

## Analysis of side effects of chemotherapy treatment for cancer patients using Neutrosophic cognitive graphs (NCG)

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### Abstract

Cancer is considered as a most dangerous disease in the world. The research shows that there is no medicine to cure the disease. Chemotherapy is one of the treatments to prolong the patient life time but the side effects cause more problems for the patient. Cognitive maps discovered many solutions for the complex problems. Neutrosophic cognitive graphs (NCG) are the advanced techniques deduced from cognitive maps efficiently draw a way to find hidden side effects and problem faced by a cancer patient having chemotherapy treatment.

### Introduction

Cancer is a chronic disease, alters the body cell and cause more damage to the organs. It is the cause of premature death around the world as per the World health organization data. There is no cure for the disease as it affects the active cell and mutate as a cancerous cell.[9] Chemotherapy is the treatment for all types of cancer. It is a type of chemical supplied to the body system through the vein contrast to the radiation therapy which was most dangerous and difficult to the patient because of radiation.[11][12][15] Chemotherapy treats the patients in a way by deactivating the cancerous cell. During the course of treatment, it damages other active human cell which supplies energy to the body system. The side effects of chemotherapy are most painful for the patients.[13][14][16] The research base is to analyze the side effects caused by chemotherapy. It employs the modern technology called NCG to frame a pattern hidden in the data collected from the patient.

Cognitive maps are also called as mental maps devised by a political scientist Robert Axelrod in the year 1976 to find the characteristics of an object in the group of object and deploys it for the final solution.[1][2][3][5] NCG is based on cognitive maps and fuzzy cognitive maps provide solution for many real time problems. It has four states [-1, 0, 1, I] instead of having two states like Boolean logic. -1, 0 and 1 are normal states to indicate out of range, not present and present. I is the new state used to indicate the indeterminant value present in the data.[4][6][7] The indeterminant value used to evaluate the data with a customized constraint to find the hidden pattern in the data [7][8]

The figure 1.1, 1.2 and 1.3 shows the side effects of the chemotherapy. The research has formulated a common set of side effects of chemotherapy and presented the same to the patients for the collection of data. The purpose of this research is to reveal the indeterminancy found in the data.

### Review of Literature

Geetha lakshmi et.al., proposed a research on neutrosophic cognitive graphs(NCG) and analyzed problems faced by IT professionals in a particular region in India. They gave general information about the preliminaries found in Neutrosophic cognitive maps (NCM). They have made the analysis by having a collection of problems faced by IT professionals.

Surpati pramanik and sourendranath chakrabarti have employed NCM to analyze problems of construction workers in the particular region in india. They have analyzed the effect of instantaneous state vectors on neutrosophic adjacency matrix. Calefariu et.al., proposed a neutrosophic model for the investment plan and they have analyzed various factors and specialist report and prepared a model for the future prediction for the customers.

Tahir Guerram et.al., proposed a qualitative model to solve complex problem using NCM and they have made analysis with some real time issues using their model. The research had revealed some insights of NCM.

Kalaichelvi and Gomathy have made a research based on NCM and analyzed the problems faced by the female students during their studies. The analysis comprises problems like changes on routine study hours and lack of concentration in studies.

Albert William et.al., have made a study using NCM on the risk factors of breast cancer. They have analyzed problems like radiation exposure, increasing age and obesity.

### Research Methodology

The research has two parts; first part evaluates the physical and mental side effects data collected from the patients. The evaluation process will take product of a dynamic state of a common side effect with the neutrosophic matrix contains the patient data. The neutrosophic matrix has normalized value of patient data. It has only [-1,0,1,I]. The iteration of product process continues until the previous and current results are same.The first part will help to find the interdependency inside the data. The second part will map the physical and mental side effects by applying the product iteration.

### Result and Discussion

The following neutrosophic matrix shows the normalized value of patient data. A number of 100 cancer patients had approached to supply the physical and mental side effects data. For the normalization process, the specialists in the chemotherapy field were approached to get the data in the clear form to perform the analysis process.

NM(C) is the conclusion matrix collected from the cancer specialist. A dynamic state vector  $S1 [1\ 0\ 0\ 0\ 0\ 0\ 0]$  and  $S2 [1\ 0\ 0\ 0]$  were applied on  $NM(P)$  and  $NM(M)$  and the research arrived with  $S1$ .  $NM(P) = [1\ 1\ 1\ 1\ 1\ 1\ 1]$  and  $S2$ .  $NM(M) = [0\ 1\ 1\ 1]$ . The result shows when  $A1$  is 1 then  $A4, A6$  and  $A7$  also 1 and When  $B1$  is 1 then  $B3$  and  $B4$  are also 1.

The second part of the research is used to map the  $NM(P)$  &  $NM(M)$  and  $NM(M)$  &  $NM(C)$ . The figure 4.1 and 4.2 represents the mapping of Physical and Mental side effects and Mental and Conclusion.

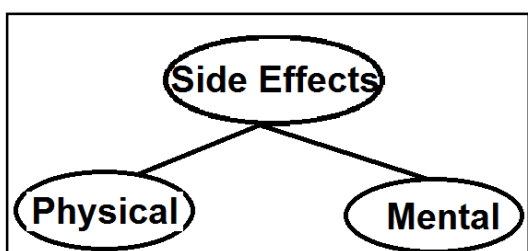
The product iteration applied on the matrices and arrived with  $[1\ 1\ 1\ 1\ 0\ 0\ 1]$  and  $[1\ 1\ 1\ 1]$  and  $[1\ 1\ 1\ 1]$  and  $[1\ 1]$ . The result shows the physical side effects fatigue, Diarrhea & Constipation and fast track menopause are interconnected and cause more damage to the patient. Hair loss and Blood clotting are indeterminant. Depression and Frustration are damaging factors of patient and Stress and Loneliness being indeterminant. The second part shows the Depression and Frustration leads the patient to die early comparing to remaining side effects mentioned in the research.

**Conclusion**

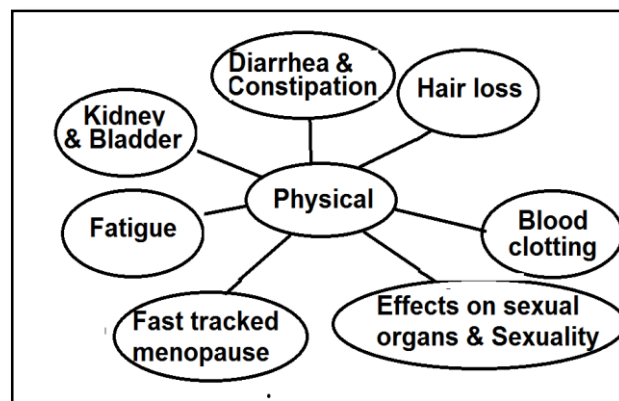
The NCG is the useful concept to handle the complex data analysis. The research has employed the concept to evaluate the side effects of chemotherapy and found the important factors causing damage to the patient. It is clear that the patient suffers a lot from mental side effects come from the physical side effects. The mapping shows the side effects are interdependent to each other. The next level of NCG will be more useful in the data analysis.

**Table 4.1:** Physical and Mental Side effects and conclusion

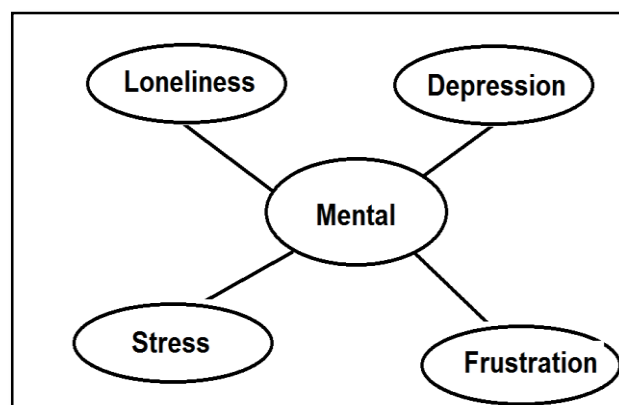
A1-Fatigue	B1-Stress	C1-Suicide
A2-Hair loss	B2-Depression	C2-Death
A3-Blood clotting	B3-Loneliness	
A4-Diarrhea & Constipation	B4-Frustration	
A5-Kidney & Bladder		
A6-Effects on sexual organs & sexuality		
A7-Fast tracked menopause		



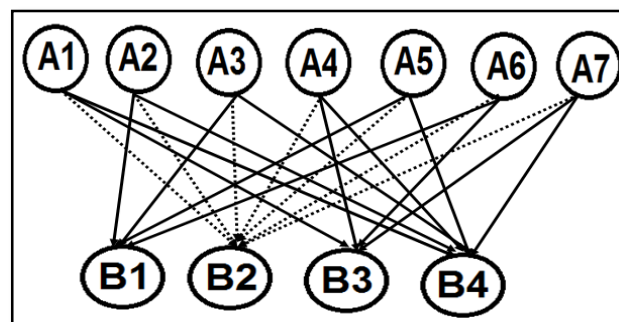
**Figure 1.1:** Types of Side Effects



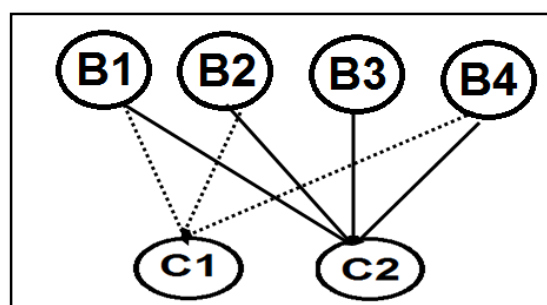
**Figure 1.2:** Physical Side Effects



**Figure 1.3:** Mental Side Effects



**Figure 4.2:** Neutrosophic mapping of  $NM(P)$  and  $NM(M)$



**Figure 4.3:** Neutrosophic mapping of  $NM(M)$  and  $NM(C)$

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