©NIJRMS
Publications 2023

OPEN ACCESS
ISSN: 2992-5460

NEWPORT INTERNATIONAL JOURNAL OF RESEARCH IN MEDICAL SCIENCES (NIJRMS)
Volume 3 Issue 2 2023

Alterations in whole blood stored at 2-6 degrees and the suitability in management of breast cancer

Joseph E. Udosen[1], Precious E. Ekoh[2], Euphoria C. Akwiwu[3] *, Dennis Abunimye[3], David U. Akpotuzor[3], Josephine O. Akpotuzor[3], Emmanuel Ifeanyi Obeagu[4]

[1]Department of Surgery, University of Calabar, Calabar, Nigeria.
[2]Department of Haematology, University of Calabar Teaching Hospital, Calabar, Nigeria.
[3]Department of Haematology and Blood Transfusion Science, University of Calabar, Calabar, Nigeria.
[4]Department of Medical Laboratory Science, Kampala International University, Uganda.
ORCID Number: 0000-0001-6097-557X; 0000-0002-4538-0161

ABSTRACT

Haematological derangements accompany breast cancer management particularly in our local setting where such derangements appear to be common within the general population. Anaemia, leucopenia and thrombocytosis arising from possible tumour-mediated immunosuppression and chemotherapeutic interruption of normal haemopoiesis occur frequently among breast cancer patients. Depending on the degree of reduction in cellular elements of blood, blood transfusion is often required to correct severe situations. Thus, haematological changes in stored whole blood may influence the clinical outcome. A prospective observational study was conducted on fresh whole blood collected in a CPDA1 blood bag stored at 2-6 degree Celsius. Haematological parameters such as red cell count, haemoglobin concentration, Pack cell volume, red cell viability, plasma percentage haemoloysis, total white cell count, and platelet count were measured sequentially by standard methods on daily basis up to day 35. The data were presented as figures. Red cell count, haemoglobin concentration, pack cell volume, red cell viability, total white cell count, and platelet count decrease at varying degrees while percentage haemoloysis increased progressively up to 35 days. There are varying reductions in the cellular elements of whole blood stored up to 35 days, thus making stored blood less ideal for managing conditions with profound blood cell depletion such as exists in breast cancer.

Keywords: Breast cancer, blood, transfusion

INTRODUCTION

Breast cancer is among the leading malignancies with significant female preponderance and immense contribution to maternal mortality [1-4]. Its management comes with the challenge of blood cell

deficits among other derangements [5]. This is particularly so in Nigeria where more than half of the female population are anaemic owing to nutritional deficiencies and haemo-parasitic infections [6-7]. Consequently, both the high prevalence of anaemia in the general population and anaemia arising from cancer pathophysiology such as tumour vascularization and diversion of nutrients work together to increase the burden of anaemia in breast cancer. A prevalence of 78% anaemia has been observed locally among breast cancer patients prior to their commencement of chemotherapy, while 100% anaemia was recorded during assessment for fifth course in a six-course chemotherapy [8]. That study also reported increasing leucopenia from 14% before commencement of chemotherapy to 100% by midway into the six-course chemotherapy, while thrombocytopenia that was initially absent occurred to the tune of 56% through the course of treatment. This underscores the high dependence on blood transfusion for effective management of breast cancer.

Management of breast cancer patients in Nigeria is compounded by late detection [7, 9-10]. Similar to observations in general health conditions that impact maternal health, presentation at advanced stages translates to heightened demands for therapeutic interventions including transfusion therapy [11-13]. Juxtaposed on the prevailing challenges of blood banking such as scarcity of voluntary donors and concern for safe blood, high demand for blood transfusion in the management of breast cancer calls for optimal utilization of blood products. Blood is an extracellular fluid that carries oxygen and other element to the tissues and carbon dioxide away from the tissues through the heart and vascular system of mammals. The cellular components which consist of erythrocytes, thrombocytes and leucocytes are particularly central to the general usefulness of blood. Each component of blood has specific functions ranging from: transportation, regulatory, protective, restrictive and defensive roles [14-15].

In transfusion practice, blood is usually collected and stored to be used for transfusion. Long term goal of storage is to ensure readily available blood that is safe for transfusion. When whole blood is aseptically withdrawn from the body for transfusion purposes and stored in the blood bank between 2 to 6 degrees Celsius, it is cut off from its in vivo natural environment as well as its nutritional supplies and to provide the above externally, anticoagulant is required. An anticoagulant is a substance that is used in preventing clot formation or coagulation. The most commonly used anticoagulant for whole blood storage in transfusion medicine is citrate phosphate dextrose adenine (CPDA) which keeps blood up to 35 days in better state compared to some other anticoagulants [16-17]. Considering the scale of blood cell deficits previously observed in breast cancer, the present study investigated the rate of depletion in cellular elements of stored blood in order to determine suitability of stored blood in the management of breast cancer patients.

MATERIALS AND METHODS

The study was conducted in the blood bank unit of the University of Calabar Teaching hospital, located in Cross River State of Nigeria. The hospital on an average, records up to 10 transfusions a day. The design was a longitudinal one as the investigation were followed up from day zero to day 35. Blood bag of 450ml containing 63ml of Citrate Phosphate Dextrose Adenine anticoagulant was used to collect blood from a fit donor. Standard safety precautions were observed to avoid contamination and possible transmission of blood borne pathogens. The unit of blood was dispensed into small aliquot in universal sterile bottles and stored at 2-60C for 35 days. This is to maintain the blood in sterile state and avoid contamination for the period of study. Complete blood count was determined using DYMIND DF50 Haematology auto-analyzer. Red cell viability was determined using trypan blue method while Percentage haemolysis was determined using cytotoxicity haemolytic activity test at 540nm. A time series of the haematologic parameters of the stored blood was performed and presented graphically.

RESULTS

In this study, some haematological parameters of the fresh blood stored at 2-6°C for a period of 35 days in UCTH blood bank was assessed. A complete blood count, percentage haemolysis and percentage viability, were assessed. The results obtained for day Zero were used as controls. It was observed that daily changes occurred in all the parameters, while some changes were declining, others were increasing. Again, some changes were slow and steady while others were sporadic. In figure 1 red blood cell count reduced from 4.95 $x10^{12}$/L by day zero to 3.3 $x10^{12}$/L by day 35 which is a 66.7% reduction. Haemoglobin consistently reduced from 134 g/L at day zero to 109 g/L equivalent of 81.3 % fig2 while haematocrit values revealed a slow but steady decrease from baseline value of 0.40 L/L to 0.33 L/L by day 35 which is 82.5 % fig3. The percentage viability of red blood cells showed marked reduction from 99.7% by day zero to 65.9 % by day 35 of storage showing a difference of 33.8% fig 4. On the other hand, figure 5 showed increasing values of percentage haemolysis with progressive storage; from a base- line value of 2.9% by day zero to 29.2 % by day 35 which is over ten folds. The

OPEN ACCESS
ISSN: 2992-5460

TWBC reduced from 4.80 x 10^9/L from day zero to 2.80 x 10^9/L which gives 58.3 % fig 6 while platelet counts revealed a sharp fall up to 75.9% between day zero and the second day of storage and then continued to fall within the storage period from 465 x 10^9/L at day zero to 61 x 10^9/l by day 35 giving a reduction rate of 13.4%.

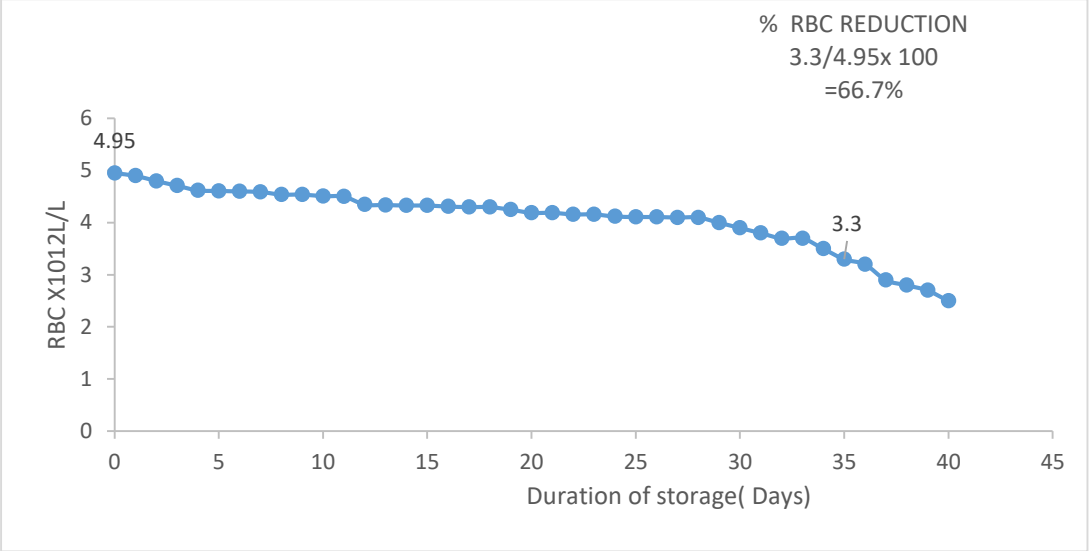

FIG 1 line graph of daily values of red cell count

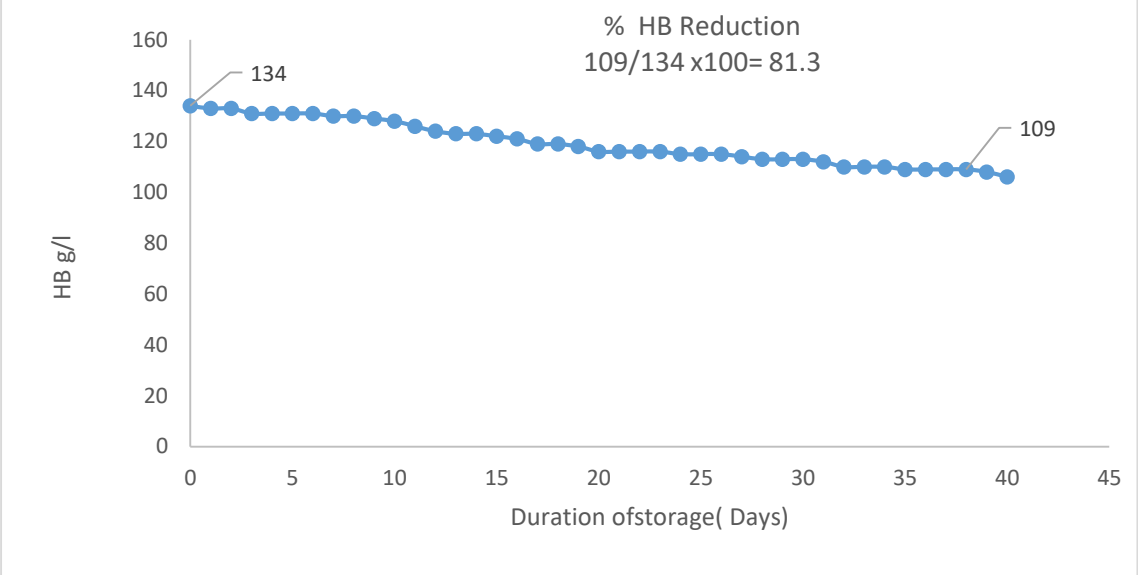

FIG 2 line graph of daily values of red cell count

OPEN ACCESS
ISSN: 2992-5460

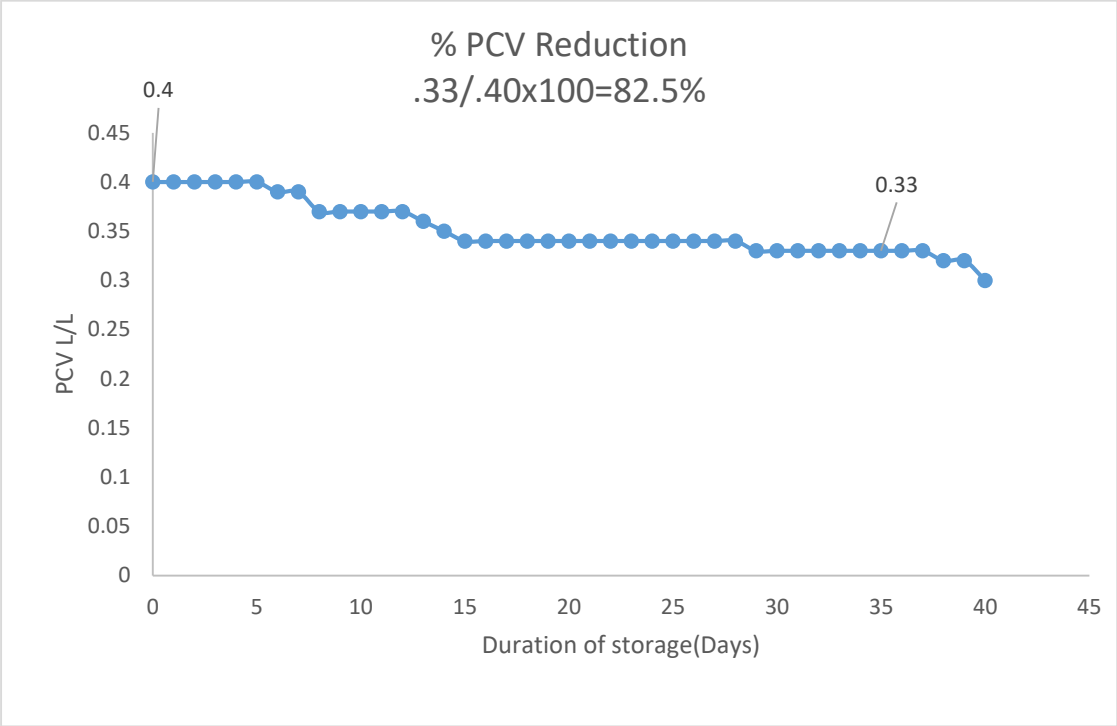

FIG 3 line graph of daily values of red cell count

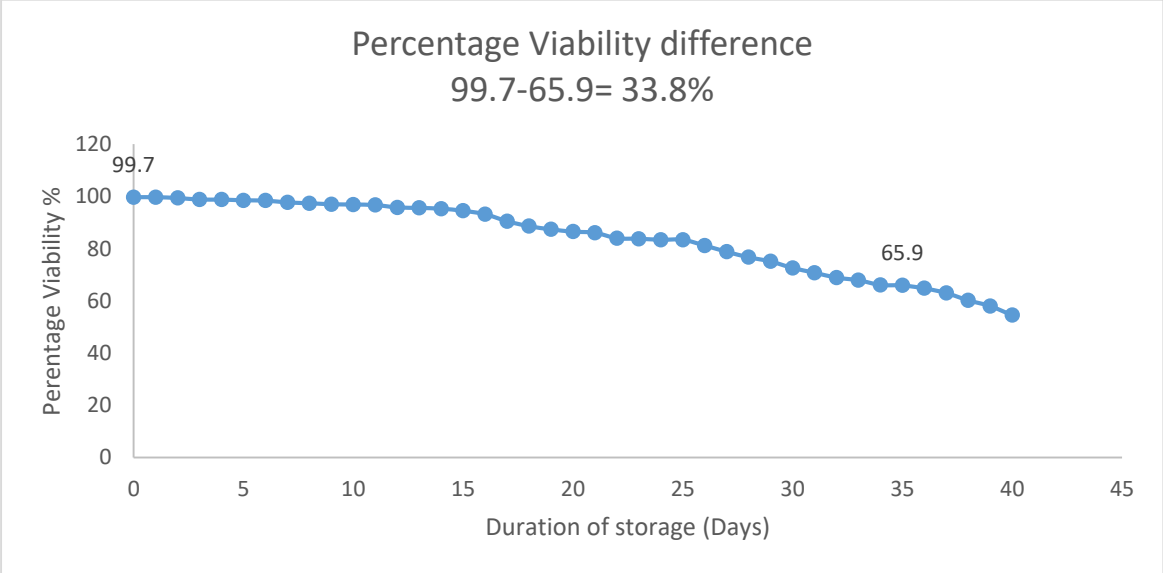

FIG 4 line graph of daily values of red cell count

OPEN ACCESS
ISSN: 2992-5460

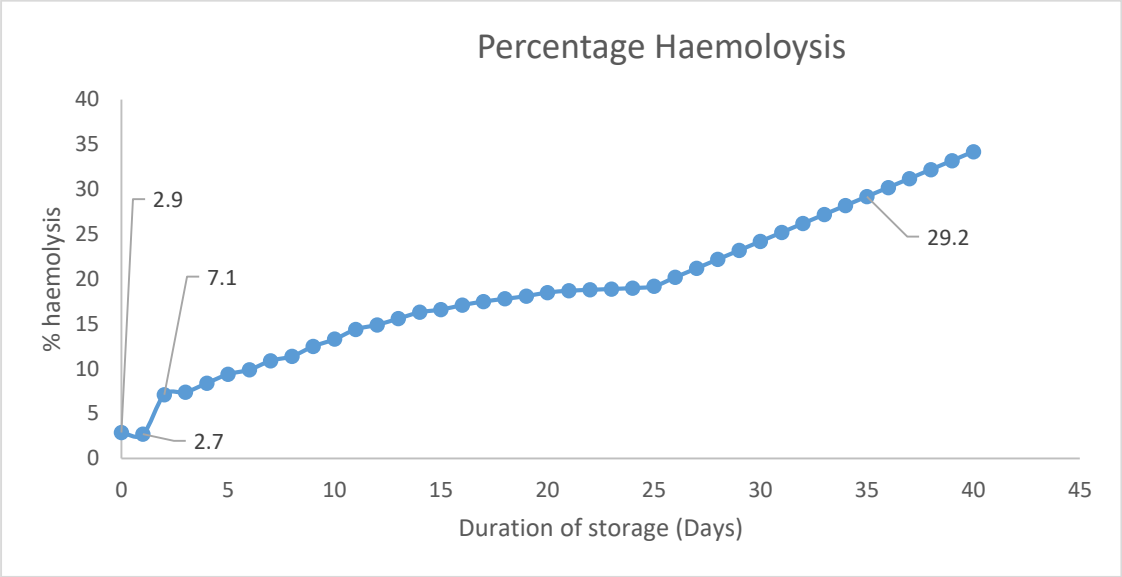

FIG 5 line graph of daily values of Haemoglobin concentration

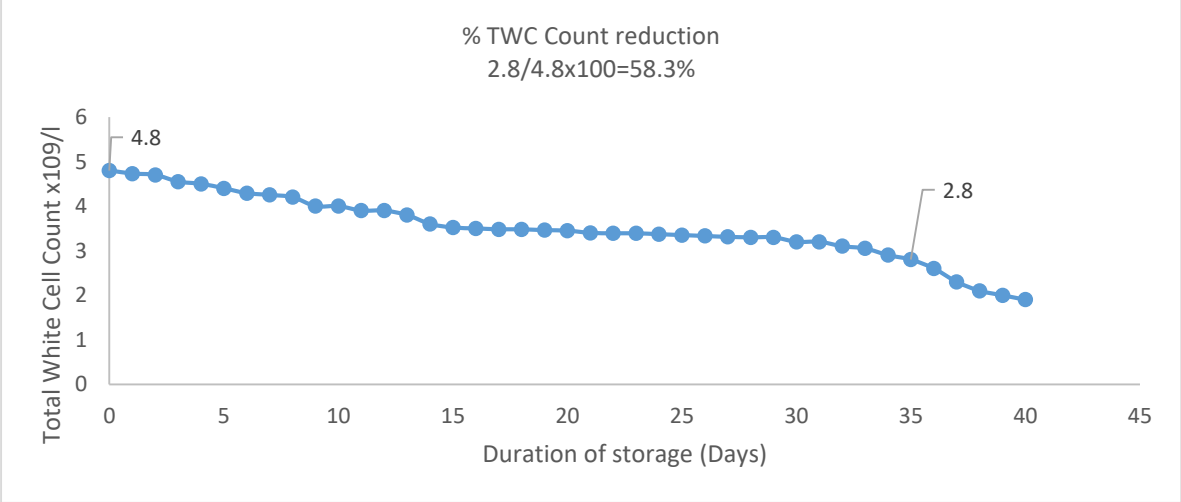

FIG 6 line graph of daily values of total white cell count

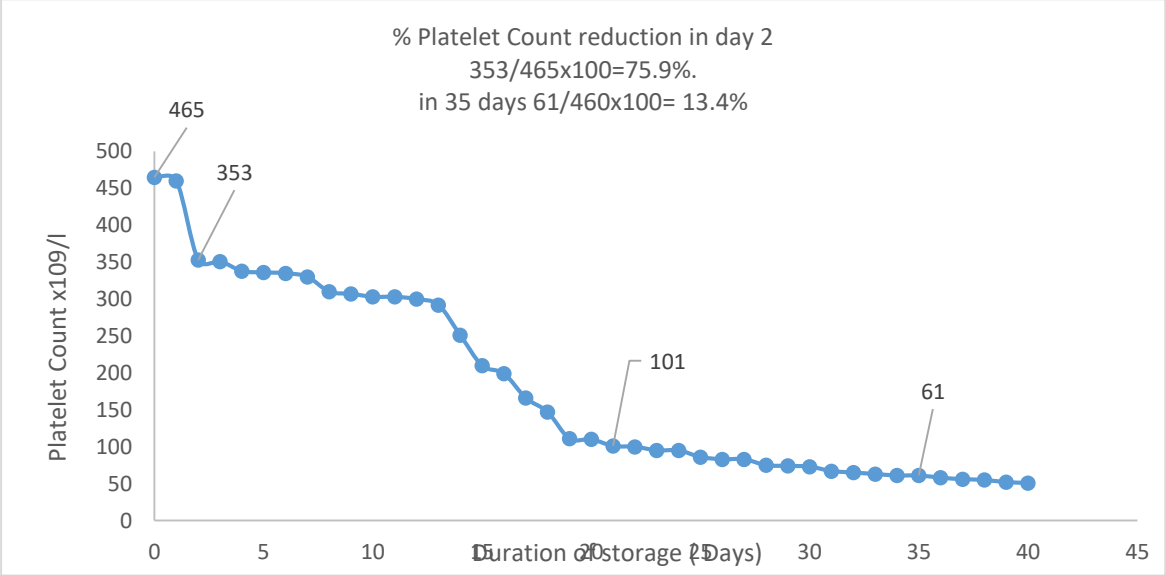

FIG 7 line graph of daily values of Platelet count

OPEN ACCESS
ISSN: 2992-5460

DISCUSSION

Blood transfusion is the major medium for replacement of blood for health conditions where it is indicated. Blood for transfusion needs to be collected, processed and stored in order for it to be available when required. This storage however raises a question about the state of the stored blood at the time of transfusion as well as the benefits derived by the recipient of the blood when transfused. Quality of fresh stored blood at temperature between 2° to 6°C for a period of 35 days, was the focus of this study. Red cell count revealed a slow but steady reduction from day zero to day 35 with a 66.7 % reduction in count. This is in conformity with previous reports. The gradual reduction may be due to normal red cell apoptosis or cell death. On storage, the red cells change shape from discs to echinocytes and finally to sphere which makes them become more rigid and shed their lipids. The resultant effect is a fall in ATP and 2, 3-DPG content as the duration of storage increases [18-19]. This change in shape and loss of deformability will affect the functionality of stored red cells in the circulation of the recipient and for this reason stored blood may not be good enough for use when transfusion is needed in breast cancer management rather fresh whole blood should be advocated where red cell component is not available. Haemoglobin concentration was observed to reduce gradually from day zero with the highest reduction of 81.3 % seen on day 35. This is due to the fact that there is no more production within stored blood to compensate for non-viable cells [18-19]. The implication is that the stored blood when transfused, may not have the ability to carry oxygen in the recipient's circulation and therefore may not be suitable in the face of anaemia during breast cancer management. Similar reduction rate of 81.5 % in the haematocrit values within the period of storage up to day 35 also occurred. Again the reduction is due to the continuous destruction of red cells which reduces the number of red blood cells as well as some red cells attaining their full lifespan of 120 days within the storage period leading to their loss in the stored blood.

In the present study, percentage viability of 99.70 % on day zero was reduced by the day to 65.9% by day 35. This finding shows that the difference between day zero and day 35 of storage is 33.8 %. The steady decrease we attribute to reduced red blood cells flexibility or deformability which is a major determinant of red cell viability and therefore such blood may not benefit the breast cancer recipient. On the other hand, a dramatic increase was observed in percentage haemolysis of red cells in plasma over the storage duration from 2.9 to 29.3% by day 35 giving a 10-fold rise. This could be attributed to the fact that red cells undergo spontaneous haemolysis in whole blood storage as the anticoagulant citrate phosphate dextrose adenine-1 alters erythrocyte membrane proteome [18] thus such blood will not be beneficial for breast cancer patient. The total white blood cells revealed a progressive decrease from day zero throughout the period of storage. Findings have shown that the total white cell count goes down by half by the end of 35 days. This could be as a result of the short life span of white cells which ranges from hours to a few days. This type of blood will not benefit breast cancer patients particularly those with marked leucopenia. Platelets showed a noticeable sharp reduction in the first 2 days (75.2%). This implies that about 25% of platelet is lost on storage and therefore not good enough for use when platelet therapy is indicated. From the 3rd day there is a marginal steep fall up to 21days and continues as storage progressed with the lowest percentage value of 13.4 % (61 x109/l) by day 35. This is probably due to the short life span of platelets; the average life span of circulating platelets is 8-9 days [18-22]. This finding indicates that stored blood is not adequate in platelet count for use in breast cancer management.

CONCLUSION

This work then concludes that the cellular elements in whole blood alters in varying degrees on storage and therefore may not be beneficial to the recipients with high degree of blood cell depletion such as seen in breast cancer management.

REFERENCES

1. World Health Organization. Fact sheets on cancer. *https://www.who.int/news-room/fact-sheets/detail/breast-cancer. 2021.*
2. World Health Organization (2019). Maternal mortality 2019 Fact sheets. https://www.who.int. 2019.
3. Stachs A, Stubert J, Reimer T, Hartmann S. Benign Breast Disease in Women. *Deutsches Arzteblatt International*, 2019; 116(33-34), 565-574.
4. Sadler IJ, Jacobsen PB. Progress in understanding fatigue associated with breast cancer treatment. *Cancer Investigation*, 2011; 19(7), 723-731.

5. Udosen JE, Akwiwu EC, Akpotuzor DU, Akpotuzor JO. Some Haematological Parameters of Breast Cancer Patients accessing therapy at University of Calabar Teaching Hospital, Calabar Nigeria. *Sokoto Journal of Medical Laboratory Science*, 2022; 7(1), 89-93.
6. World Health Organization. Maternal and Reproductive Health. https://www.who.int accessed. 2022.
7. Akpotuzor JO**,** Akwiwu EC, Okpokam DC, Keunmoe P. Analyses of haematological malignancies records from University of Calabar Teaching Hospital Calabar, Nigeria (1983-2008). *International Journal of Natural and Applied Sciences*, 2011; 7(1), 133-136.
8. Udosen JE, Akwiwu EC, Njar VE, Akpotuzor DU, Akpotuzor JO. Proportions of Blood Cell Deficits in Breast Cancer Patients undergoing Chemotherapy. *African Journal of Laboratory Haematology and Transfusion Science. 2023;* **2 (1)**: 81-86.
9. Olasehinde O, Alatise O, Omisore A, Wuraola F, Odujoko O, Romanoff A, … Kingham TP. Contemporary management of breast cancer in Nigeria: insights from an institutional database. *International Journal of Cancer*, *2021;* 148, 2906–2914.
10. Fatiregun OA, Bakare O, Ayeni S, Oyerinde A, Sowunmi AC, Popoola A, Salako O, Alabi A, Joseph A. 10-Year Mortality Pattern Among Cancer Patients in Lagos State University Teaching Hospital, Ikeja, Lagos**.** *Frontiers in Oncology; 2020; https://doi.org/10.3389/fonc.2020.573036*
11. Ndem BN, Akwiwu EC, Akpan PA, Akpotuzor JO, Bassey IE, Isong IK, Onukak EE. Timely accessing of antenatal care and prevalence of vitamin B12 and folate deficiencies among pregnant women in a Nigerian population. *New Zealand Journal of Medical Laboratory Science,2021;* 75, 12-15.
12. Akwiwu EC, Okafor AO, Akpan PA, Akpotuzor JO, Asemota EA, Okoroiwu HU, Anyanwu SO. Serum P53 Protein Level and Some Haematologic Parameters among Women of Reproductive Age Living with HIV Infection. *Nigerian Journal of Physiological Science*, 2021; 36 (1), 85 – 89.
13. Edem MS, **Akwiwu EC,** Akpotuzor JO, Asemota EA, Isong IK. Glycated Haemoglobin, Fasting Plasma Glucose, Plasminogen Activator Inhibitor Type-1 and Soluble Thrombomodulin Levels in Patients with Type 2 Diabetes Mellitus. Nigerian Journal of Physiological Science, 2021; 36 (2): 159 – 164.
14. Basu D, Kulkami R. Overview of Blood Components and Their Preparation. *Indian Journal Anesthesia*, 2014; **58**, 529-537.
15. Lotens A, Naydovski T, Cellier N, Ernotte B, Lambermont M, Rapaile A. (New Approach to Top and Bottom Whole Blood Separation Using the Multi Unit TASCI WB System. Quality of Blood Components. *Vox Sang*, *2014;* **107,** 261-268.
16. Al-Thani AM, Voss SC, Al-Menhali AS, Barcaru A, Horvatovich P, Jaber HA, Nikolovski Z, Latiff A, Georgakopoulos C, Merenkov Z, Segura J, Algayrafi, M. (2018). Whole Blood Storage in CPDA 1 Blood Bags Alters Erythrocyte Membrane Proteome. *Oxidative Membrane and Cellular Longevity,2018;* 12 http//doi.org/10.1155/
17. Lee G, Arepally GM. Anticoagulation Techniques in Apheresis from Heparin to Citrate and Beyond. *Journal of Clinical Apheresis*, 2012; **27**, 117-125.
18. Cluitmans TC, Hardman MR, Dinkla S, Brock R, Bosman GJ. Red Blood Cell Deformability During Storage. Towards Functional Proteonics and Metabolomics in the Blood Bank. *Blood Transfusion*, 2012; **10**(2), 512 – 518. Doi: 10. 2450/2012.0045.
19. Bhattacharya P, Marwaha N, Dhawan HK, Roy P, Sharma R. Transfusion – Related Adverse Events at the Tertiary Care Center in North India: An Institutional Haemovigilance Effort. *Asian Journal Transfusion Science*, 2011; **5**(2), 164-170.
20. Obeagu EI, Okoroiwu IL. Blood Storage Lesions and Other Biochemical Changes Associated with Donor Blood. World Journal of Pharmaceutical Research, 2015; 4 (5):191-199.
21. Oloro OH, Obeagu EI, Puche RO, Lawal OA. Blood Products in Blood Banking: Preparation and Clinical Importance. Madonna University journal of Medicine and Health Sciences, 2022;2(3):102-9.
22. Galano ES, Obianagha NF, Nayak KR, Said OH, Obeagu EI, Okafor CJ, Haji HT. Race as Determinant of Red Blood Cell Osmotic Stress Haemolysis in South Indian and African Populations. Journal of Pharmaceutical Research International. 2021;33(2):46-52.

OPEN ACCESS
ISSN: 2992-5460

Joseph E. Udosen, Precious E. Ekoh, Euphoria C. Akwiwu*, Dennis Abunimye, David U. Akpotuzor, Josephine O. Akpotuzor, Emmanuel Ifeanyi Obeagu (*2023*). Alterations in whole blood stored at 2-6 degrees and the suitability in management of breast cancer. *NEWPORT INTERNATIONAL JOURNAL OF RESEARCH IN MEDICAL SCIENCES (NIJRMS)* 3(2): 47-54.