Cognitive and Neurological Effects of Cancer Therapies

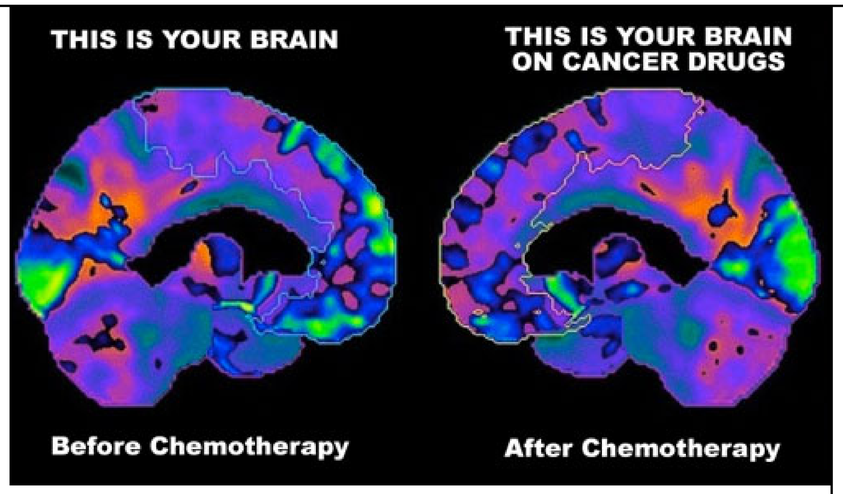
Mechanisms, Neuroimaging Evidence, and Clinical Implications of Treatment-Induced Cognitive Impairment

AUTHORS

Akshatha Chengalvala

AFFILIATIONS

Independent Researcher
The University of Manchester



Brain before and after chemotherapy (Berkeley Institute)

01. Introduction

Cancer therapies have significantly improved survival outcomes, yet their impact on cognitive function is an increasingly recognized challenge in survivorship care. Many patients experience cancer-related cognitive impairment (CRCI), commonly called “chemo brain,” with deficits in memory, attention, and executive function.

These impairments can persist beyond treatment, affecting daily functioning, work performance, and quality of life. As survivorship increases, understanding and addressing neurological consequences of cancer therapies within a holistic care framework is critical.

02. Objectives

- To investigate the cognitive and neurological effects of major cancer therapies
- To compare neurocognitive outcomes across treatment modalities
- To examine underlying biological mechanisms contributing to CRCI
- To evaluate clinical implications for patient care and survivorship

Key Evidence

- 15–75% of patients experience cognitive impairment during or after chemotherapy
- 35% continue to experience symptoms long term
- Neuroimaging shows white matter changes, hippocampal alterations, and reduced activity in prefrontal regions
- Case studies highlight both direct drug toxicity and immune related effects

03. Methodology

This study adopts a hybrid approach combining:

- A critical review of existing neuro-oncology and clinical literature
- Analysis of neuroimaging findings, including MRI and fMRI studies
- Examination of selected case studies illustrating treatment-induced neurotoxicity
- Development of a conceptual framework for assessing patient-reported cognitive symptoms

04. Findings

Cognitive Effects

- Memory loss, attention deficits, mental fog, reduced processing speed

Treatment Specifics

- Chemotherapy: persistent neurotoxicity and "chemo brain"
- Radiation therapy: structural brain damage and delayed cognitive decline
- Targeted therapy: variable neurological side effects, including confusion or headaches
- Immunotherapy: inflammation related cognitive changes, including ataxia and encephalopathy

Case Highlights

- Methotrexate induced leukoencephalopathy in CNS lymphoma patient
- Pembrolizumab induced reversible toxic leukoencephalopathy in NSCLC patient

05. Analysis

Cognitive impairment arises from neuroinflammation, oxidative stress, and disrupted neurogenesis, affecting memory, attention, and executive function. Neuroimaging shows white matter and hippocampal changes, plus reduced prefrontal activation.
SpringerOpen case studies:

- Methotrexate: CNS lymphoma patient
- Pembrolizumab: NSCLC patient

Severity varies by treatment, dose, age, and pre-existing conditions. Fatigue, anxiety, and depression worsen symptoms.

Images A & B: Annotated MRI scans of treatment-induced neurotoxicity.

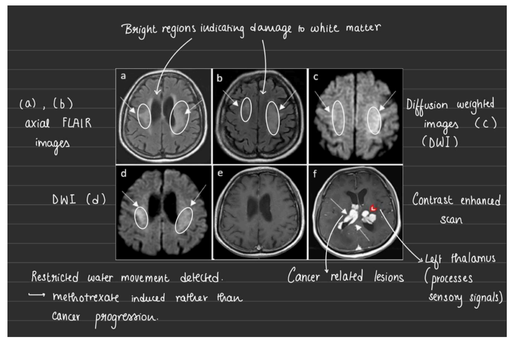


Image A: Methotrexate: White matter damage, DWI confirms toxicity, thalamus lesions

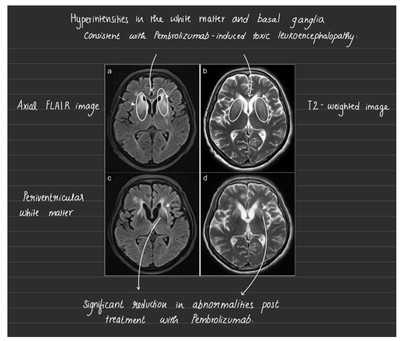


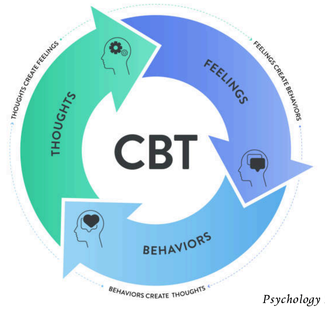
Image B: Pembrolizumab: White matter & basal ganglia hyperintensities, post-treatment improvement.

06. Conclusion

Cancer therapies are essential for improving survival, yet they can induce significant cognitive and neurological challenges that persist beyond treatment. Recognizing and addressing these effects is crucial to preserving functional independence, emotional well-being, and overall quality of life for survivors.

A comprehensive, patient-centered approach should integrate neurocognitive assessment, personalized treatment planning, and evidence-based rehabilitation strategies. Digital tools, cognitive training applications, and therapies such as Cognitive Behavioural Therapy can further enhance recovery and support long-term cognitive resilience.

Future oncology care must adopt a holistic paradigm that values neurological preservation alongside tumor control. By prioritizing brain health in survivorship planning, clinicians can ensure patients not only survive but maintain cognitive integrity, empowering them to engage fully with life, return to daily activities, and thrive in their personal and professional roles.



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FRAMEWORK

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