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Laboratory Outcomes of Pre and Post Chemotherapy among Breast Cancer Patients

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Authors' contributions

This work was carried out in collaboration among all authors. Author RK designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors YB and LG managed and collected the data of the study. Authors YB and KH managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: Breast cancer is the most common type of cancer among women in Guyana, accounting for one in every four cancer diagnosis. Chemotherapy has been medically and scientifically proven to be most effective treatment for many types of cancers. However, there were also severe effects of chemotherapy on biochemistry and hematology functions. Neutropenia is the most serious hematologic toxicity of cancer chemotherapy, often limiting the doses of chemotherapy, the degree and duration of the neutropenia determine the risk of infection. Thus this study identified the significance of blood parameters during chemotherapy among breast cancer patients.
Study Design: Laboratory based descriptive study.
Place and Duration of Study: Sample: Cancer Institute, Georgetown Public Hospital Cooperation, Guyana between 2013 to 2015.
Methodology: Sample: A total of 184 cases diagnosed with breast cancer were included for the study. Mean ± SD was used to measure biochemical and hematological means.
Results: Mean ± SD of the patients age was 54.0±11.2 and BMI 30.7±6.6. Most prevalent breast

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cancer was ductal cancer (41.3%), followed by infiltrating ductal cancer (26.6%). Stage I cancer (87.2%) was most prevalent than other stages. Most patients were on injection cyclophosphamide (95.1%) and/or injection adriamycin (74.5%). There was a variation noted in the values of the hematological and biochemical parameters. Most hematology and biochemistry parameters exhibited a variation in pre and post chemotherapy.

Conclusion: The patients showed variation in the biochemical and hematological parameters between pre and post absolute neutrophil count and other laboratory parameters due to chemotherapy. This confirms the potential toxicities of certain chemotherapeutic agents to hematological and metabolic functions.

Keywords: Chemotherapy; laboratory assessments; Guyana.

1. INTRODUCTION

Breast cancer is known to be the most commonly diagnosed cancer among women worldwide [1]. Although mortality has decreased in developed countries, incidence is still at peak in developing countries [2,3,4]. Many factor could contribute to the risk of breast cancer like family history, ethnicity and genetics [5].

Hematology and biochemistry laboratory variations are common observations. Febrile neutropenia (FN) being the most common complications associated with cancer chemotherapy. Studies have reported 25–40% of chemotherapy patients developing FN which is known to cause many deadly infections causing further morbidity and delay in treatment [6]. Published studies report that 33% of cancer patients get infected post chemotherapy mostly due to neutropenia [7,8]. Another factor associated with cancer patient is anemia especially chemotherapy with rituximab-CHOP (combining cyclophosphamide, hydroxydaunorubicin, oncovin, and prednisone or prednisolone) [9]. Thrombocytopenia is a side effect of chemotherapeutic drugs, which could lead to massive bleeding [10]. It's no wonder that liver dysfunction is another finding with chemotherapy and liver function tests need to be monitored among the cancer patients [11]. Moreover, hyperkalemia, hypercalcemia and hyponatremia are some other manifestations often observed in patients with breast cancer [12]. Therefore, it is very important to have a close monitoring of laboratory parameters before and after treatment of cancer patients.

The study therefore analyzes laboratory parameters among breast cancer patients before and after chemotherapy at the Oncology Department of GPHC, Georgetown, Guyana.

2. MATERIALS AND METHODS

For this study, all patients diagnosed with breast cancer and receiving chemotherapy at the cancer institute, Guyana during 2013 – 2015 were enrolled. The laboratory investigations collected for evaluations included 2 categories of routine blood tests:

(1) Complete blood count: Hemoglobin, white blood cell, platelets, neutrophils, lymphocytes, basophils, eosinophils, monocytes and absolute neutrophil counts (ANC).
(2) Hepato-renal function: Sodium (Na^+), Potassium (K^+), Chloride (Cl^-), Alanine transaminase (ALT), Aspartate Transaminase (AST), Blood Urea Nitrogen (BUN), Total Bilirubin, Direct Bilirubin, Indirect Bilirubin and Serum Creatinine.

The absolute Neutrophil count was calculated using the neutrophil count and total WBC measured by the Beckman & Coulter. Furthermore, the grades of neutropenia were expressed based on information from National Cancer Institute, 1999; National Comprehensive Cancer Network & American Cancer Society, 2002. Information about primary tumor site, chemotherapy regimen, sex, age, BMI, location, co-morbidities and chemotherapy regimens were evaluated to determine the level of association with chemotherapy induced neutropenia and the effect of chemotherapy on the various organs. Assessment of these results was done at the beginning of every chemotherapy regimen.

Absolute Neutrophil Count (ANC) =Total WBC count x (% neutrophils + % bands)

Inclusion criteria: Patients diagnosed with breast cancer, normal neutrophil level before chemotherapy.

Exclusion criteria: Patients diagnosed with low-grade lymphoma (or leukaemia), administered with cytokines or granulocyte growth factors during or after chemotherapy were excluded from the study, HIV positive patients and incomplete data were excluded from the study.

Ethical approval: Permission to carry out this research was obtained by the Director of Cancer Institute and ethical approval was granted by Institutional Review Board (IRB) under Ministry of Public Health. No names of patients were collected during the study. All data was calculated in percentages. The descriptive data were presented as mean ± SD. P-value ≤0.05 was considered to be statistically significant. All analysis was done in Minitab software.

3. RESULTS

3.1 Demographics of Patients

A total of 184 patients were included in the study during the year 2013 – 2015. There was an increase in cases recorded during the study period, 2013 (20.7%), 2014 (18.4%) and 2015 (60.5%). The average age range of patients was 54±11.2 years (mean±SD). Most patients were from region 4 (37.9%), followed by region 3 (22.5%). Significantly, Indo-Guyanese (41.9%) ethnicity was predominant followed by Afro-Guyanese (34.7%) and the mixed race (21.9%) (Table 1). Table 2 shows clinical history of patients. Ductal CA recorded 41.3%, followed by infiltrated ductal CA 26.6%, invasive ductal CA represent 24.5% and chemical suspicion high grade with 6.5%. Majority of carcinoma was on right breast (43.2%) and 24.5% on the left breast (p≤0.05). Most patients were on stage I carcinoma (87.2%). Most common drug used were Dexamethasone 94%, Ondersetron 79.3%, Rantidine 71.7%, Adriamycin 97.8%, Cyclophosamide 95.1%, Cimethidine 80.4%, Zantac 70.1%, Pacilaxel 57.6%.

Table 3 shows laboratory parameters among breast cancer patients. The hematological and biochemical changes were observed before and after chemotherapy.

Hb and eosinophils showed no major variance within the pre & post chemotherapy cycles. Platelets, neutrophils, lymphocytes, basophils, monocytes, WBCs and ANC were found to have a variation within the pre & post chemotherapy cycles. On the other hand, biochemistry data showed BUN, chlorine and ALT to have a variation within the pre & post chemotherapy cycles. The creatinine, sodium, potassium, AST, D-bilirubin, T-bilirubin and I-bilirubin test was found to have no major variation within the pre & post chemotherapy cycles.

Table 1. General characteristics of breast cancer patients

Variables	Mean±SD	Median
Age	54.0±11.2	55
BMI	30.7±6.6	29.7
Ethnicity	**n (%)**	
Afro Guyanese	58 (34.7)	
Indo Guyanese	70 (41.9)	
Mixed	35 (21.0)	
Amerindian	3 (1.8)	p≤0.05
Gender		
Female	178 (96.7)	
Male	6 (3.3)	p≤0.05
Region		
Region 2	4 (2.2)	
Region 3	41 (22.5)	
Region 4	69 (37.9)	
Region 5	18 (9.9)	
Region 6	37 (20.3)	
Region 7	1 (0.5)	
Region 10	12 (6.6)	p≤0.05

4. DISCUSSION

Assessing the risk of laboratory parameters especially ANC would be crucial before chemotherapy. A large number of cancer patients have to delay the chemotherapy due to hematological toxicity. Chemotherapy gradually exhausts the stem-cell in the bone marrow [13] thus reducing WBC. This is usually manifested as a reduction in WBC with successive cycle of chemotherapy.

Crawford J, et al reported an occurrence and timing of neutropenic events and chemotherapy treatment in cancer patients. Initiating a new chemotherapy regimen revealed that most breast cancer patients experienced an ANC lower than 500 cells/mm^3. White Blood Cells, monocytes, lymphocytes and platelets were found to have a variation within the pre & post chemotherapy cycles. This research revealed that chemotherapy induces the suppression of blood cells in the hematological system. Some health concerns include, WBC depletion, the inability of the body to produce healthy platelets, red blood cells thus, resulting in an overall low blood count [14].

Table 2. Clinical characteristics of breast cancer patients

Clinical characteristics	n (%)	
Ductal CA	76 (41.3)	
Infiltrating ductal CA	49 (26.6)	
Invasive ductal CA	45 (24.5)	
Chemical suspicion high grade	12 (6.5)	
Right breast	79 (43.2)	
Left breast	45 (24.5)	
Stage		
Stage I	75 (87.2)	
Stage II	6 (7.0)	
Stage III	1 (1.2)	
Stage IV	4 (4.7)	p≤0.05
CA treatment		
Injection Cyclophosphamide	175 (95.1)	
Injection Adriamycin	180 (97.8)	
Paclitaxel	106 (57.6)	
Radiotherapy	7 (3.8)	
Injection Dexeranethasone	173 (94)	
Injection Ranitidine	132 (71.7)	
Ondansetron	146 (79.3)	
Cimethidine	148 (80.4)	
Zantac	129 (70.1)	p≤0.05
Other complications		
Allergy	9 (4.9)	
Diabetes	14 (7.6)	
Hypertension	16 (8.7)	p=0.4

CA: Carcinoma

Table 3. Post and pre chemotherapy laboratory values

	Pre C Mean±SD	PC 1 Mean±SD	PC 2 Mean±SD	PC 3 Mean±SD	PC 8 Mean±SD
Hematology					
Hb	12.1±2	11.8±1.9	11.9±1.9	11.7±1.9	12.1±1.4
Platelets	348.9±105	369.0±104.2	362.8±110.9	358.8±115.4	326.7±99.7
WBC*	3747.2±3562	2883.7±2738.8	2992.5±2827.1	3224.3±3077.9	4433.0±3058.2
Neutrophils	51.7±11	46.9±12.0	43.9±9.6	49.1±11.9	40.5±17.1
Lymphocytes	37.9±12	40.2±11.9	38.9±10.7	37.5±12.0	35.7±11.4
Basophils	2.4±1	2.9±1.6	2.9±1.6	2.7±1.5	2.3±1.21
Eosinophil	2.0±2	2.1±1.8	2.5±2.2	2.2±2.3	1.4±0.89
Monocytes	5.9±3	7.2±4.2	6.5±3.9	6.5±4.2	7.0±2.86
ANC	3151.2±1511	2366.1±1249.0	2221.7±1251.4	2330.9±1307.3	2344±1222
Biochemistry					
BUN	14.7±7	14.5±5.8	14.4±5.6	15.1±5.7	12.2±4.07
Creatinine	1.2±1	1.1±0.6	1.1±0.6	1.1±0.6	0.9±0.41
Na	140.3±4	139.4±4.2	140.3±4.2	140.1±4.3	139.2±4.48
K	4.3±1	4.3±0.6	4.3±0.6	4.4±0.6	4.3±0.57
Cl	106.7±12	104.3±7.3	107.0±11.5	106.2±11.1	104.1±7.48
ALT	32.6±14	31.8±12.3	31.2±15.2	29.7±12.6	27.6±12.8
AST	32.5±13	32.2±11.4	30.8±14.6	30.7±13.6	31.8±13.9
D-bilirubin	0.3±0	0.3±0.2	0.4±0.2	0.3±0.2	0.3±0.21
T-bilirubin	0.7±1	0.6±0.3	0.7±0.3	0.7±0.3	0.7±0.34
I-bilirubin	0.6±0	0.6±0.4	0.4±0.3	0.5±0.3	0.6±0.32

**Statistically significant at p<0.001; (SD-standard deviation; pre C-pre chemotherapy; PC-post chemotherapy); ANC Absolute Neutrophil Count*

The liver plays a major role in the metabolism of many commonly used anticancer agents [11]. Thus liver function assessment is a fundamental part of initial and ongoing management of patients with cancer. Patients with liver dysfunction will show reduced effectiveness to chemotherapy. Furthermore, several chemotherapy agents induce liver injury or dysfunction, which can manifest as abnormal serum liver biochemistry. Conventional serum liver and kidney biochemical testing does not always predict these potential complications. In the present study, we aim to find the effect of chemotherapy on laboratory parameters. The findings revealed that chemotherapy could alter the laboratory parameters among cancer patients.

5. CONCLUSION

We found a variation between pre and post absolute neutrophil count and other hematology and metabolic function due to chemotherapy regimen in breast cancer patients. This confirms the potential toxicities of certain chemotherapeutic agents to hematological and metabolic functions. The provision of baseline pre-chemotherapy blood work will provide a basis for monitoring the effects of both the cancer and the chemotherapy. It is recommended that our findings be further studied to create a multivariate risk assessment model, which aims to identify patients at risk for neutropenia even before treatment based on their risk factors. This will provide valuable information in the prevention neutropenia through care monitoring during chemotherapy treatment.

CONSENT

It is not applicable.

ETHICAL APPROVAL

Permission was sought from the Ministry of Health and Institutional Review Board, Guyana. Additionally, permission was sought from the Director of Georgetown Public Hospital Corporation (GPHC) and Head of the Oncology Department. No patient's identity was used in this study.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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