Available online at **www.ijmrhs.com**

ISSN No: 2319-5886

International Journal of Medical Research & Health Sciences, 2018, 7(5): 29-32

A Fuzzy PROMETHEE Approach for Breast Cancer Treatment Techniques

Dilber Uzun Ozsahin[1,2]* and Ilker Ozsahin[1]

[1] *Department of Biomedical Engineering, Near East University, North Cyprus, Turkey*

[2] *Gordon Center for Medical Imaging, Radiology, Massachusetts General Hospital and Harvard Medical School, Boston, USA*

**Corresponding e-mail: dilber.uzunozsahin@neu.edu.tr*

ABSTRACT

Breast tumor is a growth that occur in the healthy breast tissue, whereby abnormal cells undergo division in an uncontrolled manner. It comes in different types and stages and the ability to metastasize and infect distant tissues. Several studies have showed that one in eight women in the US have develop breast cancer during their life time. Therefore, early diagnosis and treatment is widely approved as being essential to effectively alleviate the disease. The aim of this study is to comparatively analyze certain breast cancer treatment procedures which include surgery, hormone therapy, chemotherapy, and radiation therapy. Fuzzy PROMETHEE (preference ranking organization method for enrichment of evaluations) a multi-criteria decision-making process was used to evaluate the treatments on factors that include side effects, overall survival rate, cost of treatment and treatment time.

Keywords: Breast cancer, Multi-criteria decision theory, PROMETHEE, Fuzzy PROMETHEE

INTRODUCTION

Breast cancer is the main cause of tumor deaths in women [1]. Early diagnosis of the disease is widely approved as being essential for effective treatment [2]. An estimate of about 246,660 new breast cancer cases was reported in 2016, and the death rate was reported to be 40,450 in that same year. Breast cancer is the second most common type of cancer after skin. There are several factors that increase the risk of breast cancer which include the genetic factor, hormonal factor, life style and environmental factors [3]. An estimate of about 5-10% of breast cancer are connected to gene mutation, increased risk factors for breast cancer that comprises of family history, personal history, radiation exposure, etc. Due to this reason, diagnosis of breast cancer at early stage is important to reduce the incidences and mortality rates. Furthermore, awareness and improved treatment techniques have increased the breast cancer survival rate.

There are different breast cancer treatment techniques which are chemotherapy, radiotherapy, hormone therapy and surgery. The treatments are usually influenced by patient type, disease type and the treatment basis [4]. Furthermore, there are certain exclusive factors that leverage the breast cancer treatment decision, that include overall survival rate of the treatment, the treatment time, the cost of the treatment, and the side effects. These factors are very essential during the treatment and are therefore crucial in evaluating the various treatment techniques.

In this study, we propose the Fuzzy PROMETHEE, one of the most important multi-criteria decision-making techniques, to analyze the breast cancer treatment techniques based on their necessary factors.

Breast Cancer Treatment Techniques

Surgery

This technique involves the surgical removal of a breast tumor and sometimes accompanying healthy tissue. It can further be used to investigate the underarm lymph nodes. Surgery options include lumpectomy, which is used to excise a small lump around the tumor while preserving the majority of the breast tissue. The lumpectomy technique is also referred as breast-conserving surgery. The other counterpart is mastectomy, which involves surgical excision of the whole breast [5].

Radiotherapy

This technique involves using high energy radiation to eradicate the cancer cells. The treatment includes external beam therapy, brachytherapy, and intra-operative radiation therapy. External beam therapy involves use of radiation from an external source to destroy the cancer cells. Brachytherapy involves introducing a radioactive substance into the cancer cell, and intraoperative therapy involves probing cancer in a theater room. External beam therapy is the most widely used as it is employed to a variety of cancer at different locations whereas, brachytherapy can only be employed in cancers that have not metastasize. Sometimes, the radiation therapy treatment maybe given before or after surgery to shrink a large tumor or to further render the alternative treatments effectively [6].

Chemotherapy

It involves use of certain drugs to prevent the cancer cells from further growing. It could be employed in a systemic way to reach the cancer cells via the blood stream. Chemo treatment can be performed prior to surgery to constrict large tumors, a condition known as neo-adjuvant chemotherapy. In adjuvant chemotherapy, the treatment is done to minimize the risk of recurrence. Intravenous and oral are the methods of delivering chemotherapy [3].

Hormone therapy

This form of treatment is given to estrogen or progesterone receptor positive cancers. Certain types of cancers often rely on these hormones to facilitate their growth. Preventing the body from production of these hormones or modifying the action of the hormones helps to stop cancer from returning after treatment. This treatment technique can either be used alone or in conjunction with neo-adjuvant or adjuvant chemotherapy. Hormonal therapy could also be referred as neo-adjuvant or adjuvant hormonal therapy, given to constrict tumors prior to surgery or given after surgery to prevent further recurrence. Tamoxifen is the most widely used hormone therapy drug [3].

MATERIALS AND METHODS

In contrast with PROMETHEE method, Fuzzy PROMETHEE method is used around the world in a wide variety of decision scenarios. Fuzzy PROMETHEE method is the combination of PROMETHEE method with fuzzy logic. Wang, et al., in 2008 suggested this technique to compare the alternatives while the parameters are not numerical [7]. In real world situations it is difficult to collect crisp data to analyze a system, fuzzy logic allows the decision maker to analyze the system even in the vague condition and convert the linguistic variable into the mathematical variable. Therefore, in fuzzy PROMETHEE method we can compare fuzzy value. In the study conducted by Ozsahin, et al., in 2017 the fuzzy PROMETHEE technique was discussed in detail [8,9]. They used the fuzzy PROMETHEE method to compare several nuclear medicine imaging devices. In this study, the same method is used to analyze the breast cancer treatment techniques.

RESULTS AND DISCUSSION

To analyze the breast cancer treatment techniques, triangular fuzzy scale was used (Table 1) to obtain the importance of each criterion and then applied to Yager index to defuzzify the triangular fuzzy numbers to calculate the weight of each criterion.

Table 1 Linguistic fuzzy scale

Linguistic scale for evaluation	Triangular fuzzy scale	Priority ratings of criterions
Very high (VH)	(0.75, 1, 1)	Treatment Time, Cost of Treatment, Side Effect, Overall Survival Rate
Important (H)	(0.50, 0.75, 1)	
Medium (M)	(0.25, 0.50, 0.75)	
Low (L)	(0, 0.25, 0.50)	
Very low (VL)	(0, 0, 0.25)	

After all the parameters were collected for the breast cancer treatment techniques, Gaussian preference function was used for each criterion (Table 2). Visual PROMETHEE decision lab program was then applied. The obtained results are shown in Table 3.

Table 2 Application of fuzzy-PROMETHEE to breast cancer treatment techniques

Criteria	Treatment Time (weeks)	Cost of Treatment ($)	Side Effect	Overall Survival Rate (%)
Preferences				
(min/max)	min	min	min	max
Weight	0.92	0.92	0.92	0.92
Preference Fn.	Gaussian	Gaussian	Gaussian	Gaussian
Evaluations				
Radiotherapy	4.5	15455	High	65
Chemotherapy	20	15113	Very High	80
Surgery	2.5	11691	Low	90
Hormone therapy	390	10000	Medium	75

Table 3 Complete ranking of breast cancer treatment techniques

Complete Ranking	Alternatives	Positive outranking flow	Negative outranking flow	Net Flow
1	Surgery	0.6042	0.0887	0.5156
2	Hormone Therapy	0.3482	0.3877	-0.0396
3	Chemotherapy	0.3130	0.4247	-0.1117
4	Radiotherapy	0.1643	0.5277	-0.3643

As it can be seen from the Tables 2 and 3, with short treatment time, minimum side effect and highest overall survival rate, surgery is the best alternative for the patient. However, due to its high cost, high side effect and low overall survival rate, radiotherapy comes last according to the ranking.

Furthermore, the positive and negative side of each criterion was determined and shown in Figure 1. The parameters for surgery are more on the positive side, as compared to radiotherapy and chemotherapy which are on the negative side and lastly the parameters for hormone therapy are equally distributed on the positive and negative side.

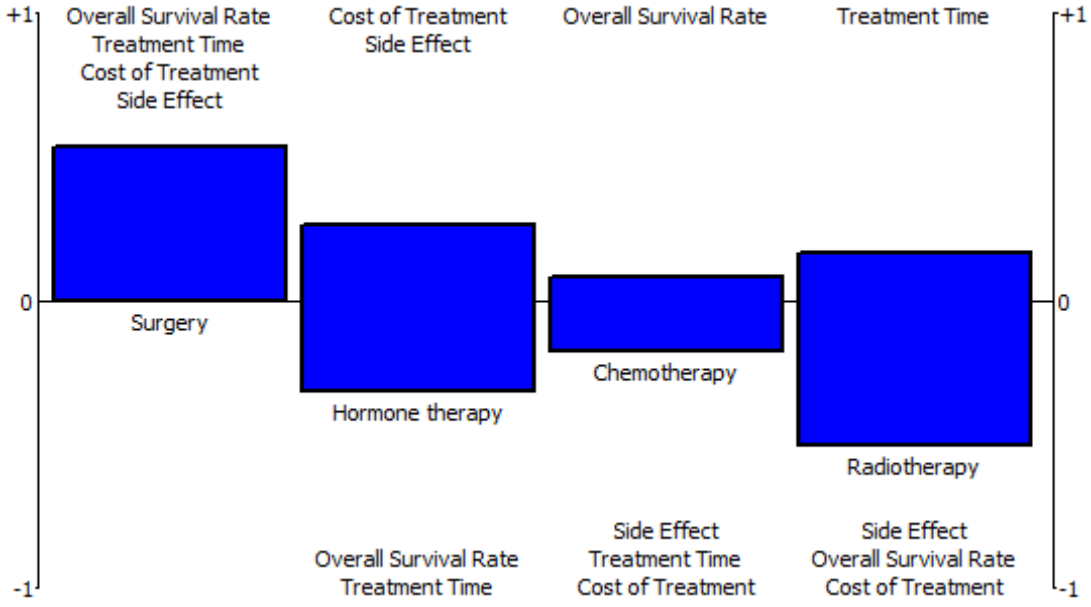

Figure 1 Evaluation of the parameters for the breast cancer treatment techniques

CONCLUSION

In this study, we were able to achieve optimum decision in the healthcare problems by employing fuzzy PROMETHEE, a multi-criteria decision-making technique. The obtained parameters were converted into fuzzy input data. After defuzzification, we applied to the PROMETHEE method and obtained the result. The study shows that the proposed method is very effective at giving solutions to decision-making problems in healthcare.

DECLARATIONS

Conflict of Interest

The authors have disclosed no conflict of interest, financial or otherwise.

REFERENCES

[1] Harris, Kathleen M., and Victor G. Vogel. "Breast cancer screening." *Cancer and Metastasis Reviews,* Vol. 16, No. 3-4, 1997, pp. 231-62.

[2] Henson, Donald Earl, and Lynn A. Ries Ms. "Progress in early breast cancer detection." *Cancer,* Vol. 65, No. S9, 1990, pp. 2155-58.

[3] National Cancer Institute. "*Breast cancer treatment."* https://www.cancer.gov/types/breast/patient/breast-treatment-pdq, 2017.

[4] Ubel, Peter A., Andrea M. Angott, and Brian J. Zikmund-Fisher. "Physicians recommend different treatments for patients than they would choose for themselves." *Archives of Internal Medicine,* Vol. 171, No. 7, 2011, pp. 630-34.

[5] American Cancer Society. "Surgery for breast cancer." https://www.cancer.org/cancer/breast-cancer/treatment/surgery-for-breast-cancer.html, 2017.

[6] Silberstein, Edward B. "Systemic radiopharmaceutical therapy of painful osteoblastic metastases." *Seminars in Radiation Oncology,* Vol. 10. No. 3. 2000, p. 2.

[7] Wang TC, Chen LY, Chen YH. "Applying fuzzy PROMETHEE method for evaluating IS outsourcing suppliers". Fuzzy Systems and Knowledge Discovery, Fifth International Conference on, IEEE, Vol. 3, 2008, pp. 361-65

[8] Ozsahina, Dilber Uzun, et al. "Evaluating cancer treatment alternatives using Fuzzy PROMETHEE Method." *International Journal of Advanced Computer Science and Applications,* Vol. 8, No. 10, 2017, pp. 177-82.

[9] Ozsahin, Dilber Uzun, et al. "Evaluating nuclear medicine imaging devices using fuzzy PROMETHEE method." *Procedia Computer Science,* Vol. 120, 2017, pp. 699-705.