

THE EFFECTS OF CHEMOTHERAPY ON LANGUAGE WHEN TREATING BREAST CANCER

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Abstract

There are recorded side effects of chemotherapy that are known and accepted, such as pain, lethargy, and loss of appetite and hair. However, chemotherapy's impact on the patients' speech and language skills is one side effect that is still debate. This effect is commonly referred to as 'chemo-brain' or 'chemo-brain fog,' meaning that "post-chemotherapy cognitive impairment related to linguistic abilities exists. The word 'cognitive' refers to the way your brain works to help you communicate, think, learn, solve problems, and remember" (American Cancer Society, n.d., para. 1). The reviewed literature suggests a correlation between chemotherapy usage and lingual decline compared to control group research subjects (Kesler et al., 2009; de Ruiter et al., in press; Inagaki et al., 2007; McDonald et al., 2008). In order to research this topic more in-depth, research subjects who are in different stages of chemotherapy treatment regimens will take tests/assessments to accurately evaluate what their current speech and language skills are. Results and conclusions will be shared as will implications for future research.

Keywords: Cancer, Chemotherapy, Language, Speech, Chemo-brain, Chemo-brain fog

Introduction

The commonly known "chemo brain" is an effect of chemotherapy when treating cancer. It stems from variations of cognitive and language decline in several different areas of the brain (McDonald & Saykin, 2013). Due to the frequency of cancer patients who go through chemotherapy, researchers have conducted studies to see if the brain's chemicals are involved in treatment.

This article will include a literature review that discusses how the brain functions when an individual is receiving chemotherapy and the different ways of assessing brain function. Additionally, this researcher will

discuss what the literature reveals about the resulting types of data collected when examining the brain using technology. This author will also share methods to be used for the study. Upon the completion of testing, results and discussion be shared. Lastly, this literature review will reveal the limitations and implications for future research.

Literature Review

Analysis of Brain Function

Researchers have conducted experiments to gain data related to chemotherapy varied in terms of brain information analysis. One prominent method in the literature was referred to as voxel by voxel analysis

(McDonald et al., 2013; Mo et al., 2016). This analysis is completed by "using statistics to identify differences in brain anatomy between groups of subjects" (Whitwell, 2009, para. 2). Another method was via magnetic resonance imaging (MRI) and magnetic resonance spectroscopy (MRS) findings (Brown et al. 1995; Mo et al., 2016). There had to be controls in the data for depression and anxiety in regions of interest (ROI) at baseline in resting state-functional magnetic resonance imaging (RS-fMRI) and diffusion tensor imaging (DTI) (Mo et al., 2016) so as not to skew the data. The primary purpose of obtaining this data was to see the varying ROI changes among varying studies subjects.

In Gilewski et al. (1988), to obtain corresponding data to chemotherapy's cognitive and learning effects, the subject would take memory functioning tests. The main groups in the research were women going through breast cancer pre-surgery and took varying tests to measure cognitive ability at certain times during chemotherapy treatment. It is important to note that the subjects tested did not have a metastatic variation of breast cancer (McDonald et al., 2012). Mo and colleagues (2016) also found that these women were similar in age, around 37-50.

Moreover, Kesler et al. (2009); de Ruiter et al. (in press), Inagaki et al., (2007); McDonald et al. (2008); and Saykin et al. (2003) have published several studies showing that women with breast cancer show lower activation of ROI and less gray matter of the brain. According to Saykin et

al. (2003), this would mean that "memory and executive functions could be preferentially affected" because of chemotherapy. Saykin et al. (2003) also reported the potential for "atrophy of cerebral gray matter (GM) and/or demyelination of white matter (WM) fibers, secondary immunologic responses causing inflammatory reactions, and microvascular injury." This atrophy of grey matter of the brain in the ROI of the brain ("prefrontal, parahippocampal, and cingulate gyrus, and precuneus") could mean that the patient going through chemotherapy may experience several cognitive deficits related to the patients' speech and language (Inagaki et al., 2007).

This literature review has discussed what researchers have found in terms of brain functioning in chemotherapy processes. It has also covered methods of exploring brain function.

Methods

This study will be a mixed-methods design that will use the Aphasia Diagnostic Profile with normative data for comparative reasons and will use a demographic interview of the subjects to gather perceptual data. Due to Covid-19, subject recruitment will be remote either through social media or online Breast Cancer support groups.

Subject Recruitment

Using convenience sampling, the primary investigator and her mentor will solicit research subjects using social media outlets and local cancer support groups. The primary investigator will obtain written consent using a format from the Institutional

Review Board of Saint Louis University (IRB). The investigator will inform each research subject (experimental and control groups) that their name will be entered into a raffle for a twenty-dollar Amazon gift card as an incentive to participate in the study. Additionally, subjects will be informed that their identities will remain anonymous and that they may drop out at any time from the study.

Instrumentation

The instruments used for this research will include a self-reporting test on executive functioning that would require a written and spoken portion in which the primary investigator would ask research subjects questions in an interview-like fashion. The tests selected for use in the study include the *Aphasia Diagnostic Profile Test* (Helm-Estabrooks, 1992). This assessment would provide some of the data needed to see if and how chemotherapy has affected their language and executive functioning skills. There would also be a standardized test used to assess the cognitive-linguistic competence of the research subjects. The primary investigator is still in the process of determining which standardized measure to use for the project.

Research protocol

First, the primary investigator will collect a case history and other demographic information via a recorded face-to-face interview. Next, the primary investigator will collect test data from each of the research subjects. Once data is collected, the primary investigator will use statistical analyses to interpret the data. The

investigation will compare data from the experimental and normative data from the *Aphasia Diagnostic Profile* (Helm-Estabrooks, 1992). After reaching the data gathered, the primary investigator will discuss the findings and implications for future research.

Subject eligibility criteria

There are several eligibility criteria to be considered for participation in this study. The subject must be female in order since Breast Cancer predominantly affects women. They must also be between 30 and 55 years old; if they are too young, the researcher would have to account for spontaneous recovery. If they are above the age range, the researcher would have to account for cognitive decline due to aging and cognitive decline due to chemotherapy. Subjects participating in this study will also have to be currently going through or have gone through chemotherapy for Breast Cancer in the past two years. Any longer than this and spontaneous recovery will come into effect and potentially skew results. While the researcher acknowledges that Socioeconomic status and ethnicity are essential factors in this study, due to the time constraint of completing this project within the academic year, SES and ethnicity will not be considered. The participants' first language must be English because that is the language given in the *Aphasia Diagnostic Profile* (Helm-Estabrooks, 1992), which will prevent any discrepancies in the semantics of the test. Lastly, any stage of breast cancer can and will be accepted for this study to gather a wide variety of data to answer the researcher's research question.

Results

Due to the researcher waiting for approval from IRB, there are no results at this time. However, due to the extensive literature review the researcher conducted, they can predict based on said literature, the study's results.

Results of Chemotherapy in the Literature

Results gained from MRI, fMRI, and computed tomography (CT) scans have shown a lack of gray matter in chemotherapy patients' brains. The studies if McDonald et al. (2012), Kesler et al. (2009), Bromis et al. (2017), Raffa (2010), and Kaschkaa et al. (2017) have shown this lack of gray matter. These results would mean that there is the support of varying regions of interest (frontal and hippocampus mainly) being affected by chemotherapy when treating cancer. This study also serves as evidence that language skills are being disproportionately involved in these studies. These studies' findings show a correlation between women with breast cancer who go through chemotherapy and lingual decline. There is already some evidence that "The studies that evaluated patients shortly after completion of chemotherapy (12,13) suggested that a very high percentage of patients experience cognitive deficits (75–95%)" (Ahles & Saykin, 2001, page 815). As more research is conducted, more information can become available about the severity of this decline and what can health professionals, alongside researchers, can do about it.

Conclusion and Discussion

This research will be completed during the 2020-2021 academic year. As such, no definitive conclusions can be posited at this time. This study aims to see if there is a correlation between chemotherapy and cognitive decline and see how significant the correlation is. Another purpose of this research is to fill the current void of research on the topic of chemo-brain. This author is hopeful that results and conclusions will shed light on a phenomenon that, up to this point, has had little investigation by Speech-Language Pathologists. Limitations of this study follow.

Limitations

One limitation of this study that has previously been identified is the study's planned sample size, ten people, which reduces the study's power and increases the error margin. Another limitation is the project's scope, which is limited to an academic year, defining what the primary investigator can do because of time restrictions. The last limitation is that these investigations only use one test in the study instead of multiple trials to gather more data.

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