile non hemolytic transfusion reaction (FNHTR) was considered with the rise of 1 °C rise of body temperature during or within an hour of blood transfusion. Allergic reactions are diagnosed when dermatological manifestations of hives or urticaria are apparent.

Due to technical restraints, diagnosis of transfusion related acute lung injury (TRALI)/transfusion associated cardiac overload (TACO) is based on clinical criteria. According to the European Hemovigilance Network (EHN), TRALI is diagnosed on the basis of respiratory distress within 6 hours of initiation of the transfusion, the absence of signs of cardiac overload, radiographic evidence of new bilateral pulmonary infiltrates [11], hypoxemia (PaO2/FIO2 < 300 mm Hg or pulse oximetry <90%) and absence of risk factors for acute lung injury [12]. Central venous pressure monitoring and PaO2/FIO2 ratio are performed in the ICU setting only. We do not do a post-complete blood count (CBC) to evaluate for transient (<6 hours) drops in white cells. TACO is diagnosed if there is a new onset or exacerbation of three or more of the following within 6 hours of cessation of transfusion: acute respiratory distress (dyspnea, orthopnea, cough), elevated BNP; elevated central venous pressure, evidence of left heart failure, evidence of positive fluid balance, and radiographic evidence of pulmonary edema [13].

2.4. Audit criteria

This audit was conducted from 1st April 2010 to 30th April 2011. During the study period, reported transfusion reactions and the provider-reported information (top of the form) was evaluated. In this audit, the variables identified were the type of transfusion reaction, the blood component transfused, the health care personnel filling the form,

The Aga Khan University Hospital, Karachi
Clinical Laboratory.Blood Bank
Transfusion Reaction Reporting Form

Note: This form must be accompanied by used blood bag (with remaining blood) along with administration set (without needle). One 4ml EDTA blood sample from the recipient labeled as "post transfusion" along with urine sample (if voided) should be send **within ONE HOUR** to the blood bank.

NB. This part of the form will be filled in by doctor reporting the transfusion reaction.

Patient's Name:	M.R.#:	
Location:	ABO & Rh_Group:	
Donor No:	Component: P/C FFP PLT	Group & Rh:
Transfusion started on Date:	Time:	By:
Transfusion stopped on Date:	Time:	By:
Approximate Volume Transfused ml.		

Please mark "X" for the reaction noted:
Chills ☐ Fever ☐ Nausea ☐ Dyspnea ☐ Urticaria ☐
Hemorrhage ☐ Hematuria ☐ Any Other ☐

(Signature of physician reporting reaction) (Date) (Time)

BLOOD BANK REPORT (To be filled in by blood bank personnel)
Sample Received

Blood Bag with tubes Yes ☐ No ☐ EDTA blood sample Yes ☐ No ☐
Urine Sample Yes ☐ No ☐

Name of technologist who received above sample:		Date & Time:
Recipient's ABO& Rh group, re-checked Pre- sample:		Post -sample:
Donor Blood Group & Rh, re-checked:		
Recipient & donor re-cross matched	Pre- sample:	Post sample:
Direct Coomb's result on recipient	Pre-sample:	Post sample:
Recipient's Hemoglobin	Pre-sample:	Post sample:
Recipient's peripheral film findings	Pre sample:	Post sample:
Blood Bag sent for culture & sensitivity: Yes □ No □		Results of C&S:
Urine sent for D/R	Yes □ No □	Results of urine D/R:
Remarks (if any by technologist):		

Technologist signature: Date & Time:
Resident Comments: Signature
Final conclusion Signature

AKUH0935/CL031	September 2008	Rev: 01

Fig. 1. Transfusion reaction reporting form.

legible handwriting and completely filled form. Traceability of the health care personnel filling the form was assessed by their signature, pager number or mnemonic. Since there was no available international bench mark, our focus was estimating the frequency of completely filled transfusion reaction forms in our setting. Once this is known, we can set the target for ourselves in the future and can elevate the bar each year to achieve 100% compliance.

2.5. Statistical analysis

All data were entered into SPSS version 19.0 (IBM, Armonk, NY, USA). Descriptive data were given as percentages. The forms were scored one or zero depending on the degree of completion. Forms scoring one were considered as completely filled forms. Transfusion reactions were reported as a percentage of total units transfused.

2.6. Ethical approval

The study was given exemption from ethical approval by the ethical review committee of The Aga Khan University (#2800-Pat-ERC-13).

3. Results

During the study period, 17,880 packed red cells, 13,200 platelets, 13,620 fresh frozen plasma (FFP) and 2256 cryoprecipitate were transfused and 106 transfusion reactions (0.23%) were reported. Ninety-five (89.6%) of the forms had

Table 1
Samples received by the blood bank along with transfusion reaction form.

Blood bank	Blood bag n(%)	Tubing n(%)	Urine sample n(%)	EDTA sample n(%)
Received within 1 hour	27 (25.5)	27 (25.5)	25 (23.6)	30 (28.3)
Received after 1 hour	71 (67)	70 (66)	43 (40.6)	69 (65.1)
Not received	8 (7.5)	9 (8.5)	38 (35.8)	7 (6.6)

legible hand writing. Seventy-eight (83.6%) forms were completely filled. Demographics (which include name, age, gender and medical record number), symptoms and signs were mentioned in 106 forms. The amount of the blood component transfused was missing in 10 (9.4%) forms. Traceability (which includes name, mnemonic, pager number or signature) was present in 92 (86.8%) forms. Fifty-three (50%) forms were filled by the doctors and 44 (83%) were completely filled, while 35 (33%) forms were filled by nurses and 24 (68.6%) were completely filled. In the remaining 18 forms it was not clear whether it was the nurse or doctor who filled in the form and 10 (55.6%) were completely filled. The samples received by the blood bank within the required time frame are given in Table 1.

The frequency of different types of transfusion reactions due to different blood components transfused is shown in Table 2. Packed red cells accounted for 86.8% of the transfusion reactions followed by platelets (7.5%), FFP (4.7%) and cryoprecipitate (0.09%). The frequency of FNHTR and allergic reactions was 0.1% each while for TRALI it was 0.006% of the total units transfused.

FNHTR was the most frequent reaction (47%) followed by allergic transfusion reactions (45%) and these occurred predominantly with packed red cell transfusions. TRALI (2.8%) was reported for two patients after packed red cell transfusion and one patient after FFP was transfused. The donors in the TRALI cases in our audit were males. There were a total of five nonspecific transfusion reactions (4.7%) and all of them occurred with packed red cells. In these patients the only sign was tachycardia and the transfusion was stopped and reported. There were no IBCT or clerical errors reported in our audit.

The following transfusion reactions were observed during administration of nine leukoreduced blood components: FNHTR (n = 3), allergic reactions (n = 4) and TRALI (n = 1) and one non-specific transfusion reaction (in which the only sign was tachycardia).

4. Discussion

We found that more than 80% of transfusion reaction forms were completely filled in our setting. To the best of our knowledge, there are no other institutions (national or international) that have audited the compliance of health care personnel in sending completely filled transfusion reaction forms to the blood bank. The highest frequency of transfusion reactions in our audit occurred with packed red cells (86.8%) followed by platelets (7.5%), FFP (4.7%) and cryoprecipitate (0.09%). Similar rates have been reported in another audit in which packed cell transfusion caused the most frequent transfusion reactions (62.4%) followed by platelets (14.4%) and FFP (11.2%) [14]. We reported a lower frequency of transfusion reactions (0.23%) compared to a Nigerian hospital which was high at 8.7% [15]. Similarly, the frequency of reactions was 1.6% in a pediatric intensive care unit in Montreal [16]. Studies conducted in India, Brazil and Malaysia reveal a reporting rate that was lower or almost comparable to our reporting rate (0.05, 0.24 and 0.53% respectively) [12,17,18]. The lower frequency as reported by us might represent under-reporting because of the inferior sensitivity of nurses/residents monitoring blood transfusion. Following this recognition, we initiated verification of information from the primary medical record or through interviews of staff or the transfusion recipient by hematology residents. Also, we initiated an on-line incident reporting for every event related to blood transfusion, hence maximizing reporting.

FNHTR were the most common reactions (approximately 47%) in our setting and majority occurred with packed red cell transfusions. Similar high frequencies in the range of 41% and 70% have been observed by others [12,19]. The estimated frequency of febrile reactions in non-leukoreduced red blood cells ranges from 0.34 to 6.8% of all units transfused [19–23]. Apparently, a FNHTR of 0.1% of non-leukoreduced blood/blood products transfused in our study

Table 2
Frequency of transfusion reactions with different blood components.

Component	Types of transfusion reaction					
	No. of blood components transfused	Febrile non hemolytic	Allergic	TRALI	Non specific	Total n(%)
Packed red cell	17,880	44	41	2	5	92 (86.8)
Platelet	13,200	4	4	0	0	8 (7.5)[a]
Fresh frozen plasma	13,620	1	3	1	0	5 (4.7)
Cryoprecipitate	2256	1	0	0	0	1 (0.9)
TOTAL n(%)	46,956	50 (47.2)	48 (45.3)	3 (2.8)	5 (4.7)	106

[a] The denominator counted were individual random platelets dispensed.

was also an under reporting. Pre-storage leukoreduction would have been more beneficial in preventing FNHTR [19]; however, due to the expenses involved and considering the non-affordability of the majority of our patient population, it is not applicable in our setting. Bedside leukoreduction was performed in our institute for chronically transfused patients such as thalassemics, patients who underwent bone marrow transplant and those with hematological malignancies; however, FNHTR was still reported in this population. At least one-third to one-half of FNHTR sent to the blood bank may have been due to underlying medical conditions and only coincidental to transfusion. We were not able to determine the frequency of these conditions during the study period. This prompted us to initiate verification of information by a hematology resident as stated earlier.

An allergic transfusion reaction was the second most frequent occurring mainly with packed red cell transfusions. It accounted for 45% of the total transfusion reactions reported while the frequency of allergic reactions ranged between 26 and 46% in other studies [12,19]. The estimated overall frequency of allergic transfusion reactions reported in other studies ranged from 0.09 to 0.15% of all units transfused [19,20,23] and this was comparable to the frequency in our audit (0.1%).

The frequency of TRALI was 2.8% in our audit while other studies have reported a frequency of 0.5–0.8% [17,24]. One of the limitations was that the diagnosis of TRALI was clinical because of the non availability of a specialized technique needed to detect anti neutrophil/anti HLA antibodies responsible for the development of TRALI. Hence the reported TRALI might be the tip of the iceberg as it was highly dependent on nurse/doctor recognition of TRALI symptoms. A literature review reveals that leukocyte antibodies were identified in blood donors of 80% TRALI cases [25] and the majority of the donors were women with a previous history of pregnancy [26,27]. These antibodies are targeted against human neutrophil alloantigens (HNA), human leukocyte antigen (HLA) class I and HLA class II [28,29]. Anti-HNA-3a is mainly associated with a fatal prognosis of TRALI [28,29]. HLA class II antibodies were present in the donors of 50% of all TRALI cases [30–35].

This audit addresses an important issue of reporting transfusion reactions and it is the first audit report from Pakistan. A frequency of 84% of completely filled in forms was observed for reporting transfusion reactions. To the best of our understanding there is no published literature regarding similar audit as conducted by us. As given in Table 1, the majority of the samples were sent to the blood bank after 1 hour or were not sent at all. The bags and tubes were discarded by the nursing staff in most cases. Doctors were more compliant in completely filling in the transfusion reaction form compared to nurses. Therefore, efforts will be made to educate the nurses regarding the importance of transfusion reaction reporting.

A drawback of this audit was that delayed transfusion reactions were not reported to the blood bank. This may be because there is no policy to report delayed transfusion reaction. Such patients were often discharged by the physician and later present to the outpatient clinic with a delayed reaction. Interestingly, no reactions were reported in the day care setting where the majority of the blood transfusions take place. This is most likely due to universal premedications including antihistamines and antipyretics to all patients which may suppress fever or allergic reactions. Bedside leukoreduction is also performed in all these patients, further decreasing the rate of the FNHTR reported.

Recently, BUC has arranged educational programs for nurses and residents. They have also linked the blood transfusion reaction reporting to incident reporting thereby making it mandatory for the transfusion reaction to be reported. Since October 2011, the hematology resident on call in the blood bank goes to the ward once a reaction is reported to personally verify the authenticity of the information provided to the blood bank.

There was no IBCT reported in our audit, therefore since August 2012, IBCT has also been introduced as a component of hemovigilance. Flyers have also been distributed in the wards regarding “Correct Patient Correct Blood”. In the future, a clerical check for hemolysis will be introduced as a part of the transfusion reaction reporting form and it will be made mandatory for health personnel to report.

Our aim of performing this audit was to identify the weak links in our system and to rectify them. Despite limitations in our study, we achieved our goals of studying the practices of filling transfusion forms. Considering the morbidity and mortality associated with transfusion reactions, it is important that we receive complete information from the ward so that a root cause analysis can be performed and such reactions be avoided in the future. In view of this, we need to raise the benchmark to 100% for sending completely filled transfusion reaction forms to the blood bank in the future.

5. Conclusion

We conclude that the frequency of receiving completely filled blood transfusion reaction forms was 84%. We will elevate the target annually by 10% to achieve 100% compliance. Considering the low frequency of the transfusion reactions reported (0.23%) compared to other institutions, there may be near miss events or under-reporting of transfusion reactions in our set up. Febrile non hemolytic transfusion reactions were the most common reaction reported and the majority of the transfusion reactions occurred with packed red cells.

Authors’ contributions

Shabneez Hussain collected and analyzed the data and wrote the original draft of the paper. Bushra Moiz reviewed the paper, analyzed the data and provided new ideas to incorporate into the paper. Fatima Azra Ausat helped in collecting the data. Mohammad Khurshid provided the original idea for conducting this audit and guided the work.

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Natasha Ali reviewed the paper and Musa Khan assisted in literature review. All authors approved the final manuscript.

References

[1] McClelland B., Love E., Scott S., Williamson L.M. Hemovigilance: concept, Europe and UK initiatives. Vox Sang 1998;74(Suppl. 2):431–9.
[2] Faber J.C. Hemovigilance in Europe: the European Hemovigilance Network. Transfus Clin Biol 2001;8(3):285–90.
[3] Andreu G., Morel P., Forestier F., Debeir J., Rebibo D., Janvier G., et al. Hemovigilance network in France: organization and analysis of immediate transfusion incident reports from 1994 to 1998. Transfusion 2002;42(10):1356–64.
[4] Faber J.C. Worldwide overview of existing hemovigilance systems. Transfus Apher Sci 2004;31(2):99–110.
[5] Williamson L.M., Lowe S., Love E.M., Cohen H., Soldan K., McClelland D.B., et al. Serious hazards of transfusion (SHOT) initiative: analysis of the first two annual reports. BMJ 1999;319(7201):16–19.
[6] Menitove J.E. Hemovigilance in the United States of America. Vox Sang 1998;74(Suppl. 2):447–55.
[7] Shi L., Wang J.X., Stevens L., Ness P., Shan H. Blood safety and availability: continuing challenges in China's blood banking system. Transfusion 2014;54(2):471–82.
[8] Bisht A., Singh S., Marwaha N. Hemovigilance program-India. Asian J Transfus Sci. 2013;7(1):73–4.
[9] Karim F., Moiz B., Shamsuddin N., Naz S., Khurshid M. Root cause analysis of non-infectious transfusion complications and the lessons learnt. Transfus Apher Sci 2014;50(1):111–7.
[10] Roback J.D., Combs M.R., Grossman B.J., Hillyer C.D. Non infectious complications of blood transfusion. In: Roback J.D., editor. Technical manual. 16th ed. Bethesda: American Association of Blood Banks; 2008. pp. 717–18.
[11] Kleinman S., Caulfield T., Chan P., Davenport R., McFarland J., McPhedran S., et al. Toward an understanding of transfusion-related acute lung injury: statement of a consensus panel. Transfusion 2004;44(12):
1774–89.
[12] Rabeya Y., Abdul-Kahar A.H., Leong C.F. An audit of reported acute transfusion reactions in Universiti Kebangsaan Malaysia Medical Centre. Malays J Pathol 2011;33(1):25–9.
[13] Ellsworth B., Ellsworth P., Stevens W.T. Adverse reaction case definition criteria from Appendix A of the Biovigilance Component of the National Healthcare Safety Network (NHSN) manual, <http://www.cdc.gov/nhsn/PDFs/Biovigilance/BV-HV-protocol-current.pdf>; 2013. [accessed 13.10.15].
[14] Grujic J., Gulan Z., Budakov Z. Importance of hemovigilance and reports on transfusion reaction in blood component therapy. Med Pregl 2012;65(1–2):50–3.
[15] Arewa O.P., Akinola N.O., Salawu L. Blood transfusion reactions; evaluation of 462 transfusions at a tertiary hospital in Nigeria. Afr J Med Med Sci 2009;38(2):143–8.
[16] Gauvin F., Lacroix J., Robillard P., Lapointe H., Hume H. Acute transfusion reactions in the pediatric intensive care unit. Transfusion 2006;46(11):1899–908.
[17] 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(2):109–15.
[18] de Sousa Neto A.L., Barbosa M.H. Analysis of immediate transfusion incidents reported in a regional blood bank. Rev Bras Hematol Hemoter 2011;33(5):337–41.
[19] King K.E., Shirey R.S., Thoman S.K., Bensen-Kennedy D., Tanz W.S., Ness P.M. Universal leukoreduction decreases the incidence of febrile nonhemolytic transfusion reactions to RBCs. Transfusion 2004;44(1):25–9.
[20] Paglino J.C., Pomper G.J., Fisch G.S., Champion M.H., Snyder E.L. Reduction of febrile but not allergic reactions to RBCs and platelets after conversion to universal prestorage leukoreduction. Transfusion 2004;44(1):16–24.
[21] Heddle N.M., Klama L.N., Griffith L., Roberts R., Shukla G., Kelton J.G. A prospective study to identify the risk factors associated with acute reactions to platelet and red cell transfusions. Transfusion 1993;33(10):794–7.
[22] Perrotta P.L., Snyder E.L. Non-infectious complications of transfusion therapy. Blood Rev 2001;15(2):69–83.
[23] Da Ponte A., Bidoli E., Talamini R., Steffan A., Abbruzzese L., Toffola R.T., et al. Pre-storage leucocyte depletion and transfusion reaction rates in cancer patients. Transfus Med 2005;15(1):37–43.
[24] Beckers E.A., Dinkelaar R.B., te Boekhorst P.A., van Ingen H.E., van Rhenen D.J. Reports of transfusion incidents: experiences from the first year of hemovigilance in the region of the former ZWN (South West Netherlands) blood bank in Rotterdam. Ned Tijdschr Geneeskd 2003;147(31):1508–12.
[25] Middelburg R.A., van Stein D., Briet E., van der Bom J.G. The role of donor antibodies in the pathogenesis of transfusion-related acute lung injury: a systematic review. Transfusion 2008;48(10):2167–76.
[26] Triulzi D.J., Kleinman S., Kakaiya R.M., Busch M.P., Norris P.J., Steele W.R., et al. The effect of previous pregnancy and transfusion on HLA alloimmunization in blood donors: implications for a transfusion-related acute lung injury risk reduction strategy. Transfusion 2009;49(9):1825–35.
[27] Vassallo R.R., Hsu S., Einarson M., Barone J., Brodsky J., Moroff G. A comparison of two robotic platforms to screen plateletpheresis donors for HLA antibodies as part of a transfusion-related acute lung injury mitigation strategy. Transfusion 2010;50(8):1766–77.
[28] Bux J., Sachs U.J. The pathogenesis of transfusion-related acute lung injury (TRALI). Br J Haematol 2007;136(6):788–99.
[29] Davoren A., Curtis B.R., Shulman I.A., Mohrbacher A.F., Bux J., Kwiatkowska B.J., et al. TRALI due to granulocyte-agglutinating human neutrophil antigen-3a (5b) alloantibodies in donor plasma: a report of 2 fatalities. Transfusion 2003;43(5):641–5.
[30] Kopko P.M., Popovsky M.A., MacKenzie M.R., Paglieroni T.G., Muto K.N., Holland P.V. HLA class II antibodies in transfusion-related acute lung injury. Transfusion 2001;41(10):1244–8.
[31] Wallis J.P., Lubenko A., Wells A.W., Chapman C.E. Single hospital experience of TRALI. Transfusion 2003;43(8):1053–9.
[32] Win N., Massey E., Lucas G., Sage D., Brown C., Green A., et al. Ninety-six suspected transfusion related acute lung injury cases: investigation findings and clinical outcome. Hematology 2007;12(5):461–9.
[33] Reil A., Keller-Stanislawski B., Gunay S., Bux J. Specificities of leucocyte alloantibodies in transfusion-related acute lung injury and results of leucocyte antibody screening of blood donors. Vox Sang 2008;95(4):313–17.
[34] Chapman C.E., Stainsby D., Jones H., Love E., Massey E., Win N., et al. Ten years of hemovigilance reports of transfusion-related acute lung injury in the United Kingdom and the impact of preferential use of male donor plasma. Transfusion 2009;49(3):440–52.
[35] Keller-Stanislawski B., Reil A., Gunay S., Funk M.B. Frequency and severity of transfusion-related acute lung injury – German hemovigilance data (2006–2007). Vox Sang 2010;98(1):70–7.