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Original Article

Short-Term Blood Transfusion Outcomes in Preterm Infants admitted to Neonatal Intensive Care Unit (NICU): A Retrospective Analytical Study

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Abstract

Background: Red blood cell (RBC) transfusions in preterm infants have been associated with increased risk of short-term morbidities, as necrotizing enterocolitis (NEC), bronchopulmonary dysplasia (BPD), retinopathy of prematurity (ROP) and intracranial hemorrhage (ICH). **Aim of work:** To study the relationship between RBC transfusions and short-term morbidities in preterm infants. **Patients and Methods:** Retrospectively, the relationship between RBC transfusions, number of transfusions and short-term morbidities were investigated in the first week and month over two years from 1st March 2018 to 29th February, 2020. One hundred sixty-one preterm infants were included: 91 females and 70 males who were ≤ 32 weeks of gestation and 1500 grams. **Results:** First week transfusions significantly correlated with the incidence and severity of ROP and BPD (P-value 0.012 & 0.014 for ROP) and (P-value 0.001 for the incidence and severity of BPD) and only the incidence of NEC and ICH regardless of the number of transfusions (P-value <0.001 for both), except for the outcome, where number of transfusions was significant in addition (P-value 0.007) compared to a highly significant outcome in relation to first week transfusion (P-value <0.001). First month transfusions were considerably associated with the incidence and severity of ROP (P-value <0.001 for both) and only associated with the incidence of NEC, ICH, and BPD (P-value of <0.001 for all). First month number of transfusions significantly correlated with the incidence and severity of BPD (P-value 0.024 & and 0.006 respectively) and the outcome (P-value 0.004). **Conclusion:** RBCs transfusion should be limited to the extremely indicated preterm infants especially in the first month of life.

Key words: Blood Transfusion, Preterm, NICU, necrotizing enterocolitis, bronchopulmonary dysplasia, retinopathy of prematurity.

Introduction

The improvement of neonatal intensive care has increased the survival rate among tiny premature infants [1], leading to a rise in the rate of RBC transfusions [2]. RBC transfusion increases tissue oxygenation through higher circulation of hemoglobin. The tinier the premature infants are, the more prone they are to cardiopulmonary compromise, frequent phlebotomies, subsequent anemia, and frequent RBC transfusions [3-6].

The guidelines for blood transfusion in the Neonatal Intensive Care Unit (NICU) are generalized and subjective [7,8]. Symptomatic anemia occurs and affects the clinical condition when the imbalance between oxygen delivery and consumption is observed; the hemoglobin is not at the standard level and varies with every preterm [9]. The decision for transfusion is made by the neonatologist, who expects the benefits to outweigh the risks. However, these decisions are not always evidence-based and highly dependent on experience and local guidelines [10].

In the previous two decades, the evidence showed the adverse effects of frequent RBC transfusions, including the risk of mortality, multi-organ system failure, and prolonged hospital stay. Preterm infants were more prone to tissue injury due to impaired tissue oxygenation. Neonatal studies compared RBC transfusion with the incidence of short-term outcomes such as BPD, NEC, ROP, and ICH [11-17].

This study was conducted to eradicate the inconsistency found so far and to elucidate the relationship between RBC transfusion and short-term morbidities and outcomes in preterm infants with gestation of less than or equal to 32 weeks and weighing less than or equal to 1500 grams. This study was conducted in line with the standard RBC transfusion protocol.

Methods

Inclusion Criteria: This research centered on infants having a gestational ages of

less than or equal to 32 weeks and weighing less than or equal to1500 grams. They were admitted to Cairo University Children Hospital (Aburreesh El-Mounira) from the 1st of March 2018 to the 29th of February 2020.

Neonatal data included gestational age, birth weight, sex, mode of delivery, and multiple gestations.

Maternal history included premature rupture of membranes, preeclampsia, gestational diabetes mellitus, and administration of antenatal medications like steroids.

Exclusion criteria: Infants who died during the first month and newborns with congenital anomalies.

RBC transfusion was implemented on a clinical basis and in line with the transfusion guidelines as stated in the Manual of Neonatal Care [18]. Packed RBCs (PRBC) were transfused at a dose of 15 mL/kg over two to three hours. The RBC units were filtered and irradiated. Feeding was skipped before and after RBC transfusion. During the study period, delayed cord clamping was rarely performed as many obstetricians did not follow the guidelines for delayed cord clamping.

Neonatal morbidities included respiratory distress syndrome (RDS), bronchopulmonary dysplasia (BPD), pneumothorax, patent ductus arteriosus (PDA), early-onset sepsis (EOS), late-onset sepsis (LOS), necrotizing enterocolitis (NEC) (stage≥2), intracranial hemorrhage (ICH) (grade ≥1), retinopathy of prematurity (ROP) and infectious episodes such as pneumonia, CNS infections, urinary tract infections, wound infections, infective endocarditis, myocarditis, septic arthritis and omphalitis. Hospital duration, oxygenation, total parenteral nutrition (TPN) duration, inotropes, and inhaled steroids were recorded.

RDS was diagnosed based on characteristic clinical symptoms and chest X-rays. BPD diagnosis and severity were carried out depending on the severity-based definition of BPD by the

National Institute of Child Health and Human Development (NICHD) [19]. At the time of assessment, infants with no oxygen need were considered as mild BPD. Moderate BPD was considered for cases requiring less than 30% oxygen while severe BPD was considered for cases needing positive pressure and/or oxygen support ≥30% [19].

Sepsis was diagnosed when a positive blood culture and systemic symptoms were present. Early-onset sepsis was defined as sepsis occurring at less than seven days and late-onset sepsis as sepsis occurring seven days or more after birth. NEC was diagnosed based on systemic symptoms and radiographic findings, with severity based on the staging criteria modified by Bell et al. [20]. Moreover, PDA was diagnosed by clinical symptoms and echocardiography. ROP was established by a neonatologist and confirmed by an ophthalmologist following a schedule of the American Academy of Ophthalmology [21]. Furthermore, ICH was identified via brain ultrasound [22–24]. An initial brain ultrasound was performed within 72 hours of birth and rescreening was performed at intervals of one to four weeks. In cases of abnormal brain ultrasound or neurological symptoms, brain MRI was performed prior to discharge.

In the RBC transfusion group, the number of transfusions, age, and Hb (Hematocrit) level at time of the first transfusion were further reviewed. The number of PRBC transfusions within seven days (Group1) and 30 days of life (Group2) were recorded for each patient.

Ethical consideration

This study's protocol has been approved by the Ethics Committee of the Faculty of Medicine, Cairo University, and complies with the provision of the Declaration of Helsinki in 1964 and its later amendments or comparable ethical standards. Informed written consent has been obtained from the parents–of each child before their enrollment in this study.

Statistical analysis

Data analysis was performed using the IBM SPSS program version 21. Quantitative variables were described as mean, standard deviation (SD), median, and interquartile range (IQR) while qualitative variables were defined as number and percentage. A Chi-square test was employed to compare qualitative variables; the Pearson correlation was used to test linear relations between variables. A P-value less than or equal to 0.05 was considered significant, and less than or equal to 0.01 was deemed highly significant.

Results

During the two-year study period, 161 premature infants with less than or equal to 32 weeks of gestation and less than or equal to 1500 gm were admitted to our NICU. There were 91 males and 70 females. Table 1(a, b, and c) displays that the (a) average gestational age was 30.8±1.2 (mean± standard deviation); (b) average birth weight in grams was 1287±144.1; (c) average admission period in days was 44.4±16.4; (d) average duration of oxygen in days was 25.3±14.3; (e) average duration of caffeine citrate was 32.4±16.5; and (f) average duration of mechanical ventilation, CPAP, oxygen blender, head box, and incubator oxygen was 16.6±16.6, 9.8±7.5, 5.7±3.2, 2.7±1.4, 2.8±1.9, respectively.

Table 1 also shows that the average duration of TPN in days was 17.7±11.7; the average onset of trophic feeding in days was 2.3±1.3; the average intake of inotropes duration in days was 12.4±7.6; and average inhaled steroids duration in days was 17±12.6. Furthermore, the average hemoglobin and hematocrit on admission were 15± 2.7 and 43.9±8.1, respectively; while at the time of the first transfusion, the average hemoglobin and hematocrit were 9.5±1.6 and 27.3±4.3. Additionally, the average blood volume transfused was 54.9±30.2; the average infectious episodes were 1.9±1.2; and the average maternal age in years was 26.8±4.

There were 139 RDS cases (86.3%), 155 VLBW infants (96.3%), 6 ELBW cases (3.7%), 29 PROM cases (18%), and 41 multiple gestation cases (25.5%). Antenatal steroid use was found in 45 cases (28%), and oxygen was administered for 140 neonates in the form of CPAP, blender, mechanical ventilation, head box, and incubator oxygen (124 (77%), 127 (78.9%), 58 (36%), 113 (70.2), 126 (78.3%), respectively). TPN was administered in 141 cases (87.6%) while inotropes were given in 83 cases (51.6%). PDA was diagnosed in 57 cases (35.4%) and was treated in 55 cases (34.2%).

Early onset sepsis (EOS) developed in 65 cases (40.4%) while late onset sepsis (LOS) appeared in 126 cases, accounting for 78.3%. There was also NEC in 34 cases (21.1%), ICH in 45 cases (34.2%), jaundice in 92 cases (57.1%), ROP in 102 cases (63.4%), BPD in 60 cases (37.3%), and pneumothorax in 36 cases (22.5%). Forty-five cases (28%) received surfactant. Forty-three cases received blood in the first week accounting for 26.7%, and 86 cases in the first month (53.4%). Thirty-five cases (21.7%) were delivered by vaginal delivery and 126 cases (78.3%) by caesarian section. Maternal illnesses documented in the records were 11 DM (6.8%) and 19 preeclampsia (11.8%) as shown in Table 1.

Blood transfusion in the first week was predominantly associated with the incidence of NEC, ICH, ROP and its degrees of severity as well as with BPD and its degree of severity, regardless of the number of transfusions. However, the outcome was significant in addition to the number of transfusions, as shown in table 2 and table 3.

In the first month, blood transfusion was significantly correlated with the incidence of NEC, ICH, and ROP and its degree of severity. Blood transfusion was also substantially related to the incidence of BPD although no statistical significance with the severity of BPD was found. The number of transfusions in

the first month was considerably linked to the incidence and severity of BPD and the outcome as shown in table 4 and table 5.

As shown in table 6, a moderate positive correlation was identified between the duration of oxygen in days, the duration of mechanical ventilation, the duration of TPN, the use of inhaled steroids, and infectious episodes and the number of transfusions in the first month. Moreover, there was a weak positive correlation between the duration of inotropes intake and the number of transfusions in the first month.

Additionally, in the first week, there was a moderate positive correlation between the number of transfusions and the duration of mechanical ventilation and a moderate negative relationship between the number of transfusions and CPAP duration. The number of transfusions in the first month showed a moderate negative correlation to the birth weight and gestational age. Age at time of the first transfusion showed a moderate positive correlation to birth weight and a weak positive correlation to gestational age in weeks as shown in table 7.

Table (8) compared the incidence of morbities in relation to first week (Group 1) and month (Group 2) transfusions

Figures (1-4) described the incidence of individual morbidity in relation to first week and month transfusions

Discussion

The study revealed that RBC transfusion in the first week of life in preterm infants whose gestational age was less than or equal to 32 weeks and whose weight was less than or equal to 1500 grams was associated with an increased risk of death. This finding is consistent with the results provided by Dos Santos et al. [11] and Wang et al. [25]. This can be explained by pro-inflammatory mechanisms and is considered to be one of the associations of transfusion-related immunomodulation according to the study of Vamvakus and Blajchman [26].

Blood transfusion during the first week and month was significantly associated

with the incidence of NEC, ICH, and ROP along with its severity, regardless of the number of transfusions; mortality was significant in addition to the number of transfusions. Moreover, blood transfusion in the first week was largely connected to the incidence and severity of BPD, and only to the incidence of BPD at one month, regardless of the number of transfusions. However, the number of transfusions only became significant at one month. Both the incidence and severity were significant for the number of transfusions.

Regarding NEC, this research agreed with those reported by mny other studies [12, 13 & 27], but contradicts the studies of Wang et al. [25] and Wallestein et al. [28]. Severe anemia causes a reduction in mesenteric blood flow and eventually hypoxia. The re-oxygenation induced by blood transfusion causes reperfusion injury [29-32].

Concerning ICH, this study concurs with the researches [3, 16] but disagrees with other reports [8, 27]. The main cause for development or progression of ICH in relation to transfusion is unclear and needs further future studies. Though, it might be related to fluctuations in blood pressure in relation to transfusion, coagulation defect or might be the reason or related to the initial reason for transfusion.

With BPD, this paper's outcome coincided with the findings of many studies [7, 8, 27, 32 & 33] but opposes Wang et al.'s results [25]. Transfusion increases oxidative injury caused by, an increase in non-transferrin bound iron, and inflammatory mediators present in stored blood products.

In reference to ROP, this research was consistent with other reports [9, 14, 15 & 33] who reported a correlation between the grades of ROP (more than or equal to two) and transfusions in ELBW and VLBW infants (more than or equal to two); however, this study opposes the findings of others reports [4, 7 & 27].

Blood transfusions increase the risk of ROP by two mechanisms: (a) by

increasing retinal oxygen supply and (b) by increasing oxygen free radicals through free iron overload. Despite these explanations, there are conflicting studies that compare ROP and anemia [10, 34 & 35].

Regarding mortality, RBC transfusions in the first week was essentially related to death as shown in the research of Dos Santos et al. [11] and Wang et al. [25].The reason for mortality in relation to first week transfusion is unclear and may be related to the entity of prematurity itself.

Vamvakus et al. [26] suggested that transfusion might be associated with multi-organ system failure, pro-inflammatory mechanisms, and transfusion-related immunomodulation. These explanations may not explain fully the mortalities in this study as neonates included, died long time after the first week transfusions and even more than one month of age. This finding necessitates further prospective studies to detect the reason behind first week transfusions and 100% mortality as is the case in our study.

From the results of this study we recommend the following: It is of the utmost importance to limit the number of samplings in the preterm infants as they are the most common cause of RBC transfusion. Emphasis should be made on the use of a delayed cord clamping policy and early enteral feeding together with iron supplementation. Moreover, transfusions in the first week should be limited to infants designated as extremely indicated preterm. Further research is needed to establish comprehensive guidelines specifying the timing of transfusions in relation to development and severity and calling for close follow-up of the aforementioned morbidities.

Limitations: The limitations of this retrospective study are linked to the improper recording of data that has impeded the achievement of better results. Moreover, several factors, including all the complications of prematurity other than those studied such

as hypothermia, neonatal sepsis and nosocomial infections demonstrated the same outcome and could not be properly evaluated, except through statistical analysis.

Conclusions

RBCs transfusion should be limited to the extremely indicated preterm infants especially in the first month of life with special emphasis on the first week with close follow up of transfusion associated morbidities like NEC, ROP, BPD and ICH.

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Author's contributions

NG: Conceptualization; Investigation and writing the original draft. AA: Data curation; validation; software writing, review & editing. NG and AA: Writing - review & editing. All authors have read and approved the final manuscript.

Conflict of interest

The author has no conflict of interests to declare.

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References

1. Shim JW, Jin HS, Bae CW. Changes in survival rate for very-low-birthweight infants in Korea: comparison with other countries. J Korean Med Sci. 2015; 30(1):S25-34.
2. Widness JA, Madan A, Grindeanu LA, Zimmerman MB, Wong DK, Stevenson DK. Reduction in red blood cell transfusions among preterm infants: results of a randomized trial with an in-line blood gas and chemistry monitor. Pediatrics 2005; 115:1299-306.
3. Baer VL, Lambert DK, Henry E, Snow GL, Christensen RD. Red blood

cell transfusion of preterm neonates with a Grade 1 intraventricular hemorrhage is associated with extension to a Grade 3 or 4 hemorrhage. Transfusion 2011; 51:1933-9.

4. Brooks SE, Marcus DM, Gillis D, Pirie E, Johnson MH, Bhatia J. The effect of blood transfusion protocol on retinopathy of prematurity: A prospective, randomized study. Pediatrics 1999; 104(3 Pt 1):514-8.
5. Mohamed A, Shah PS. Transfusion associated necrotizing enterocolitis: a meta-analysis of observational data. Pediatrics 2012; 129:529-40.
6. Zhang Z, Huang X, Lu H. Association between red blood cell transfusion and bronchopulmonary dysplasia in preterm infants. Sci Rep. 2014; 4:4340.
7. Valieva OA, Strandjord TP, Mayock DE, Juul SE. Effects of transfusions in extremely low birth weight infants: a retrospective study. J Pediatr. 2009; 155:331-337.
8. Kirpalani H, Whyte RK, Andersen C, Asztalos EV, Heddle N, Blajchman MA, et al. The Premature Infants in Need of Transfusion (PINT) study: a randomized, controlled trial of a restrictive (low) versus liberal (high) transfusion threshold for extremely low birth weight infants. J Pediatr. 2006; 149:301-307.
9. Chirico G, Di Stefano G, Romeo MG, Scuderi A, Di Pietro M, Pisano F, et al. Italian multicentre study on retinopathy of prematurity. Eur J Pediatr. 1997; 156:939-43.
10. Bell EF, Strauss RG, Widness JA, Mahoney LT, Mock DM, Seward VJ, et al. Randomized trial of liberal versus restrictive guidelines for red blood cell transfusion in preterm infants. Pediatrics 2005; 115:1685-1691.
11. Dos Santos AM, Guinsburg R, De Almeida MF, Procianoy RS, Leone CR, Marba ST, et al. Red blood cell transfusions are independently associated with intra-hospital

mortality in very low birth weight preterm infants. J Pediatr. 2011; 159:371-376.

12. Mally P, Golombek SG, Mishra R, Nigam S, Mohandas K, Depalhma H, et al. Association of necrotizing enterocolitis with elective packed red blood cell transfusions in stable, growing, premature neonates. Am J Perinatol. 2006;23:451-458.
13. Blau J, Calo JM, Dozor D, Sutton M, Alpan G, La Gamma EF. Transfusion-related acute gut injury: necrotizing enterocolitis in very low birth weight neonates after packed red blood cell transfusion. J Pediatr. 2011; 158:403-409.
14. Inder TE, Clemett RS, Austin NC, Graham P, Darlow BA. High iron status in very low birth weight infants is associated with an increased risk of retinopathy of prematurity. J Pediatr. 1997; 131:541-544.
15. Dani C, Reali MF, Bertini G, Martelli E, Pezzati M, Rubaltelli FF. The role of blood transfusions and iron intake on retinopathy of prematurity. Early Hum Dev. 2001; 62:57-63.
16. Christensen RD, Baer VL, Lambert DK, Ilstrup SJ, Eggert LD, Henry E. Association, among very-low-birthweight neonates, between red blood cell transfusions in the week after birth and severe intraventricular hemorrhage. Transfusion 2014; 54:104-10814.
17. Baer VL, Lambert DK, Henry E, Snow GL, Butler A, Christensen RD. Among very-low-birth-weight neonates is red blood cell transfusion an independent risk factor for subsequently developing a severe intraventricular hemorrhage? Transfusion 2011; 51:1170-1178.
18. Asimenia I, Angelidou, Christou HA. Cloherty and Stark's Manual of neonatal care. 8th ed. Philadelphia, PA: Wolters Kluwer; 2017. Pp. 613-623.
19. Jobe AH, Bancalari E. Bronchopulmonary dysplasia. Am J

Respir Crit Care Med. 2001; 163:1723-9.

20. Bell MJ, Ternberg JL, Feigin RD, Keating JP, Marshall R, Barton L, et al. Neonatal necrotizing enterocolitis. Therapeutic decisions based upon clinical staging. Ann Surg. 1978; 187:1-7.
21. Fierson WM, American Academy of Pediatrics Section on Ophthalmology. American Academy of Ophthalmology. American Association for Pediatric Ophthalmology and Strabismus. American Association of Certified Orthoptists Screening examination of premature infants for retinopathy of prematurity. Pediatrics 2018; 142: e20183061.
22. Benson JE, Bishop MR, Cohen HL. Intracranial neonatal neuro-sonography: an update. Ultrasound Q. 2002; 18:89-114.
23. Flodmark O, Roland EH, Hill A, Whitfield MF. Periventricular leukomalacia: radiologic diagnosis. Radiology 1987; 162(1 Pt 1):119-24.
24. Dorner RA, Burton VJ, Allen MC, Robinson S, Soares BP. Preterm neuroimaging and neuro-developmental outcome: a focus on intraventricular hemorrhage, post-hemorrhagic hydrocephalus, and associated brain injury. J Perinatol. 2018; 38:1431-43.
25. Wang YC, Chan OW, Chiang MC, Yang PH, Chu SM, Hsu JF, et al. Red Blood Cell Transfusion and Clinical Outcomes in Extremely Low Birth Weight Preterm Infants. Pediatrics & Neonatology [Internet]. 2017 Jun; 58(3):203-204. Available from: https: //pubmed. ncbi. nlm. nih.gov/ 27514234/ DOI:10.1016/j.pedneo.2016.03.009
26. Vamvakas EC, Blajchman MA. Transfusion-related immunomo-dulation (TRIM): an update. Blood Rev. 2007; 21:327e48.
27. Lee EY, Kim SS, Park GY, Lee SH. Effect of red blood cell transfusion on

short-term outcomes in very low birth weight infants. Clin Exp Pediatr. [Internet]. 2020 Feb; 63(2):56-62. Available from: https:// www. ncbi. nlm. nih.gov /pmc/ articles/ PMC 7029666/ DOI: 10.3345 /kjp. 2019. 00 990.

28. Wallenstein MB, Arain YH, Birnie KL, Andrews J, Palma JP, Benitz WE, et al. Red blood cell transfusion is not associatedwith necrotizing enterocolitis: a review of consecutive trans-fusions in a tertiary neonatal intensive care unit. J Pediatr. 2014; 165:678e82.
29. Luban NL. Neonatal red blood cell transfusions. Vox Sang. 2004; 87 (suppl 2):184-188.
30. Connely RJ, Whyte RK. Early versus late red cell transfusion in low birth weight infants (abstract). Pediatr Res. 1998; 43:170.
31. Mukhopadhyay K, Ghosh PS, Narang A, Dogra MR. Cut off level for RBC transfusion in sick preterm neonates. Pediatr Res. 2004; 55:288A.
32. Chen HL, Tseng HI, Lu CC, Yang SN, Fan HC, Yang RC. Effect of blood transfusions on the outcome of very low body weight preterm infants under two different transfusion criteria. Pediatr Neonatol. 2009; 50:110-116.
33. Ghirardello S, Dusi E, Cortinovis I, Villa S, Fumagalli M, Agosti M, et al. Effects of Red Blood Cell Transfusions on the Risk of Developing Complications or Death: An Observational Study of a Cohort of Very Low Birth Weight Infants. Am J Perinatol. [Internet]. 2017 Jan; 34(1):88-95. Available from: https:/ /pubmed. ncbi.nlm.nih. gov/ 2724 9797/ DOI: 10.1055/s-0036-1584300.
34. Giannantonio C, Papacci P, Cota F, Vento, G, Tesfagabir MG, Purcaro, V et al. Analysis of risk factors for progression to treatment-requiring ROP in a single neonatal intensive care unit: is the exposure time relevant? J Matern Fetal Neonatal Med. 2012; 25(5):471-477.

35. van Sorge A, Kerkhoff F, Halbertsma FJ, Schalij-Delfos N. Severe retinopathy of prematurity in twin-twin transfusion syndrome after multiple blood transfusions. Acta Ophthalmol. (Copenh) 2014; 92(2):e167-e168.

Table 1a. Clinical and Demographic Data of studied group

Neonatal Data	Mean±SD	Median (IQR)	Maximum: Minimum
Birth weight (gms)	1287.5±144.1	1300(1210:1390)	1490:770
Gestational age (weeks)	30.8±1.2	31(30:32)	32:28
Duration of caffeine citrate (days)	32.4±16.5	27(22:37)	98:0
Duration of admission (days)	44.4±16.4	40(32:50)	98:15
Duration of Oxygen (days)	25.3±14.3	22(16:32)	82:2
Continuous Positive Airway Pressure duration	9.8±7.5	8(5:12)	47:1
Blender duration (days)	5.7±3.2	5(3:8)	18:1
Mechanical ventilation duration (days)	16.6±16.6	7.5(4:33)	66:2
Head box duration (days)	2.7±1.4	2(2:4)	6:1
Incubator Oxygen duration	2.8±1.9	2(1:4)	12:1
Infectious episodes	1.9±1.2	2(1:3)	4:0
Onset of trophic feeding (days)	2.3±1.3	2(2:2)	13:1
Duration of Total Parenteral Nutrition (days)	17.7±11.7	13(10:21)	51:4
Intake of inotropes duration (days)	12.4±7.6	11(6:16.5)	34:2
Inhaled steroids duration (days)	17±12.6	12(8:20)	68:3
Maternal age (years)	26.8±4.7	27(23:30)	39:17
Hemoglobin (g/dl) on admission	15±2.7	14.8(13.4:16.8)	22.9:4.5
Hematocrit on admission (%)	43.9±8.1	43(38.9:48.3)	67.4:12.9
Intake of blood volume	54.9±30.2	49(33:70)	160:18
Age at first transfusion (days)	10.8±6.9	9(5:16)	26:1
Hemoglobin at first transfusion (g/dl)	9.5±1.6	9.4(8.7:10.4)	12.6:4.5
Hematocrit at first transfusion (%)	27.3±4.3	27.2(24.1:29.8)	35.6:12.9

Table 1b. Continued Clinical and Demographic Data

Neonatal Data		**N(%)**
Sex	Males/ Females	91(56.5)/70(43.5)
Respiratory Distress Syndrome(RDS)	yes	139(86.3)
VLBW(Very Low Birth Weight(VLBW)	Yes	155(96.3)
ELBW(Extreme Low Birth Weight	Yes	6(3.7)
History of Premature Rupture Of Membranes (PROM)	Yes	29(18)
Antenatal steroid use	Yes	45(28)
Multiple gestations	Singletons	120(74.5)
	Twins	36(22.4)
	Triplets	4(2.5)
	Quadruplets	1(0.6)
Oxygen need	Yes	140(87)
Continuous Positive Airway Pressure	Yes	124(77)
Nasal Blender	Yes	127(78.9)
Mechanical Ventilation	Yes	58(36)
Head box	Yes	113(70.2)
Incubator oxygen	Yes	126(78.3)
Early-onset neonatal sepsis	Yes	65(40.4)
Late-onset neonatal sepsis	Yes	126(78.3)
Total Parentral Nutrition	Yes	141(87.6)
Patent Ductus Arteriosus(PDA)	Yes	57(35.4)
Treatment of PDA	Yes	55(34.2)
Intake of inotropes	Yes	83(51.6)
Intake of blood	Yes	86(53.4)
Jaundice	Yes	92(57.1)
Intracranial hemorrhage grades	0	106(65.8)
	1	17(10.6)
	2	20(12.4)
	3	15(9.3)
	4	3(1.9)
Severity of ROP	Absent ROP	59(36.6)
	Low grade	75(46.6)
	Severe grade	27(16.8)

Table 1c. Continued Clinical and Demographic Data

Neonatal Data		**N (%)**
Severity of Bronchopulmonary Dysplasia (BPD)	Mild	7(11.7)
	Moderate	27(45)
	Severe	26(43.3)
BPD	Yes	60(37.3)
Development of pneumothorax	Yes	36(22.5)
Intake of inhaled steroids	Yes	131(81.4)
Intake of surfactant	Yes	45(28)
Mode of delivery	NVD/ C.S	35(21.7)/ 126(78.3)
Intake of blood	Yes	86(53.4)
Number of transfusions in the first week	One time	36(83.7)
	Two times	7(16.3)
Number of transfusions in the first month	One time	21(24.4)
	Two times	20(23.3)
	Three times	21(24.4)
	Four times	11(12.8)
	Five times	9(10.5)
	Six times	3(3.5)
	Seven times	1(1.2)
Number of transfusions in the first week	Yes	43(26.7)
Number of transfusions in the first month	Yes	86(53.4)
Retinopathy of Prematurity (ROP)	Yes	102(63.4)
Necrotizing Enterocolitis(NEC)	Yes	34(21.1)
Outcome	Died/ Discharged	16(9.9)/ 145(90.1)
History of other maternal diseases	No history of diseases	131(81.4)
	Diabetes Mellitus	11(6.8)
	Pre-eclampsia	19(11.8)

BPD: Bronchopulmonary Dysplasia, NVD: normal vaginal delivery; C.S: Caesarean section

Table 2. Blood Transfusion in the First Week in Relation to Morbidities and Outcomes

Morbidities and outcomes	Yes/No	Blood Transfusion in the First Week		P-value
		No	Yes	
		N (%)	N (%)	
NEC	No	102(86.4)	25(58.1)	0.001**
	Yes	16(13.6)	18(41.9)	
Intracranial hemorrhage	0	88(74.6)	18(41.9)	0.001**
	1	14(11.9)	3(7)	
	2	10(8.5)	10(23.3)	
	3	6(5.1)	9(20.9)	
	4	0(0)	3(7)	
Jaundice	No	53(44.9)	16(37.2)	0.472
	Yes	65(55.1)	27(62.8)	
ROP	No	50(42.4)	9(20.9)	0.012**
	Yes	68(57.6)	34(79.1)	
Severity of ROP	Absent ROP	50(42.4)	9(20.9)	0.014**
	Low grade	53(44.9)	22(51.2)	
	Severe grade	15(12.7)	12(27.9)	
Severity of BPD	Mild	5(18.5)	2(6.1)	0.001**
	Moderate	17(63)	10(30.3)	
	Severe	5(18.5)	21(63.6)	
BPD	No	91(77.1)	10(23.3)	0.001**
	Yes	27(22.9)	33(76.7)	
Outcome	Died	0(0)	16(37.2)	0.001**
	Discharged	118(100)	27(62.8)	

NEC=Necrotizing enterocolitis, ROP=Retinopathy of prematurity, BPD=Bronchopulmonary dysplasia
** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed)

Table 3. Number of Transfusions in the First Week in Relation to Morbidities and Outcome

Morbidities and outcome	Item	Number of Transfusions in the First Week		P-value
		One time N (%)	Two times N (%)	
NEC	No	21(58.3)	4(57.1)	1
	Yes	15(41.7)	3(42.9)	
Jaundice	No	12(33.3)	4(57.1)	0.394
	Yes	24(66.7)	3(42.9)	
ROP	No	9(25)	0(0)	0.314
	Yes	27(75)	7(100)	
Severity of ROP	Absent ROP	9(25)	0(0)	0.494
	Low grade	16(44.4)	6(85.7)	
	Severe grade	11(30.6)	1(14.3)	
Severity of BPD	Absent BPD	2(7.7)	0(0)	
	Low grade	9(34.6)	1(14.3)	0.396
	Severe grade	15(57.7)	6(85.7)	
BPD	No	10(27.8)	0(0)	
	Yes	26(72.2)	7(100)	0.172
Intracranial hemorrhage	0	17(47.2)	1(14.3)	
	1	2(5.6)	1(14.3)	0.394
	2	9(25)	1(14.3)	
	3	7(19.4)	2(28.6)	
	4	1(2.8)	2(28.6)	
Outcome	Died	10(27.8)	6(85.7)	0.007**
	Discharged	26(72.2)	1(14.3)	

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed)

4. Blood Transfusion in the First Month in Relation to Morbidities and Outcome

Morbidities and outcome	Yes/NO	Blood Transfusion in First Month		P-value
		No	Yes	
		N(%)	N(%)	
NEC	No	72(96)	54(63.5)	0.001**
	Yes	3(4)	31(36.5)	
IV hemorrhage	0	61(81.3)	44(51.8)	0.001**
	1	14(18.7)	3(3.5)	
	2	0(0)	20(23.5)	
	3	0(0)	15(17.6)	
	4	0(0)	3(3.5)	
Jaundice	No	37(49.3)	32(37.6)	0.136
	Yes	38(50.7)	53(62.4)	
ROP	No	40(53.3)	18(21.2)	0.001**
	Yes	35(46.7)	67(78.8)	
Severity of ROP	Absent ROP	40(53.3)	18(21.2)	0.001**
	Low grade	31(41.3)	44(51.8)	
	Severe grade	4(5.3)	23(27.1)	
Severity of BPD	Mild	0(0)	7(12.5)	0.43
	Moderate	3(75)	24(42.9)	
	Severe	1(25)	25(44.6)	
BPD	No	71(94.7)	29(34.1)	0.001**
	Yes	4(5.3)	56(65.9)	

NEC=Necrotizing enterocolitis, ROP=Retinopathy of prematurity, BPD=Bronchopulmonary dysplasia
** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed)

Table 5. Number of Transfusions in the First Month in Relation to Morbidities and Outcome

Morbidities and outcomes	Number of Transfusions in the First Month							P-value
	One time	Two times	Three times	Four times	Five times	Six times	Seven times	
NEC	N(%)	N(%)	N(%)	N(%)	N(%)	N(%)	N(%)	
No	17(81)	15(75)	10(47.6)	5(45.5)	5(55.6)	2(66.7)	1(100)	0.055
Yes	4(19)	5(25)	11(52.4)	6(54.5)	4(44.4)	1(33.3)	0(0)	
ROP								
No	5(23.8)	3(15)	6(28.6)	0(0)	3(33.3)	1(33.3)	1(100)	0.194
Yes	16(76.2)	17(85)	15(71.4)	11(100)	6(66.7)	2(66.7)	0(0)	
Severity of ROP								
Absent ROP	5(23.8)	3(15)	6(28.6)	0(0)	3(33.3)	1(33.3)	1(100)	0.631
Low grade	10(47.6)	12(60)	11(52.4)	6(54.5)	4(44.4)	1(33.3)	0(0)	
Severe grade	6(28.6)	5(25)	4(19)	5(45.5)	2(22.2)	1(33.3)	0(0)	
BPD								
No	7(33.3)	10(50)	10(47.6)	0(0)	1(11.1)	1(33.3)	1(100)	0.024 *
Yes	14(66.7)	10(50)	11(52.4)	11(100)	8(88.9)	2(66.7)	0(0)	
Severity of BPD								
Absent BPD	5(35.7)	0(0)	1(9.1)	0(0)	1(12.5)	0(0)	0(0)	0.006**
Low grade	5(35.7)	7(70)	8(72.7)	2(18.2)	2(25)	0(0)	0(0)	
Severe grade	4(28.6)	3(30)	2(18.2)	9(81.8)	5(62.5)	2(100)	0(0)	
Intracranial Haemorrhage								
0	13(61.9)	13(65)	13(61.9)	2(18.2)	3(33.3)	0(0)	1(100)	0.278
1	0(0)	0(0)	1(4.8)	1(9.1)	1(11.1)	0(0)	0(0)	
2	4(19)	5(25)	3(14.3)	4(36.4)	2(22.2)	2(66.7)	0(0)	
3	4(19)	1(5)	4(19)	2(18.2)	3(33.3)	1(33.3)	0(0)	
4	0(0)	1(5)	0(0)	2(18.2)	0(0)	0(0)	0(0)	
Outcome								
Died	0(0.0)	5(25.0)	1(4.8)	5(45.5)	3(33.3)	2(66.7)	0(0.00)	0.004**
Discharged	21(100.0)	15(75.0)	20(95.2)	6(54.5)	6(66.7)	1(33.3)	1(100.0)	

NEC=Necrotizing enterocolitis, ROP=Retinopathy of prematurity, BPD=Bronchopulmonary dysplasia

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed)

Table 6. Pearson correlation showing linear relations between variables

Item	Number of Transfusions in the First Week		Number of Transfusions in the First Month	
Spearman's rho	r	P-value	r	P-value
Duration of Oxygen in days	0.237	0.13	.374**	0.001**
CPAP duration	-.446**	0.006**	-0.066	0.571
Blender duration	-0.24	0.21	-0.107	0.376
MV duration	.430*	0.014**	.597**	0.001**
Head box duration	-0.044	0.836	-0.116	0.36
Incubator Oxygen duration	-0.28	0.149	0.107	0.381
Infectious episodes	0.074	0.638	.557**	0.001**
Duration of TPN in days	0.164	0.3	.444**	0.001**
Intake of inotropes duration in days	0.006	0.97	.275*	0.029*
Inhaled steroids duration	0.206	0.196	.391**	0.001**
Maternal age	0.212	0.173	0.064	0.561
HGB on admission	-0.003	0.987	-0.008	0.939
HCT on admission	-0.015	0.923	-0.013	0.905
Number of transfusions in the first week	----------	.---------	0.15	0.337
Number of transfusions in the first month	0.15	0.337	----------	----------

CPAP=Continuous positive airway pressure, MV=Mechanical ventilation, TPN=Total parentral nutrition, HGB=Haemoglobin, HCT=Haematocrite

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed)

Table 7. Pearson correlation showing linear relations between variables

Spearman's rho	**Birth weight in gm**		**Gestational age in weeks**	
	r	**P-value**	**r**	**P-value**
Gestational age in weeks	.604**	0.001**	---------	----------
Haemoglobin on admission	-0.113	0.159	-0.019	0.807
Haematocrite on admission	-0.077	0.335	-0.014	0.862
Number of transfusions in the first week	-0.081	0.604	-0.109	0.485
Number of transfusions in the first month	-.462**	0.001**	-.352**	0.001**
Age at first transfusion	.315**	0.003**	.219*	0.038*

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table (8) Blood Transfusion in the First Week (group1) and month (group2) in relation to morbidities

Morbidities and outcomes	Yes/No	Blood Transfusion in the First Week (Group1)		P-Value	Yes/No	Blood Transfusion in the First Month(Group2)		P-Value
		No	Yes			No	Yes	
		N (%)	N (%)			N(%)	N(%)	
NEC	No	102(86.4)	25(58.1)	0.001**	NO	72(96)	54(63.5)	0.001**
	Yes	16(13.6)	18(41.9)		YES	3(4)	31(36.5)	
Intracranial hemorrhage	0	88(74.6)	18(41.9)	0.001**	0	61(81.3)	44(51.8)	0.001**
	1	14(11.9)	3(7)		1	14(18.7)	3(3.5)	
	2	10(8.5)	10(23.3)		2	0(0)	20(23.5)	
	3	6(5.1)	9(20.9)		3	0(0)	15(17.6)	
	4	0(0)	3(7)		4	0(0)	3(3.5)	
Jaundice	No	53(44.9)	16(37.2)	0.472	NO	37(49.3)	32(37.6)	0.13
	Yes	65(55.1)	27(62.8)		Yes	38(50.7)	53(62.4)	
ROP	No	50(42.4)	9(20.9)	0.012	NO	40(53.3)	18(21.2)	0.001
	Yes	68(57.6)	34(79.1)		Yes	35(46.7)	67(78.8)	
Severity of ROP	Absent ROP	50(42.4)	9(20.9)	0.014**	Absent ROP	40(53.3)	18(21.2)	0.001**
	Low grade	53(44.9)	22(51.2)		Low grade	31(41.3)	44(51.8)	
	Severe grade	15(12.7)	12(27.9)		Severe grade	4(5.3)	23(27.1)	
Severity of BPD	Mild	5(18.5)	2(6.1)	0.001**	Mild	0(0)	7(12.5)	0.43
	Moderate	17(63)	10(30.3)		Moderate	3(75)	24(42.9)	
	Severe	5(18.5)	21(63.6)		Severe	1(25)	25(44.6)	
BPD	No	91(77.1)	10(23.3)	0.001**	No	71(94.7)	29(34.1)	0.001**
	Yes	27(22.9)	33(76.7)		Yes	4(5.3)	56(65.9)	

NEC=Necrotizing enterocolitis, ROP=Retinopathy of prematurity, BPD=Bronchopulmonary dysplasia
** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed)

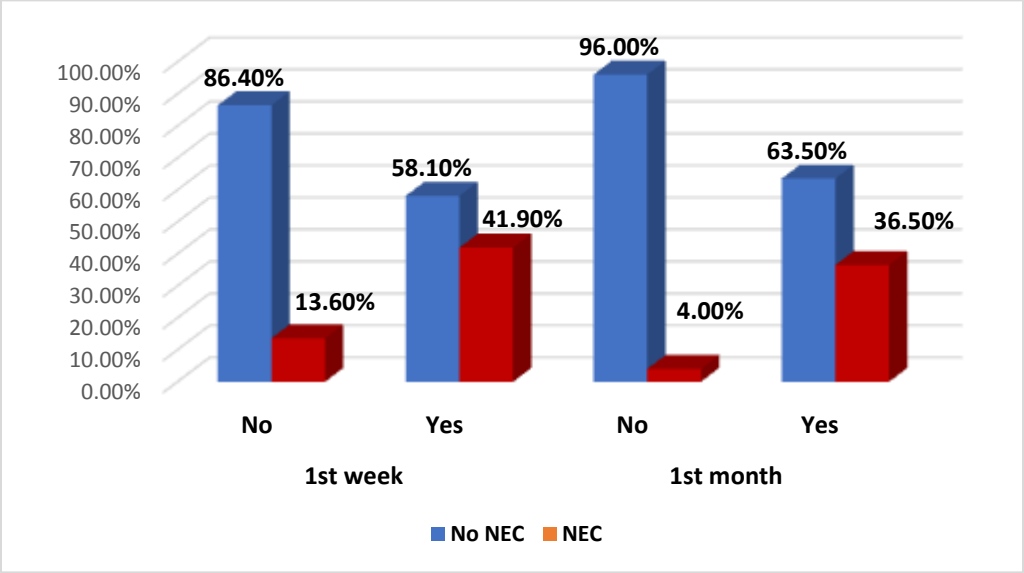

Figure (1): Incidence of NEC in relation to blood transfusion in the first week and month

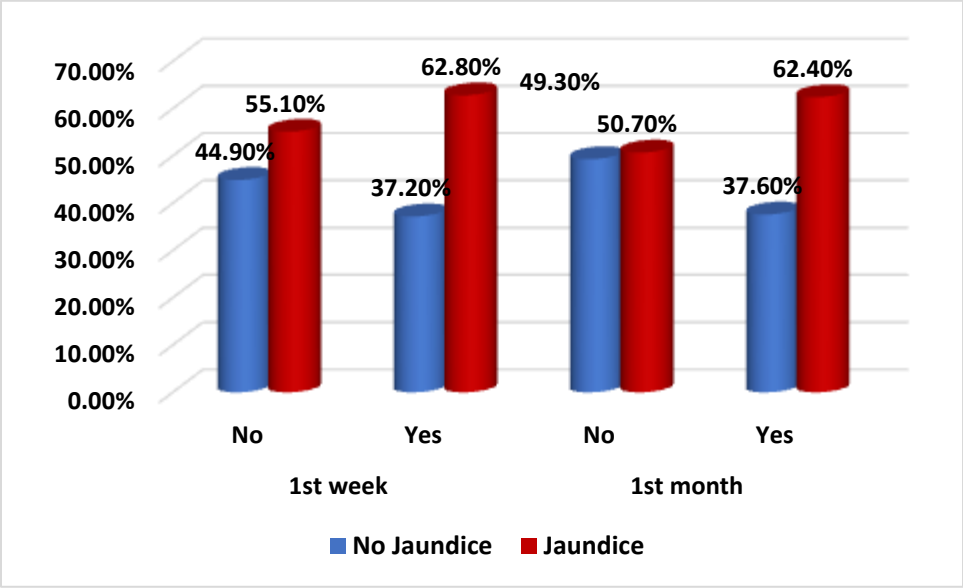

Figure (2): Incidence of jaundice in relation to blood transfusion in the first week and month

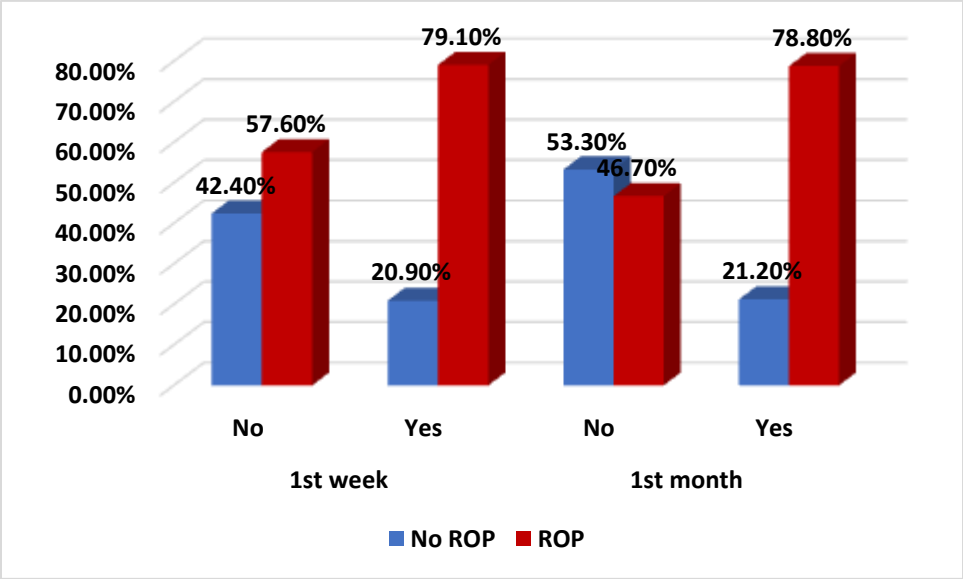

Figure (3): Incidence of ROP in relation to blood transfusion in the first week and month

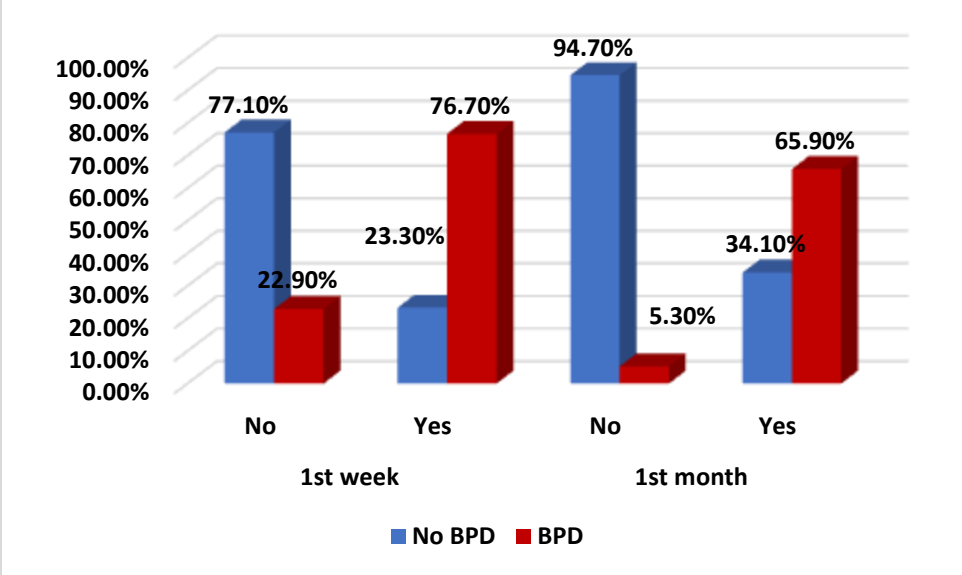

Figure (4): Incidence of BPD in relation to blood transfusion in the first week and month

Citation: Nancy A.S Gomaa, and Abeer A. Abdelkhalik. Short-Term Blood Transfusion Outcomes in Preterm Infants admitted to Neonatal Intensive Care Unit (NICU): A Retrospective Analytical Study. Annals of Neonatology Journal 2021; 3(2): 23-49. doi:10.21608/ANJ.2021.69935.1025