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Original Article

Frequencies of clerical errors and discrepancies in ABO blood group at donor bags in blood banks of Khartoum state

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Abstract

Background: Safe transfusion focuses on reducing patient the risks of blood transfusion reactions due to incompatible blood and blood products. The clerical errors and ABO discrepancies are serious health obstacle those faced the possess of blood transfusion. **Method:** This cross sectional study was conducted in different blood banks in the Khartoum State to detect the clerical errors and ABO discrepancies in 1200 collected donors blood bags. Manual direct serologically ABO grouping method analyzed those bags. **Results:** The obtained analyzed results reported total summation of clerical errors and discrepancy in all blood banks in the Khartoum State was 3.5% (42/1200) and 0.58 %(7/1200) respectively. The frequencies of clerical errors were distributed as; 1% (12/1200) for technical, 0.75% (9/1200) for adhesive sticker and 1.75% (21/1200) for document registration in files and for the discrepancies as; A_2 0.08% (1/1200), A_2B 0.25% (3/1200), auto AB 0.17% (2/1200), and B-acquired 0.08% (1/1200). **Conclusion:** The highest number of clerical errors and discrepancies were observed so, it is very important to find out the discrepant results and resolve them. Therefore, the precision of performing the ABO blood grouping and well identification of donors are essential to prevent the incompatibility of ABO grouping.

Keywords: ABO grouping, Blood bank, Clerical error, Discrepancies

1. Introduction

1.1 ABO blood group system

The blood transfusion process starts exactly after the 1900s by Landsteiner who discovered the ABO antigens on the red blood cells (RBCs) surfaces which known as A, B and O antigens). Before that it was thought that the all blood was the same for all individuals and started by transfusing of animal blood into humans and then transfusions of blood from human to human. Also most of the cells of the body are covered with same antigens (Dean, L. 2005 & Dharmesh Chandra Sharma, et al., 2013).

The ABO blood typing based on the detecting of the presence or absence of the A and B antigens on the RBC surface. On the other hand the body produce natural occurring antibodies against those antigens (anti-A and anti-B antibodies are usually IgM antibodies) during the first three months of life by stimulation of the environment like substances such as food, bacteria, and viruses. In addition, they found that the ABO antigens are also present on other animals, such as chimpanzees, bonobos, rodents and apes (Barbara J. Bain, Imelda Bates, and Mike A. Laffan, 2017).

1.2 ABO Genes and Antigens

There four expression of ABO blood group system (A, B, AB and O) depending on the presence or absence of the A antigens and B antigens (Emili Cid, Miyako Yamamoto & Fumiichiro, 2018). The H substance is the common precursor which converted from oligosaccharides to the ABO antigens by catalyzed glycosyltransferases (AT and BT) those encoded by efficient A and B alleles at the ABO genetic locus, respectively (located on chromosome 9) (Fumiichiro Yamamoto, 2021). FUT1 gene is located on the chromosome number 19 and is responsible of producing the H antigen. The O allele differs from the A allele by deletion of one base pair and produce inactive enzyme that does not produce either A or B antigens. All these antigens including the H antigen can be found on the surface of other body tissues (Eric J. Duell, Catalina Bonet1, Xavier Mu~noz, et al., 2015).

The function of Fucosyl-transferases (FUTs) enzymes can form the H precursor by adding fucose sugar to glycan precursors. The most important FUT genes include FUT1, FUT2, FUT3, FUT5and FUT6 which are located on the chromosome 19, but FUT4 gene located on chromosome 11 and FUT7 gene on chromosome 9 which all of them form proteins with different activities for H antigen precursor and Lewis (Le) and Secretor (Se) antigen formation that determine secretor status (spholm-Hurtig M, Dailide G, Lahmann M, et al., 2004).

1.3 Genes and Enzymes

The ABO system also known as ABO histo-blood group also has the three antigens (A, B, and H). And the individuals also possess the glycosyltransferase enzymes that produce the A antigen and B antigen, but the O individuals lack to that activity as in the ABO blood group system. (Iwamoto S, Kumada M, Kamesaki T, et al., 2002). It is almost expressed in most body tissues and there for called histo-blood group (Ronald Hoffman, Edward J. Benz, et al., 2018).

In 1990 the ABO gene was discovered after the purification of A transferase; and there are over 200 different alleles have been described (Yamamoto F. et al., 1990). The amino acids by which we can differentiate between A and B transferases, two of them (Leu266Met and Gly268Ala) are essentially responsible for the substrate specificity. It is found that the individuals of group O phenotype lost the glycosyltransferase activity, so they can`t convert the H substance to any antigen (Yamamoto F. et al., 1990).

1.4 ABO Antibodies

Every normal healthy individual, can produce red cell antibodies against the antigen which he lacks. These antibodies considered as naturally occurring antibodies and classified as IgM immunoglobulins (pentamire) can immediately bind to and destroy the RBCs carrying the corresponding antigens.

When the patients transfused with ABO incompatible blood donor, intravascular hemolysis will occur due to the immediate Hemolytic Transfusion Reaction (HTR) may result in complement activation that responsible of the sever hemolysis also result in overwhelming disorder of hemostatic equilibrium, that cause shock and renal failure (Zaremba R, Brooks A& Thomovsky E. 2019).

1.5 Importance of Weak ABO Subgroups

The ABO antigens have different subgroups among different races that can be clinically most important and can cause transfusion reaction, which include: (A_1, A_2, A_3, A_1B and A_2B, …….). The most serious are subgroups A_1 and A_2, and the differentiation between them depend on the reactivity of A_1 cells but not A_2 cells by using anti-A_1 lectin which produce from plant (Dolichos biflorus) (Kumar N, Sharma N, Singh A. 2019). The detection of subgroups of A can be performed by using anti-A antisera which give very weak reactions or non-reaction with A_1 red blood cells than the subjects with A_2 RBCs, (J P Cartron, A Gerbal, N C Hughes-Jones, C Salmon 1974). Because of the antigen so weak that it is not detected, and give false negative result the red cells are mistyped as group O. Problems may arise because the serum of an individual typed A_2, A_2B, A_3, or Ax may contain anti-A_1 antibody may cause confusion (H E Heier 1, et al., 1994).

1.6 Anti-A1 and Anti-H

The anti-A_1 antibody can react well only with A_1 and A_1B cells and rare detected in the serum of group

A_2 persons (1–8%) and to somewhat in the serum of group A_2B individuals (25–50%). However, anti-A_1 normally reacts as a cold antibody and rarely reacts at 37°C. There are a few reports of red cell hemolysis due to anti-A_1. Anti-H antibody is cold antibody can react very strongly with group O and group A_2 subjects, it is rare the anti-H occurs in individual with Oh Bombay grouping, which is an IgM antibody and causes hemolysis at 37°C so that the Oh Bombay individuals typed is required for transfusion (Emili Cid, Miyako Yamamoto & Fumiichiro, 2018).

1.7 Clerical errors in ABO grouping

The detection of errors in blood banks delivery are commonly reported. Linden et al. measured the risk of the administration error at 1 in 19,000 RBCs units transfused and the risk of fatal acute hemolytic transfusion reaction occurring due to the errors at 1 in 1,800,000 units (Ferrera-Tourenc, et al., 2015). ABO incompatible blood transfusions may be due to human errors and dropping of any one of the safety step. Mislabeled of samples collected for cross matching procedures are common happened and are responsible for about one third of transfusion-related deaths (Layla Bashawri, et al., 2009). ABO errors may not have done only by the mislabeled but can also be by during registration and identification. These findings emphasize the requirement to standardize data transmission between health care staff (J Chiaroni, et al., 2004).

1.8 ABO Typing Discrepancies

Modern banks always focusing in the patient safety and minimizing the risks when transfused by blood or blood products. ABO discrepancies one of the common problem in health care in clinical practice (The Lancet Haematology, 2016).

ABO discrepancies defined as the mismatched between the forward and reverse typing reactions. This makes the judgment and determination of the patient's blood group typing mysterious and can pose a threat to the patient's safety due to incompatible blood transfusion (Meny GM, 2017).

Now with the automaization and standardization of technique, the occurring of ABO discrepancies has been reduced considerably due to minimized of technical errors. However, when these discrepancies happened, they need accurate analysis for solution and explanation. When these discrepancies occurred, it need to find out the technical errors first, which include incorrect labeling of samples, A wrong technique of the procedure, Reagent contamination or expiry (Javadzadeh Shahshahani H & Hayati A, 2020). The following steps can be carried out to resolve the discrepancies:

1. Repeat the ABO grouping for the same sample.

2. Reviewed all the technical factors for correction.

3. Collect a new sample for full ABO typing.

The patient’s transfusion history, identification, diagnosis, medications that may be extremely helpful to and provide important key to the cause of discrepancies (Mandal A., 2021).

This study was designed to cover the ABO Genes, enzymes, antigens and ABO antibodies and particularly to gives insight about the Frequencies of Clerical errors and Discrepancies in ABO blood group at donor bags in blood banks of Khartoum state.

Clerical errors and discrepancy lead to incompatible blood transfusion may cause fatal complication of transfusion related morbidity and mortality. And its importance looking for the developing to improve the quality in the blood banks and safe blood transfusion, to our knowledge there are a few publications similar to our case study have been done in Sudan.

2. Material and Methods

This is a retrospective descriptive study. It was conducted on 1200 units of blood collected between June 2020 and May 2021. 5 mL of ACD blood was collected into tubes after the collection of blood unit from each donor for forward grouping, as the same time 5 ml of venous blood samples were been collected in plain containers to obtain the serum for reverse grouping. The ABO grouping was carried out by standard tube technique after washing the donor RBC's three times by 0.9% normal saline. The direct grouping was performed using commercially available monoclonal antisera (anti-A and anti-B) from two

manufacturers (Rapid Labs and Span diagnostics) according to standard operating instruction. Serum grouping was performed by using A cells, B cells, and O cells (in-house pooled). Also the agglutination reaction of RBCs by anti-A_1 and anti-H lectin (Rapid Labs) was also performed. All the results were confirmed after microscopic examination and then the results of ABO typing (forward and reverse) were matched, for checking the discrepancy. On all observed discrepancies samples, the test was repeated to avoid the possibility of technical errors, then the discrepancies were classified according to the reaction occurred either in the red cell or serum testing. Additional donor information also obtained including the age, sex, pregnancy, history of previous blood transfusion, and medication. Checking of blood group A_2 and A_2B was done by using reagents anti–A_1 and anti-H (Rapid Labs) as has been shown in (Table 1, 2). We also carried out the test with setting incubation at 4 °C along with auto control and 'O' cells for checking Auto reaction also the reaction of Acquired B blood group by using 'O' cells as has been shown in (Tables 3, 4) respectively. Checking of the Adhesive Sticker in Blood Bags was done to compare between regrouping and the adhesive sticker.

3. Result

Clerical errors and discrepancies cause of incompatible blood transfusion, they are leading to cause the hemolytic transfusion reactions related to morbidity and mortality (Quillen K & Murphy K., 2006). The total of 1200 blood units were examined from three blood banks in Khartoum state (Khartoum Teaching Hospital, Khartoum North; Bahari Hospital and Omdurman) from each blood bank we have taken 400 blood bags (100 blood bags were checked from each O, A, B and AB blood group).

The reported total summation of clerical errors and discrepancy in all blood banks hospitals in the Khartoum State was 3.5% (42/1200) and 0.58 % (7/1200) respectively.

The errors have been classified in to three categories, (technical errors, adherence sticker and registration in document file of blood banks). Discrepancy is another error type that may cause the hemolytic transfusion reaction. It happened when the red cell testing does NOT match the serum testing results. Discrepancy includes (A_2, A_2B, Auto AB and acquired B). Figure2 Showed the distribution of all type of clerical errors and the discrepancies in overall blood banks,1% (12/1200) for technical, 0.75% (9/1200) for adhesive sticker and 1.75% (21/1200) for document registration in files, for A_2 0.08% (1/1200), A_2B 0.25% (3/1200), auto AB 0.16% (2/1200), and B-acquired 0.08% (1/1200).

The obtained frequencies of clerical errors from each blood bank were distributed as 0.25% (1/400) for technical, 0.25% (1/400) for adhesive sticker and 0.75% (3/400) for document registration in files at Khartoum hospital. In Bahari hospital`s blood bank distributed as 0.25% (1/400) for technical, 0.00% for adhesive sticker and 0.5% (2/400) for document registration. Finally, in Omdurman blood bank the clerical errors distrusted as 0.5% (2/400) for technical, 0.25% (1/400) for adhesive sticker and 1% (4/400) for document registration (Figure 3). On the other hand, we found that the highest errors among ABO blood grouping which detected in all blood banks for (B) blood group 1.42% (17/1200) then (AB) 0.83% (10/1200), (A) 0.58% (7/1200) and (O) blood group 0.67(8/1200) in all blood banks as presented in Figure 4. Moreover, the frequencies of all type of discrepancies detected were 0.17% (2/1200) in Khartoum hospital`s blood bank, 0.17% (2/1200) in Bahari hospital and 0.25% (3/1200) in Omdurman hospital, as shown in Figure 5. The distribution of the ABO discrepancies in each blood bank as follows: In Khartoum blood bank, for A_2 0.00%, A_2B 0.25% (1/400), auto AB 0.0% and B-acquired 0.25% (1/400), in Bahari hospital for A_2 0.25% 1/400), A_2B 0.25% (1/400), auto AB 0.0% and B-acquired 0.0% and in Omdurman hospital A_2 0. 0%, A_2B 0.25% (1/400), auto AB 0.5% (2/400), and B-acquired 0.00% as described in Figure 6.

The highest type of clerical errors (technical, sticker, registration) was observed in document registration file 1.75% (21/1200) as shown in Figure 2 and the highest type of discrepancies (A_2, A_2B, Auto AB and acquired B) was A_2B 0.25% (3/1200) as shown in Figure 5.

In order to realize the statistical significant difference between three categories of clerical errors in the three hospital blood banks, the Odds ratio and P-value of errors were considered Table 5 shows the significances the types of clerical errors have been occurred, the highly significance was happened for Registration The p-value of errors in Khartoum state hospitals under test was 0.0005; which is less than the standard errors of blood banks (the standard errors of blood banks is 0.05) from this results we could

say that the statistical significant difference have been obtained.

Table 1. The phenotype of A_2 blood grouping

Anti A	Anti B	Anti AB	Anti-A_1	Anti-H	A_1 cell	B cell	O cell	Auto
3+/4+	O	3+/4+	O	2+/3+	2+/3+	2+/3+	O	O

Table 2. The Phenotype of Allo A_2B blood group

Anti A	Anti B	Anti AB	Anti-A_1	Anti H	A_1cell	B cell	O cell	Auto
3+/4+	3+/4+	3+/4+	O	2+/3+	2+/3+	O	O	O

Table 3. The phenotype of Auto AB reaction blood grouping

Anti A	anti B	anti AB	A_1 cell	B cell	O cell	Auto
3+/4+	3+/4+	3+/4+	O	2+/3+	O	2+/3+

Table 4. The Phenotype Acquired B blood grouping

Anti A	Anti B	Anti AB	A1cell	B cell	O cell	Auto
3+/4+	1+/2+	3+/4+	O	3+/4+	O	O

Table 5. Statistical analysis of the types of clerical errors among hospitals blood bank in the State.

	NO.	(95% CI)	*P*-value
Technical:	12 (1.00%)	0.040 (0.002 to 0.676)	0.0054
Sticker:	9 (0.75%)	0.053 (0.003 to 0.905)	0.0106
Registration:	21 (1.75%)	0.023 (0.002 to 0.384)	0.0005

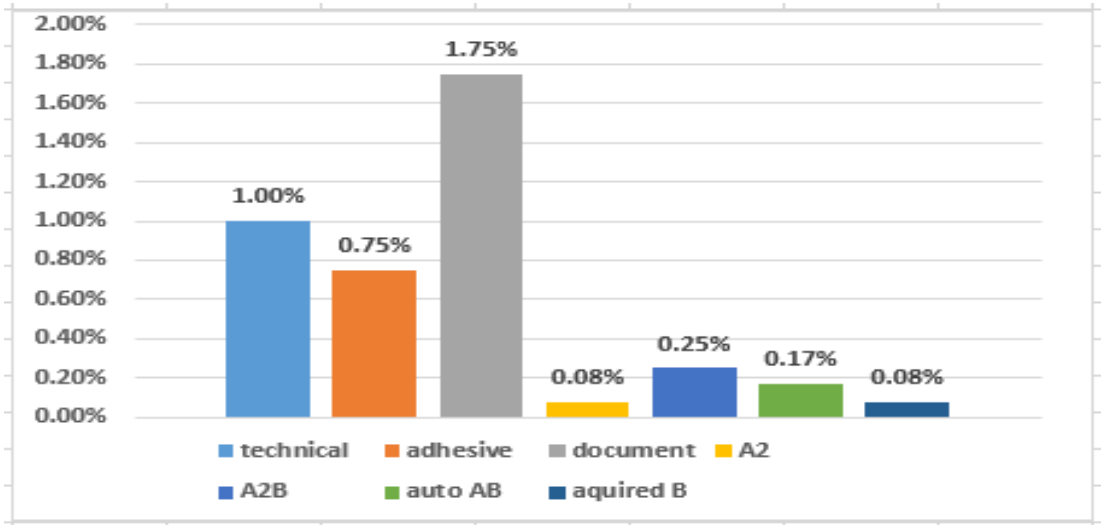

Figure 1. The frequency of type of clerical errors and discrepancies among all blood banks

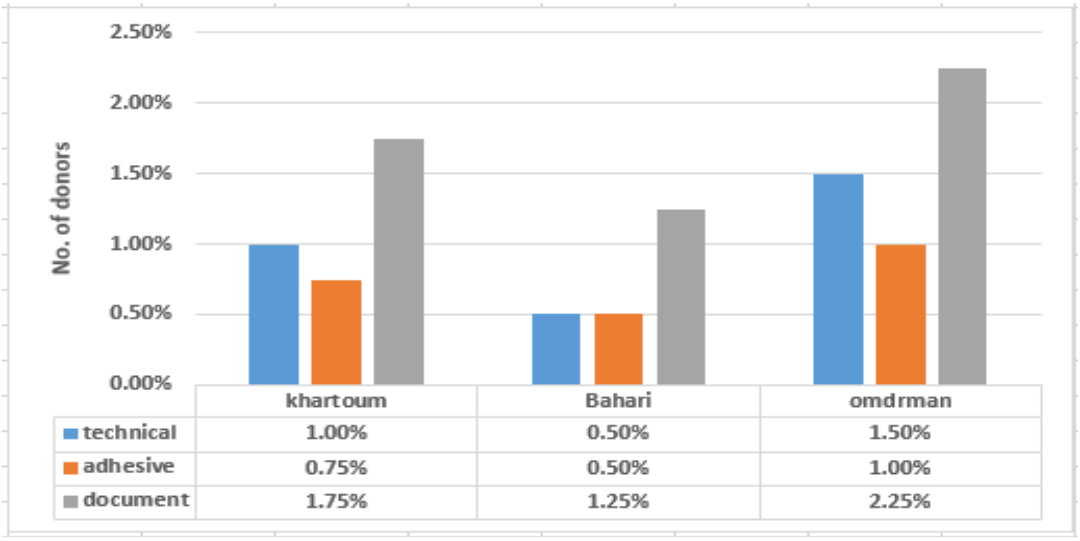

Figure 2. The frequency of all types of clerical errors in each hospital`s blood bank

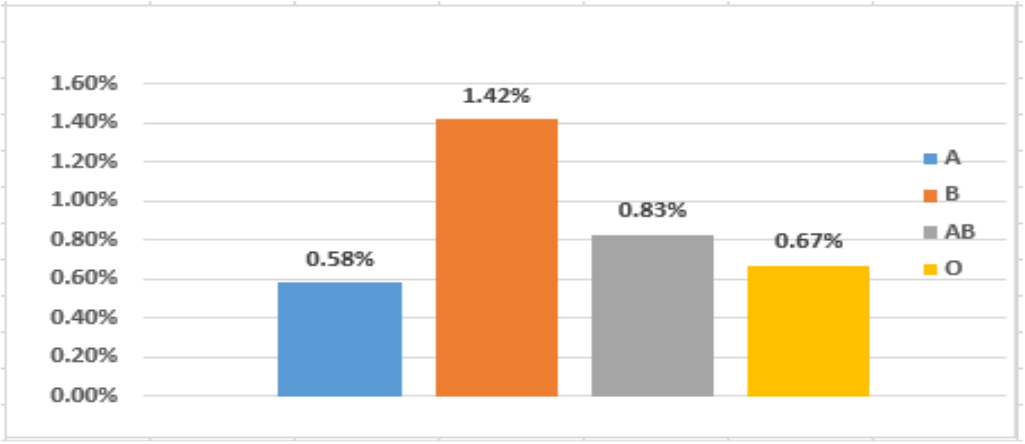

Figure 3. The distribution of clerical errors among blood grouping in all blood banks

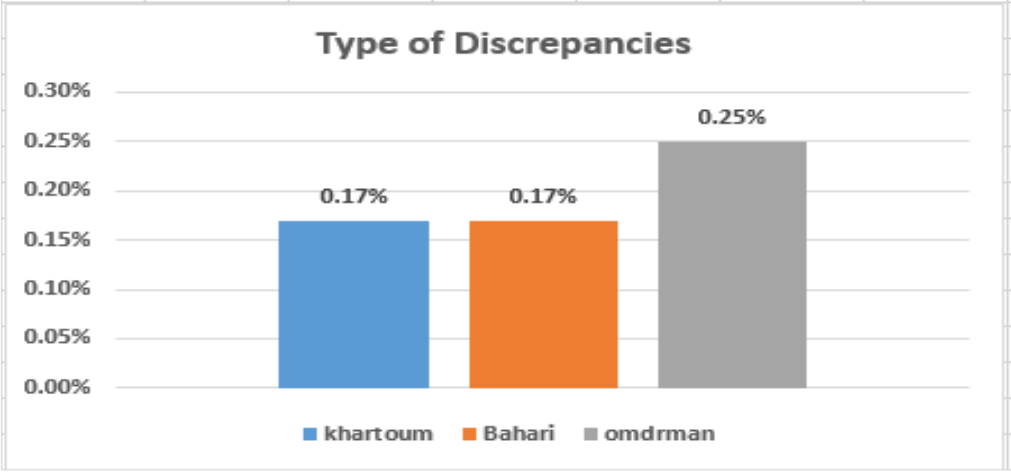

Figure 4. The frequency ABO discrepancies in the all blood banks in the State

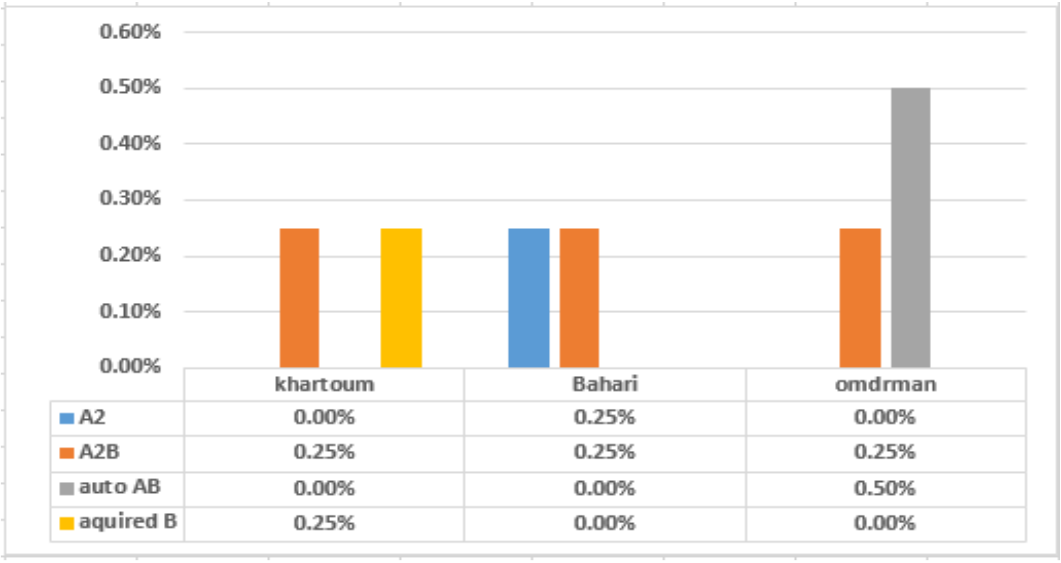

Figure 5. The distribution of the ABO discrepancies in each blood bank

4. Discussion

The ABO grouping and typing is an essential test so that the using proper techniques is very important for blood transfusion. The detection of errors or discrepancies in ABO grouping conceder as a serious complications of blood transfusion. In this study of clerical errors and discrepancy, which identified in 1200 blood bags, were collected from three blood banks in Khartoum state (Khartoum Teaching Hospital, Khartoum North; Bahari Hospital and Omdurman) from each blood bank we have taken 400 blood bags. After testing we found the percentage of clerical errors was high than the frequencies of discrepancies which presented 3.5% (42\1200) and 0.58% (7\1200). The distribution of each error among all blood banks in Khartoum State as follows: 1% (12/1200) for technical, 0.75% (9/1200) for adhesive sticker and 1.75% (21/1200) for document registration in files. Also the frequencies of all errors in each hospital`s blood bank distributed as 1.58% (19\1200) in Omdurman, 1.42% (14\1200) in Khartoum and 0.75% (9\1200) in Bahari. This study similar to a study done by G Kaur. et al (2014, Chandigarh, India.) in 44425 donors were tested during the study period and they noticed that there were technical errors. Also our study was agreed with study described the rate of technical errors over 2 years of the study period in hospital of Bangalore done by C Sindhulina and N J Joseph (2014). Also the clerical errors were discovered during patient registration or identification occurred at a University Hospital, Al-khobar, Saudi Arabia, which carried out by (Layla Bashawri et al., 2009) agreed with our study. A similar study performed by (J V Linden and others 2000) in USA, New York State Department of Health in October 2000, they found that the clerical errors of administration was observed in 19, 000 concentrated RBCs bags.

The frequencies of discrepancies 0.58% (7\1200), distributed as: 0.17% (2/1200) in Khartoum hospital`s blood bank, 0.17% (2/1200) in Bahari hospital and 0.25% (3/1200) in Omdurman hospital. This study similar to a study done by (Bipin Nepal 2019) in Grande International Hospital, Nepal. In addition, our study similar to another study carried out among patients and blood donors by (R. N. Makroo, B. Kakkar et al. 2019) in New Delhi, India. In Bahadur Hospital, Delhi, India there is a study performed by (Tanya Sharma et al 2014) on the Analysis of ABO Discrepancies among donors, it is finding as the same as our study. However, our study agreed with other one in Iran carried out by Hayedeh Javadzadeh Shahshahani and Azam Hayati at a Regional Blood Center (2020) and they found the discrepancies during the blood group.

The highest number of clerical errors and discrepancies observed in Omdurman and the possible causes might be to the high number of blood units (high workloads) coming to the hospital, the urgency of individual cases at short time duration (time pressures), furthermore the staff ratio to the number of the

processed blood bags was low, in addition to other miscellaneous cases like the high stress (emotional demands of work) fatigue (physical and mental presser).

Between the type of the clerical errors the higher number of errors found in registration errors (p value= 0.0005) see Table 5, these due to lack of concentration, interruptions during work, rotating of staff in the blood bank and the urgency of individual cases at short time duration.

5. Conclusion

The study found that the clerical errors and discrepancies were observed so, it is very important to use accurate method for correcting the clerical errors and find out the discrepant results and resolve them. Therefore, the precision of performing the ABO blood grouping and well identification of an individual are essential to prevent ABO incompatibility.

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