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Evaluation of Some Hematological Parameters in Breast Cancer Patients Attending Oncology Clinic at American Cancer Hospital, Iho, Imo State

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Abstract:

Breast cancer is associated with complex alterations in hematological parameters. This study aimed to evaluate selected hematological parameters in breast cancer patients attending the Oncology Clinic at American Cancer Clinic, Iho. The study population comprised seventy-five (75) histologically confirmed breast cancer patients and seventy-five (75) apparently healthy individuals without any known malignancy who served as the control group. EDTA samples were analyzed for full blood count and differential count with Sysmex XP-300 hematology autoanalyzer. Data obtained in this study was analyzed using Statistical Package for Social Sciences (SPSS) version 21. The student independent t-test and one-way ANOVA were used to compare means across groups. The results showed that the mean values of hemoglobin level was significantly decreased (p=0.001) in breast cancer patients on chemo (9.56 ± 1.39 g/dL) and newly diagnosed patients (10.05 ± 1.03 g/dL) compared to post-surgery breast cancer patients on chemo (11.45 ± 1.17 g/dL) and controls (12.71 ± 1.55 g/dL), while mean lymphocyte percentage was significantly decreased (p=0.001) in newly diagnosed patients (15.07 ± 2.83%) compared to breast cancer patients on chemo (19.45 ± 3.97%), post-surgery patients on chemo (24.31 ± 3.62%) and controls (32.93 ± 8.96%). The mean total WBC count, neutrophil, monocyte, eosinophil, basophil percentage, and neutrophil-lymphocyte ratio were significantly increased (p=0.001, p=0.001, p=0.000, p=0.000, p=0.001, p=0.000) in newly diagnosed patients (9.73 ± 2.02 ×10⁹/L, 75.72 ± 4.28%, 6.30 ± 1.22%, 3.00 ± 0.95%, 0.47 ± 0.25%, 5.20 ± 1.05) compared to those on chemo (6.36 ± 1.96 ×10⁹/L, 63.07 ± 7.88%, 5.01 ± 1.15%, 1.85 ± 0.84%, 0.33 ± 0.19%, 3.40 ± 0.94), post-surgery patients on chemo (7.17 ± 1.75 ×10⁹/L, 59.18 ± 6.18%, 5.31 ± 1.11%, 2.47 ± 0.81%, 0.32 ± 0.09%, 2.48 ± 0.42) and controls (7.14 ± 1.64 ×10⁹/L, 55.85 ± 8.63%, 4.75 ± 1.07%, 2.39 ± 0.83%, 0.33 ± 0.11%, 1.98 ± 1.20). In conclusion, breast cancer is associated with significant alterations in hematological profiles, especially in newly diagnosed patients due to immune deregulations likely linked to tumor progression and treatment response but improved with chemotherapy and surgery.

Key words: hematological parameters; breast cancer patients; oncology clinic. american cancer hospital; iho

Introduction:

Breast cancer continues to be the most often diagnosed cancer and the primary cause of cancer-related mortality for women globally. The unchecked proliferation of the epithelial cells that line the breast's ducts or lobules is a characteristic of this diverse illness. In 2020 alone, there were over 2.3 million new cases and 685,000 deaths worldwide from breast cancer [1]. Due to a notable increase in occurrence in low- and middle-income regions, especially sub-Saharan Africa, the disease's impact is not just confined to high-income nations. With a 5-year survival rate that is significantly lower than in industrialised countries, breast cancer is the most common cancer among women in Nigeria and contributes significantly to cancer morbidity and mortality[2].
Genetic, hormonal, and environmental variables interact intricately in the pathophysiology of breast cancer. The immune system and inflammation's roles in the initiation and spread of cancer have drawn a lot of attention in recent years. Haematological indices are essential markers of both healthy and diseased conditions. These include haemoglobin concentration, total white blood cell (WBC) count, and differential counts (neutrophils, lymphocytes, monocytes, eosinophils, and basophils). Chemotherapy, bone marrow infiltration, or persistent inflammation can all cause anaemia, which is frequently observed in cancer patients [3]. Changes in differential counts and leukopenia or leukocytosis may be signs of bone marrow suppression or systemic inflammation. Derived from differential counts, the neutrophil-to-lymphocyte (N-L) ratio has become a straightforward and affordable indicator of systemic inflammation and has predictive value for a number of malignancies, including breast cancer [4].

Evaluating these biomarkers may help with diagnosis, prognosis, and therapy monitoring while providing information on the immunological and inflammatory environment of breast cancer [5]. Therefore, the purpose of this study is to assess haematological markers in patients with breast cancer in order to ascertain their potential usefulness in therapeutic management, particularly in settings with limited resources.

With disproportionately high death rates in low- and middle-income nations, breast cancer remains a major global public health concern. The late discovery and diagnosis of the disease, which frequently results from insufficient screening programs, low awareness, and restricted access to diagnostic facilities, is a significant factor to this mortality. The majority of breast cancer patients in Nigeria are discovered at an advanced stage, with few available treatments and poor prognoses [6]. In many countries with limited resources, the incorporation of haematological indicators into routine breast cancer evaluation is still poor, despite advancements in oncological therapy.

Data on the haematological profile of patients with breast cancer are scarce in the setting of the American Cancer Clinic, Iho. This disparity emphasises how important it is to thoroughly assess these biomarkers in order to improve patient outcomes and care.
Numerous studies have suggested that haematological indices, in particular the N-L ratio, might independently predict the course of a disease and how well a treatment would work [8,9].

However, there is a lack of localised research, especially in Imo State, Nigeria, that thoroughly assesses these parameters in patients with breast cancer. Many patients with breast cancer are treated at the American Cancer Clinic in Iho, but little is known about their haematological conditions. The goal of this study is to assess the levels of haematological parameters in breast cancer patients who visit the oncology clinic at American Cancer Clinic, Iho, in order to close this knowledge gap and provide baseline data that may guide clinical practice and future research.

Materials and Methods:

Study Area
The study was conducted at the American Cancer Clinic, Iho, located in Ikeduru Local Government Area of Imo State, Nigeria.
Ethics Advocacy and Pre-Survey Contact
The Ethical clearance was granted. Informed consent was obtained from all study participants after explaining the study's objectives, procedures, risks, and benefits.
Selection Criteria
Inclusion Criteria:
Participants included in the study met the following criteria:

- Female subjects within the ages of 25 and 70 years.
- Breast cancer patients confirmed by histopathological diagnosis.
- Individuals who voluntarily provided informed consent for participation in the study.
- Apparently healthy female individuals of the same age range with no history of malignancy served as control.

Exclusion Criteria:

- Subjects below 25 years or above 70 years.
- Subjects diagnosed with other chronic illnesses such as autoimmune, infectious, or hematological disorders, HIV/AIDS,

or other forms of carcinoma.
- Pregnant women or women with recent blood transfusion.
- Subjects who declined to give informed consent.

Study Design

This was a hospital-based cross-sectional study carried out between April and June 2025. The study consisted of two groups. Group 1 comprised seventy-five (75) histologically confirmed breast cancer patients attending the Oncology Clinic at the American Cancer Clinic, Iho, while Group 2 comprised seventy-five (75) apparently healthy individuals without any known malignancy, and they served as the control group. The breast cancer group was further categorized into: Group A: 25 newly diagnosed breast cancer patients not yet initiated on any treatment; Group B: 25 breast cancer patients currently undergoing chemotherapy; and Group C: 25 breast cancer patients who had undergone surgical resection and were being maintained on chemotherapy. All participants were sampled only once and blood samples were collected under standard aseptic conditions to evaluate the levels of hemoglobin, total white blood cell count, and differential count (neutrophil, lymphocyte, monocyte, eosinophil, basophil and N-L Ratio).

Sample Collection

five milliliters (5mL) of venous blood was aseptically collected from the ante-cubital vein of each participant using a sterile disposable 10 mL syringe and needle through venipuncture. The blood was dispensed into EDTA tube. The EDTA blood sample was stored at 4˚C until analysis for full blood count and differential count.. All assays were completed within 48 hours of sample collection to ensure reliable and accurate results.

Laboratory Procedures

All reagents and kits used were commercially purchased and the manufacturer's standard operating procedures were strictly followed.

Determination of Hemoglobin, White Blood Cell Count and Differential Count

The test was done by Hematology Autoanalyzer **(**Coulter principle) (van Dievoet *et al.*, 2016) as modified by Sysmex Co-operation, Japan.

Principle

The Sysmex XP-300 hematology autoanalyzer operates based on the electrical impedance principle, also known as the Coulter principle. In this method, a blood sample is aspirated and diluted with an isotonic electrolyte solution, which acts as a conductive medium. As the cells are pulled through a small aperture concurrent with an electric current, each cell displaces its volume in the electrolyte, momentarily changing the impedance. This brief increase in resistance causes a drop in the electrical current, which is detected and counted as a pulse. The magnitude of each pulse is directly proportional to the volume of the cell that passed through the aperture. In this way, the analyzer is able to count and size the blood cells, including red blood cells (RBCs), white blood cells (WBCs), and platelets. For hemoglobin measurement, the analyzer uses a non-cyanide colorimetric method. A lysing reagent is added to the sample to release hemoglobin from the red cells, forming a stable colored complex whose absorbance is measured photometrically. Differential counts are derived based on volume and complexity using a two-angle light scatter method.

Procedure

The XP-300 hematology analyzer was first switched on and allowed to perform an automatic background check to ensure system readiness. All reagents and consumables were verified to be within their expiry dates. Blood samples collected in K_2EDTA anticoagulated tubes were gently mixed to ensure homogeneity. A sample identification number was entered into the system using the keypad. The sample tube was placed securely in the sample holder at the probe. With the tube in place, the start button was pressed to initiate sample aspiration and analysis. The system automatically aspirated the sample, performed dilution, lysed the red cells for hemoglobin estimation, and measured various hematological parameters including total WBC count, hemoglobin concentration, and the differential percentages and absolute counts of neutrophils, lymphocytes, monocytes, eosinophils, and basophils. Upon completion, results were displayed on the LCD screen and automatically printed for documentation. Quality control was ensured by running control samples at regular intervals and verifying their values against established ranges.

Determination of Neutrophil-Lymphocyte (N-L) Ratio

The Neutrophil-Lymphocyte Ratio (N-L Ratio) was determined by calculating the proportion of the absolute neutrophil count to the absolute lymphocyte count obtained from the hematology autoanalyzer (Model XP-300, Sysmex Co-operation, Kobe, Japan). After running the complete blood count (CBC) on each blood sample, the analyzer provided both the percentage and absolute values for each type of white blood cell, including neutrophils and lymphocytes.

To determine the N-L Ratio, the absolute count of neutrophils (expressed in cells × 10^9/L) was divided by the absolute count of lymphocytes (also expressed in cells × 10^9/L). This calculation was done manually using the following formula:

N-L Ratio = Absolute Neutrophil Count ÷ Absolute Lymphocyte Count

The resulting ratio was recorded for each subject.

Statistical Analysis

Data obtained in this study were analyzed using Statistical Package for Social Sciences (SPSS) version 21.0. The student independent T-test and one-way ANOVA were used to determine mean differences across groups. Results were expressed as Mean ± standard deviation. Pearson's correlation coefficient was employed for correlation analyses among parameters. Test with probability of $p<0.05$ was considered statistically significant.

Results:

GROUP	VARIABLES (UNITS)			
	Hb (g/dL)	WBC (×10⁹/L)	Neutrophils (%)	Lymphocytes (%)
Newly Diagnosed (A) (n = 25)	10.05 ± 1.03	9.73 ± 2.02	75.72 ± 4.28	15.07 ± 2.83
On Chemotherapy (B) (n = 25)	9.56 ± 1.39	6.36 ± 1.96	63.07 ± 7.88	19.45 ± 3.97
Post-Surgery + Chemo (C) (n = 25)	11.45 ± 1.17	7.17 ± 1.75	59.18 ± 6.18	24.31 ± 3.62
Healthy Control (D) (n = 75)	12.71 ± 1.55	7.14 ± 1.64	55.85 ± 8.63	32.93 ± 8.96
F-value	43.98	17.81	44.26	54.98
P-value	*0.001	*0.001	*0.001	*0.001
A vs B	1.000	*0.000	*0.000	0.150
A vs C	*0.003	*0.000	*0.000	*0.000
A vs D	*0.000	*0.000	*0.000	*0.000
B vs C	*0.000	0.659	0.429	0.079
B vs D	*0.000	0.347	*0.000	*0.000
C vs D	*0.001	1.000	0.351	*0.000

Table 1: *Mean ± Standard Deviation, ANOVA and Post-Hoc Values of Some Hematological Parameters in Newly Diagnosed Breast Cancer Patients, Patients on Chemotherapy, Post-Surgery Patients on Chemotherapy, and Apparently Healthy Individuals*

KEY: Hb = Haemoglobin, WBC = Total White Blood Cell Count, Vs = Versus, g/dL = gram per deciliter, L = liter, % = Percentage, n = Sample Size, * = Statistically significant at $P \leq 0.05$.

Analysis:

Table 2 presents the mean ± standard deviation, ANOVA, and post-hoc values of haemoglobin (Hb), total white blood cell count (WBC), neutrophil percentage, and lymphocyte percentage in newly diagnosed breast cancer patients, patients on chemotherapy, post-surgery patients on chemotherapy, and apparently healthy individuals.

There were significant differences in the mean values of Hb, WBC, neutrophils, and lymphocytes among the various groups ($p < 0.001$). The post-hoc multiple comparison showed that the mean ± SD of Hb in newly diagnosed patients (10.05 ± 1.03 g/dL) was not significantly different ($p = 1.000$) from those on chemotherapy (9.56 ± 1.39 g/dL), but was significantly lower ($p = 0.003$) than that of post-surgery patients on chemotherapy (11.45 ± 1.17 g/dL), and also significantly lower ($p = 0.000$) than that of the healthy controls (12.71 ± 1.55 g/dL). Similarly, the Hb of patients on chemotherapy was significantly lower ($p = 0.000$) when compared with both post-surgery patients on chemotherapy and the healthy control group, while the difference between post-surgery patients on chemotherapy and healthy controls was also statistically significant ($p = 0.001$).

The WBC count was significantly higher ($p = 0.000$) in newly diagnosed patients (9.73 ± 2.02 ×10⁹/L) when compared with those on chemotherapy (6.36 ± 1.96 ×10⁹/L), post-surgery chemotherapy patients (7.17 ± 1.75 ×10⁹/L), and the healthy controls (7.14 ± 1.64 ×10⁹/L). However, WBC showed no significant difference between patients on chemotherapy and post-surgery chemotherapy patients ($p = 0.659$), as well as with healthy controls ($p = 0.347$ and $p = 1.000$ respectively).

Neutrophil percentage was significantly elevated ($p = 0.000$) in newly diagnosed patients (75.72 ± 4.28%) compared to those on chemotherapy (63.07 ± 7.88%), post-surgery chemotherapy patients (59.18 ± 6.18%), and healthy controls (55.85 ± 8.63%). Likewise, patients on chemotherapy had significantly higher neutrophils ($p = 0.000$) than the healthy controls but did not differ significantly from post-surgery chemotherapy patients ($p = 0.429$). No significant difference ($p = 0.351$) was observed between post-surgery chemotherapy patients and healthy controls.

Lymphocyte percentage was significantly lower ($p = 0.000$) in newly diagnosed patients (15.07 ± 2.83%) compared to post-surgery chemotherapy patients (24.31 ± 3.62%) and healthy controls (32.93 ± 8.96%). However, it did not differ significantly ($p = 0.150$) from the values in patients on chemotherapy (19.45 ± 3.97%). Furthermore, patients on chemotherapy had significantly lower lymphocyte counts compared to healthy controls ($p = 0.000$) but did not differ significantly from post-surgery chemotherapy patients ($p = 0.079$). The lymphocyte count in post-surgery chemotherapy patients also remained significantly lower ($p = 0.000$) than in the healthy control group.

GROUP	VARIABLES (UNITS)			
	Monocytes (%)	Eosinophils (%)	Basophils (%)	NLR
Newly Diagnosed (A) (n = 25)	6.30 ± 1.22	3.00 ± 0.95	0.47 ± 0.25	5.20 ± 1.05
On Chemotherapy (B) (n = 25)	5.01 ± 1.15	1.85 ± 0.84	0.33 ± 0.19	3.40 ± 0.94
Post-Surgery + Chemo (C) (n = 25)	5.31 ± 1.11	2.47 ± 0.81	0.32 ± 0.09	2.48 ± 0.42
Healthy Control (D) (n = 75)	4.75 ± 1.07	2.39 ± 0.83	0.33 ± 0.11	1.98 ± 1.20
F-value	12.254	7.770	5.692	63.120
P-value	*0.000	*0.000	*0.001	*0.000
A Vs B	*0.000	*0.000	*0.012	*0.000
A Vs C	*0.013	0.174	*0.007	*0.000
A Vs D	*0.000	*0.012	*0.001	*0.000
B Vs C	1.000	0.062	1.000	*0.013
B Vs D	1.000	*0.042	1.000	*0.000
C Vs D	0.199	1.000	1.000	0.238

Table 2: *Mean ± Standard Deviation, ANOVA and Post-Hoc Values of Some Hematological Parameters in Newly Diagnosed Breast Cancer Patients, Patients on Chemotherapy, Post-Surgery Patients on Chemotherapy, and Apparently Healthy Individuals*

KEY: NLR = Neutrophil-to-Lymphocyte Ratio, % = Percentage, Vs = Versus, n = Sample Size, * = Statistically significant at P ≤ 0.05.

Analysis

Table 2 shows the mean ± standard deviation, ANOVA, and Post-hoc values of monocytes, eosinophils, basophils, and neutrophil-to-lymphocyte ratio (NLR) in newly diagnosed breast cancer patients, patients on chemotherapy, post-surgery patients on chemotherapy, and apparently healthy individuals.

There were significant differences in the mean values of monocytes, eosinophils, basophils, and NLR across the groups ($p < 0.05$). The multiple post-hoc comparison showed that the mean ± SD value of monocytes in newly diagnosed breast cancer patients (6.30 ± 1.22%) was significantly higher ($p = 0.000$) than in patients on chemotherapy (5.01 ± 1.15%), post-surgery patients on chemotherapy (5.31 ± 1.11%), and healthy individuals (4.75 ± 1.07%). However, the difference between patients on chemotherapy and post-surgery patients on chemotherapy ($p = 1.000$) as well as between patients on chemotherapy and healthy controls ($p = 1.000$) was not statistically significant. Similarly, monocyte values in post-surgery patients on chemotherapy and healthy controls showed no significant difference ($p = 0.199$).

For eosinophils, the mean ± SD in newly diagnosed patients (3.00 ± 0.95%) was significantly higher ($p = 0.000$) than those on chemotherapy (1.85 ± 0.84%) and healthy controls (2.39 ± 0.83%), but not significantly different from post-surgery chemotherapy patients (2.47 ± 0.81%, $p = 0.174$). Also, patients on chemotherapy showed a significantly lower eosinophil count when compared to healthy controls ($p = 0.042$), but the difference was not significant when compared to post-surgery patients ($p = 0.062$). Post-surgery patients on chemotherapy and healthy controls showed no significant difference ($p = 1.000$).

The mean ± SD value of basophils in newly diagnosed patients (0.47 ± 0.25%) was significantly higher than in patients on chemotherapy (0.33 ± 0.19%, $p = 0.012$), post-surgery patients on chemotherapy (0.32 ± 0.09%, $p = 0.007$), and healthy controls (0.33 ± 0.11%, $p = 0.001$). There were no significant differences in basophil values between patients on chemotherapy and post-surgery patients ($p = 1.000$), chemotherapy and healthy controls ($p = 1.000$), and between post-surgery patients and healthy controls ($p = 1.000$).

The mean ± SD value of NLR was significantly elevated ($p = 0.000$) in newly diagnosed patients (5.20 ± 1.05) compared to those on chemotherapy (3.40 ± 0.94), post-surgery chemotherapy patients (2.48 ± 0.42), and healthy individuals (1.98 ± 1.20). NLR also remained significantly higher in patients on chemotherapy when compared to post-surgery chemotherapy patients ($p = 0.013$) and healthy controls ($p = 0.000$). However, the difference in NLR between post-surgery chemotherapy patients and healthy individuals was not statistically significant ($p = 0.238$).

Discussion:

In addition to the malignant transformation of breast epithelial cells, breast cancer is a heterogeneous disease that is marked by notable haematological abnormalities that indicate the severity of the disease and the effectiveness of treatment [10].

Additionally, as shown in Table 1, the haematological characteristics of patients with breast cancer shed additional light on the systemic changes linked to the disease and its management. Compared to healthy controls, haemoglobin levels were significantly lower in patients with breast cancer, especially those receiving chemotherapy and those who had just received a diagnosis. Chronic inflammation, malnutrition, and bone marrow suppression brought on by tumour invasion or the cytotoxic effects of chemotherapy drugs are all contributing factors to this anaemia [11]. Anaemia is still a well-known side effect in

cancer patients, frequently linked to poor clinical results and a lower quality of life [12]. This study's findings are in line with previous observations by [13], who also noted anaemia as a prevalent haematologic problem in cohorts of people with breast cancer.

Furthermore, compared to other categories and controls, newly diagnosed patients had significantly higher neutrophil percentages and total white blood cell (WBC) counts. The elevated level of systemic inflammation that characterises untreated cancer is reflected in these data. Since neutrophils have been demonstrated to release cytokines and enzymes that stimulate angiogenesis, tumour development, and immune suppression, neutrophili in particular are suggestive of a pro-tumorigenic milieu [14]. This inflammatory environment is further supported by the higher neutrophil-lymphocyte (N-L) ratio seen in the newly diagnosed group. A higher N-L ratio is frequently linked to advanced illness and poor survival outcomes and has been consistently found to be a reliable predictive biomarker in a number of malignancies, including breast cancer [15]. Additionally, the newly diagnosed group had significantly greater monocyte counts. Tumor-associated macrophages (TAMs), which are known to promote angiogenesis, tumour growth, and immune evasion within the tumour microenvironment, are derived from monocytes. This study's higher monocyte count supports that of [16], who reported comparable increases in malignancy and linked them to the aggressiveness and potential for metastasis of the disease.

In contrast, individuals with breast cancer, particularly those who had just received a diagnosis, had far lower lymphocyte percentages. Tumor-induced immunosuppression, which impairs host anti-tumor immunity and has been linked to a poor prognosis for patients with breast cancer, is suggested by this lymphopenia [17]. The results are consistent with those of [18], who noted that lower lymphocyte counts are frequently associated with lower survival and more severe illness. Additionally, compared to other groups, newly diagnosed patients had larger percentages of eosinophils and basophils. Although cancer immunology has not historically placed much emphasis on these granulocytes, new research indicates that they might be affected by cytokine dysregulation or allergic-type immune reactions triggered by tumour antigens. [19] Thus, underlying tumor-related haematopoietic changes may be reflected in the trends our study found. That being said, their exact function is still unclear and needs more research.

These results are in line with the notion that anaemia in cancer is complex, involving renal insufficiency, bone marrow infiltration, nutritional inadequacies, and toxicity from treatment [20].

Conclusion:

Elevated levels of WBC, neutrophils, monocytes and N-L ratio parallels reduced levels of hemoglobin and lymphocytes in breast cancer patients, which reflect tumor-induced anemia. These abnormalities are most pronounced in newly diagnosed patients and tend to partially normalize or improve with chemotherapy and surgical intervention. Overall, the findings suggest that hematological markers can aid in assessing disease status and treatment response in breast cancer.

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