Application of Decision Support Systems for Selection of Radiotherapy Methods Breast Cancer Patients

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Keyword: Decision Support System, Breast Cancer, Radiotherapy, 3D-CRT, IMRT, VMAT.

Abstract: Radiotherapy is a treatment against malignant tumor or cancer by using ionizing radiation, such as X-rays, gamma rays or high-energy electrons. Radiotherapy methods include 3D-CRT, IMRT, VMAT. Decision-making in the selection of radiotherapy methods in case of breast cancer is unique to each patient so doctors need consideration. Selection of radiotherapy method for breast cancer patients so that it becomes optimal with support of decision support system. Analytical Hierarchy Process's decision support system helps solve complex problems by structuring a hierarchy of criteria, stakeholders, outcomes and displaying considerations to develop possible options. The purpose of this research is the application of AHP-based aids decision system that can be used by doctors as an alternative selection tool from existing radiotherapy methods and educational facilities of prospective doctors in learning about radiotherapy methods in breast cancer patients. The resulting of decision support system is used in the selection of radiotherapy methods in breast cancer patients that greatly assist the physician in selecting decisions. Suggested software applications need to develop step instructions and questions to be more complex and tailored to the condition of patients and hospitals.

1 INTRODUCTION

Breast cancer is a degenerative disease resulting from cells in the breast tissue dividing and growing uncontrollably (Miranda, et al 2013). According to data Globacan, International Agency for Research on Cancer (IARC) in 2012 found that breast cancer ranks first as the most common type of cancer suffered by women in the world. Breast cancer accounts for 25% of all newly diagnosed overall cancer cases (Infodatin Kemenkes, 2015). Breast cancer has a contribution of 30% and is the most dominant type of cancer in Indonesia, beating cervical cancer that contributes 24% (DepKes RI, 2013).

One treatment of cancer is to use radiotherapy where Radiotherapy is a recognized therapy, and 45-50% of cancer patients are cured, radiotherapy plays a role in the healing. New and growing radiotherapy methods are used for breast cancer therapy, which is radiation using 3DCRT (Three-dimensional Conformal Radiation Therapy) techniques, IMRT (Intensity Modulated Radiotherapy) techniques, and VMAT (Volumetric Modulated Arc Therapy) techniques (Liu, et al 2013).

Decision-making in the selection of breast cancer therapy using various methods of radiotherapy is often a problem that is often faced for a doctor (clinician) and a patient / patient with breast cancer, including cancer stage, surgery that has been done, radiation target, and total dose of radiation. Therefore, one of the methods that can be implemented in the health world is a decision-based system based on Analytical Hierarchy Process. Decision support system based on Analytical Hierarchy Process that can be used in determining the selection of the best alternative radiotherapy methods and becomes very important in providing knowledge and learning about radiotherapy methods.

The purpose of this research is the selection of radiotherapy method for breast cancer patients so that it becomes optimal with the support of decision support system based on Analytical Hierarchy Process and can know the limitations of radiotherapy method selection manually.

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2 LITERATURE REVIEW

2.1 Breast Cancer

Breast cancer is principally a malignant tumor of one of the skins on the outside of the chest cavity. The armpit lymph gland forms the lymphatic drainage system for both upper quadrants of the body, as well as the breasts including both arms (Jong, 2005). Breast cancer is a malignancy of breast tissue that may originate in the ductal and lobular epithelium. Breast cancer is one of the most cancer types in Indonesia.

Based on Pathological Based Registration in Indonesia, Breast Cancer ranks first with relative frequency of 18.6% (Cancer Data in Indonesia Year 2010, according to Histopathological data, Cancer Registry Agency of Indonesian Pathology Specialist Association and Indonesian Cancer Foundation (YKI)). It is estimated that the incidence rate in Indonesia is 12 / 100,000 women, whereas in the United States are about 92 / 100,000 women with a fairly high mortality of 27 / 100,000 or 18% of deaths found in women. This disease can also be suffered in men with frequency about 1%. In Indonesia, more than 80% of cases are found to be in an advanced stage, where treatment efforts are difficult. Therefore, it is necessary to understand about prevention efforts, early diagnosis, curative and palliative remedies as well as good rehabilitation efforts, so that the service in patients can be done optimally (Komite Penanggulangan Kanker Nasional DepKes RI, 2015).

2.2 Radiotherapy

Radiotherapy is an utilization of ionizing rays in a therapeutic attempt by providing a precise dose of radiation to a determined tumor volume by reducing normal surrounding tissue damage to a minimum. The principle of radiotherapy is to kill cancer cells by giving the appropriate dose to the targeted tumor or target and to keep the radiation effect on healthy tissue to a minimum (Murat, et al, 2010).

Radiotherapy is a treatment against malignant cancer or cancer by using ionizing radiation, such as X-rays, gamma rays or high-energy electrons (Sarkar, et al 2012). Radiotherapy is a recognized therapy, and 45-50% of cancer patients are cured, radiotherapy plays role in the healing (Susworo, 2007).

2.3 Radiotherapy Methods

2.3.1 3D-CRT Method (3 Dimension Conformal Radiation Theraphy)

3D-CRT (Conformal Radiation Theraphy) is a radiotherapy irradiation method based on 3D anatomical information and uses the appropriate dose distribution for volume targets in the case of adequate doses of target volume and minimal doses of healthy tissue. With the computer system work 3D-CRT method can know the shape, size, and location of tumors and can calculate the virtual three-dimensional tumor.3D-CRT inidimana planning and delivery treatment based on 3 dimensions of volumetric image data with each radiation field in accordance with the form of target volume conformity (Khan, 2014).

2.3.2 IMRT Method (Intensity Modulated Radiotheraphy)

The principle of IMRT is to provide irradiation to the patient with some amount of irradiation direction with a non-uniform pitch which has been optimized to give the maximal dose to the target organ and provide minimal dosage to the surrounding organ. Radiation The IMRT method may be provided by the operation of MLC (Multi Leaf Collimator) from one of the three bases; The segmented MLC, or so-called step and shoot, dynamic MLC or often called sliding, and intensity modulated arc therapy (IMAT). In the MLC step and shoot, there is a field inside the radiation field, the MLC will move to cover the already enough dose, and the radiation will come out if the MLC finishes moving. In dynamic MLC, MLC will continue to cover the part of organ that has enough dose, as long as it is also radiation out. In the IMAT (VMAT), MLC will move following the organ shape and the gantry will rotate around the patient (Levitt, et al, 2012).

2.3.3 VMAT Method (Rapid Arc)

VMAT was first introduced in 2007 and is described as a new radiation method that allows simultaneous variation of three parameters during treatment, ie gantry rotation speed, aperture form of treatment through MLC leaf movement and dose rate (Teoh, et al, 2011). RapidArc uses the Volumetric Modulated Arc Therapy (VMAT) Method, in which treatment is given at a dose for the overall volume of the cancer (Cimasi. RJ, 2014). RapidArc is a dynamic treatment by way of radiation with 360-degree gantry rotation around a given patient with complex planning

whereby the velocity of the gantry, dose rate, and shape of the irradiation field will change following the shape of the tumor itself using a device called MLC or Multi Leaf Collimator. The rotating gantry and irradiation of the radiation field following the overall shape of the tumor reduces the irradiation times compared to the conventional Modulated Radiotherapy (IMRT) Method. Besides reducing the exposure time, the use of RapidArc is also very useful in reducing the doses received by the risky organs around without reducing the radiation that reaches the target organ.

2.4 Decision Support System

Decision Support System as a set of model-based procedures for processing and assessment data to help managers make decisions. Decision support systems have the primary goal of helping decision makers through several stages of each decision-making process through the exploitation of computerized information systems (Hartono. AA, 2014).

Decision support system has three main sub system, namely database management subsystem, model subsystem, and dialog subsystem. These three subsystems are important elements in modeling and decision-making simulations to provide more appropriate decision alternatives using the AHP (Analytical Hierarchy Process) method (Shaot. A, et al, 2014).

The basis for thinking of the AHP method is the numerical forming process to rank each decision alternative based on how the alternative should be matched against the decision-making criteria (Supriyono, 2007). This AHP method helps solve complex problems by structuring a hierarchy of criteria, stakeholders, outcomes and by drawing considerations for developing weights or priorities.

Thus AHP is used when decisions are taken involving many factors, when decision makers have difficulty in determining the weight of each factor. AHP will solve a complex, unstructured situation into several components in a hierarchical arrangement. By giving subjective values about the relative importance of each variable, and specifying which variable has the highest priority aims to influence the outcome of the situation when the decision will be taken.

The steps or procedures on the AHP method are: (Saaty. TL, 2004)

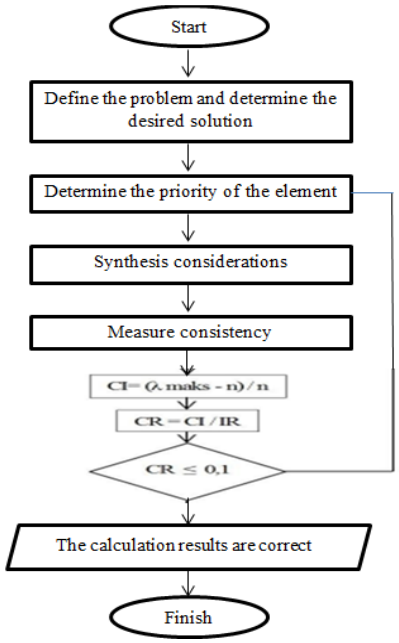

Figure 1: Flowchart procedure on AHP.

3 METHODS

This research uses qualitative method with experimental quasi, with approach of longitudinal research because in research implementation not at certain period of time. The research was carried out from August to November 2017 at the Radiotherapy Installation of MRCCC Siloam Jakarta and the Biomedical Technology Campus of FTUI Salemba, Jakarta. Samples taken purposively based on assessment by programmers and doctors PPDS Radiation Oncology at RSCM Hospital Jakarta.

Tools and materials used in this research are:

a. Computers / Laptops, with AMD A8 processor specifications or Intel core-i7 processors and RAM memory of 2-3 GB.
b. Programming language
   1) Front base: Html 5, CSS, Bootstrap, JS
   2) Back base: Php
   3) Database: Mysql

Data collection methods used are:

a. Literature Review
b. Interview
c. Preparation of Analytical Hierarchy Process
d. Systems Analysis and Design
e. Creation of Application software
f. Trials

4 RESULTS

4.1 Analysis and Design System

A system architecture design is done by doing the analysis so that the proposed system will be made.

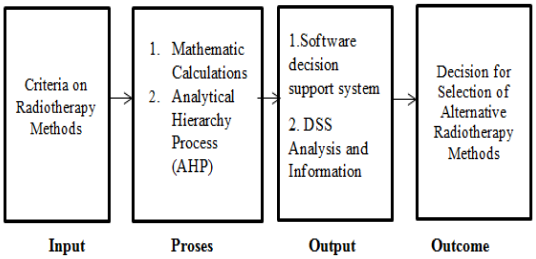

Figure 2: System interconnection.

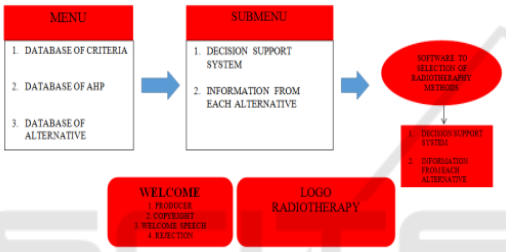

Figure 3: Interface design system.

4.2 Application of AHP

4.2.1 Define the Problem and Determine the Desired Solution, then Determine the Hierarchy.

First we have to define the situation carefully, include as many relevant details as possible, then arrange the model in a hierarchy consisting of several levels of detail, ie the focus of the problem, criteria, and alternatives.

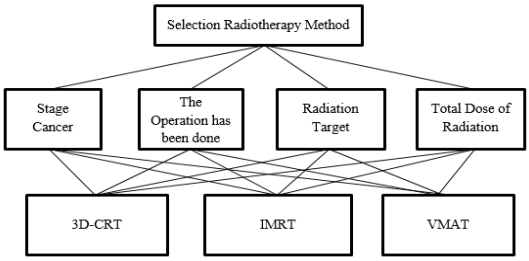

Figure 4: Structure of AHP.

4.2.2 Creating a Pairwise Matrix Matrix

Matrix of pairwise comperition is made by comparing the setlap of alternative pairs against the criteria tested.

4.2.3 Synthesizing Comparisons

Synthesis aims to obtain the priority of all decision alternatives after all data in the benchmark matrix is performed. Synthetic is done by comparing the matrix normalization, which is obtained by dividing each entry by the number of columns in the corresponding entry. The number of each column will be equal to one. From a normalized matrix, multiply the relative priority value with each entry in the corresponding column in the benchmark matrix. Add the multiplication in a row.

Next on the row number column, for each entry with the entry corresponding to the priority vector, the result is a consistency vector. The lambda value is the average of the consistency vector. And then calculated consistency index (CI) which n used in this research that is 3 (number of alternative compare).

$$CI = \frac{\lambda - n}{n - 1} \quad \text{.....} \quad (1)$$

For n = 3, the random index (RI) is 0.58, so the consistency ratio (CR) is:

$$CR = \frac{CI}{RI} \quad \text{.....} \quad (2)$$

The CR result in the example shows that CR = 0.011 means that the response is quite consistent and true, and does not need to re-evaluate the comparative matrix that has been made because CR <10% (0.1) Analytical Hierarchy process process that has been done got the final result that is:

Table 1: Final summary.

Alternative	Prioritas			
	Stage Cancer	The Operation has been done	Radiation Target	Total Dose of radiation
3D-CRT	0.16 (*3)	0.16 (*3)	0.13 (*3)	0.55 (*1)
IMRT	0.59 (*1)	0.30 (*2)	0.38 (*2)	0.18 (*3)

VM AT	0.25 (*2)	0.54 (*1)	0.54 (*1)	0.27 (*2)

4.3 Implementation of Interface

For implementation of interface design assisted by programmer. There are three views in Interface: login menu (Username and user password), current patient data menu (data already done decision system decision process), patient input menu (included patient data and existing medical resume, and start of Decision Support System for selection method of radiotherapy in breast cancer patients).

4.3.1 Display Login Menu

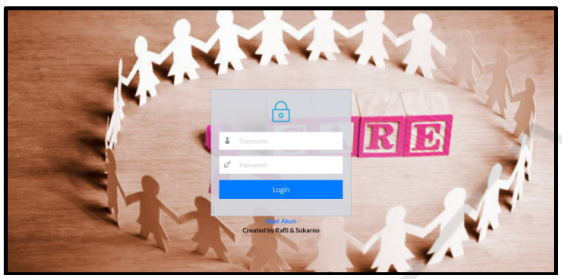

Figure 5: Menu login.

4.3.2 Recent Patient List Menu Display

Contains the latest patient data set intended to make it easier for doctors to find information from their current patients.

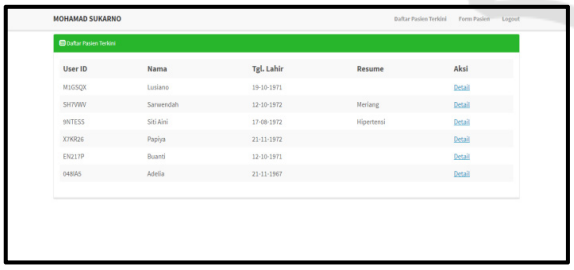

Figure 6: Recent patient data.

4.3.3 Display of Patient Form

The Patient Form is the first part of a series of therapeutic end-points determination for patients. Here is an example of a patient form:

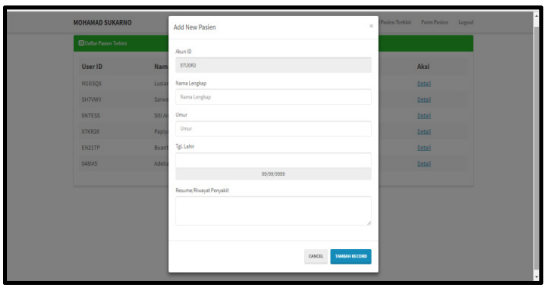

Figure 7: Patient form.

After that just go into the questionnaire is arranged hierarchically from one to ten questions, with some examples of the display are:

a. Does Patient Have Breast Cancer?
b. Does the patient include an early stage?
c. Does the patient include an advanced stage?
d. Is the patient already in surgery?
e. Has the patient been fully operational (Mastectomy)?
f. Has the patient been partially surgically removed (Lumpectomy)?
g. Does the patient need radiation on the chest wall?
g. Does the patient need radiation on all breasts?
h. Does the patient need radiation on the regional lymph nodes?
i. Does the patient need Booster on a tumor bed?

After the process on each question is completed then ultimately boils down to the result.

4.4 Trial and Verification Test

4.4.1 The Test Results on the Programmer Trials are Conducted on Three Programmers to Assess Whether the Program is Working or not, and Compliance with Programming.

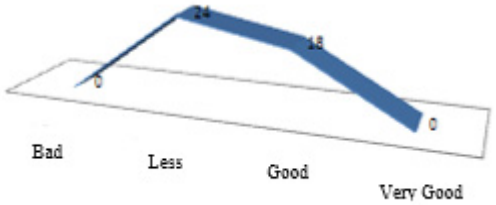

Figure 8: Programmer trial.

4.4.2 The Test Results on User

Trials were conducted on three physicians PPDS Radiation Oncology FKUI for general and

comprehensive assessments by assessing whether the program can run or not, the suitability of the content, provide an overview of information and software usability.

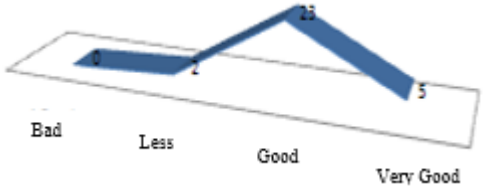

Figure 9: User trial.

4.4.3 Verification Test Results

Software verification verification conducted by 3 doctor PPDS specialist Radiation oncology FKUI at Cipto Mangunkusumo Hospital. PPDS doctors are tested on how they can make quick and precise decisions on the choice of radiotherapy methods to breast cancer patients directly and manually without the use of software that has been created and fill out the form provided. However, PPDS doctors specializing in radiation oncology are still getting difficulties such as knowledge and field experience is still lacking and limitations in making consideration questions, such as: Questions are good, Questions are added to be more specific, choice of radiotherapy method is added according to the type of therapy that has been undertaken by the patient, Questions and references added for treatment recommendations.

At this time the doctors ppds specialist radiation oncology in decision-making radiotherapy method selection is still done manually with the mindset and condition of the patient, the choice of radiotherapy methods are also still experiencing many difficulties, especially in cases of breast cancer. So with the software system decision aids for the selection of radiotherapy methods in breast cancer patients and this software can be used by PPDS radiation oncologists to facilitate in taking a decision quickly and precisely.

5 CONCLUSIONS

The results of this research in the form of web based application software that is a decision-based system Analytical Hierarchy Process in the selection of radiotherapy methods in breast cancer patients. This research produces an overview and helps / facilitates the specialist radiation oncologist ppds physicians in making decisions for the selection of rapid, appropriate and appropriate radiotherapy methods from several available alternatives and provides appropriate information as reference materials for the choice of radiotherapy methods, and the resulting decision support system and recommended in the system directly by the program as well as any permanent decisions of a specialist doctor or radiation oncologist specifies even though in making decisions the choice of radiotherapy methods is still done manually and also still experiencing many difficulties, especially in cases of breast cancer.

Suggested Further research software application needs to develop step instructions and questions to be more complex and tailored to the condition of patients and hospitals.

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