ETHIOPIAN INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH

eISSN: 2349-5715 pISSN: 2349-5707

Volume: 12, Issue 06, June-2025 SJIF 2019: 4.702 2020: 4.737 2021: 5.071 2022: 4.919 2023: 6.980 2024: 7,662

# CELLULAR-LEVEL ANALYSIS OF THE BENEFITS AND ADVERSE EFFECTS OF CHEMOTHERAPY IN BREAST CANCER AND STRATEGIES FOR MINIMIZING TOXICITY

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**Abstract:**Breast cancer remains a major health concern worldwide, and chemotherapy continues to play a critical role in its treatment. However, while chemotherapy effectively targets cancer cells, it often causes significant damage to healthy cells at the molecular and cellular levels. This study, conducted in collaboration with the Oncology and Radiology Department of the Republic of Uzbekistan, involved 30 breast cancer patients undergoing standard chemotherapy protocols. We aimed to assess both the therapeutic effects and cellular-level adverse effects of chemotherapy, including immune suppression, increased oxidative stress, and mitochondrial dysfunction in non-cancerous tissues. Biological samples were analyzed using flow cytometry, RT-qPCR, and oxidative stress assays to evaluate immune cell populations, apoptosis markers, and reactive oxygen species levels. Strategies to reduce these effects—including antioxidant supplementation, use of growth factors, and nutritional support—were implemented. Results indicate that these supportive measures reduced oxidative damage and improved treatment tolerance without compromising chemotherapy efficacy. Our findings highlight the importance of cellular-level monitoring and supportive care integration to optimize breast cancer chemotherapy outcomes.

## Introduction

Breast cancer is one of the most commonly diagnosed malignancies in women globally. Chemotherapy is often employed as a primary or adjunct treatment, particularly in stages II and III, as it can significantly reduce tumor burden and improve survival rates. However, chemotherapy agents are not selective and frequently damage rapidly dividing healthy cells such as hematopoietic stem cells, gastrointestinal epithelium, and immune cells.

This dual nature of chemotherapy poses a clinical challenge: how to balance efficacy with minimized toxicity. At the cellular level, chemotherapeutic agents induce DNA damage, oxidative stress, and mitochondrial dysfunction not only in cancer cells but also in normal cells, leading to systemic side effects such as immunosuppression, fatigue, and organ toxicity. This study aims to analyze these effects using molecular assays and to evaluate interventions aimed at reducing such toxicity in breast cancer patients in Uzbekistan.

## Methods

### Study Design and Participants

This observational study was conducted in collaboration with the Oncology and Radiology Department of the Republic of Uzbekistan. Thirty (30) female patients aged between 35 and 65, diagnosed with stage II or III breast cancer, were enrolled after providing informed consent. Patients

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received standard chemotherapy protocols, including the AC regimen (doxorubicin + cyclophosphamide) followed by taxanes (paclitaxel or docetaxel).

**Cellular Analysis Techniques**

Samples of peripheral blood and, where possible, tissue biopsies were collected at three time points: before treatment, mid-treatment (after 2 cycles), and post-treatment (after 4–6 cycles). The following laboratory techniques were used:

- **Flow cytometry**: Quantification of CD4+, CD8+ T cells, and natural killer (NK) cells to assess immune system changes.
- **RT-qPCR and Western blotting**: Analysis of apoptosis-related gene and protein expression, particularly BAX and BCL-2.
- **Mitochondrial assays**: Evaluation of mitochondrial membrane potential in non-cancerous fibroblasts.
- **ROS assays**: Measurement of oxidative stress markers (e.g., MDA) and antioxidant enzymes (SOD, catalase).

**Interventions to Reduce Toxicity**

Three major supportive care measures were implemented in subgroups of patients:

1. **Antioxidant supplementation** (e.g., N-acetylcysteine, vitamin C)
2. **Hematopoietic growth factor therapy** (e.g., G-CSF for neutropenia)
3. **Nutritional and vitamin D support**, with diet adjustments based on individual assessments.

**Results**

**Chemotherapy Efficacy**

- **Tumor response**: 25 out of 30 patients (83%) showed a reduction in tumor size, confirmed by ultrasound and imaging.
- **Pathological complete response** (pCR) was achieved in 6 patients (20%).

**Cellular-Level Toxicity**

- **Immune suppression**: A 40% average decline in CD4+ T cell and NK cell counts by cycle 3.
- **Oxidative damage**: ROS levels increased by 65% post-treatment; antioxidant enzymes were reduced by 30–45%.
- **Apoptosis markers**: BAX expression increased significantly, while anti-apoptotic BCL-2 was suppressed, especially in epithelial and hematopoietic cells.
- **Mitochondrial dysfunction**: Mitochondrial membrane potential decreased by 45% in non-cancerous cell lines, indicating cellular stress.

**Effectiveness of Supportive Strategies**

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- Patients receiving antioxidants showed 20–30% lower ROS levels.
- G-CSF administration significantly reduced neutropenia incidence.
- Nutritional interventions improved general well-being and reduced gastrointestinal toxicity reports.

**Discussion**

While chemotherapy remains a mainstay in breast cancer treatment, its toxicity poses significant challenges. The cellular-level findings confirm that the treatment negatively affects healthy immune and epithelial cells, potentially leading to long-term health consequences. The oxidative stress response and mitochondrial damage in non-cancerous cells suggest that reactive oxygen species play a central role in off-target effects.

Supportive interventions, especially antioxidant therapy and hematopoietic support, proved partially effective in reducing these toxicities. This emphasizes the potential of combining chemotherapy with targeted protective strategies to enhance patient safety and compliance.

**Conclusion**

Chemotherapy is highly effective against breast cancer, but it comes at the cost of cellular damage in healthy tissues. Regular cellular-level monitoring and implementation of toxicity-reduction strategies can significantly improve patient outcomes. Future studies with larger cohorts and more precise molecular targeting are needed to optimize treatment regimens further.

**References:**

1. Chatterjee, N., & Bivona, T. G. (2019). Polytherapy and Targeted Cancer Therapy: Combating Resistance and Toxicity. Cancer Cell, 35(3), 309–318. https://doi.org/10.1016/j.ccell.2019.02.005
2. Hortobagyi, G. N. (1997). Treatment of breast cancer. New England Journal of Medicine, 337(14), 990-998. https://doi.org/10.1056/NEJM199710023371407
3. Wang, X., & Wang, J. (2017). Reactive oxygen species-induced mitochondrial dysfunction in chemotherapy. Oncotarget, 8(45), 79264. https://doi.org/10.18632/oncotarget.20600
4. Valko, M., et al. (2007). Free radicals and antioxidants in normal physiological functions and human disease. The International Journal of Biochemistry & Cell Biology, 39(1), 44-84. https://doi.org/10.1016/j.biocel.2006.07.001
5. Gligorov, J., & Lotz, J. P. (2004). Preoperative chemotherapy in breast cancer: state of the art. The Breast, 13(5), 520–528. https://doi.org/10.1016/j.breast.2004.08.002
6. Ministry of Health of the Republic of Uzbekistan. (2023). National Clinical Guidelines on Oncology. Tashkent: Ministry Publications.