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Alterations in Hematological and Biochemical Profiles in Cancer Patients Before and After Chemotherapy at Dhamar General Hospital Authority , Yemen

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Abstract

Background: Chemotherapy, a cornerstone of cancer treatment, is associated with significant hematological and biochemical toxicities that require careful monitoring. In resource-limited settings like Yemen, where the healthcare system faces profound challenges, the patterns and management of these side effects are poorly documented.
Aim: This study aimed to evaluate the alterations in hematological and biochemical profiles in cancer patients before and after chemotherapy at a public hospital in Yemen.
Methods: A hospital-based observational study was conducted on 50 cancer patients at the Oncology Unit of the Dhamar General Hospital Authority (DGHA) . A structured questionnaire was used for collecting the Socio-demographic information and relevant medical history. While, the clinical, and laboratory data (Complete Blood Count, Liver Function Tests, Kidney Function Tests) were collected from patient records pre- and post-chemotherapy. Data were analyzed using SPSS version 21. Paired t-tests was used to compare mean differences of Hematological and biochemical parameter values. A p-value < 0.05 was considered statistically significant.
Results: Results: The most of patients were female (64%, n=32), presented with advanced-stage disease (at Stage III/IV) (54 %, n=27), and had breast cancer (22%, n=11). Post-chemotherapy, the analysis revealed no statistically significant alterations in the majority of hematological parameters, including hemoglobin, white blood cells, and platelets (P > 0.05). For biochemical profiles, a significant decrease in Alanine Aminotransferase (ALT) (mean differences: 3.97 U/L ;P=0.035) and a significant increase in Alkaline Phosphatase (ALP) (mean differences: -12.21 U/L ; P=0.036) were observed. Other liver and kidney function parameters showed no significant changes.
Conclusion: The advanced stage at diagnosis highlights critical gaps in early detection and cancer awareness in Yemen. The absence of significant hematological toxicity suggests that chemotherapy protocols may be adapted, potentially through dose modifications, to mitigate risks in a setting with limited supportive care. These findings underscore the urgent need for context-specific treatment guidelines and strengthened healthcare infrastructure to improve oncology outcomes in Yemen.

Keywords: Chemotherapy, Cancer, Hematological Toxicity, Biochemical Profiles, Yemen.

1. Introduction

Cancer, a disease characterized by the uncoordinated and invasive proliferation of abnormal cells, remains a leading cause of mortality worldwide [1, 2]. While a significant proportion of cancer deaths are preventable through early intervention and treatment, the management of the disease often involves aggressive therapies like chemotherapy [3].

Chemotherapy, a cornerstone of cancer treatment, utilizes cytotoxic agents to target rapidly dividing cancer cells. However, its mechanism of action is non-selective, also damaging healthy cells with high turnover rates, such as hematopoietic progenitor cells in the bone marrow and parenchymal cells of vital organs [1]. This collateral damage frequently leads to significant treatment-related toxicities, manifesting as alterations in hematological and biochemical profiles. Common consequences include myelosuppression—resulting in anemia, neutropenia, and thrombocytopenia—as well as hepatotoxicity and nephrotoxicity [5, 6]. These alterations can precipitate life-threatening complications like severe infections and hemorrhage, and if not managed properly, can lead to dose reduction, treatment delays, or even therapeutic failure [7].

To mitigate these risks, routine monitoring through Complete Blood Count (CBC), Liver Function Tests (LFTs), and Kidney Function Tests (KFTs) is a standard of care before and after chemotherapy cycles. This practice allows for the timely detection and management of adverse effects [3].

Despite the critical importance of this monitoring, there is a notable lack of localized data characterizing these profile changes in cancer patients within Yemen, specifically in the Dhamar Governorate. A recent study from Ibb, Yemen, highlighted the high prevalence of hematologic malignancies but also underscored the general lack of information on cancer in the country [8] . Another study from Yemen focused on baseline hematological parameters in breast cancer patients and explicitly called for further research to evaluate these parameters during chemotherapy [9]. Therefore, this study aims to fill this gap by providing essential medical knowledge about the hematological and biochemical alterations in cancer patients undergoing chemotherapy at the Dhamar General Hospital Authority (DGHA).

2.Motheds

Study Design and Setting

A hospital-based observational study was conducted at the Oncology Unit of the DGHA in Dhamar Governorate, Yemen, from April to June 2024.

Study Population and Sampling

The study population consisted of all Yemeni cancer patients who received chemotherapy at the DGHA oncology unit during the study period. A non-probability convenience sampling method was employed. From an approximate pool of 180 patients, 54 were initially recruited. After applying inclusion and exclusion criteria, a final sample of 50 patients with complete medical data was included in the analysis. The mean age of participants was 45.92 $\pm$ 19.04 years.

Inclusion and Exclusion Criteria

Inclusion Criteria: Adult cancer patients who provided informed consent to participate, and had complete medical records containing the required pre- and post-chemotherapy laboratory data.

Exclusion Criteria: Patients were excluded if they had incomplete laboratory data, discontinued follow-up before completing the treatment cycle, or had pre-existing comorbidities known to significantly affect hematological or biochemical profiles (e.g., chronic liver or kidney disease).

Data Collection

Data were collected using a pre-tested, structured questionnaire. The researcher conducted direct interviews to gather socio-demographic information (e.g., age, gender, residence) and relevant medical history. Clinical data, including cancer type, stage, and laboratory results (CBC, LFTs, KFTs), were extracted from patient medical records. Laboratory parameters were recorded at two time points: Pre-chemotherapy: Values obtained before the initiation of a chemotherapy cycle. Post-chemotherapy: Values obtained after receiving the treatment, typically before the next scheduled dose.

Statistical Analysis

Data were analyzed using SPSS Statistics version 21 (IBM Corp., USA). Descriptive statistics (frequencies, percentages, mean $\pm$ standard deviation) were used to summarize demographic and clinical characteristics. A paired samples t-test was employed to compare the mean differences between pre- and post-chemotherapy hematological and biochemical parameters. A p-value of < 0.05 was considered statistically significant.

Ethical Considerations

Ethical approval was obtained from the Department of Medical Laboratory at Al-Hikma University and the administration of the Dhamar General Hospital Authority. The purpose and nature of the study were explained to all participants, and written informed consent was secured from each individual prior to their enrollment.

3. Results

Socio-Demographic Characteristics of patients

A total of fifty (50) Yemeni cancer patients were included in the study. The mean age of the participants was 45.92 ± 19.04 years, with an age range of 3 to 75 years.

As shown in Table 1, the cohort was predominantly female (64.0%), married (72.0%), and resided in urban areas (60.0%). A significant proportion of participants were illiterate (44.0%). In terms of occupation, the majority were housewives (60.0%), followed by government employees (14.0%), farmers (10.0%), and laborers (6.0%). The remaining 10% were children. The reported monthly family income ranged from 50,000 to 200,000 Yemeni Rial, with a mean ± SD of 132,000 ± 31,558.17 Rial. Notably, over half of the patients (54.0%) reported a monthly income of 150,000 Rial, and all participants stated that their income was insufficient to cover their needs.

Table 1:Socio-Demographic Characteristics of Cancer Patients

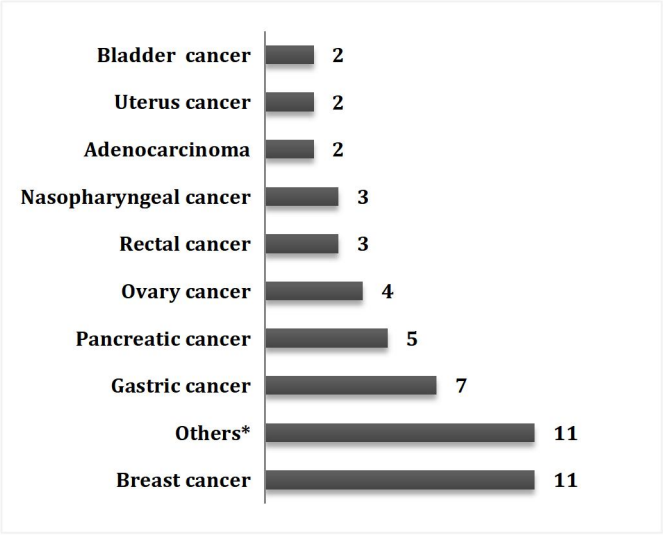
Variable	n	%
Total number	**50**	
Sex (Female**)**	32	64
Residence (Urban**)**	30	60
Social status		
Married	36	72
Single	13	26
Divorced	1	2
Age/year		
<5	1	2
5-14	4	8
15-24	2	4
25-44	15	30
45-65	20	40
>65	8	16
Patients' education		
Illiterate	22	44
Reading & writing	13	26
Primary	5	10
Secondary	3	6
High school	3	6
University and above	4	8
Patients' occupation		
Housewife	30	60
Worker (laborer)	3	6
Government Employee	7	14
Farmer	5	10
Unemployed**	5	10
Family monthly income/ YR (mean ± SD**)**	132,000 ±31,558	

*Age category based on CDC classification. YR: Yemeni Rial
** including the children

Clinical and Medical History of Patients

The analysis of cancer type frequency revealed a diverse oncological profile among the 50 participants. Breast cancer was the most predominant single type, accounting for 22% (n=11) of all cases. An equal proportion (22%) was represented by a collection of other, less frequent cancers. Gastric cancer was the second most common specific diagnosis, comprising 14% (n=7) of the cohort, followed by pancreatic cancer (10%) and ovarian cancer (8%). The remaining cases included rectal cancer (6%), nasopharyngeal cancer (6%), adenocarcinoma (4%), uterine cancer (4%), and bladder cancer (4%). This distribution highlights a significant burden of breast and gastrointestinal malignancies within the studied patient population, Figure 1.

Regarding cancer staging at diagnosis, stage III was the most prevalent (42.0%), followed by stage II (40.0%). A minority of patients (20.0%) reported a family history of cancer. The duration of cancer diagnosis and chemotherapy treatment varied among participants, as detailed in Table 2.



Others: Squamous cell carcinoma ,leukemia, Colon cancer, Neuroblastoma, Eye cancer, Glioblastoma, Lung cancer, Bone cancer Liver cancer

Figure 1: Distribution of patients by Cancer Types/site

Table 2 Medical history of cancer patients (n=50)

Variable	n	%
Family history of cancer		
Yes	10	20
No	40	80
Relative level (If yes of family history)		
Father	2	4
Mother	2	4
Brother	4	8
Uncle	2	4
None	40	80
Cancer stage		
I-Stage	3	6
II-Stage	20	40
III-Stage	21	42
VI-Stage	6	12
Cancer duration/ year		
< one	9	18
Two	19	38
Three	12	24
> Three	10	20
Chemotherapy duration/ month		
1-4	14	28
5-8	14	28
9-12	8	16
> 12	14	28
Receiving travel of chemotherapy dose/ week		
One	11	22
Two	8	16
Three	29	58
Four	2	4

Comparison of Hematological and Biochemical Profiles in Pre- and Post -Chemotherapy of study subjects

The comparison of hematological and biochemical parameters before and after chemotherapy is summarized in Table 3. The analysis revealed minor, non-significant changes in all measured hematological parameters following treatment (P > 0.05 for all parameters). On the other hand, the mean values of most CBC levels were within the normal reference values Pre- and Post-chemotherapy whereas, the mean of Hb, PCV and RBC values were slightly lower than the normal reference values. For biochemical profiles, a significant decrease in Alanine Aminotransferase (ALT) (the mean differences: 3.97 U/L ; P =0.035) and a significant increase in Alkaline Phosphatase (ALP) (the mean differences: -12.21 U/L; P= 0.036) were observed. Other liver and kidney function parameters showed non-significant changes (P > 0.05).

Table 3: Comparison of Hematological and Biochemical Profiles in Pre- and Post- Chemotherapy, Dhamar General Hospital Authority, Oncology unit, Yemen

	Descriptive statistics					Paired differences		
	Pre-treatment		Post-treatment			Pre and -Post treatment		
Parameter	Mean	SD	Mean	SD	Reference value	Mean	*t*	*P*
Hematological Profiles								
Hb	11.78	1.92	11.76	2.31	M: 13.0-18.0 g/dl F:11.5-16.5 g/dl	0.01	0.05	0.963
PCV	34.95	5.81	35.44	5.67	M: 45-54% F: 37-47%	-0.49	-0.67	0.504
RBCs	4.33	0.88	4.29	1.13	M:5.4-6.3 10^{12}/L F:5.0-6.0 10^{12}/L	0.05	0.38	0.705
MCV	80.18	8.41	80.10	8.99	77-96 fl	0.08	0.09	0.932
MCH	26.85	3.46	26.94	3.82	26-32 pG	-0.09	-0.26	0.798
MCHC	32.27	4.59	32.24	2.45	32-36 g/dl	0.03	0.04	0.964
Total WBC count	7.66	18.35	7.63	19.73	4-10 X 10 /L	0.03	0.07	0.948
Neutrophil	53.30	18.75	54.44	16.73	40-70%	-1.14	-0.37	0.712
Lymphocyte	32.24	13.77	31.54	14.12	20-45%	0.70	0.26	0.794
Monocytes	10.16	12.87	10.00	11.02	2-10%	0.16	0.11	0.910
Eosinophil	4.72	3.25	4.78	3.10	1-6%	-0.06	-0.10	0.923
Basophil	0.08	0.40	0.04	0.20	0-1%	0.04	0.69	0.493
Platelets	280.82	124.46	282.44	135.99	150-450 X 10 /L	-1.62	-0.10	0.919
Biochemical Profiles								
Creatinine	0.58	0.47	0.62	0.55	0.3-1.2 mg/dL	-0.04	-1.00	0.321
Urea	25.06	26.63	24.22	10.63	10-50 mg/dL	0.84	0.26	0.797
GOT-AST	25.40	12.72	23.32	11.84	Up to 46 U/L	2.08	0.95	0.346
GPT-ALT	23.73	16.19	19.76	11.48	Up to 46 U/L	3.97	2.17	0.035
ALP	77.75	36.48	89.96	33.29	M: 40-129U/L F: 35-104 U/l	-12.21	-2.15	0.036
Bil-total	0.48	1.10	0.54	1.06	Up to 1.0 mg/ dL	-0.06	-1.07	0.288
Bil-Direct	0.32	1.10	0.32	0.98	Up to 0.25 mg/ dL	0.00	0.03	0.979
Bil-Indirect	0.20	0.14	0.23	0.24	Up to o.75 mg/ dL	-0.03	-0.78	0.436

Degree of freedom = 49. Data are expressed as mean ± SD, Mean at P < 0.05 with 95% confidence interval. SD: Standard Deviation; *t*: the paired *t-test,* M:Male, F:Female.

4. Discussion

This study addressed the problems related to chemotherapy especially on hematological and biochemical profile and their alterations in pre- and post-chemotherapy of cancer patients in Dhamar governorate, Yemen, providing important knowledge and essential medical information about this public health problem in this area. Although, the findings of the present study showed an non-significant slightly decrement of Hb, RBC cunt levels; and an non-significant slightly increment of PCV levels in post-chemotherapy compared to pre-chemotherapy. However, a recent study showed a significant decrement of Hb, RBC cunt, and PCV in post-chemotherapy compared to pre-chemotherapy [1]. On the other hand, the mean hematological values of Hb, PCV, and RBC cunt were noted to be lower than the normal reference values in Pre- and Post-Chemotherapy in the current study.

The current study showed an non-significant decrement of WBC count in post-chemotherapy compared to pre-chemotherapy. This finding was consistent with findings of a previous study done by Mughal., (2004) [10] and findings of a recent study done by Wondimneh et al, (2021) [1]. The results of the latter, was statistical significance. Accordingly, cancer patients develop an infection after taking chemotherapy, because of the reduction of WBCs that are important for fighting against infection [11]. The current study showed a non-significant decrement of lymphocyte levels in post-chemotherapy compared to pre-chemotherapy. This finding was consistent with the findings reported also by Wondimneh et al. indicating to that chemotherapy reduces circulating lymphocyte levels, where T and B cells significantly decreased after completion of chemotherapy. Similarly , the findings of the current study showed an non-significant slightly increment of neutrophil and platelets count in post-chemotherapy compared to pre-chemotherapy. This finding was not

consistent with findings of other studies showed that neutrophil [1, 12] and platelet levels significantly decreased in post-chemotherapy compared to pre-chemotherapy [1, 13]. Although, the findings of the current study showed an non-significant slightly increment of neutrophil level and platelets count; and a non-significant decrement of lymphocyte level. However, lymphocyte, neutrophil and platelets levels were noted to be within the normal reference ranges in Pre- and Post-chemotherapy

Although, the present study showed that a non-significantly increased of creatinine levels in post-chemotherapy than pre- chemotherapy. However, a previous studies stated also that creatinine levels significantly increased in post-chemotherapy than pre-chemotherapy due to impaired formation or impaired excretion of urine [14]. It has been shown that chemotherapy can lead to necrosis of kidney cells. This damage is clinically manifested as increased levels of creatinine [15]. In contrast, a recent study showed that a non-significant decrement of creatinine levels in post-chemotherapy than pre- chemotherapy [1]. On the other hand, findings of this study showed that the mean values of creatinine were within the normal reference range in Pre-chemotherapy and Post- Chemotherapy. This was in agreement with a study carried out on breast cancer patients, stated that the mean creatinine value was observed to be within the normal reference range during the different courses of chemotherapy as well as there was no specific alterations was observed in creatinine level [16].

The present study indicated the urea levels was within the normal reference ranges whether Pre-chemotherapy or Post-chemotherapy. similar findings were observed in a study of [17] evaluated the biochemical profile of Breast cancer patients. It indicted also metabolite levels slightly increases and decreases were mostly within the normal reference range. The present study showed a significant decrement of Alanine transaminase (ALT) levels in post-chemotherapy compared to pre-chemotherapy($P < 0.05$). This was not consistent with the reported findings in two similar studies. The first study reported that the serum levels of ALT significantly increased [18] in post- chemotherapy than pre-chemotherapy. While, the second study reported that the serum levels of ALT non-significantly increased also in post- chemotherapy than pre-chemotherapy indicating, that the increments of ALT levels may be attributed to an inflamed condition of the liver, severe scarring of the liver, or death of liver tissue that resulted from the chemotherapy [19].

Findings of this study showed that Aspartate transaminase (AST) levels non-significantly declined in post-chemotherapy compared to pre-chemotherapy . This was not consistent with findings of other studies showed that AST levels increased in post-chemotherapy compared to pre- chemotherapy [11, 19]. The current study showed that the ALP and Bil-total, and Bil-Indirect levels non-significantly increased in post-chemotherapy compared to pre-chemotherapy.

This study has several limitations. The single-center design and relatively small sample size may limit the generalizability of the findings across Yemen. The use of convenience sampling could also introduce selection bias. Furthermore, the lack of detailed data on the specific chemotherapeutic regimens, exact dosages, and use of supportive medications limits a deeper interpretation of the hematological findings.

5. Conclusions

Laboratory analysis demonstrated a distinct pattern of chemotherapy-induced alterations, with no statistically significant hematological toxicities observed post-treatment, suggesting possible protocol adaptations to mitigate risks in a setting with constrained supportive care. However, significant biochemical changes were evident, particularly in liver function parameters, with a marked decrease in ALT and increase in ALP levels. These results highlight the necessity for context-specific treatment protocols and enhanced monitoring systems to optimize oncology care in Yemen, and early detection programs to improve overall cancer management outcomes.

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Data Availability

All data relevant to this study are presented in this manuscript. Additional datasets are available from the corresponding author upon reasonable requests.

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Conflicts of interest

The authors declare that there are no conflicts of interest.

Consent for publication

Not applicable.

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