Research Article

Blood Transfusion and Associated Factors in Pregnant Women Admitted to a Tertiary Care Hospital in Southeast Iran

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Abstract

Background: Effective blood transfusion is a life-saving practice in obstetrics and gynecology emergencies that can prevent blood product wastage in hospitals.

Objectives: This study was performed to evaluate the appropriateness of the use of blood products in pregnant women in a tertiary care hospital in Zahedan, southeast Iran.

Methods: This cross-sectional study was carried out from September 2019 to March 2020 to assess the patterns of blood utilization in a tertiary care hospital in Zahedan, Iran. Blood bank registries and the data of 1,500 pregnant women were used for data analysis, using blood transfusion indices, including cross-matched to transfusion (C/T) ratio, transfusion probability (T), and transfusion index (TI).

Results: Out of 1,064 units of requested blood products, 581 (54.6%) were cross-matched, and 774 (72.7%) were transfused to patients. The blood transfusion indices of C/T, T%, and TI were 2.11, 48.48%, and 0.76, respectively. The transfusion rate was 6.2%, and the commonest associated obstetrics complication requiring transfusion was uterine atony (32.2%), followed by anemia (17.2%). There was a statistically significant relationship between the type of delivery, uterine and placental problems, coagulation disorders during pregnancy, number of deliveries, and residence place, and the probability of blood transfusion (P < 0.05).

Conclusions: The overall blood utilization indices were encouraging; however, the proportion of blood wastage was relatively high. Regular auditing is needed to optimize the use of blood and blood products in obstetrics and gynecology departments.

Keywords: Pregnant Women, Blood Utilization, Iran

1. Background

Obstetric bleeding is a leading cause of nearly 14 million cases of maternal mortality that occur each year worldwide [1]. Postpartum hemorrhage (PPH) is the most common type of obstetric hemorrhage. A cumulative blood loss equal to or greater than 500 mL within 24 hours following normal vaginal delivery or 1000 mL bleeding after cesarean section is considered PPH [1]. Approximately one-quarter of all maternal deaths worldwide are attributed to PPH [2]. It has been estimated that up to 3% of all women receive blood transfusion as a treatment for postpartum hemorrhage [3]. In some conditions, patients with life-threatening bleeding require massive transfusion (i.e., transfusion of more than 10 units of blood/blood products within 24 hours) [1]. Despite advances in the diagnosis, prevention, and management of obstetric hemorrhage, reducing deaths from obstetric bleeding remains a global challenge.

Most obstetric hemorrhages are preventable, and early and timely interventions can avert the development of dreadful conditions. Appropriate blood transfusion and rational clinical use of blood products are essential components of emergency obstetric care which have been shown to reduce maternal mortality [1]. The reasonable use of blood products has been defined as "providing the right blood or products, in the right quantity, to the right patient and at the right time, and bridging demand and supply gap" [4].

Blood transfusion is a life-saving intervention, but inappropriate usage of blood components in obstetric emergencies is highly likely to increase the risk of morbidity and maternal mortality [5]. Moreover, there are some controversies in transfusion practices carried out in obstetric

emergencies, such as transfusion of a single versus multiple units of blood, utilizing blood products versus whole blood, transfusing blood products based on clinical judgment versus the level of hemoglobin, and using different guidelines for massive transfusion, which need to be scientifically addressed through the implementation of evidence-based policies ([6]).

Studies on the efficiency of blood transfusion practices have used various performance indicators. The three commonly used transfusion indices are as follows:

(1) Cross-match to transfusion (C/T) ratio is calculated by dividing the number of cross-matched units by the total number of actually transfused blood units. A ratio of 2.5 or below is considered an indication of appropriate blood component usage ([7]). A C/T ratio above 2.5 indicates that 60% of cross-matched blood units are not transfused ([8]).

(2) Transfusion index (TI) is defined as the number of transfused units per cross-matched patient ([8]). A value of 0.5 or higher indicates that the blood is being used efficiently. This indicator highlights the adequacy of the number of cross-paired blood units.

(3) Transfusion probability (T) is calculated by dividing the number of patients receiving the transfusion by the number of patients cross-matched multiplied by 100. A T value of 30% or higher is considered to indicate adequate blood transfusion requirements and usage ([9]).

2. Objectives

This study was conducted to identify the patterns, indications, and factors related to the transfusion of blood products in pregnant women admitted to a tertiary care hospital in Zahedan, Iran.

3. Methods

3.1. Study Setting

This cross-sectional study was carried out from September 2019 to March 2020 in Ali Ibn Abi Taleb (PBUH) Hospital, a 523-bed tertiary care and referral center in Zahedan, Iran. In addition to routine admissions, the majority of complicated obstetric cases in the province are referred to this hospital for specialist management.

3.2. Subjects

According to the data obtained from the hospital information system (HIS), during the first three months of the same year of the study, 1,400 pregnant women were hospitalized, of whom 310 (22%) patients had received the blood products. Hence, the expected prevalence of blood transfusion for sample size calculation was considered as

P = 0.22, with a level of confidence of 95% (α = 0.05), and a relative precision of d = 0.03, and the estimated sample size was calculated as 733 pregnant women. The number of 733 cases was enough to determine the prevalence of blood transfusion. However, as there were about 17 independent variables in the regression modeling, a large sample size was needed to simultaneously examine the effect of the independent variables, so the sample size was doubled and rounded to 1,500 cases.

The inclusion criteria included all pregnant women admitted to maternity, obstetrics-gynecology, and postpartum wards in Ali Ibn Abi Taleb (PBUH) Hospital. Cases that had outcomes other than childbirth (natural vaginal delivery or cesarean section), such as abortion and hysterectomy, were not included in the study.

3.3. Data Collection

This study included two sets of data. First, blood requisition and transfusion by/of the hospital wards of maternity, obstetrics-gynecology, and postpartum were collected from the hospital blood bank registries for the study period of six months. For each ward, the number of requested, cross-matched, and transfused blood units and the number of cross-matched and blood-receiving patients were retrieved from blood bank records. The second data set, comprising the medical records of 1,500 pregnant women admitted to maternity, obstetrics-gynecology, and postpartum wards, was randomly selected from the hospital HIS. As a standard unique identifier, the medical record numbers for the patients admitted to those wards were compiled into three separate Microsoft Excel files and then entered into SPSS software. The required sample size and the share of each ward were determined using probability proportional to size based on the number of admissions during the first six months of the study year. The "select cases" command was used to generate a random sample of 570, 660, and 270 cases for the maternity, obstetrics-gynecology, and postpartum wards, respectively.

A 26-item checklist was developed to elicit patient-specific information on demographic characteristics, obstetrics and medical history, diagnosis, and transfusion details. The questionnaire collected data on the number of pregnancies, deliveries, and abortions, gestational age (weeks), multiple births, type of delivery (cesarean section, normal vaginal delivery, etc.), history of postpartum hemorrhage, blood transfusions in previous pregnancies, history of coagulation disorder and taking anticoagulants, placental and uterine complications, underlying disease (such as diabetes, hypertension, preeclampsia, etc.) blood transfusion in the current pregnancy, if any, the indication of blood and blood products transfusion, the type and the number of transfused blood products, patient's blood

group, and Rh. All data were retrieved from the hospital HIS records.

3.4. Statistical Analysis

Numbers and percentages were used to present categorical data. In addition to the frequency and proportion of the type and the number of utilized blood component units, the C/T ratio, T%, and TI were calculated to assess blood usage patterns. The wastage rate of blood and blood product units was calculated as a percentage of the requested blood and blood product units that were not transfused to patients.

We fitted several logistic regression models using the forward likelihood ratio method to identify relevant factors associated with blood transfusion in pregnant women. The following variables that showed a conservative p value of less than 0.25 in univariate logistic regression models were included in the final model: maternal age, place of residence, education, history of abortion, history of bleeding in a previous pregnancy, history of blood transfusion in a previous pregnancy, multiple pregnancies, type of delivery, coagulation disorder in pregnancy, history of anticoagulant use, uterine complications, placental complications, underlying disease, gestational age, number of pregnancies, and number of deliveries. In all analyses, p values less than 0.05 were considered statistically significant. Data analysis was conducted using the SPSS version 23 statistical software package (Chicago, IL). Ethical approval for this study was obtained from the Zahedan University of Medical Sciences Ethics Committee (Ethics Committee Code: IR.ZAUMS.REC.1398.324).

4. Results

4.1. Blood Transfusion Indices

According to the hospital blood bank data during the study period of six months, a total of 1,046 units of blood products were requested by maternity, obstetrics-gynecology, and postpartum wards (Figure 1), including 581 units of packed red blood cells (54.6%), 199 units of fresh frozen plasma (18.7%), 194 units of platelets (18.2%), and 90 units of cryoprecipitate (8.5%). Out of 1,064 requested units of blood components, 774 (72.7%) units were transfused to patients. Out of 581 units of crossed-matched blood products, only 275 units were transfused, with a C/T ratio of 2.11. Overall, 275 blood units were transfused to 361 cross-matched patients yielding a TI of 0.76. Out of 361 cross-matched patients, 175 received the blood components, with a T% of 48.48%.

4.2. Blood Components Consumption Pattern

Out of 1,500 randomly selected pregnant women admitted to the three aforementioned hospital wards, 93 (6.2%) patients received the blood products (Table 1). A total of 37 (40%) cases received a single-unit transfusion, and eight (8.6%) cases received a massive blood transfusion. The packed red blood cells were the most frequently used blood product (71%), followed by platelets (10.6%). None of the patients experienced acute transfusion reactions.

Table 1. The Distribution of the Number and the Type of Blood Products Consumed in Pregnant Women, Zahedan, Iran, September 2019 to March 2020 (n = 93)

Variables and Subgroups	No. (%)
Number of blood product units transfused per case	
1	37 (39.8)
2	30 (32.2)
3 - 9	18 (19.4)
10 ≤ [a]	8 (8.6)
Type of product	
Packed red blood cells	66 (71)
Platelets	10 (10.7)
Packed red blood cells and fresh frozen plasma	6 (6.4)
Packed red blood cells and platelets- cryoprecipitate and fresh frozen plasma	5 (5.4)
Packed red blood cells and fresh frozen plasma and platelets	4 (4.3)
Packed red blood cells and platelets	1 (1.1)
Packed red blood cells and fresh frozen plasma and cryoprecipitate	1 (1.1)
Blood group	
O	37 (39.8)
A	22 (23.6)
B	25 (27)
AB	9 (9.6)
Rh	
Positive	85 (91.4)
Negative	8 (8.6)

[a] Massive blood transfusion.

Uterine complications were the most frequent category of indications for blood product transfusion (37.6%), followed by placental complications (26.9%) (Table 2). Uterine atony and anemia were the most common indications for blood transfusion, constituting 32.2% and 17.2% of blood component recipients, respectively.

4.3. Factors Associated with Blood Transfusion

According to the results of the multiple logistic regression model (Table 3), living in rural areas (OR = 2.12; 95%
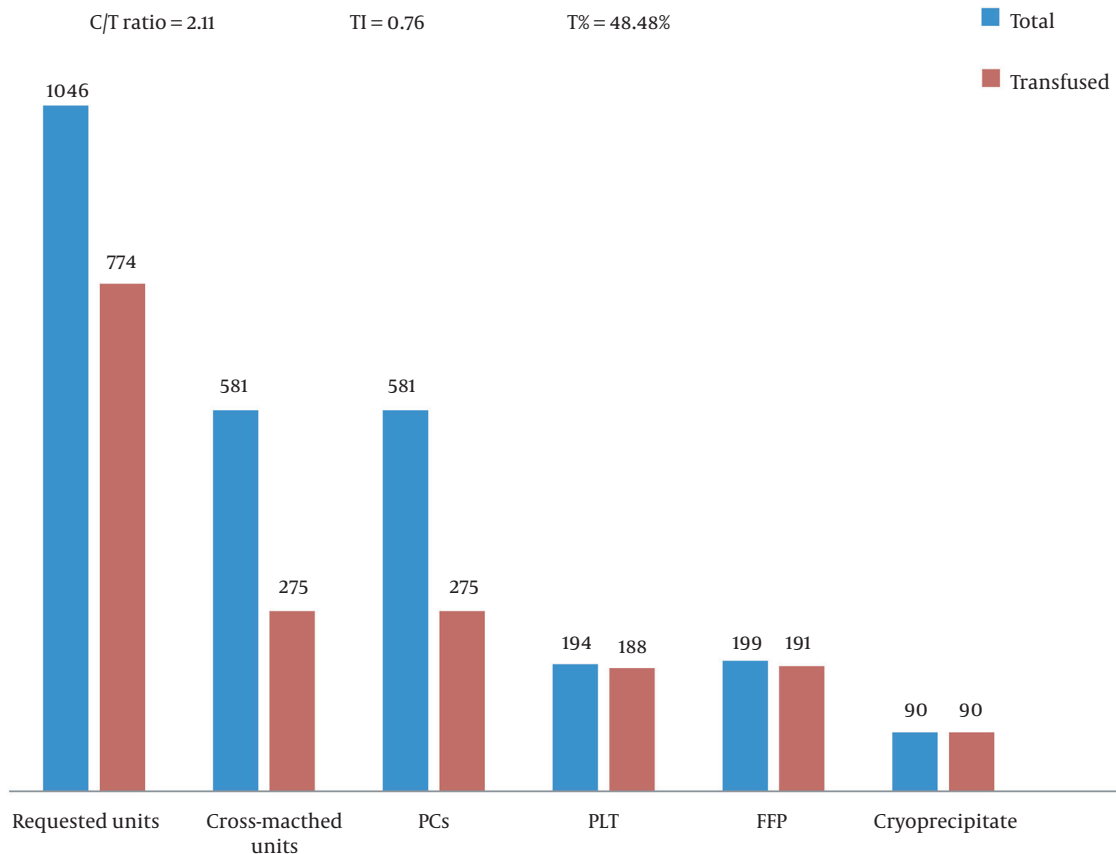
Figure 1. Frequency of requested and consumed blood products and related transfusion indices in maternity, obstetrics-gynecology, and postpartum wards, Ali Ibn Abi Taleb (PBUH) Hospital, Sep 2019 to March 2020, Zahedan, Iran (C/T ratio, cross-match transfusion ratio; TI, transfusion index; T, transfusion probability; PCs, packed red blood cells; FFP, fresh frozen plasma; PLT, platelets).

CI: 1.05 - 4.31), coagulation disorder during pregnancy (OR = 168.53; 95% CI: 54.69 - 519.33), uterine complications (OR = 727.32; 95% CI: 224.34 - 2357.99), placental complications (OR = 75.93; 95% CI: 30.66 - 188.08), Cesarean delivery (OR = 6.08; 95% CI: 2.51 - 14.63), and more than three deliveries (OR = 2.74; 95% CI: 1.30 - 5.72) were significantly associated with an increased chance of blood transfusion.

5. Discussion

This study aimed to assess the patterns of blood transfusion and related factors in pregnant women admitted to a tertiary care hospital using blood transfusion indices. In the present study, the C/T ratio was 2.11 (less than 2.5), TI was 0.76 (more than 0.5), and T was 48.48% (above 30%). All of the blood transfusion indices were within the recommended optimal range. This may be because our hospital is the only tertiary care referral institute in Sistan and Baluchestan Province, and our obstetrics and gynecology

department specialists have expertise in managing complicated obstetric cases with life-threatening conditions. Every year they care for thousands of pregnant women with bleeding problems. During the past two decades, a wide range of interventions has been implemented to prevent avoidable maternal deaths resulting from bleeding, focusing on appropriate management of acute PPH and proper use of blood products in obstetrics and gynecology patients. These interventions have optimized therapeutic modalities in obstetric emergencies and improved blood transfusion indices.

Inappropriate use of blood products is common in the maternity, obstetrics, and gynecology hospital wards in Iran. In 2014, a survey on blood consumption patterns in teaching hospitals in Zahedan, Iran, found that the C/T ratio and TI indices in the gynecology ward were 2.62 and 1.31, respectively (10). A study on the efficiency of blood utilization in a teaching hospital in Birjand, Iran, showed that the C/T ratio, TI, and T for the maternity ward were 6.1, 0.2, and

Table 2. Indications for Transfusions of Blood and Blood Components in Pregnant Women, Zahedan, Iran, September 2019 to March 2020, (n = 93)

Indications of Blood Transfusion and Subgroups	No. (%)
Group A: Placental complications	25 (26.9)
Placenta adhesion (accrete-increta-percreta)	9 (9.7)
Placenta previa	7 (7.5)
Placental abruption	5 (5.4)
Retained placenta	1 (1.1)
A combination of complications (adhesion + previa)	3 (3.2)
Group B: Uterine complications	35 (37.6)
Uterine atony	30 (32.2)
Rupture of the uterine wall	5 (5.4)
Group C: Other causes of blood transfusions	33 (35.5)
HELLP syndrome	6 (6.5)
Multiple pregnancies and repeat cesarean deliveries	2 (2.1)
Repeat cesarean deliveries	4 (4.3)
Anemia	16 (17.2)
Low platelet counts	5 (5.4)

12.4%, respectively. Similarly, the C/T ratio, TI, and T for the obstetrics-gynecology ward were reported as 5.3, 0.4, and 27.1%, respectively (11). Likewise, a study on the use of blood products in a university hospital in Mashhad, Iran, showed that the most unfavorable indices were observed for the obstetric and gynecologic ward where the blood transfusion indices of C/T ratio, TI, and T were 18.6, 3.37%, and 0.06, respectively (12).

In our study, a high rate of wastage (27.2%) was observed in blood products. The wastage rate of different blood products ranged from 0% for cryoprecipitate to 52.6% for PCs. This result is similar to a study in Zahedan, Iran, in 2015 that reported that the wastage rate in the maternity and obstetrics wards for different blood products was 28.4% and 24.4%, respectively (13). However, these figures showed an improvement compared to a study on the use of blood and blood components in Zahedan teaching hospitals in 2007, which found that 53.9% of requested blood product units in the obstetrics and gynecology wards were not utilized (14).

In this study, 40% of the cases received a single-unit transfusion. A review of the literature shows that the rate of single-unit transfusion ranges between 25% and 50% in both developing and developed countries (15-17). Some clinicians discourage the practice of single-unit transfusion. They believe this practice can be avoided in most cases as the patients are eligible for alternative conservative management (4). We found that the two most common indications for blood transfusion were uterine com-

plications (especially uterine atony) and anemia. This is consistent with the findings of studies on transfusion practices in antenatal and postnatal patients conducted in developing countries (17, 18).

In this study, factors associated with an increased risk of peripartum transfusion included living in rural areas, coagulation disorder during pregnancy, uterine complications, placental complications, Cesarean deliveries, and having more than three deliveries. Women in rural areas are less likely to have timely access to skilled labor and essential emergency obstetric services. Moreover, underutilization of maternity services increases the chance of pregnant women experiencing complicated deliveries, increasing the possibility of blood transfusion in those patients. Coagulopathies that occur during pregnancy can present as obstetric emergencies with catastrophic bleeding events requiring blood components transfusion (19). Accordingly, women with abnormal placentation and uterine complications have an increased risk of postpartum transfusion. Cesarean section is associated with an increased risk of significant intra-operative blood loss; hence, women undergoing Cesarean sections are at increased risk for administering blood products in obstetric emergencies (20). In agreement with our study results, a multinational, randomized trial of 20,060 women with postpartum hemorrhage conducted in 193 hospitals in 21 countries found that cesarean section and the presence of identifiable causes of bleeding significantly increased blood transfusion likelihood in the study population (21). Accordingly, a retrospective cohort study carried out in China found that factors such as polyembryony, placental and uterine complications (including placental implantation abnormalities, placenta previa, retained placenta, intrauterine adhesions, and uterine rupture), stillbirth, and HELLP syndrome significantly increased the probability of perinatal blood transfusion (22). A timely referral to obstetrics and gynecologist specialists can help identify those risk factors. Therefore, necessary measures can be taken to prevent life-threatening complications, reduce the need for blood transfusions, and improve patient outcomes.

Patient blood management has been effectively fulfilled in various clinical settings, but it seems that some obstetricians and gynecologists are still oblivious to the importance of appropriate usage of blood products (23). Improving patient blood management in obstetrics and gynecology practices can be achieved through the training of updated standard guidelines on the appropriate utilization of blood components and regular audits of blood transfusion practices. This can be followed by active interventions to optimize therapeutic options in obstetric emergencies and prevent erroneous use of blood components (17).

Table 3. Results of Multiple (Adjusted) Logistic Regression Analysis of the Factors Associated With Blood Transfusion in Pregnant Women, Zahedan, Iran, September 2019 to March 2020 (n = 1,500) [a]

Variables	Transfusion	No Transfusion	Crude OR (95% CI)	Adjusted OR (95% CI)	P-Value
Residence					0.037
Urban	55 (5.5)	944 (94.5)	1	1	
Rural	38 (7.6)	463 (92.4)	1.41 (0.91 - 2.16)	2.12 (1.05 - 4.31)	
Type of delivery					0.001
NVD	20 (2.3)	848 (97.7)	1	1	
Cesarean section	73 (11.6)	559 (88.4)	5.54 (3.34 - 9.19)	6.08 (2.51 - 14.63)	
Coagulation disorder in pregnancy					0.001
No	76 (5.1)	1400 (94.9)	1	1	
Yes	17 (70.8)	7 (29.2)	44.74 (18.01 - 111.14)	168.53 (54.69 - 519.33)	
Placental problems					0.001
No	68 (4.6)	1396 (95.4)	1		
Yes	25 (69.4)	11 (30.6)	46.66 (22.05 - 98.75)	75.93 (30.66 - 188.08)	
Uterine problems					0.001
No	58 (4.0)	1402 (96.0)	1	1	
Yes	35 (87.5)	5 (12.5)	169.21 (63.94 - 447.77)	727.32 (224.34 - 2357.99)	
Number of deliveries					0.008
3 ≥	62 (5.1)	1142 (94.9)	1	1	
3 <	31 (10.5)	265 (89.5)	2.15 (1.37 - 3.38)	2.74 (1.30 - 5.72)	

[a] The final multiple logistic regression model was adjusted for maternal age, education, history of abortion, history of bleeding in a previous pregnancy, history of blood transfusion in a previous pregnancy, multiple pregnancies, history of anticoagulant use, underlying disease, gestational age, and the number of pregnancies.

One limitation of the present study is that it was conducted on data collected from a single referral hospital, and the findings only give an insight into the patterns of blood and blood product utilization in pregnant women in this single tertiary care referral center.

5.1. Conclusions

This study highlights the importance of proper and rational use of blood components in pregnant women. Development and meticulous administration of clinical guidelines for the appropriate use of different blood products and regular evaluation of transfusion practices are needed to identify areas for improvement.

Footnotes

References

1. World Health Organization. *WHO Recommendations for the Prevention and Treatment of Postpartum Haemorrhage.* Geneva, Switzerland: World

Health Organization; 2012.

2. Say L, Chou D, Gemmill A, Tunçalp Ö, Moller AB, Daniels J, et al. Global causes of maternal death: a WHO systematic analysis. *Lancet Glob Health*. 2014;**2**(6):e323–33. [PubMed ID: 25103301]. https://doi.org/10.1016/s2214-109x(14)70227-x.

3. Thurn L, Wikman A, Westgren M, Lindqvist PG. Incidence and risk factors of transfusion reactions in postpartum blood transfusions. *Blood Adv*. 2019;**3**(15):2298–306. [PubMed ID: 31366586]. [PubMed Central ID: PMC6693016]. https://doi.org/10.1182/bloodadvances.2019000074.

4. Chhabra S, Namgyal A. Rationale use of blood and its components in obstetric-gynecological practice. *J Mahatma Gandhi Inst Med Sci*. 2014;**19**(2):93. https://doi.org/10.4103/0971-9903.138427.

5. Adukauskienė D, Veikutienė A, Adukauskaitė A, Veikutis V, Rimaitis K. The usage of blood components in obstetrics. *Medicina (Kaunas)*. 2010;**46**(8):561–7. [PubMed ID: 20966634].

6. Tomic Mahecic T, Dünser M, Meier J. RBC Transfusion Triggers: Is There Anything New? *Transfus Med Hemother*. 2020;**47**(5):361–8. [PubMed ID: 33173454]. [PubMed Central ID: PMC7590774]. https://doi.org/10.1159/000511229.

7. Boral LI, Henry JB. The type and screen: a safe alternative and supplement in selected surgical procedures. *Transfusion*. 1977;**17**(2):163–8. [PubMed ID: 403642]. https://doi.org/10.1046/j.1537-2995.1977.17277151923.x.

8. Friedman BA, Oberman HA, Chadwick AR, Kingdon KI. The maximum surgical blood order schedule and surgical blood use in the United States. *Transfusion*. 1976;**16**(4):380–7. [PubMed ID: 951737]. https://doi.org/10.1046/j.1537-2995.1976.16476247063.x.

9. Mead JH, Anthony CD, Sattler M. Hemotherapy in elective surgery: an incidence report, review of the literature, and alternatives for guideline appraisal. *Am J Clin Pathol*. 1980;**74**(2):223–7. [PubMed ID: 7405903]. https://doi.org/10.1093/ajcp/74.2.223.

10. Khazaei A, Jahromi AS, Khoshfetrat M, Behnampoor M, Jahandideh M. Monitoring blood consumption with emphasis on MSBOS table in Educational Hospitals Zahedan, Iran, 2014. *J Res Med Dental Sci*. 2018;**6**(2):574–7. https://doi.org/10.5455/jrmds.20186288.

11. Anani Sarab G, Asadi Fard M, Mesbahzadeh B. [Study of blood utilization in Vali-e Asr educational hospital in Birjand Iran: short communication]. *J Birjand Univ Med Sci*. 2015;**22**(2):176–81. Persian.

12. Yazdi AP, Alipour M, Jahanbakhsh SS, Gharavifard M, Gilani MT. A Survey of Blood Request Versus Blood Utilization at a University Hospital in Iran. *Arch Bone Jt Surg*. 2016;**4**(1):75–9. [PubMed ID: 26894224]. [PubMed Central ID: PMC4733241].

13. Miri-Moghaddam E, Tahmasebi A, Khedria S, Khosravi S. Determination of Blood components Utilization Pattern in Zahedan City, Southeast of Iran. *Mod Care J*. 2020;**17**(1). e97586.

14. Karami SH, Purkhosravi N, Sanei Moghadam E, Khosravi SOHEYLA. [Consumption trend of blood and blood components in Zahedan teaching hospitals]. *Scientific Journal of Iran Blood Transfus Organ*. 2009;**5**(4):257–66. Persian.

15. Asgharnia M, pakseresht S. [Blood Products Consumption in Women who Admitted at the Obstetrics and Gynecologic Teaching Hospital of Rasht, 2011-2014]. *Iran J Surg*. 2018;**26**(1):55–62. Persian.

16. Flores CJ, Sethna F, Stephens B, Saxon B, Hong FS, Roberts T, et al. Improving patient blood management in obstetrics: snapshots of a practice improvement partnership. *BMJ Qual Improv Rep*. 2017;**6**(1). e000009. [PubMed ID: 28824807]. [PubMed Central ID: PMC5492477]. https://doi.org/10.1136/bmjquality-2017-000009.

17. Kandasamy D, Kumar Selvarajan A, Jeyakumar JD. Outcome of audit and education on blood transfusion practice in obstetrics setting. *Hematol Transfus Cell Ther*. 2022;**44**(2):151–5. [PubMed ID: 33422489]. [PubMed Central ID: PMC9123551]. https://doi.org/10.1016/j.htct.2020.08.014.

18. Bangal VB, Gavhane SP, Aher KH, Bhavsar DK, Verma PR, Gagare SD. Pattern of utilization of blood and blood components in obstetrics at tertiary care hospital. *Int J Reprod Contracept Obstet*. 2017;**6**(10):4671. https://doi.org/10.18203/2320-1770.ijrcog20174462.

19. Bhave AA. Coagulopathies in Pregnancy: What an Obstetrician Ought to Know!. *J Obstet Gynaecol India*. 2019;**69**(6):479–82. [PubMed ID: 31844360]. [PubMed Central ID: PMC6888769]. https://doi.org/10.1007/s13224-019-01290-8.

20. Abbas S, Mughal S, Hussain SNF, Hossain N. Blood transfusion and high-order cesarean delivery; Report from a developing country. *Pak J Med Sci*. 2019;**35**(6):1520–5. [PubMed ID: 31777486]. [PubMed Central ID: PMC6861507]. https://doi.org/10.12669/pjms.35.6.539.

21. Kolin DA, Shakur-Still H, Bello A, Chaudhri R, Bates I, Roberts I. Risk factors for blood transfusion in traumatic and postpartum hemorrhage patients: Analysis of the CRASH-2 and WOMAN trials. *PLoS One*. 2020;**15**(6). e0233274. [PubMed ID: 32492040]. [PubMed Central ID: PMC7269233]. https://doi.org/10.1371/journal.pone.0233274.

22. Xing Z, He Y, Ji C, Xu C, Zhang W, Li Y, et al. Establishing a perinatal red blood cell transfusion risk evaluation model for obstetric patients: a retrospective cohort study. *Transfusion*. 2019;**59**(5):1667–74. [PubMed ID: 30801731]. [PubMed Central ID: PMC6563495]. https://doi.org/10.1111/trf.15208.

23. Surbek D, Vial Y, Girard T, Breymann C, Bencaiova GA, Baud D, et al. Patient blood management (PBM) in pregnancy and childbirth: literature review and expert opinion. *Arch Gynecol Obstet*. 2020;**301**(2):627–41. [PubMed ID: 31728665]. [PubMed Central ID: PMC7033066]. https://doi.org/10.1007/s00404-019-05374-8.