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EFFECT OF ENVIRONMENTAL STORAGE ON RED BLOOD CELLS PARAMETERS

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ABSTRACT

Background: Blood transfusion is a life-saving treatment for patients with massive blood loss and chronic anemia and a supportive therapy to optimize oxygen delivery and tissue perfusion in critical illness.[1,2] During storage of packed RBCs units, the quality of stored RBCs progressively decreases during hypothermic storage. RBCs undergo a series of biochemical and biomechanical changes, collectively known as the 'hypothermic storage lesion'(HSL).[3] **Methods**: This is prospective analytical cross sectional study conducted in Elmak Nimer University Hospital blood bank, and aimed to study the effect of storage on haematological parameters of Red Blood Cells. Anon probability blood samples were taken from afresh collected blood bags, which were already collected from donors for the purpose of clinical routine work after physician approval as fit person, suitable for donation. Then sample of RBCs concentrates are stored in the refrigerator at 2-6 ^{0}C. Two ml of stored sample was sent to hematology laboratory for analysis at (days zero, 17 and 35), by Mindray BC 3000 automated haematology analyzer. **Results**: The results showed a significant variation during storage period in the Hb level, HCT, MCV and MCH, while there was no significant variation in RBCs count and MCHC in the early period of storage, but the variation was clearly observed at the end period of storage (P.value $\leq$ 0.05). Also there was significant variation in RDW-CV in the early period of storage, but it tends to disappear at the end of storage and this is might be due to the lysis of old cells. **Conclusion**: The value of some red blood cells parameters can be affected by storage in the refrigerator at 2-6 ^{0}C.

KEYWORDS: Red blood cells parameters, Blood banking, Sudan.

INTRODUCTION

Blood transfusion is a life-saving treatment for patients with massive blood loss and chronic anemia and a supportive therapy to optimize oxygen delivery and tissue perfusion in critical illness.[1,2] The clinical benefits of blood transfusion were made possible through the development of techniques to preserve cell viability ex vivo, allowing the blood donation and transfusion to be separated in time and space.[4] In the 1960s, with the introduction of plastic blood bags[5], whole blood transfusion was replaced for specific blood component therapy red blood cells (RBCs), platelets and plasma components translating the life-saving benefits of one whole blood donation to up to four transfusion recipients.[6] Currently packed RBCs (pRBCs) the most highly used blood component, are produced by two common component manufacturing methods: the whole blood filtration method and the buffy coat method.[7,8] The general procedure is (400-500) ml of whole blood in Citrate Phosphate Dextrose Adinin (CPDA1) is centrifuged, plasma and RBCs are separated, and RBCs can be resuspended in an additive solution, commonly accompanied by leucoreduction.[8]

During storage of pRBC units, the quality of stored RBCs progressively decreases during hypothermic storage. RBCs undergo a series of biochemical and biomechanical changes, collectively known as the 'hypothermic storage lesion' (HSL).[3] Characteristics of the HSL includes RBC membrane remodeling, decreased metabolites such as ATP and 2,3-DPG, loss of intracellular potassium, oxidative injury of protein structures and lipid peroxidation, membrane loss, vesiculation, and ultimately haemolysis (the fragility leads to the release of cell free haemoglobin and formation of microparticles submicron haemoglobin containing vesicles and additional haemolysis.[9,10,11]

There are increasing concerns regarding the effect of the HSL on hemorheology, including RBC aggregability, deformability and membrane remodeling, effects that could potentially lead to impairment of the oxygen delivery capacity of transfused blood.[12,13,14]

METHODS

This is prospective analytical cross sectional study conducted in Elmak Nimer University Hospital blood

bank, and aimed to study the effect of storage on haematological parameters of Red Blood Cells. Blood collection bag was labeled with donor identification number before withdrawal of blood of about 450 ± 50 ml, into blood bags containing CPD A1 anticoagulant solution (63 ml) from healthy donors.

Blood bags after being given aunique number, and after preparation of packed red blood cells, samples from them sent as possible early to hematology laboratory to study red blood cells parameter (Hb, PCV, RBCs count, MCV, MCH, MCHC and RDW-CV) at day 0.

Then sample of RBCs concentrates are stored in the refrigerator at 2-6 °C. 2 ml of stored sample was sent to hematology laboratory for analysis at (days 17, and 35). In 3 parts analyze with Mindray BC 3000 automated haematology analyzer.

RESULTS

According to the table (1) the mean of haemoglobin level in day zero was (24.1 g/dl), while in day 17 was (22.6 g/dl) then decreased to (23.5 g/dl) in day 35.

Table (1): Show the mean of Haemoglobin level according to the period of storage.

Day of storage	Mean of Hb level
Day zero	24.1 g/dl
Day 17	22.6 g/dl
Day 35	23.5 g/dl

Also according to the table (2) the mean of red blood cells count in day zero was (7.4×10^{12} /L), while in day 17 was (7.4×10^{12} /L) then increased to (7.5×10^{12} /L) in day 35.

Table (2): Show the mean of RBCs count according to the period of storage.

Day of storage	Mean of RBC count
Day zero	7.4×10^{12} /L
Day 17	7.4×10^{12} /L
Day 35	7.5×10^{12} /L

The mean of haematocrit in day zero was (72.8%), while in day 17 was (69.4%) then decreased to (68.1%) in day 35 as demonstrated in table (3).

Table (3): Show the mean of HCT according to the period of storage.

Day of storage	Mean of HCT level
Day zero	72.8%
Day 17	69.4%
Day 35	68.1%

While the mean of mean cell volume in day zero was (91.1fL), while in day 17 was (93.8 fL) then increased to (99.6 fL) in day 35 as noted in table (4).

Table (4): Show the mean of MCV according to the period of storage.

Day of storage	Mean of MCV level
Day zero	91.1 FL
Day 17	93.8 FL
Day 35	99.6 FL

According to the table (5) the mean of mean cell haemoglobin level in day zero was (32.3 pg), while in day 17 was (30.6 pg) then decreased to (31.3 pg) in day 35.

Table (5): Show the mean of MCH according to the period of storage.

Day of storage	Mean of MCH level
Day zero	32.3 pg
Day 17	30.6 pg
Day 35	31.3 pg

Also according to the table (6) the mean of mean cell haemoglobin concentration in day zero was (32.5 g/dl), while in day 17 was (32.6 g/dl) then increased to (34.6 g/dl) in day 35.

Table (6): Show the mean of MCHC according to the period of storage.

Day of storage	Mean of MCHC level
Day zero	32.5 g/dl
Day 17	32.6 g/dl
Day 35	34.6 g/dl

The mean of red cell distribution width in day zero was (15.5%), while in day 17 was (14.1%) then decreased to (14.3%) in day 35 as referred in table (7).

Table (7): Show the mean of RDW-CV according to the period of storage.

Day of storage	Mean of RDW-CV level
Day zero	15.5%
Day 17	14.1%
Day 35	14.3%

DISCUSSION

This descriptive prospective cross sectional analytical study was conducted in Elmak Nimer university hospital blood bank during the period of April to August 2018 and aimed to determine the effect of storage on Red Blood Cells Parameters. A total of voluntary donors satisfying the inclusion criteria were taken.

The results of this study showed that the mean of heamoglolobin level in day zero was (24.1 g/dl), while in day 17 was (22.6 g/dl) and (23.5 g/dl) in day 35. Statistical analysis showed that there was significant variation with P.value of (0.000) in day 17 and (0.000) in day 35. This result was similar to result of study done by Karama and his colleague in Mosul 2008[15], in which though significant fall in haemoglobin from 10 days onwards of storage with ($p < 0.05$). This decrease can be attributed to haemolysis which occurs during storage. Significant fall from 7th day onward was also observed by Ahmed and his colleague in Mosul 2003, ($p<0.05$).[16]

The mean of RBCs count in day zero was (7.4×10^{12} /L), while in day 17 was (7.4×10^{12} /L) and (7.5×10^{12} /L) in day 35. Statistical analysis showed that there was no significant variation with P.value of (0.491) in day 17. This result was similar to result of study done by Sonia Chhabra in India 2017[17], ($p >0.05$), and other study done by Adias TC and his colleague in Nigeria 2012[18] ($p = 0.376$). The statistically significant rise in the mean of RBCs count on day 35 with p.value of (0.008) and this might be due to the delaying in sample processing or improper mixing of blood.

The mean of HCT was (72.8%) in day 0, while in day 17 was (69.4%) and (68.1%) in day 35. Statistical analysis showed that there was significant variation with P.value of (0.017) in day 17 and (0.017) in day 35. This result was similar to result of study done by Karama MI and his colleague in Mosul 2008[15] and other study done by Ahmed Y and his colleague in Mosul 2003($p = 0.008$).[16]

The mean of MCV in day zero was (91.1 fL), while in day 17 was (93.8 fL) and (99.6 fL) in day 35. Statistical analysis showed that there was significant variation with P.value of (0.002) in day 17 and (0.000) in day 35. This result was similar to result of study done by Sonia Chhabra in India, 2017 ($P<0.05$)[17], However statistically non significant increased were observed by Adias TC and his colleague in Nigeria 2012[18] ($p=0.677$) The rise in MCV is attributed to the swelling of RBCs during the storage period.

The mean of MCH in day zero was (32.3 pg), while in day 17 was (30.6 pg) and (31.3pg) in day 35. Statistical analysis showed that there was significant variation with P.value of (0.000) in day 17 and (0.004) in day 35, However statistically non significant changes were observed by Sonia Chhabra in Indi 2017[17] and by Adias TC and his colleague in Nigeria 2012 **(**$p =0.805$).[18]

The mean value of MCHC was (32.5 g/dl) in day zero then (32.6 g/dl) in day 17 and (34.6 g/dl) in day 35. Statistical analysis showed that there was in significant variation with P.value of (0.513) in day 17, This result was similar to result of study done by Sonia Chhabra in India[17] and by Adias TC and his colleague **(**$p =0.470$) in Nigeria 2012.[18] Also Statistical analysis showed that there was significant variation with P.value of (0.000) in day 35, this may be attributed to gradual fall in haematocrit during storage.

The mean of RDW-CV in day zero was (15.5%), while in day 17 was (14.1%) and (14.3%) in day 35. Statistical analysis showed that there was significant variation with P.value of (0.000) in day 17. The statistical analysis revealed that there was insignificant variation with P.value (0.234) in day 35 was similar to result were observed by Adias TC and his colleague in Nigeria (2012)[18], with p. value of (0.316) during the 28 day storage period, and by Sonia Chhabra and his his colleague in India (2017).[17]

CONCLUSION

By the end of this study we conclude that there was significant variation in Hb, HCT, MCV, and MCH values during storage, while there was no significant variation in RBCs count, MCHC and RDW-CV.

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