# A DECISION ANALYTIC MODEL FOR EARLY STAGE BREAST CANCER PATIENTS: LUMPECTOMY VS MASTECTOMY

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

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IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF MASTER OF SCIENCE
IN
INDUSTRIAL ENGINEERING

SEPTEMBER 2006

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# ABSTRACT


## A DECISION-ANALYTIC MODEL FOR EARLY STAGE BREAST CANCER PATIENTS: LUMPECTOMY VS MASTECTOMY

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September 2006, 209 pages

The purpose of this study was to develop a decision model for early-stage breast cancer patients. This model provides an opportunity for comparing two main treatment options, mastectomy and lumpectomy, with respect to quality of life by making use of Decision Theoretic Techniques.

A Markov chain was constructed to project the clinical history of breast carcinoma following surgery. Then, health states used in the model were characterized by transition probabilities and utilities for quality of life. A Multi Attribute Utility Model was developed for outcome evaluation. This study was performed on the sample population of female university students, and utilities were elicited from these healthy volunteers. The results yielded by Multi Attribute Utility Model were validated by using Von Neumann-Morgenstern Standard Gamble technique. Finally, Monte Carlo Simulation was utilized in Treeage-Pro 2006 Suit software program in order to solve model and calculate expected utility value generated by each treatment option. The results showed that lumpectomy is more favorable for people who participated in this study. Sensitivity analysis on transition probabilities to local recurrence and salvaged states was performed and two threshold values

were observed. Additionally, sensitivity analysis on utilities showed that the model was more sensitive to no evidence of disease state; however, was not sensitive to utilities of local recurrence and salvaged states.

Key Words: Decision Analysis, Markov Chain, Breast Cancer, Quality of Life, Multi Attribute Utility Model.

# ÖZ

## ERKEN EVRE MEME KANSERİ HASTALARI İÇİN ÇÖZÜMLEMELİ KARAR MODELİ: LUMPEKTOMİYE KARŞI MASTEKTOMİ

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Eylül 2006, 209 sayfa

Bu çalışmanın amacı, erken-evre meme kanseri hastaları için çözümlemeli karar modeli geliştirmekti. Bu model, meme kanseri hastalarına uygulanan iki temel tedavi şekli olan Mastektomi ve Lumpektomi operasyonlarını, teorik karar verme tekniklerini kullanarak yaşam kaliteleri açısından karşılaştırmaya olanak sağlar.

Operasyon sonrası meme kanserinin klinik sürecini yansıtmak için Markov zinciri oluşturuldu. Daha sonra, modelde tanımlanan sağlık durumları geçiş olasılıkları ve yaşam kalitesi için fayda değerleri ile nitelendirildi. Sonuç değerlendirmesi için Çok Kriterli Fayda Modeli geliştirildi. Bu çalışma bayan üniversite öğrencilerinden oluşan örnek nüfusa uygulandı ve fayda değerleri sağlıklı gönüllülerden oluşan bu örneklemeden çıkartıldı. Çok Kriterli Fayda Modelinden elde edilen sonuçlar Von Neumann-Morgenstern Standart Kumar tekniği ile doğrulandı. Son olarak, modeli çözmek ve her bir tedavi şekline ait tahmini fayda değerini hesaplamak için Treeage-Pro 2006 Suit bilgisayar yazılımında Monte Carlo Simülasyonu kullanıldı. Simülasyondan elde edilen sonuçlar, bu çalışmada yer alan katılımcıların Lumpektomi seçeneğini daha fazla tercih ettiğini gösterdi. Kanserin lokal tekrarı ve bu tekrardan sonraki iyileşme durumu olasılıkları üzerinde yapılan hassasiyet

çalışmaları sonucunda iki eşik değeri gözlendi. Ayrıca, fayda değerleri üzerinde yapılan hassasiyet çalışmaları, modelin hastalığın geçmiş olma durumundaki fayda değerlerindeki değişimlere karşı daha fazla hassas olduğunu; buna karşın hastalığın tekrar ettiği ve daha sonraki iyileşme durumlarındaki fayda değerlerindeki değişimlere karşı hassas olmadığını ortaya koymuştur.

Anahtar Kelimeler: Karar Analizi, Markov Zinciri, Meme Kanseri, Yaşam Kalitesi, Çok Kriterli Fayda Modeli.

To My Family

# ACKNOWDLEGMENTS

I would like to thank to my supervisor Dr. Güldal Büyükdamgacı for her guidance, advices, criticism, patience, encouragements and insight throughout the research. Her understanding throughout the whole study is gratefully acknowledged.

I would also like to express my gratitude to my supervisor Prof. Dr. Çağlar Güven.

I would also present my deepest thanks to Asst. Prof. Dr. Mutlu Hayran for his belief in my study, encouragements, clinical guidance and valuable support.

I am also thankful to Ümit Serkan Sarıoğlu. With his logistic and moral support, I was able to perform this study.

In addition, I would like to thank to all my friends and survey participants who took place in this study.

Finally, I am greatly indebted to my family for their endless support throughout my study.

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# LIST OF ABBREVIATIONS

QALY : Quality Adjusted Life Year
HUI : Health Utilities Index
QWB : Quality of Well Being
MAUM : Multi Attribute Utility Model
SG : Standard Gamble
TTO : Time Trade Off
RS : Rating Scale
VAS : Visual Analogue Scale
MUIS : Mishel Uncertainty in Illness Scale
POMS : Profile of Mood States
FACT-B : Functional Assessment of Cancer Therapy for Patients with Breast Cancer
HUOH : Hacettepe University Oncology Hospital
DM : Decision Maker
NED : No Evidence of Disease
NEDI : No Evidence of Disease but Having Hormone Therapy
NEDII : No Evidence of Disease but Having Chemotherapy
L-NED : No Evidence of Disease for Lumpectomy
M-NED : No Evidence of Disease for Mastectomy
L-NEDI : No Evidence of Disease but Having Hormone Therapy for Lumpectomy
M-NEDI : No Evidence of Disease but Having Hormone Therapy for Mastectomy
L-NEDII : No Evidence of Disease but Having Chemotherapy for Lumpectomy
M-NEDII : No Evidence of Disease but Having Chemotherapy for Mastectomy
MTMM : Multi Trait Multi Method

# CHAPTER 1

# INTRODUCTION

## 1.1 Objective of the Study

Objective of this study is to analyze the decision context of early stage breast cancer patients in relation to two main treatment options, and to construct a decision making model that incorporates patient preferences over differing health state prospects as well as incorporating other typical complexities of such decision situations such as uncertainty.

The analysis focuses on early stage breast cancer patients, which means that patients are operable. Patients' age interval under consideration is 45-55, so that they are assumed to be pre-menopausal.

This study has two basic outcomes; first it demonstrates how Decision Theoretic Techniques can be utilized for critical health decisions, and second, the best treatment option can be determined by using the constructed instrument with respect to patients' individual values and preferences.

## 1.2 Problem Definition

Today breast cancer is the most common type of cancer in women worldwide and its occurrence is steadily increasing. Every year more than 250,000 new cases of breast cancer are diagnosed in Europe, and approximately 175,000 in the United States, with a death rate of over 165,000 patients in Europe and 44,000 in the United States. Worldwide, more than 700,000 women die annually of breast cancer, and it is estimated that eight to nine percent of women will suffer from breast cancer in their lifetime (http://www.nationalbreastcancer.org, 2006). On the other hand, according to the statistics of Ministry of Health, in Turkey, approximately 30,000 women are diagnosed with breast cancer every year, and it is the most common cancer in women (http://www.saglik.gov.tr, 2006).

With technological advances, different types of treatment options have been adopted to extend survival of patients with breast cancer. Choosing the most appropriate cancer treatment is a decision that ideally should involve the patient, the family, and the health care team. Choice of treatment for early stage breast cancer depends on many factors, including size and stage of cancer, patient's age, and other health problems of patient, risks and advantages of treatments.

In the literature, when previously mentioned factors are taken into account, two basic treatment options are mentioned: lumpectomy and mastectomy. Briefly, mastectomy is the surgical removal of an entire breast, which contains cancer; on the other hand, lumpectomy, which is also called breast-conserving surgery, is the surgical removal of the tumor only (http://www.cancer.org, 2006). According to literature and experts' opinions both treatment options have benefits and drawbacks (Desch, et.al, 1999; Kiebert, 1991; Curran, et.al; 1998).

In general, surgeons recommend a treatment according to their experiences and the first thing taken into account is generally the survival of patient not the quality of life after surgery. However, their experiences may not always reflect the "best"

decision, and preferences of health professionals may conflict with patient preferences. Especially, when the chance of survival is nearly the same for both surgical treatment options, women's choice among these treatment options often focuses on quality of life issues. Thus, considerable amount of research has focused on the quality of life in breast cancer patients after surgery in order to make a better informed decision on treatment options.

Decision Making Techniques are useful for critical decisions in health care and have been used for over thirty years around the world. In fact, the idea of using decision theory in medical practice was first proposed by Ledley and Lusted (1959). However, decision analysis techniques have been used in clinical situations effectively only after the beginning of 1970's. In Turkey, health sector is unexplored territory with regard to such studies. The fundamental purpose of decision analysis is to provide useful strategies appropriate for dealing with complex clinical situations and opportunity for consideration of all possible outcomes.

In this study, we considered the patients for whom both treatment options can be applicable, and hence the patient preferences can legitimately make a difference if they could be modeled into the decision making process. For this purpose, we tried to create a quantitative representation of this decision situation involving both treatment choices. This quantitative representation of the breast cancer problem allowed for incorporating of choices, uncertainty and outcome measures. Expected value of outcomes that result from the two possible treatment options can be calculated and compared in order to decide on the best option for one patient. Similar studies from literature such as Lee (2002), who constructed a Markov model that describes clinical outcomes of breast carcinoma following mastectomy and performed cost-effectiveness evaluation of post mastectomy radiation therapy in high-risk premenopausal breast cancer patients, and Carter (1998), who developed a Markov process model specific to early-stage breast cancer patients

and determined optimal treatment choice by examining quality adjusted life years (QALYs) among various treatment options, were used as reference.

Steps of the study can be followed in Figure 1.1. The first step in such a study is the modeling of disease progress for each treatment option. A decision model can be developed for the disease progress by using suitable decision-making techniques such as decision trees, influence diagrams or Markov models. The objective of this step is to identify possible outcomes associated with each treatment options so that by evaluating these outcomes the optimal decision about choices of treatment for breast cancer patient can be made. In this study, the central choice-making is between lumpectomy and mastectomy operation, the Markov process incorporates all events/decisions following a surgery and the decision analysis compares the values of two Markov processes. Sonnenberg (1993) developed a practical guide for using Markov Models in Medical Decision Making. By following this guide, all events were represented as transitions from one health condition (state) to another. Subjects (patients) were assumed to make transitions at discrete time intervals, at the end of each year, among the states relevant to the clinical problem. Since the breast cancer problem does not involve constant transition probabilities among the Markov states, the breast cancer problem was modeled as non-time homogeneous Markov chain. A Markov chain is constructed, and then it can be characterized for both treatment options with respect to transition probabilities and rewards. After measuring outcomes, outcome values can be assigned as reward for each markov state used in the model and the evaluation of the Markov chain on outcome values yields the expected reward. Then, two treatment options can be compared with respect to their expected rewards.

The focal step of this study is the evaluation of health outcomes. After identifying possible outcomes by suitable decision modeling technique, the next and the most important step is the modeling of outcome measure. A health outcome can be measured as a quantity or quality. Quantity represents life expectancy (life saved), on the other hand quality represents quality of life (utility of patient). In fact both

measures are important criteria, so combining quality (morbidity) and quantity (mortality) measures in a single metric is the best way for measuring health outcome. Quality Adjusted Life Years (QALYs) is such a metric. It reflects the expected utility of an intervention for an individual and allows us to formulate the patient's preferences in relation to probable outcomes under uncertainty. QALY is useful to measure the effects of different medical interventions in a comprehensive way since it combines quality and quantity (Drummond et al. 1987). Since QALY reflects the expected utility, Von Neumann-Morgenstern Utility Theory is considered to present the most suitable of measures for this health related quality of life. Hence, researchers in this field utilize utility assessment techniques to obtain patients' utilities in relation to health states probable along the path of their disease progress.

There are two main approaches in order to calculate QALY value of an outcome. The first approach is to develop outcome measure from people by direct assessment (primary data), which is what we performed in this study, and the second one is using ready-made generic measures (secondary data).

In the first approach, there are two basic strategies for deriving utility value for this outcome; holistic and decomposed. The holistic approach based on global rating and requires the decision maker, patient, physician or healthy volunteer, to consider the defined outcome and rate the outcome that reflects an overall assessment by using some specific techniques such as standard gamble, time trade off etc (Drummond et al., 1987). However determining utility value of an outcome by global rating may not be reliable. Thus, as first Fischer (1977) proposed that, applied decision analysts have shown considerable interest in decomposed evaluation procedures for theoretical as well as practical reasons. The decomposed approach is based multi-attribute utility assessment procedures and requires the decision maker to consider each dimension of a problem separately; therefore it provides to decision maker to perform this evaluation task in more articulated way by using decision making techniques. In this procedure, the set of attributes are

specified and an outcome is defined in terms of these attributes. Then, the decision maker should assign relative values to each possible level of attributes. After eliciting individual values for each attribute, we need to aggregate these ratings in order to get overall utility value; thus, a composition rule for aggregating value across attributes should be specified to obtain an overall measure of worth.

As mentioned previously, the second approach to calculate QALY value of an outcome is using ready-made generic measures such as Health Utilities Index (Torrance, 1982), Quality of Well Being (Kaplan, 1988) or EQ-5D (Euroqol Group, 1990). These pre-scored multi attribute health status classification systems are developed by standardizing reference population assessments. In fact, these generic measures are results of multitude of studies on modeling outcome measure that had been previously conducted using versions of the first approach (from primary data). These ready-made measures are attractive due to practicality, and are being widely used for patient's preferences in the countries where they are available to use. However, depending on the population the utilities are assessed from, scoring systems of these measures are function of their own societal values. For instance, EQ-5D scoring system represents English society and using Turkish translation of this measure directly may not provide meaningful data due to cultural differences. On the other hand, let alone developing such scoring system, which represents Turkish society, even an outcome measure has not been developed yet.

In a study that deals with clinical decision making incorporating Turkish patient's preferences, therefore, we have only one choice, and that is implementing the first approach. For this purpose, after identifying all possible outcomes on the decision model developed as a Markov chain, a multi attribute utility model was constructed as described for measuring these outcomes. Suitable attributes were specified in order to define health states. Then we constructed scales for each attribute and assessed the location of all possible health states defined in the decision model along the scales of attributes. After assessing locations, individual values of the

patient can be obtained by direct assessment techniques. Then, overall utility values of the health states for both treatment options can be calculated for any patient.

This study was not performed on patients since they may be physically overtired or oversensitive and such interviews may affect them negatively if they are not applied by an analyst who is an expert on this area. We performed this study on a sample population of female university students, and aimed to obtain an indication of preferences of population at this specific age interval. For this purpose, individual utility values were elicited from university students and overall utility values were calculated for each possible health state. The consistency of these overall values was checked by the values yielded from global ratings.

In order to get transition probabilities among the health states in the Markov chain, subjective probability assignment method was used in this study. Probability estimates were based on a group of oncologists' consensus. Since transition probabilities among the health states are not constant over time, probabilities were estimated for each cycle (year) by considering 10-year survival for disease progression.

Final step is evaluation of the model according to data obtained from patient, obtaining QALY values that result from the two possible treatment options and deciding on optimal treatment option. Since the transition probabilities among the health states are time-dependent, it is impossible to evaluate the process with exact computation. Thus, a simulation method (Monte Carlo Simulation) was utilized in order to calculate the expected value (QALY) generated by each treatment option. The evaluation results showed that lumpectomy was more favorable for this sample population. Since we performed this study on a sample consisting of university students to generate QALY values, the results reflect their preferences.

This decision aid can be used either for taking the preferences of a single cancer patient into account in deciding on treatment, or for reflecting a reference

population's preference structure on the issue. Its best use, however, may be in training physicians' judgment on the complexities of the decision space at hand so as to improve their chances of making a wise treatment decision.

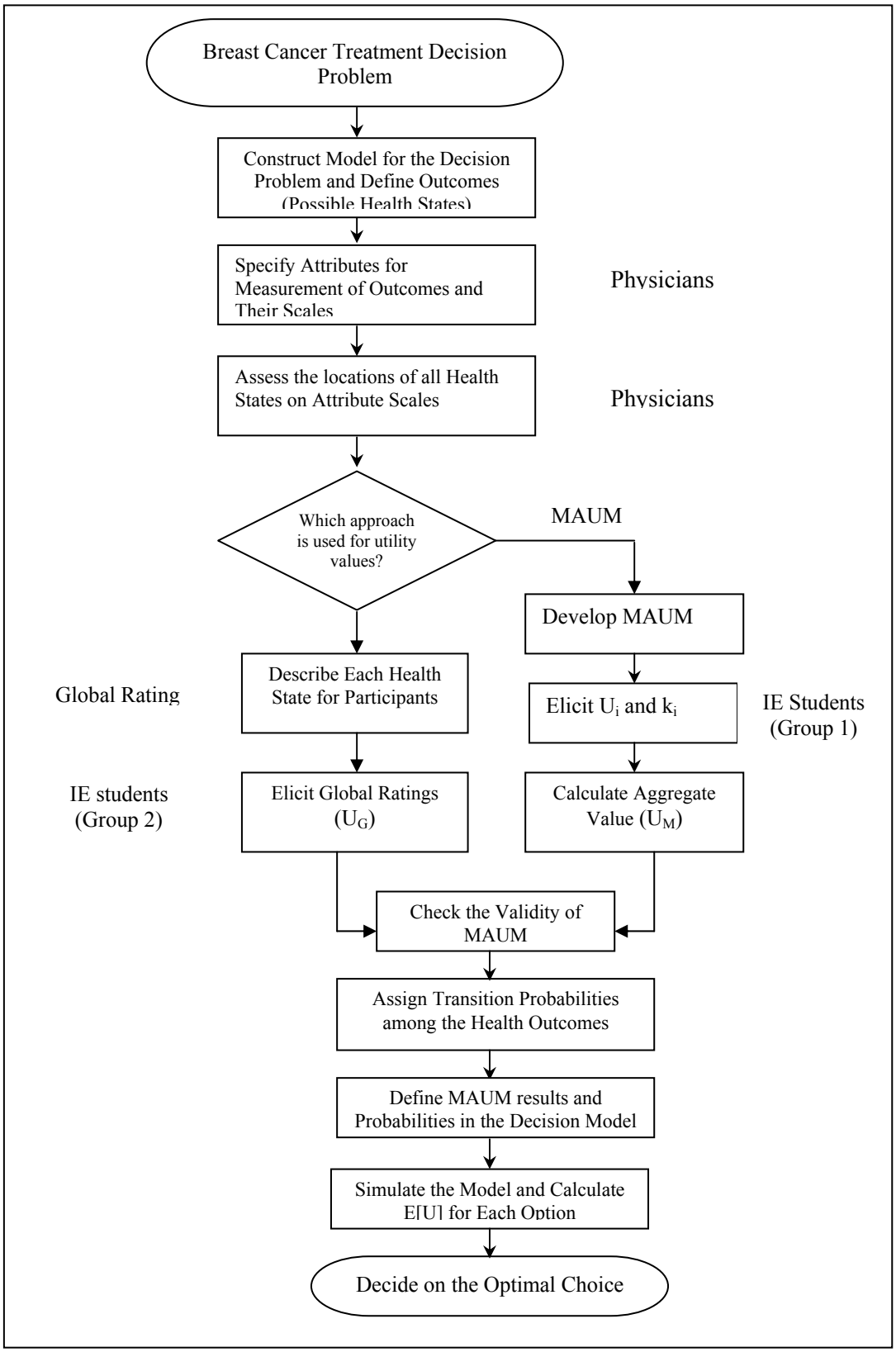



Figure 1.1. Steps of the Study

## 1.3 Outline of the Study

The outline of the thesis is as follows: After an introduction part in Chapter 1, we present a brief review of literature on decision making in health care, utility assessment techniques used in health care, and decision making and utility assessment applications on early breast cancer treatments in Chapter 2.

The model construction for the decision problem in Chapter 3 is the main part of the study. In the first section of this chapter, the rationale for and the construction of a Markov Tree for representing the decision process is presented. Then, we present the development of outcome evaluation process by means of a Multi Attribute Utility model. The chapter ends with presentation of probability assignment on the tree.

In Chapter 4, results of the simulation experiment are analyzed. Important findings from evaluation of the decision process are presented and computational results are discussed. In addition, sensitivity analysis results, performed in order to observe changes on the decision, are presented in this chapter.

Chapter 5 is devoted to the conclusions, summary of findings, and a discussion of limitations of the study. We also try to give directions for related future research studies.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Treatment Decisions in Health Care

In recent years, rising costs, advanced technologies, and increasing patient involvement in treatment decisions have contributed to the challenges faced by physicians in medical decision making. The physician has to recommend a treatment and the patient has to decide whether to go along with the treatment the physician recommends. Thus, decision analysis techniques have become standard techniques in analyzing uncertainties associated with complex medical problems.

The idea of using decision theory in medical practice was first proposed by Ledley and Lusted (1959). However, decision analysis techniques have been used in clinical situations effectively only after the beginning of 1970's. Fryback, studied subjective probability estimates (1974), decision theory (1978), and cost-benefit analysis (1977) in radiology. He pointed out that decision analysis techniques provide useful strategies for making complicated clinical decisions more manageable and rational, and improve clinician's judgments. Also Ransohoff (1976) discussed whether learning decision analysis technique is worthwhile for physicians in order to use in clinical medicine or not, and concluded that despite some problems, component parts of decision analysis is clinically helpful.

Yoshimura et al. (1998) performed decision analysis to compare between two strategies for treatment of early stage prostate cancer.

Birkmeyer (1996) reviewed the medical literature (1966 to 1994) to identify surgical decision analysis studies and to assess trends over time. Results of his study showed that publication rates of surgical decision analysis have increased dramatically over time. Of the 86 total studies, only six were published before 1980. In contrast, 44 studies appeared between 1990 and 1994.

Decision analysis provides a methodology for comparing a set of clinical choices by calculating the expected value of outcomes. Mathematical representation of the decision problem is termed as decision model and there are many decision modeling techniques. Among those techniques especially, decision trees, Markov processes, influence diagrams are found very useful in evaluating clinical problems. In many studies, cost effectiveness analysis and sensitivity analysis are performed using these techniques.

The principles of using decision trees in clinical decision making were constructed and some diseases were examined as an application by Kassirer (1973, 1976) and Pauker (1976). When time horizon of problem is taken into consideration, decision trees may be inadequate for representing the problem, and may not be realistic. Thus, Markov Models are used in medical decision making when a decision problem involves risk that is continuous over time, when important events may happen more than once, and when the timing of events is important. Sonnenberg (1993) developed a practical guide for using Markov Models in Medical Decision Making.

Kassirer (1976) presented the principles of Clinical Decision Making. He pointed out that two basic elements for decision analysis are probabilities of various outcomes and utility values of final outcomes. Probabilities are obtained from literature, previous clinical studies, statistical data, or subjective judgments of

clinicians. Utilities represent the strength of preference for the outcome and have become the standard measure of value in the analysis of health decisions. Von Neumann and Morgenstern (1944) first presented the fundamental axioms of utility theory under uncertainty, now called Expected Utility Theory. The axioms of Von Neumann and Morgenstern provide the foundation of modern decision theory, which has been widely applied in many fields for several decades. As mentioned, utility assignment is one of the basic elements of decision analysis, so various methods for measuring patient's utilities have been developed. In the next section, a detailed literature review on utility assessment in clinical studies is presented.

## 2.2 Utility Assessment in Clinical Studies

A patient's utility value or function can be elicited directly or indirectly. There are three basic approaches for direct evaluation: standard gamble technique (SG), time trade off technique (TTO) and rating scale (RS). SG technique is based on von Neumann and Morgenstern (1944) Utility Theory and it is the classical method for measuring preferences. Torrance (1972) developed the TTO method for use in health care in response to the burdensome nature of the SG. The third one is the scaling method that is the simplest one (Drummond et al., 1987). Torrance (1976) evaluated these three main techniques for different health states with respect to feasibility, validity, reliability, and comparability by using the general public as the subject population. He concluded that the TTO method was superior, since it was simpler and less costly than SG method for use on the general public. However, SG was found to be feasible for utilizing on educated people. Bass (1994) made a comparison of RS and SG in measuring patient preferences for outcomes of gallstone disease. Even though both scaling techniques yielded reliable results, the two methods did not produce equivalent scale values. However, SG values were highly correlated with, but significantly greater than, RS values. Also Bleichrodt (1997) compared the relative performance of quality weights elicited by RS, TTO and SG techniques for eight different health states about rheumatism. The results of

the experiment reported in this paper showed that, the correlation between predicted and direct ranking was significantly higher for TTO values.

However, many researchers pointed out that using any of the above direct techniques for measuring preferences for health outcomes was very time consuming and complex. Thus, pre-scored multi-attribute health status classification systems were developed. Quality of Well Being (QWB) developed by Kaplan (1988), EQ-5D developed by EuroQol group (1990), and Health Utilities Index (HUI) developed by Torrance (1982) (and then extended as HUI2 and HUI3 in 1996), are three main classification systems. All these systems, also called "generic measures", are based on Multi Attribute Utility Theory. In Appendix A, original and Turkish version of EQ-5D can be examined.

These generic measures classify patients according to different attributes with multiple levels per attribute and social preference functions are used in order to evaluate each attribute. The general approach in determining social preference function is to define a set of health states of interest, to identify a group of subjects, to measure each subject's preferences by using preferences measurement techniques such as TTO, SG or RS for the health states, and to aggregate these measures across the subjects to determine overall social preferences function (Torrance et al. 1982). Then, researchers performing a decision analysis can use these ready-made utilities in his/her study.

Primary question in obtaining utilities is 'whose utilities should be used for Decision Analysis: patient, patient family, physician, hospital administration or general public?' Torrance (1978) suggested that general public could be used for utility measurement. Hadorn (1991) mentioned the role of public values in setting health care priorities. Also, Boyd (1990), Dolan (1999) and Cappelli (2001) compared the utility results obtained from different populations for various diseases. All these studies indicated that although health states were valued lower

by general population than they would be valued by patients, the source of preference weights do not affect the base case results of comparison.

In addition, Cost Effectiveness Analysis is a widely used technique for economic evaluation of the clinical alternatives. It helps examine both value consumed (costs) and value produced (health outcome), and by this analysis, cost per unit health can be calculated. Namely, an incremental cost of a treatment is compared to incremental health effects. Unit of health outcome can be varied with respect to the objective such as blood pressure reduction, number of cases found, life years, lives saved, quality-adjusted life years (QALY) etc.

Räsänen et al. (2006) published a literature review to identify studies that used QALYs. A total of 3882 articles (from 1966 to 2004) were identified. Also it is pointed out that most of the identified studies also discussed cost per QALY (cost effectiveness). One of the most complex problems in QALY calculation is the assessment of quality of life. There are different methodological approaches for measurement of quality of life. The basic approach is obtaining quality of life values as scores by using the utility method, mentioned previously.

## 2.3 Decision Making and Utility Assessment Applications on Early Breast Cancer Treatments

Carcinoma of the breast is the most common cancer worldwide in women. The incidence has been steadily rising over the past few decades, and following lung cancer; breast cancer is today the most common cause of cancer death among women in most western countries. (http://www.nationalbreastcancer.org, 2006)

As advances have been made in medical technologies, several main treatment options have been developed to extend survival of breast cancer patients. Nissen (2001) pointed out that women with early stage breast carcinoma generally have the choice of three effective surgical options: lumpectomy (known as breast-

conserving surgery), mastectomy, and mastectomy plus reconstruction. Since all these options extend survival, the quality of life and costs of following the treatment has become topic of focus while deciding on the treatment. Considerable research has investigated quality of life in early stage breast cancer patients and studied cost effectiveness of these options.

Kiebert (1991) published a review on the impact of breast conserving treatment versus mastectomy on quality of life. He pointed out that the first study on the effect of different forms of surgical procedures in early breast cancer on quality of life was performed by Eisenberg and Goldenberg in 1966. After that, no significant report was published for 15 years. Then in 1980's researchers began to perform more studies, first in United States (Reznikoff, 1981; Steinberg, 1985; Taylor, 1985; Ganz, 1987; Wolberg, 1989; etc), and then in Denmark (Beckmann, 1983), the United Kingdom (Ashcroft, 1985; Fallowfield, 1986), and other countries. Also Ganz continued his studies and published several papers on quality of life of breast cancer patients.

Curran (1998) compared quality of life scores of early-stage breast cancer patients treated with radical mastectomy or breast conserving procedures, which were obtained via a questionnaire. Carter (1998) developed a Markov process model specific to early-stage breast cancer patients and determined optimal treatment choice by examining QALYs among various treatment options. Nissen (2001) applied MUIS (Mishel Uncertainty in Illness Scale), POMS (Profile of Mood States) and FACT-B (Functional Assessment of Cancer Therapy for Patients with Breast Cancer) measures to assess quality of life of early stage breast cancer patients who underwent breast conserving surgery, mastectomy alone or mastectomy plus reconstruction treatments. Cappelli (2001) performed a comprehensive study in which women's preferences for breast cancer treatments (lumpectomy plus radiation, double mastectomy plus chemotherapy or no treatment) were characterized by using standard gamble and rating scale techniques, and also, factors associated with quality of life were identified. Polsky

(2002) studied the impact of breast cancer treatment choice on patients' health state preferences. In this study, patient preferences for current health state, assessed with patient valuations using the visual analogue scale (VAS) from the EuroQol instrument and with general public valuations using the Health Utilities Index (HUI).

Cost effectiveness studies have become popular in health decisions in 1990's. In general, cost effectiveness studies were performed for comparison of lumpectomy and mastectomy and their derivatives, to decide whether any adjuvant therapy, which is the treatment given after the primary treatment to increase the chances of a cure, should be used or to compare of adjuvant therapies. Verhoef (1991) performed cost utility analysis (cost / QALY) for women receiving breast conserving surgery or mastectomy. Norum (1997) performed cost utility analysis for comparison of lumpectomy and mastectomy. In this study, costs (direct and indirect) were obtained from published literature and utilities were obtained with the use of EuroQol instrument. Hayman (1998) searched cost effectiveness of radiation therapy following conservative surgery and in his study; utilities were obtained by standard gamble technique. Hillner (1996) studied economic and cost effectiveness issues in breast cancer treatment. Additionally, Hillner and Smith performed series of studies in 1991-1993 on cost effectiveness of adjuvant therapies.

Cost effectiveness studies in breast cancer have increasingly continued in 2000's. Malin (2002), used cost effectiveness analysis to calculate the additional costs and benefits of various adjuvant therapy strategies, radiation after breast conserving surgery and reconstruction compared to those of surgery alone in order to define the most cost-effective breast cancer package for uninsured women. Lee (2002) constructed a Markov model that describes clinical outcomes of breast carcinoma following mastectomy and performed cost-effectiveness evaluation of post mastectomy radiation therapy in high-risk premenopausal breast cancer patients. Also Polsky (2003) studied incremental cost effectiveness analysis of breast

conservation and radiation versus mastectomy by using 5 years primary data. Naeim (2005) evaluated adjuvant treatment for early stage breast cancer with hormone therapy, chemotherapy or combination therapy to find out cost effectiveness in older patients. He concluded that decision-analytic models could help policy makers who are faced with decisions about adjuvant therapy in older breast cancer patients. Additionally, Hershman (2002) conducted a cost effectiveness analysis of tamoxifen for primary prevention in women at high risk for breast cancer. Markov modeling was used to estimate effects of tamoxifen on quality-adjusted survival, and preference ratings were elicited with time trade-off questionnaires.

Evidently, there is an increasing interest in quality of life research on breast cancer. Radice (2003) performed a study to provide a literature-based extensive overview of the quality-of-life and cost issues posed by the management of breast cancer. Mandelblatt (2004) published a descriptive review of the literature on breast cancer outcomes: 1990 through 2000. He summarized all measures and the instruments used in the studies of breast cancer outcomes. He studied 382 articles and summarized the characteristics of the studies, such as phase of care (screening, diagnosis, treatment, adjuvant therapy, survivor, etc.), study design, population, sample size, outcomes measures, and mode of assessment. This paper concluded that the most frequently reported outcomes were health-related quality of life (%54 of articles) followed by economic analysis (%38 of articles). It also points out that there was a wide variety of instruments used in the study sample for measuring preferences; however, given the complexity of breast cancer care and the heterogeneity in patient population, no single instrument is sufficiently comprehensive. Additionally, Mandelblatt (2003) reviewed research published between 1995 and June 2003 on breast cancer quality of life and outcomes among women aged 65 and older treated for breast cancer. He concluded that, few randomized trials or cohort studies that measured quality of life after treatment focused exclusively on older women; however, the processes of care, such as choosing therapy, good patient-physician communication, receiving treatment

concordant with preferences about body image, and low perceptions of bias, were associated with better quality of life and satisfaction.

# CHAPTER 3

# MODELING A BREAST CANCER PATIENT'S DECISION PROBLEM

As mentioned previously, in this study, the patients for whom both of two treatment options can be applicable were taken into consideration, and it was aimed to develop a model representing the decision situation of such a patient so as to help compare the two treatment options in terms of both the quantity and the quality of life promised by them. By using this decision aid, QALY value (quantity and quality aggregated) that result from the two possible treatment options can be calculated, and the decision can be made on the best option for her. Two important steps during this development task were the disease process modeling and the outcome measure modeling.

## 3.1 Decision Modeling of the Breast Cancer Progress

The fundamental purpose of decision modeling in clinical situations is to create a quantitative representation of a set of clinical choices. This quantitative representation allows for incorporating of choices (individual preferences), uncertainty (probabilities) and outcome measures. This section presents decision modeling of the process of disease progress for early breast cancer.

A decision model can be developed for the disease progress by using suitable decision-making techniques such as decision trees, influence diagrams or Markov models in order to identify possible outcomes. In this study, we tried to compare lumpectomy and mastectomy operation; thus, at first, a decision tree was constructed as a decision model for the breast cancer disease progress following surgery as in Figure 3.1.

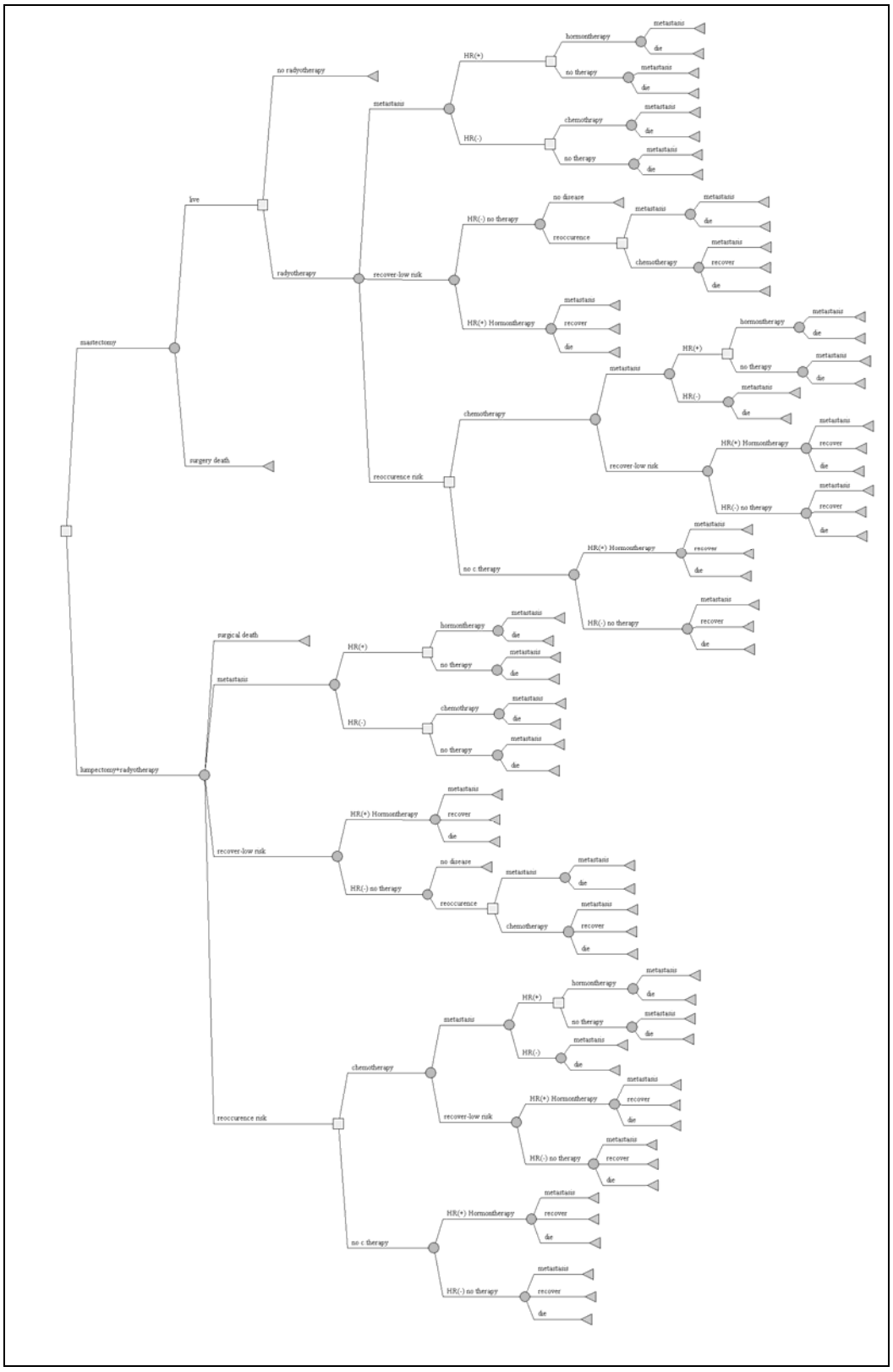



Figure 3.1. Decision Tree Structure of Natural History of Breast Carcinoma

However, this tree did not meet our requirements. Since the paths that the patient follows are under consideration, there are too many health states to study. Also, most of the events recur over time, so there are too many repetitions and cycling occurs. Additionally, probabilities of events are time dependent but decision tree cannot reflect this property. Therefore, fidelity of modeling breast cancer problem as a decision tree is low for our study.

The central choice-making is between lumpectomy and mastectomy operation, for which a Markov tree is shown in Figure 3.2. As seen in the figure, the Markov process incorporates all events/decisions following a surgery and the decision tree analysis was reduced simply for comparing the values of two Markov processes.

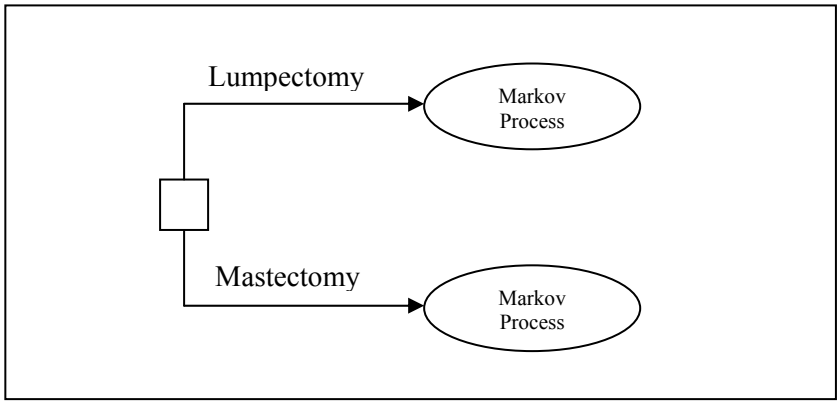



Figure 3.2. A Process Model for the Breast Cancer Treatment Problem

The decision problem on breast cancer treatment following surgery, lumpectomy or mastectomy, was modeled as a Markov Tree (Sonneberg, 1993) because of its basic properties. First of all, clinical history of breast cancer is a stochastic process with the property that its future evolution can be reasonably assumed to be conditionally independent of its past provided that the present is known. Also,

decision problem of breast cancer treatment involves risk that is ongoing and varying over time, and finally, important events may happen more than once and hence cycling may occur.

The unqualified term “surgery” was used, because the history was the same for both treatment options. That means health states used in the model were the same. The differences were the parameter values such as transition probabilities, outcome values, etc. Thus, one Markov chain was constructed at first, and then it was characterized for both treatment options with respect to transition probabilities and rewards.

$Y_t$ was referred to the health condition of the patient with breast cancer following surgery at time t, then

The stochastic process $Y= \{Y_t, t \in N\}$ with a countable and finite state space S, is a Markov Chain provided that

$$P\{Y_{t+1} = j / Y_0, Y_1, ..., Y_t\} = P\{Y_{t+1} = j / Y_t = i\} \qquad \forall\ i, j \in S \qquad t \in N$$

In this process, all events were represented as transitions from one health condition (state) to another. Subjects (patients) were assumed to make transitions at discrete time intervals among the states relevant to the clinical problem. In reality, patients can make transition from one health condition to another at any time, which requires continuity; however, we restrict ourselves to a Markov chain for simplifying problem. Literature review shows that this in fact is a simplification commonly done in similar studies (Lee, 2002). Thus, for computational simplicity the problem was modeled as a Markov chain by assuming that patients make transitions at discrete time interval, at the end of each year.

The next step was defining the state space, S, for this problem. In this study, the term “health state” is used as a markov state to describe the health status of an

individual at a particular point in time. Health states used in the model are conditions of being well (NED), having hormone therapy (NEDI) or chemotherapy (NEDII), having recurrent local disease (Local Recurrence), being salvaged after recurrence of disease (Salvaged), having distant disease (Metastasis) or death. Determination of these health states was challenging since describing clinical history of problem required serious support from medical experts. At first, detailed literature search was performed as a pre-study. Then, medical expert support was obtained from oncologists of Hacettepe University Oncology Hospital (HUOH). A series of meetings were held with oncologists through which a path of patient disease progress was represented. Then, the most basic health states that lie on the path of patient's disease progress were selected, relatively less significant ones were omitted in order to keep complexities manageable. Thus, if S denotes the countable state space, then

S = {NED, NEDI, NEDII, Local Recurrence, Salvaged, Metastasis, Death}

where
NED: No Evidence of Disease
NEDI: No Evidence of Disease but Having Hormone Therapy
NEDII: No Evidence of Disease but Having Chemotherapy

The next step in this analysis was to construct a state transition model to describe clinical history of breast carcinoma following a mastectomy or lumpectomy. At first, a natural evolvement pattern of breast cancer following surgery was developed. The principal analysis of the model focused on early stage breast cancer patients, between 45-55 years old (pre-menopausal), and therefore, operable. We analyze the process starting at the point immediately after patients have undergone curative surgery. At 1-year intervals, subjects may undergo transitions among the health states as mentioned previously. During each period, patients may remain in their current state or make transition to another health state. Obviously, death is an

absorbing state. All other states except death were transient states. The resultant state transition model is depicted in Figure 3.3.

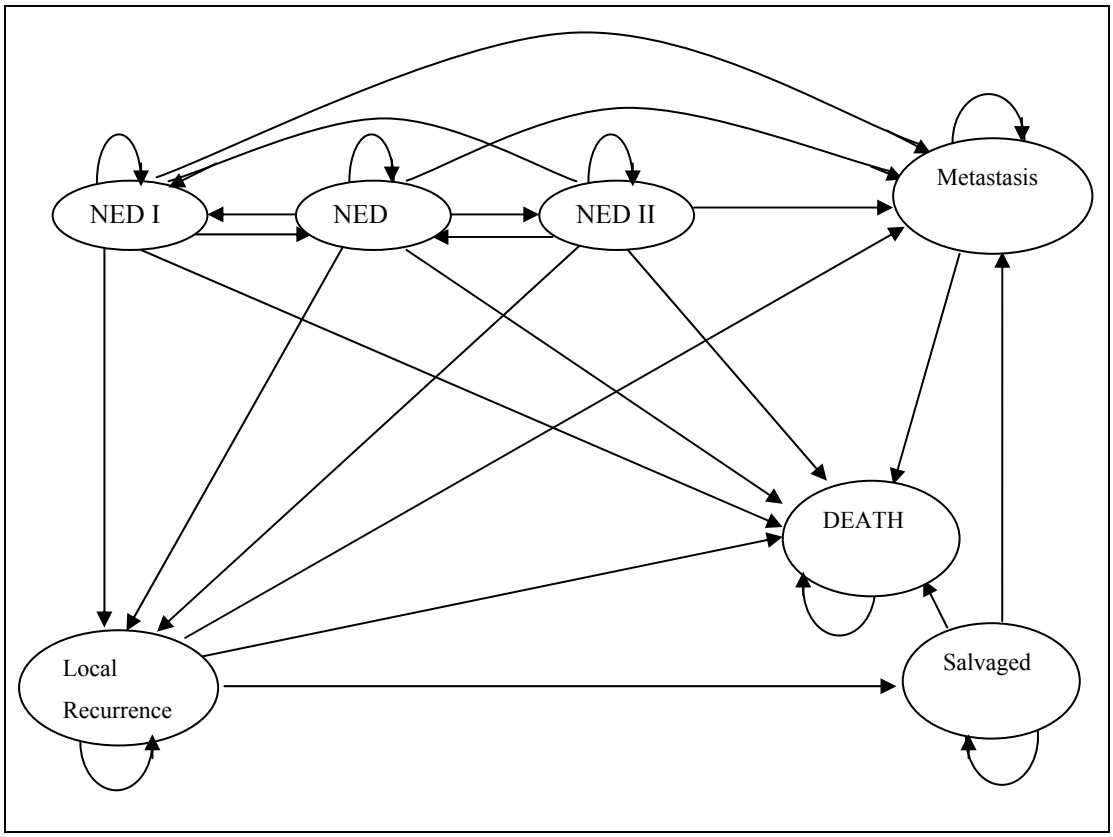



Figure 3.3. State Transition Model of the Natural History of Breast Cancer Following Surgery

This model represents the state transition diagram for the stochastic process where,

$Y = \{Y_t, t \in N\}$ with a countable state space S.

$Y_t$ = Health state of the patient at time t,

$t \in N = \{0,1,2,3\ldots\}$

S = {NED, NEDI, NEDII, Metastasis, Local Recurrence, Death, Salvaged}

The stochastic process $Y = \{Y_t, t \in N\}$ is a Markov Chain provided that

$$P\{Y_{t+1} = j / Y_0, Y_1, ..., Y_t\} = P\{Y_{t+1} = j / Y_t = i\} \qquad \forall\, i, j \in S \qquad t \in N$$

For computational simplicity, in general, it is assumed that the conditional probability expressed above is independent of time, t, such that;

$$P\{Y_{t+1} = j / Y_t = i\} = P_{ij} \qquad \forall\, i, j \in S \qquad t \in N$$

$P_{ij}$: Transition probabilities for the Markov chain X.

A Markov chain Y satisfying the condition of time independence is said to be time-homogeneous Markov chain. However, as in most medical processes, breast cancer problem does not involve constant probabilities, which means that the transition probabilities among the Markov states are not constant over time, and is not a time homogeneous process. Thus, in this study, the breast cancer problem was modeled as non-time homogeneous Markov chain and the conditional probability for this problem can be expressed as,

$$P\{Y_{t+1} = j / Y_t = i\} = P_t\{i,j\} \qquad \forall\, i, j \in S \qquad t \in N$$

$P_t\{i,j\}$ : Transition probabilities for the Markov chain Y at time t.

The assessment of transition probabilities among the health states was presented in detail at the end of this chapter.

As mentioned previously, in this study it was aimed to measure and compare outcomes related with each treatment options. After measuring outcomes, outcome

values can be assigned as a reward for each markov state used in the model and the evaluation of a Markov chain on outcome values yield the expected reward. Suppose that at each time increment t, it is given a reward whose amount depends on that state Y. If Y = j, then the reward is denoted by $R_t$ (j) depends on utility function of that state. Then, two treatment options can be compared with respect to their expected rewards. For this purpose, outcome measures assessed in Section 3.2 was assigned as state rewards.

### 3.1.1 Description of Health States and Analysis of Transition Model

As seen in Figure 3.3, seven basic health states were defined along the path of disease progress of breast cancer patient. The state of "Death" was absorbing state and the all other states were transient states. Descriptions of these health states are as follows:

NED (No Evidence of Disease) State: All patients start in a "NED" state that represents no evidence of disease after mastectomy or lumpectomy, which means that they are free of cancer but remain at risk for reoccurrence. Target health states from the NED state include Metastasis, NEDI, NEDII, Local Recurrence and DEATH.

NEDI (No Evidence of Disease but Having Hormone Therapy) State: If the reoccurrence risk is low after surgery, patients can have hormone therapy as an adjuvant therapy in order to decrease reoccurrence risk although there is no evidence of disease. Hormone therapy is a cancer treatment that removes hormones or blocks their action and stops cancer cells from growing. After the surgery, patients are tested for hormone receptors. If the test is positive (ER+) which means that they have enough receptor to perceive estrogens and progesterone hormones, patients can undergo hormone therapy. In the following time interval, patients may remain in that state, may go into NED state after therapy is finished, may go to Local Recurrence or Metastasis state because of reoccurrence or may die.

NEDII (No Evidence of Disease but Having Chemotherapy) State: If the reoccurrence risk is relatively high after surgery, patients should have chemotherapy as an adjuvant therapy. Chemotherapy is a treatment program of cancer-fighting drugs. There are number of possible side effects of treatment: one can lose her hair but it is temporary, she can have stomach upset or vomiting, she can feel tired and unhappy which can interfere with her social life, her psychology. Following health states from the NEDII state may be Local Recurrence or Metastasis state if disease relapses, NEDI state if hormone receptor test is positive, NED state if hormone receptor test is negative and still no evidence of disease, or Death state.

Metastasis State: If the disease relapses in sites further away in the body such as bones, lung or liver, and there is no probability of being well, then patients go to Metastasis state, which means reoccurrence of disease distantly. The model assumes that, after the disease recurs distantly, no patient can be successfully treated and return to NED state. Patients may remain in Metastasis state or die from cancer.

Local Recurrence State: This state is presence of disease, which may be salvaged after curative treatments. In the following time interval, if there is no evidence of disease after curative treatment, patients go to Salvaged state, patients may remain in that state, may go to Metastasis state if disease gets worse, or death state.

Salvaged State: It means that there is no evidence of disease after curative and adjuvant treatments; thus, there is no need to carry out further therapy. However, they should be observed since there is a risk of reoccurrence. After this state, patients make transitions to Metastasis state or Death state.

Death State: Patients who die (absorbing state), make no further transition. During each period, patients may make transition to Death state. Patients may die from breast cancer or from other causes; however, in this study it was considered as

patients make transition to death state when they die from breast cancer, transition probability of death from other causes were not taken into consideration.

## 3.2 Modeling of the Outcome Evaluation Measure

As mentioned before, we are dealing with comparing two treatment methods of breast cancer disease on the basis of quantity and quality of life for the patient.

Evaluation of the Markov chain representing the disease progress yields the average number cycles spent in each (health) state. However, each state can be associated with a quality factor representing the quality of life in that state relative to perfect health. In this study, this quality of life is measured with patient's utility for each health state. The utility that was associated with spending one cycle in a particular state was referred to as incremental reward. Therefore, by assigning utility for each state, evaluation of Markov chain yields expected utility (QALY), total number of cycles spent in each state; each multiplied by the expected utility for that state.

Researchers in this field utilize utility (Von Neumann-Morgenstern) assessment techniques to obtain patients' utilities in relation to health states probable along the path of their disease progress. The main step for utility assessment is the determination of utility values of each health state. Within this general approach, a number of methods are available for assigning cardinal values to outcomes. Decision Maker (DM) can directly assign overall values to each outcome or on the other hand, divide the evaluation task into set of simple subtasks. Fischer (1977) proposed that, applied decision analysts have shown considerable interest in decomposed multi-attribute utility assessment procedures for theoretical as well as practical reasons. He claimed that decomposed evaluation procedures are much more systematic than holistic evaluations and so, the procedure permits the explicit consideration of a far larger number of outcome attributes than holistic approach. Since they describe the health states by a multi-attribute classification system, all

health state measurement systems mentioned in Chapter 2 (HUI, EQ-5D, QWB, etc) are based on multi-attribute utility theory. Thus, in this study Multi-Attribute Utility Method (Keeney and Raiffa, 1976) was used.

### 3.2.1 Multi-Attribute Utility Theory

Multi-Attribute Utility Modeling is concerned with expressing the utilities of multiple-attribute outcomes as a function of the utilities of each attribute taken singly. In this procedure, the DM must specify the set of attributes then must assign relative values to each possible state (level) of attribute and finally must specify composition rule for aggregating value across attributes to obtain an overall measure of worth. The composition function can be expressed as:

$$U(X_1, X_2, ...X_n) = f\{U_1(X_1), U_2(X_2), ..., U_n(X_n)\} \qquad U, U_i \in [0,100] \forall i$$

where,

$U(X_1, X_2, ..., X_n)$ : the aggregate utility value

$X$ : evaluation object

$X_i$ : measurement of X on the $i^{th}$ attribute

$U_i(X_i)$ : the one-dimensional utility function over the $i^{th}$ attribute

The multi attribute utility theory specifies several possible forms of aggregate utility functions such as additive, multiplicative and multilinear. As a practical matter Keeney and Raiffa (1993) suggest that for $n \geq 4$, the reasonable models to consider are the additive and the multiplicative. Since we had 8 attributes in this study we concentrated on additive and multiplicative functions. Additionally, it was observed from the literature review that such studies have used one of these utility function types.

If mutual utility independence among attributes exits, that means every subset of $\{X_1, X_2,\ldots, X_n\}$ is utility independent of its complement, then, the aggregate utility function is:

$$U(X) = \sum_{i=1}^{n} k_i U_i(X_i) + k \sum_{i=1;\, j>i}^{n} k_i k_j U_i(x_i) U_j(X_j) + k^2 \sum_{i=1;\, j>,;l>j}^{n} k_i k_j k_l U_i(X_i) U_j(X_j) U_l(X_l)$$
$$+ \ldots + k^{n-1} k_1 k_2 \ldots k_n U_1(X_1) U_2(X_2) \ldots U_n(X_n)$$

where,

$k_i$ : the scaling constant of the $i^{th}$ attribute

k : additional the scaling constant

On the other hand, if additive independence exits among attributes, which means that the preferences over lotteries on $X_1, X_2,\ldots, X_n$ depend only on their marginal probability distributions for these attributes, then, the multi-attribute utility function can be expressed as an additive utility function as follows:

$$U(X_1, X_2, \ldots, X_n) = k_1 U_1(X_1) + k_2 U_2(X_2) + \ldots + k_n U_n(X_n)$$

Additive Independence among the attributes is the necessary and sufficient condition for the additive model. Independence among attributes can be improved by defining the dependence away, or by eliminating less important ones, or properly grouping some together. In this study additive utility function was used in order to aggregate utility values. Discussion on justifying additivity is given in Section 3.2.2.8.

#### *3.2.1.1 Determination of Attributes*

Health states are generally defined in terms of several domains or dimensions of health such as pain level, emotional well being, and like that. The very first step in constructing an evaluation model for a health state requires that these domains or

dimensions should be defined into a – preferably mutually independent and collectively exhausting – set of attributes.

On one hand; identifying attributes is probably best done by constructing an "objectives hierarchy" due to Keeney and Raiffa (1993). This method asks the analyst to assess the fundamental objectives of the decision maker in the decision context that is being considered. Then, by asking how this objective can be achieved, lower level objectives are identified. This hierarchy of objectives is worked through the lowest possible level where mostly *metrics* that collectively measure the fundamental objective are attained. This method makes perfect sense and it is usually very effective in the hands of a relatively experienced decision analyst.

On the other hand; the discourse of the thirty-odd years old Medical Decision Making community is beyond defining attributes, utility model building and assessment now. The standard practice is to use secondary data sources (generic preference measures, pre-assessed utility scores, established hospital records systems and nationwide data bases, etc.) which were mentioned before. Although the health state attributes used in these sources are not uniform, they share a common basis, which is accepted widely. Hence, there were two alternative ways in this study: To consider this basis as the starting point or to define attributes by constructing an objectives hierarchy while ignoring this common basis. Although defining attributes for health state evaluation from scratch by constructing an objectives hierarchy would have been very interesting and intellectually satisfying exercise, it might have been stretching the scope of this present study too much. Instead, a set of attributes commonly accepted in the related literature was adopted for the purposes of this study as a starting point. Mathematical properties of this set had to be scrutinized, and then the set accordingly had to be modified, as presented in this section.

In order to determine the attributes, at first, a thorough literature search was conducted for this purpose and all criteria related to health state designation of breast cancer patients were determined. Especially multi-attribute health status classification systems were taken as reference. Currently there are various systems available: Quality of Well Being (QWB) developed by Kaplan (1988), Health Utilities Indexes (HUI1, HUI2, HUI3) developed by Torrance (1982), EuroQol (EQ-5D) developed by EuroQol Group (1990), etc. All these systems are the "generic" measures, which means that they were generalized and can be applied to all kind of patients. These systems classify patients' health states according to different attributes. Attributes defined in some considerable generic measures are represented in Table 3.1. All attributes defined in these measures were studied and suitable attributes for designation of breast cancer were chosen. Also other medical studies conducted on QALY studies on breast cancer were studied and criteria taken into consideration in these studies were examined.

Table 3.1. Attributes Defined for Five Multi Attribute Classification Systems

| **Attributes** | | | | |
|---|---|---|---|---|
| QWB | EQ-5D | HUI1 | HUI2 | HUI3 |
| Mobility<br>Physical Activity<br>Social Activity<br>Symptom-Problem Complex | Mobility<br>Self-Care<br>Usual Activities<br>Pain<br>Anxiety | Physical Function<br>Role Function<br>Social-Emotional Function<br>Health Problem | Sensation<br>Mobility<br>Emotion<br>Cognition<br>Self-Care<br>Pain<br>Fertility | Vision<br>Hearing<br>Speech<br>Ambulation<br>Dexterity<br>Emotion<br>Cognition<br>Pain |

After this pre-study, again medical expert support was obtained from the HUOH oncologist. In the first meeting, the attributes determined by pre-study were consulted, and expert opinion was taken into consideration. Then, the expert was

engaged in a brainstorming session to think of other attributes. During this initial idea generation no judgment was used. The purpose of this meeting was to identify as many attributes as possible to characterize any health state. In the next step of the study, some attributes were omitted since they seemed irrelevant or less important than the others. Also, in these meetings, independence property was taken into account to be able to aggregate the utility function in additive form. In order to get rid of dependencies among attributes and to achieve property of independence among them, some similar and dependent ones were grouped together by considering oncologist's suggestions. Finally, a number of attributes were determined in order to characterize health states. Specified attributes and their definitions are as follows:

Physical Function ($X_1$)

The attribute of Physical Function reflects patient's ability for mobility and physical activities such as arm motion, walking, running, jumping etc.

Role Function Self Care ($X_2$)

The attribute of Role Function reflects patient's role function and daily activities such as capability of eating, dressing, doing housework, bathing, cleaning etc.

Social Function ($X_3$)

The attribute of Social Function reflects social activities of patient. Number of friends, relations with people, family relations, and hobbies are important criteria for determining this degree.

Pain ($X_4$)

The attribute of Pain reflects pain level that patient has.

Psychological Discomfort ($X_5$)

The attribute of Psychological Discomfort reflects patient's emotional status. For example, feeling happiness, sadness or depression, being anxious or angry etc. This

attribute is identified by three sub-attributes, body image, fears and concerns, and sexual function.

Body Image ($X_6$)

The attribute of Body Image reflects patient's satisfaction from her appearance. This attribute determines how disfigurement on her body affects patient such as if she feels ashamed or avoids nakedness or feels less attractive etc. This attribute affects Psychological Function, thus expressed as one of the sub attributes of this attribute.

Fears and Concerns ($X_7$)

The attribute of Fears and Concern reflects patient's fears and concerns about reoccurrence of disease or fear of death because of cancer. This attribute affects Psychological Function, thus expressed as one of the sub attributes of this attribute.

Sexual Functioning ($X_8$)

The attribute of Sexual Function reflects the sexual interest and functioning of patient. Frequency, satisfaction, problems during relation, dysfunction etc. are determining factors to degree. This attribute affects Psychological Function, thus expressed as one of the sub-attributes of this attribute.

Finally, 5 main attributes and 3 sub-attributes were determined in order to characterize one health state. Multi-level attribute tree for determination of any health state can be seen in Figure 3.4.

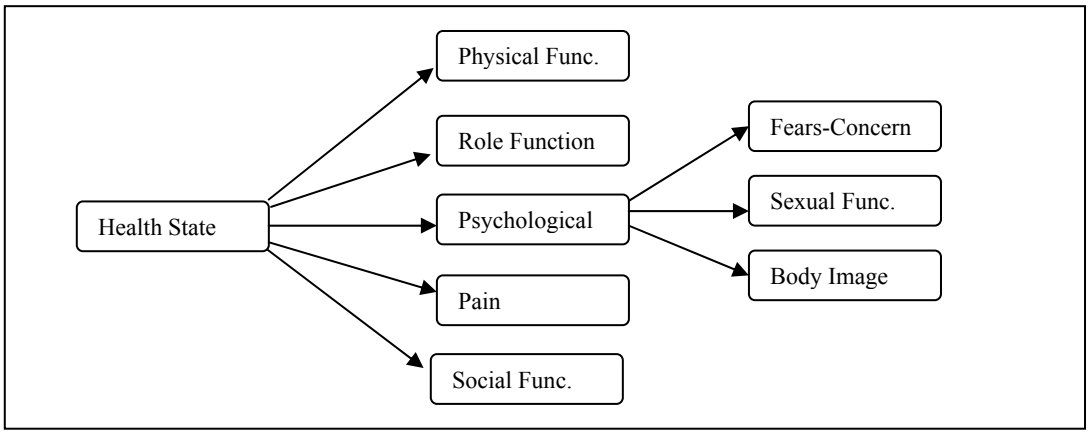



Figure 3.4. Multi Level Attribute Tree for Determination of Any Health State

5-attribute additive utility function is:

$$U(X_1, X_2, ..., X_5) = k_1U_1(X_1) + k_2U_2(X_2) + k_3U_3(X_3) + k_4U_4(X_4) + k_5U_5(X_5)$$

Since the attribute of Psychological Function ($U_5$) was defined by three sub-attribute, body image, fears and concerns, and sexual function, its utility value can be expressed as another additive multi attribute utility function:

$$U_5(X_6, X_7, X_8) = k_6U_6(X_6) + k_7U_7(X_7) + k_8U_8(X_8)$$

Finally, the 8-attribute utility function for aggregate utility value can be written as:

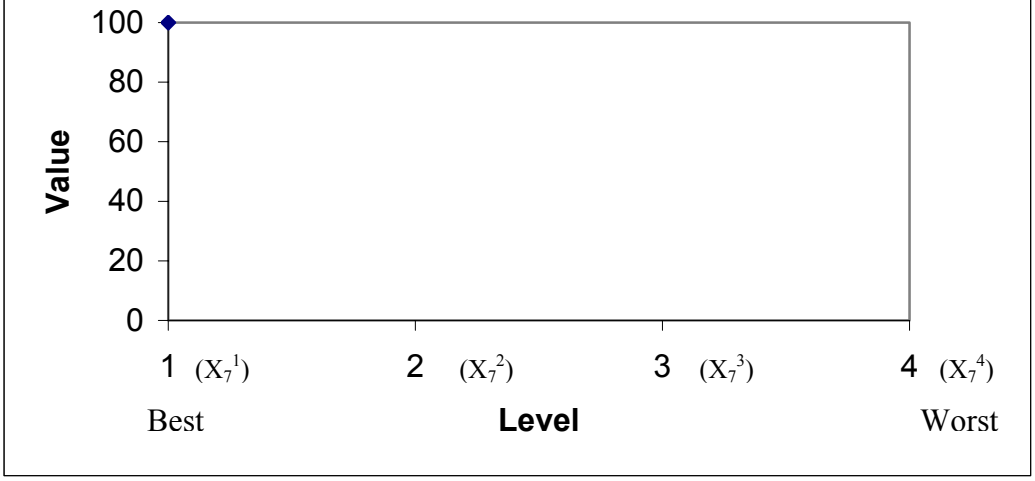
$$U(X_1, X_2, ..., X_8) = k_1U_1(X_1) + k_2U_2(X_2) + k_3U_3(X_3) + k_4U_4(X_4) + k_5\left(k_6U_6(X_6) + k_7U_7(X_7) + k_8U_8(X_8)\right)$$

Each attribute in the health state classification system is subdivided into a number of levels such that each health state can be defined by one level on each attribute. Thus, levels of attributes were made definite by the help of experts and literature search. The details of attributes' levels are in Appendix B.

In summary, classification of any health state was based on the 8-dimensional system. From now on, any health state can be defined as a function of these 8 attributes. After identifying attributes, the next step is assessment of individual utility functions ($U_i(X_i)$) for each attribute and scaling constants.

#### *3.2.1.2 Assessment of Individual Utility Scales*

An important part of the multi attribute model construction is the assessment of the single dimensional utility functions for each attribute. This was performed by a public survey (Appendix C). In this survey, clear and comprehensible definitions of each attribute and levels of these attributes were given. For each attribute a natural scale ("phrase-anchored" scale) was constructed and levels were pointed out on that scale as in Figure 3.5.




where:

**Level 1:** Having no problems about sexual relationship and sexual attractiveness

**Level 2:** Some changes in libido and frequency of sexual relationship negatively.

**Level 3**: Problems in sexual relationship, lack of sexual interest

**Level 4**: Loss of libido and sexual dysfunction

Figure 3.5. A Natural Scale for Sexual Function Attribute

As seen in Figure 3.5, the rating for the maximum level ($U_7(X_7^1)$) was predefined as 100 point for each attribute. The participants (Group 1) were requested to read the statements of each level, rate them according to personal judgments and write on the scale by considering that the best level was rated as 100 point and the death was rated as 0 point. Direct Rating Technique (Clemen, 1996) was used in for evaluation of each level. As mentioned in the previous chapter, standard gamble technique, time trade off technique and rating scale are the three basic approaches for direct evaluation. Rating Scale technique is the simplest one among these techniques, administered in less time, generally found easy to perform. There were total of 35 levels to be rated in the survey, and hence, the properties of direct rating

technique mentioned previously were very persuasive for participants. For this reason, this technique was preferred in this survey.

This way, one-dimensional value scales were obtained for each participant. In fact, since the decision maker is uncertain about the outcome of the given action, this uncertainty should be expressed. Thus the next step was to turn from values to utilities in order to consider uncertainty. However, most practical elicitations of value and utility avoid this step, and value scale is directly taken as utility scale (Edwards et al., 1986); The value scales assessed in this study were also used as utility scale. All value scales for each attribute obtained from 30 participants can be observed in Figure 3.6 through Figure 3.13.

As can be seen in the graphs, most of the participants seemed to have a tendency of risk seeking behavior for the physical function and psychological function attributes. On the other hand, except for three, the participants showed risk neutral behavior for role function attribute. As for attributes of social function and pain, it was seen that there was tendency for risk averse behavior for almost all.

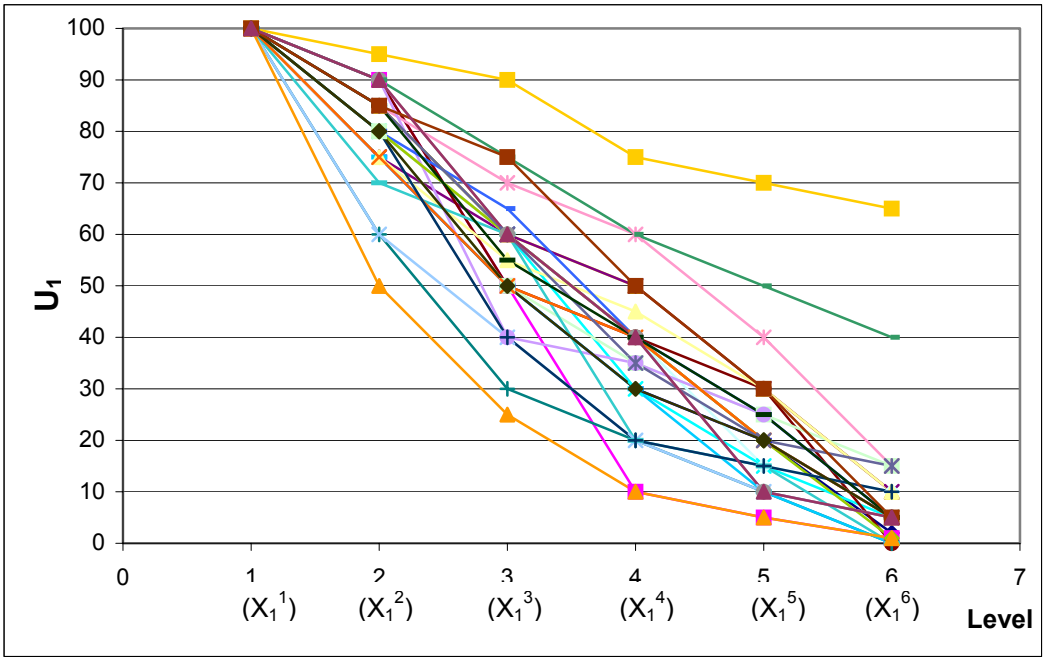



Figure 3.6. Individual Utility Function ($U_1$) (assessed from Group 1) for Attribute Physical Function ($X_1$)

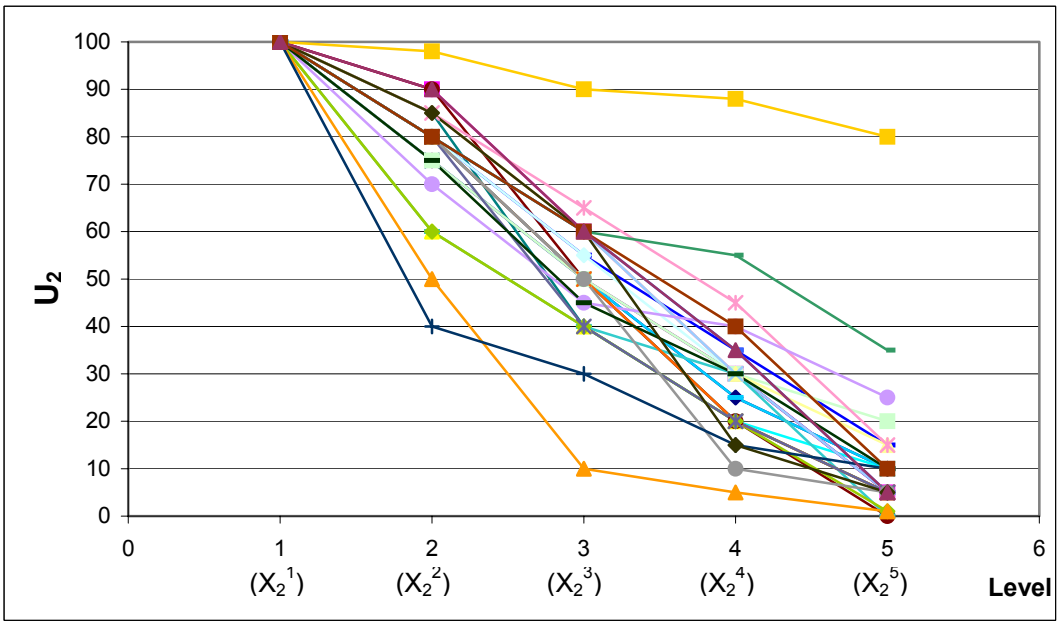



Figure 3.7. Individual Utility Function ($U_2$) (assessed from Group 1) for Attribute Role Function ($X_2$)

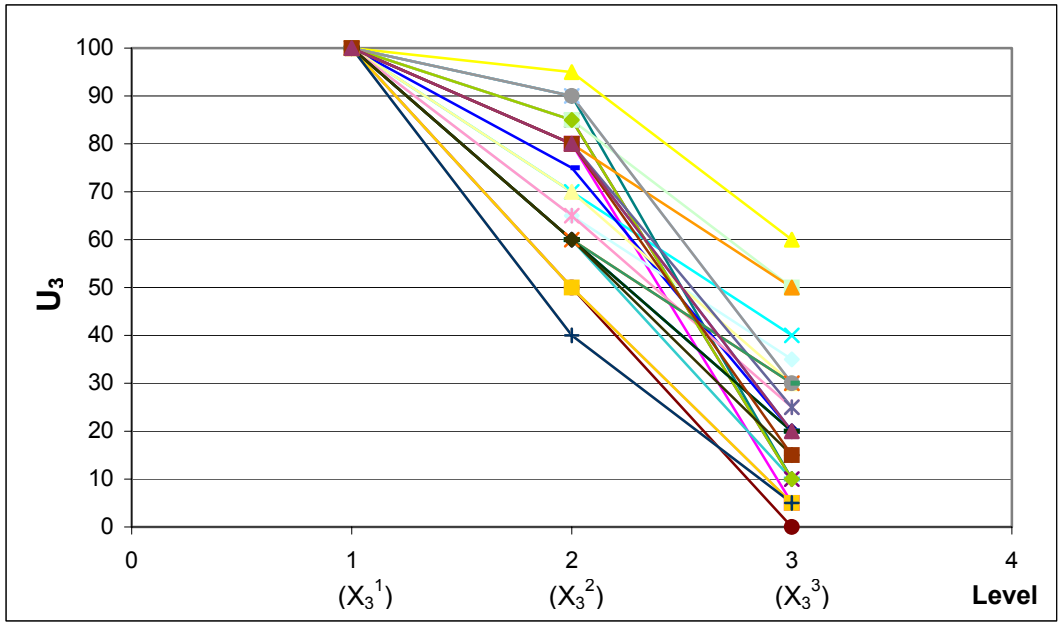



Figure 3.8. Individual Utility Function ($U_3$) (assessed from Group 1) for Attribute Social Function ($X_3$)

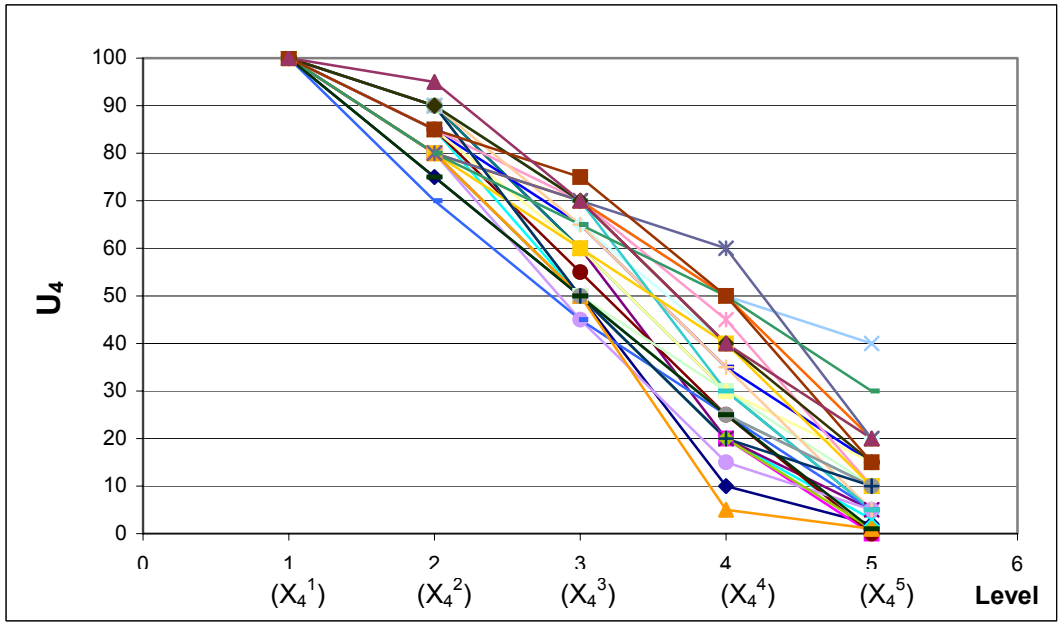



Figure 3.9. Individual Utility Function ($U_4$) (assessed from Group 1) for Attribute Pain ($X_4$)

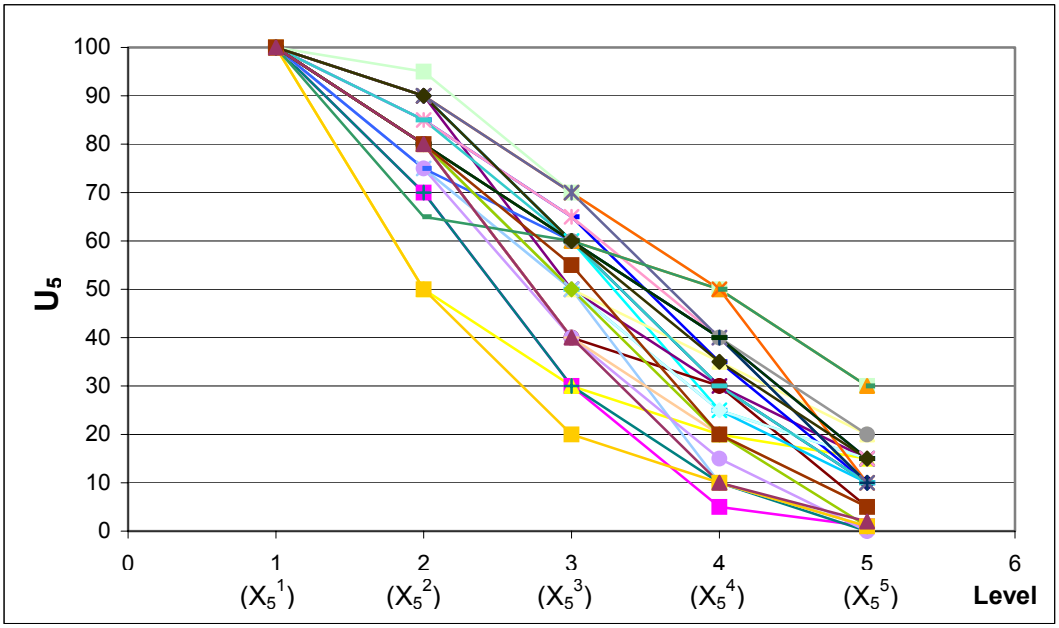



Figure 3.10. Individual Utility Function ($U_5$) (assessed from Group 1) for Attribute Psychological Function ($X_5$)

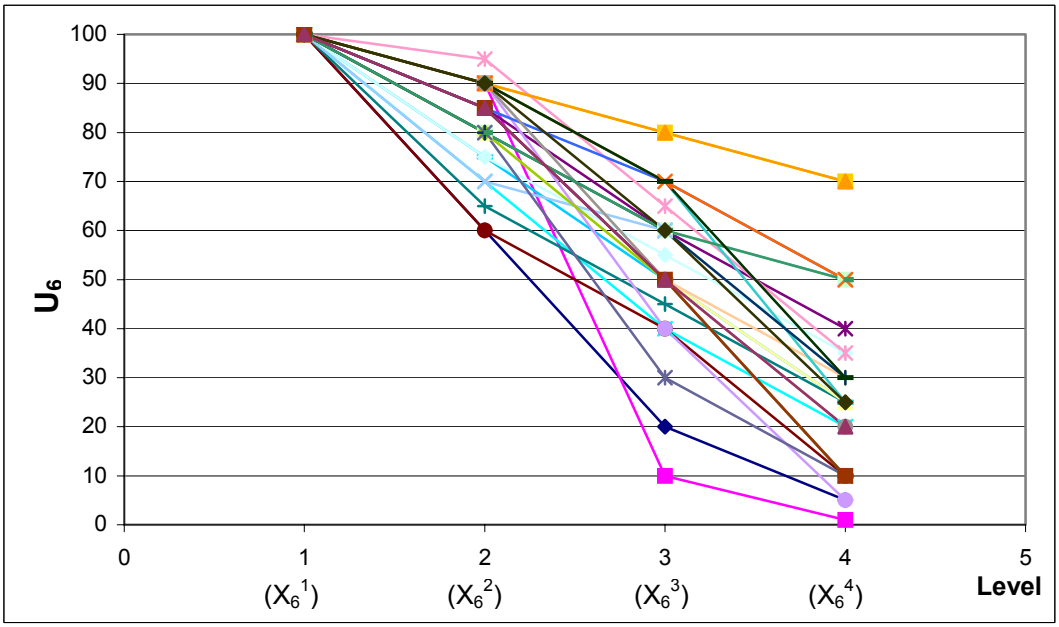



Figure 3.11. Individual Utility Function ($U_6$) (assessed from Group 1) for Attribute Body Image ($X_6$)

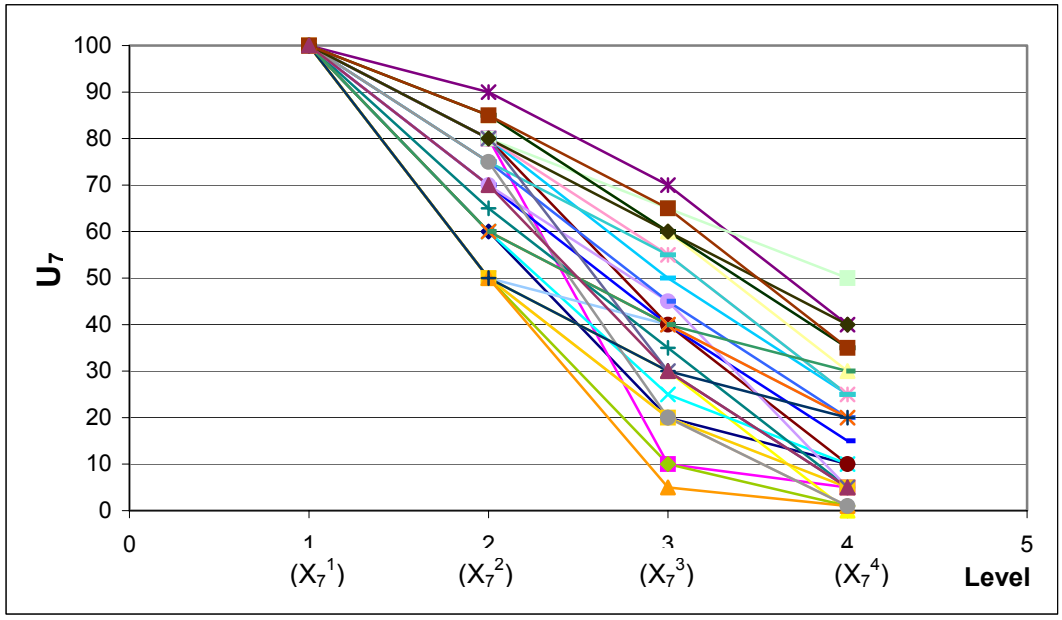



Figure 3.12. Individual Utility Function ($U_7$) (assessed from Group 1) for Attribute Fears & Concerns ($X_7$)

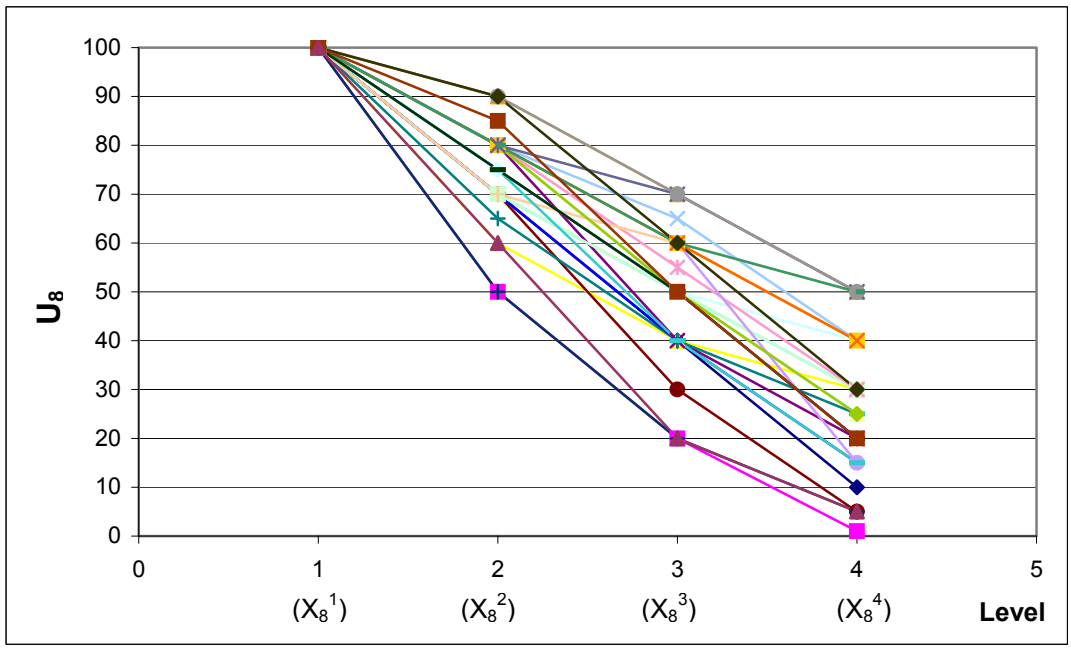



Figure 3.13. Individual Utility Function ($U_8$) (assessed from Group 1) for Attribute Sexual Function ($X_8$)

#### *3.2.1.3 Assessment of Individual Scaling Constants*

Scaling constants ($k_i$'s) indicate the relative importance of all attributes. The weight assigned to a criterion is a scaling factor which relates scores on that criterion to scores on all other criteria. In order to determine these scaling constants, a group of participants (Group 1) who performed the previous study were also asked to rank all attributes with respect to their relative importance by *swing rating* method (Clemen, 1996; Belton, 2002). In this method, DM is asked to consider all bottom-level criteria simultaneously and to assess for which attribute changing its level from worst to best gives the greatest increase in overall value; this criterion will have the highest weight. The process is repeated on the remaining set of criteria until the order of benefit resulting from a changing from worst to best on each criterion has been determined. Then SMARTER (Edwards, 1994), an improved simple method for multi attribute utility measurement, was used in order to determine relative weights of attributes at each level. Relative weights were assessed within the families of criteria, which means that 3 sub-attribute sharing the same parent (Psychological Function) were assessed such that they sum to 1; 5 main attributes at the top of the tree in Figure 3.4, were assessed such that they sum to 1. These relative weights were obtained from Table D.1 (Edwards, 1994) shown in Appendix D. Then the cumulative weight of each criterion, that is the product of its relative weight in comparison with its siblings and the relative weights of its parent, was calculated. These cumulative weights are the scaling constants. In Appendix E all the individual utility values and importance order of attributes for all participants of public survey can be examined.

#### *3.2.1.4 Selection of Participants (Group 1) for Public Survey*

In the ideal case, patients themselves should determine scaling constants and individual utility scales because these are the only people who know what is really like to be in those health states, and therefore, the only ones capable of expressing "true" preferences over different states of health. However, performing this

procedure with patients is generally not considered ethical or practical because patients may be physically overtired or oversensitive and such interviews may affect them negatively. For these reasons, generally physicians don't give permission for interviewing their patients.

On the other hand, many research studies have pointed out that it is possible to incorporate the values of general public into decision-making about health states. In some studies patient utility weights for various health states are generally higher than healthy volunteers' utility weights (Boyd, 1990; Cappelli, 2001). On the other hand, some studies suggest that there is no difference between valuation of patients and general public (Schackman, 2002). Almost all studies, which compare the utility values of various health states obtained by different groups such as patients, general public or physicians etc. indicated that although there are differences between valuations of different groups, these differences do not affect the results of the comparison. Thus, using public preferences are considered acceptable for making health decisions.

In this analysis it was decided to use a sample of healthy women for determination of scaling constants and individual utility scales for reasons mentioned above. For selection of the participants, there were some major criteria and limitations. First of all, the participants had to be well-educated people, and secondly, they should be familiar with techniques used in decision analysis for the ease of application of the assessment procedure. Thinking that it would take care of all these criteria, we decided to ask the $4^{th}$ year, M.S. or new graduate female students from Industrial Engineering of Middle East Technical University to take part in our study. The participation was on voluntary basis. Meetings were held on one-to-one basis if possible or if not, the experiment was performed by e-mail. The instructions and the information about the experiment were given to the participants before each meeting so that they became familiar with the task and the concepts. For this purpose, totally 45 participants took the survey for assessment of individual utility values and scaling constants. Seventeen of them performed the study by one-to-one

meetings and 28 of them by e-mail. However, the results of 15 participants had to be discarded since they performed the survey incorrectly.

#### *3.2.1.5 Assessment of Overall Utility Values of Health States*

As mentioned before, in order to calculate utility value of any health state, Multi-Attribute Utility Model Assessment was used. Functional form is as follows:

$$U_K = k_1 U_1(X_1^{\,j}) + k_2 U_2(X_2^{\,j}) + k_3 U_3(X_3^{\,j}) + k_4 U_4(X_4^{\,j}) + k_5\left(k_6 U_6(X_6^{\,j}) + k_7 U_7(X_7^{\,j}) + k_8 U_8(X_8^{\,j})\right)$$

where,

$U_K$ : the aggregate value for $K^{th}$ health state

$X_i^j$ : measurement of X on $j^{th}$ level of $i^{th}$ attribute

$U_i(X_i^j)$ : the value of individual utility function $U_j$ at $X_i^j$

$k_i$ : the scaling constant of the $i^{th}$ attribute

After eliciting individual utility values and scaling constants, by using these parameters for each attribute, utilities of each participant for each health state can be evaluated easily.

Implementation of the model based on assessing the location of health state along the scales of attributes. In this step, written description was developed for each health state by using location of attributes. For example, description of Health State A is shown in Table 3.2. In order to ensure accuracy of the resulting written description as much as possible, a group of ten oncologists from HUOH performed this experiment. A formal health state level evaluation form was designed for defining each health state with respect to identified attributes by self-completion of oncologists.

Three main parts constituted this form. In the first part, introductory written information was given about health states, and oncologists were rendered familiar to the concept. After that, definitions of attributes and their levels, on which classification of health states were based, were given. Finally, evaluation sheet was given in the last part and for each health state they were asked to mark the suitable level that reflects the condition of that health state for each attribute. Ten oncologists performed this task individually. Evaluation sheets obtained from the oncologists can be seen in Appendix F. The modes of scores were taken and the descriptions of the health states were developed. All health state descriptions can be seen in Appendix G. According to those descriptions, twelve health states, six for mastectomy and six for lumpectomy, were defined by feasible combination of attribute levels and finally, multi attribute utility functions were formed for each health state.

As mentioned in Section 3.1 these utility functions were defined in order to assign a reward for each Markov state and the evaluation of a Markov chain on outcome measures yielded the expected reward. The reward for state j, and at time t was denoted by $R_t(j)$. All utility functions defined for rewards of twelve health states can be seen in Table 3.3.

Table 3.2. An Example Health State Description

| Health State A | |
|---|---|
| Attribute1 | Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND NEEDING mechanical aids walk or get around. |
| Attribute 2 | Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND having NO limitations when playing, going to school, working or in other activities. |
| Attribute 3 | Feeling ashamed of own body, feeling does not like herself. |
| Attribute 4 | Feeling fear of recurrence and bothered by thoughts about the recurrence of cancer. |
| Attribute 5 | Some changes in libido and frequency of sexual relationship negatively. |

Table 3.3. Multi Attribute Utility Functions of Health States

| Reward ($R_t(j)$) | | Multi Attribute Utility Function |
|---|---|---|
| MASTECTOMY | $R_t$(NED) | $U_1=k_1U_1(X_1^1)+k_2U_2(X_2^1)+k_3U_3(X_3^1)+k_4U_4(X_4^3)+k_5(k_6U_6(X_6^3)+k_7U_7(X_7^1)+k_8U_8(X_8^2))$ |
| | $R_t$(NEDI) | $U_2=k_1U_1(X_1^2)+k_2U_2(X_2^1)+k_3U_3(X_3^1)+k_4U_4(X_4^3)+k_5(k_6U_6(X_6^3)+k_7U_7(X_7^1)+k_8U_8(X_8^2))$ |
| | $R_t$(NEDII) | $U_3=k_1U_1(X_1^2)+k_2U_2(X_2^3)+k_3U_3(X_3^2)+k_4U_4(X_4^3)+k_5(k_6U_6(X_6^3)+k_7U_7(X_7^2)+k_8U_8(X_8^3))$ |
| | $R_t$(Loc Rec) | $U_4=k_1U_1(X_1^2)+k_2U_2(X_2^3)+k_3U_3(X_3^2)+k_4U_4(X_4^3)+k_5(k_6U_6(X_6^3)+k_7U_7(X_7^3)+k_8U_8(X_8^3))$ |
| | $R_t$(Salvage) | $U_5=k_1U_1(X_1^3)+k_2U_2(X_2^4)+k_3U_3(X_3^2)+k_4U_4(X_4^4)+k_5(k_6U_6(X_6^3)+k_7U_7(X_7^3)+k_8U_8(X_8^4))$ |
| | $R_t$(Metas) | $U_6=k_1U_1(X_1^4)+k_2U_2(X_2^5)+k_3U_3(X_3^2)+k_4U_4(X_4^5)+k_5(k_6U_6(X_6^3)+k_7U_7(X_7^4)+k_8U_8(X_8^4))$ |
| LUMPECTOMY | $R_t$(NED) | $U_7=k_1U_1(X_1^1)+k_2U_2(X_2^1)+k_3U_3(X_3^1)+k_4U_4(X_4^1)+k_5(k_6U_6(X_6^1)+k_7U_7(X_7^2)+k_8U_8(X_8^1))$ |
| | $R_t$(NEDI) | $U_8=k_1U_1(X_1^1)+k_2U_2(X_2^1)+k_3U_3(X_3^1)+k_4U_4(X_4^2)+k_5(k_6U_6(X_6^1)+k_7U_7(X_7^2)+k_8U_8(X_8^1))$ |
| | $R_t$(NEDII) | $U_9=k_1U_1(X_1^2)+k_2U_2(X_2^3)+k_3U_3(X_3^1)+k_4U_4(X_4^3)+k_5(k_6U_6(X_6^1)+k_7U_7(X_7^2)+k_8U_8(X_8^3))$ |
| | $R_t$(Loc Rec) | $U_{10}=k_1U_1(X_1^2)+k_2U_2(X_2^3)+k_3U_3(X_3^2)+k_4U_4(X_4^3)+k_5(k_6U_6(X_6^2)+k_7U_7(X_7^3)+k_8U_8(X_8^3))$ |
| | $R_t$(Salvage) | $U_{11}=k_1U_1(X_1^3)+k_2U_2(X_2^4)+k_3U_3(X_3^2)+k_4U_4(X_4^4)+k_5(k_6U_6(X_6^2)+k_7U_7(X_7^3)+k_8U_8(X_8^4))$ |
| | $R_t$(Metas) | $U_{12}=k_1U_1(X_1^4)+k_2U_2(X_2^5)+k_3U_3(X_3^2)+k_4U_4(X_4^5)+k_5(k_6U_6(X_6^3)+k_7U_7(X_7^4)+k_8U_8(X_8^4))$ |

After defining rewards for each state by 8-attribute utility functions, aggregate utility values were calculated with respect to data obtained from Group 1 by using Matlab Version 7.2.0.232 computer program. For this purpose, individual utility values and scaling constants for each attribute, given in Appendix E, were defined as input data for each participant. Then, utility functions were solved for each health state, and the overall utility values were found for all participants. Calculated overall utility values can be seen in Table 3.4.

Table 3.4. Utility Results Obtained by Multi-Attribute Utility Model

| Participant | MASTECTOMY | | | | | | LUMPECTOMY | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **U1** | **U2** | **U3** | **U4** | **U5** | **U6** | **U7** | **U8** | **U9** | **U10** | **U11** | **U12** |
| **1** | 88 | 81 | 65 | 64 | 40 | 25 | 99 | 95 | 71 | 66 | 42 | 25 |
| **2** | 75 | 74 | 60 | 58 | 47 | 39 | 99 | 96 | 83 | 71 | 60 | 39 |
| **3** | 95 | 88 | 67 | 65 | 46 | 32 | 95 | 93 | 68 | 65 | 46 | 32 |
| **4** | 75 | 72 | 56 | 54 | 29 | 13 | 98 | 91 | 59 | 55 | 30 | 13 |
| **5** | 94 | 83 | 68 | 66 | 50 | 35 | 99 | 98 | 70 | 67 | 51 | 35 |
| **6** | 83 | 83 | 60 | 48 | 33 | 16 | 94 | 92 | 70 | 49 | 34 | 16 |
| **7** | 81 | 78 | 55 | 47 | 31 | 13 | 90 | 86 | 58 | 48 | 32 | 13 |
| **8** | 90 | 86 | 58 | 57 | 39 | 25 | 99 | 99 | 64 | 60 | 42 | 25 |
| **9** | 86 | 82 | 56 | 54 | 32 | 17 | 99 | 94 | 58 | 55 | 32 | 17 |
| **10** | 93 | 84 | 68 | 66 | 47 | 29 | 97 | 94 | 71 | 67 | 47 | 29 |
| **11** | 90 | 80 | 66 | 66 | 44 | 31 | 100 | 98 | 68 | 67 | 44 | 31 |
| **12** | 89 | 77 | 68 | 67 | 45 | 33 | 99 | 95 | 70 | 67 | 45 | 33 |
| **13** | 93 | 87 | 60 | 57 | 41 | 25 | 86 | 85 | 62 | 58 | 42 | 25 |
| **14** | 84 | 82 | 70 | 70 | 51 | 25 | 100 | 93 | 74 | 72 | 52 | 25 |
| **15** | 95 | 90 | 68 | 66 | 40 | 30 | 97 | 96 | 76 | 68 | 42 | 30 |

Table 3.4. (continued) Utility Results Obtained by Multi-Attribute Utility Model

| Participant | MASTECTOMY | | | | | | LUMPECTOMY | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **U1** | **U2** | **U3** | **U4** | **U5** | **U6** | **U7** | **U8** | **U9** | **U10** | **U11** | **U12** |
| **16** | 85 | 82 | 58 | 50 | 36 | 18 | 86 | 84 | 66 | 52 | 38 | 18 |
| **17** | 93 | 84 | 70 | 67 | 52 | 29 | 98 | 95 | 72 | 68 | 53 | 29 |
| **18** | 94 | 81 | 61 | 61 | 47 | 17 | 100 | 98 | 65 | 61 | 47 | 17 |
| **19** | 93 | 84 | 63 | 59 | 41 | 25 | 95 | 93 | 65 | 60 | 43 | 25 |
| **20** | 90 | 89 | 68 | 59 | 52 | 39 | 86 | 83 | 73 | 60 | 53 | 39 |
| **21** | 92 | 69 | 42 | 39 | 19 | 10 | 97 | 94 | 43 | 39 | 19 | 10 |
| **22** | 98 | 86 | 65 | 64 | 44 | 33 | 98 | 97 | 72 | 64 | 44 | 33 |
| **23** | 95 | 91 | 61 | 56 | 39 | 20 | 98 | 96 | 63 | 57 | 40 | 20 |
| **24** | 91 | 88 | 64 | 60 | 30 | 20 | 99 | 97 | 65 | 61 | 31 | 20 |
| **25** | 93 | 83 | 55 | 54 | 29 | 18 | 98 | 97 | 61 | 55 | 30 | 18 |
| **26** | 89 | 89 | 75 | 73 | 63 | 47 | 98 | 95 | 77 | 74 | 63 | 47 |
| **27** | 75 | 71 | 60 | 59 | 36 | 18 | 100 | 88 | 62 | 60 | 37 | 18 |
| **28** | 96 | 86 | 73 | 70 | 45 | 28 | 97 | 96 | 76 | 71 | 45 | 28 |
| **29** | 80 | 79 | 70 | 68 | 52 | 27 | 99 | 92 | 79 | 74 | 58 | 27 |
| **30** | 77 | 76 | 66 | 63 | 43 | 25 | 98 | 96 | 75 | 69 | 48 | 25 |
| **MEAN** | 88 | 82.03 | 63.07 | 60.07 | 41.20 | 25.13 | 96.6 | 93.37 | 67.67 | 61.83 | 42.77 | 25.13 |

#### *3.2.1.6 Results of Multi-Attribute Utility Model*

A total of 45 participants performed the survey for the assessment of individual utility values and scaling constants; however, a total of 30 participants' responses were used. Distributions of utility values obtained from these participants can be observed in Appendix K.

Utility values assessed for the health state of No Evidence of Disease (NED) vary between 75-100 and the mean value is 88 if the patient has mastectomy operation; 96.6 if she has lumpectomy operation, which means that, in general, they feel healthy if the operation is successful. Utility values of 26 participants were evaluated higher for the health state of No Evidence of Disease for lumpectomy (L-NED). This result indicates that, for almost all, if her health state is well after surgical operation, she attaches more importance to her body appearance than their fears about reoccurrence. Remaining 2 participants' data gave equal results for both operations, and interestingly according to other 2 participants' data, utility of L-NED is lower than No Evidence of Disease for mastectomy (M-NED). The reason for that is, for L-NED the only attribute whose level is lower than M-NED is Fears and Concerns. According to these two participants, the importance weight of the attribute of Fears and Concerns was so high that it compensated the low levels of other attributes in M-NED.

Calculated NED-I (No Evidence of Disease but Having Hormone Therapy as an adjuvant therapy) utility values vary between 69-98 and the mean values are 82.03 and 93.37 with respect to mastectomy and lumpectomy operations. As seen, according to opinion of general population, hormone therapy as an adjuvant therapy, does not affect quality of life significantly. All utility values of L-NEDI are higher than M-NEDI except for two participants. L-NEDI values are lower for the same two people because of the same reason mentioned above.

Utility values in NED-II (No evidence of disease but having chemotherapy as an adjuvant therapy) vary between 42-83 and the mean values are 63.07 and 67.67 for mastectomy and lumpectomy operations, respectively. Although there is no evidence of disease after surgery, which means that patient is free of cancer, utility values decreased dramatically for this state. The reasons for that may be a number of side effects of this treatment, which affect patient's life negatively. As expected, evaluated utility values of all participants for L-NEDII are higher than M-NEDII. As we examine health state descriptions for NED II, it is seen that, Fears and Concerns are at the same level for mastectomy and lumpectomy; on the other hand, levels of Body Image and Social Function are at the upper levels for lumpectomy. So theoretically it is impossible to assign higher utility values for M-NEDII.

Utility values assessed for the health state of Local Recurrence vary between 39-74 and 19-63 for the health state of Salvaged. As seen the utilities are observed relatively low for these health states since this means the disease has come back. Utility values assessed for lumpectomy are higher with respect to both health states, but differences are negligible. The reason for that is clear: the oncologists consider both treatment options equal with respect to attribute level except for body image and importance weights obtained from almost all participants for body image cause only 1-2 point variations between treatments.

Examining the health state descriptions indicates that, all attributes are at the same level for mastectomy and lumpectomy, which means that there is no difference between the two treatments for this state. Thus, all utility values for the health state of Metastasis are equal for both treatment options. In this health state, it is observed that, the utility value decreased down to 10. When the utility of death, which is 0, taken into consideration, it is clearly realized that participants believed that Metastasis is really an adverse state with respect to quality of life.

As a result, utility values obtained using multi attribute utility model shows that at every state of the breast cancer disease, utility values assigned by participants are

higher for lumpectomy operation. However, it should be made clear that after reoccurrence of the disease utility values for both treatment options are equal or very close to each other. That is to say, if cancer comes back, the only thing to consider as important is to survive, so participants do not care much about the surgical treatment option that they are offered. This point is one of the most important results of this study.

In conclusion, analysis in Table 3.5 indicates that there are statistically significant differences between utility values obtained by lumpectomy health states and mastectomy health states, and it is clear that most of the participants believe that lumpectomy provides better quality of life. In particular, if there is no evidence of disease, utility differences between them increase.

Table 3.5. Statistical Analysis of Results Obtained from Multi Attribute Utility Model (MAUM)

| **PAIR** | | **MEAN** | | **MEAN DIFF** | **T VALUE** | **P VALUE** |
|---|---|---|---|---|---|---|
| **Mastec.** | **Lumpec.** | **Mastec.** | **Lumpec.** | | | |
| NED | NED | 88.00 | 96.60 | -8.60 | -5.53 | < 0.001 |
| NEDI | NEDI | 82.03 | 93.37 | -11.33 | -9.12 | < 0.001 |
| NEDII | NEDII | 63.07 | 67.67 | -4.60 | -5.67 | < 0.001 |
| Local Rec. | Local Rec. | 60.07 | 61.83 | -1.77 | -3.79 | 0.001 |
| Salvage | Salvage | 41.20 | 42.77 | -1.57 | -3.32 | 0.002 |
| Metastasis | Metastasis | 25.13 | 25.13 | 0 | - | - |

In summary, in this section health states of interest (total of 12 health states) were defined, then a group of subjects, for performing utility assessment procedure, were identified and each subject's preferences was measured by using preference

measurement technique. The next section is devoted for validity check of overall utility values obtained by Multi-Attribute Utility Model by means of comparing with global (holistic) ratings.

### 3.2.2 Validity Check of Multi Attribute Utility Model

The utility values for each health state were assessed using Multi Attribute Utility Model. Now, we must deal with one difficult question: Do the numerical values obtained from multi attribute utility model provide valid outcomes? In order to answer this question, the validity of these values should be checked. The term "validity" was meant in this study as the consistency check of the results, utility values for each health state, obtained from the Multi Attribute Utility Model. Anastasi (1997) states that fundamentally all procedures for determining test validity are concerned with the relationships between performance on the test and other independently observable facts about the behavior characteristics under consideration.

In order to perform validation process, global (holistic) ratings for each health state were obtained from interview results of a control group (Group 2), and the values yielded by the model and the global ratings were compared. In addition to comparison of two samples (Group 1 & Group 2), in order to assess degrees to which values of health states derived by the multi-attribute utility model were consistent with the values derived by holistic procedure, a random sample was drawn from control group (Group 2), and they were also applied Multi Attribute Utility Model assessment procedures (which was the task of Group 1). So, using the sample that performed both assessment methods, "construct validation" was used to determine whether subjects' holistic preference judgments are consistent with an algebraic utility model (Anastasi, 1997).

#### *3.2.2.1 Selection of Participants for Control Group – Group 2*

In order to implement this experiment, 34 participants (Group 2) were used. At first, it was decided to use different participants for this experiment because participant's concentration could wane when both techniques were used on the same participant. Also they couldn't be objective after the first experiment, so the resulting data couldn't provide an effective validity check. The same criteria as with Group 1 were taken into consideration for selection of participants for Group 2. Similar type of participants was employed for comparison of utility values obtained from the model, versus those obtained from global ratings.

Again, the participation was on voluntary basis. At this time, all meetings were held on one-to-one basis because the method used in validation assessment was more complicated than direct rating method which was used in MAUM in terms of understanding and applying the procedure correctly. The written instructions and the information about experiment were given to the participants before each meeting so that they became familiar with the task and the concepts.

#### *3.2.2.2 Global Rating*

Von Neumann and Morgenstern Standard Gamble technique was employed for global rating because of its widespread use and its well-established reputation as the classical method of measuring preferences (utilities). Torrance (1976) proved that this method gives feasible and reliable results and has been claimed to be gold standard in terms of validity. Bennett (1996) stated that, because it involves uncertainty, a characteristic of practically all medical decisions, it is a true utility assessment method. Additionally, Ross (2003) mentioned that the reliability of the SG was very good and it is the only method consistent with the von Neumann and Morgenstern axioms of decision theory and the only utility measure for which expected value is meaningful.

The Standard Gamble technique was first proposed by von Neumann and Morgenstern. The heart of this measurement process is a paired comparison in which the participant is presented with two alternatives and asked to select the preferred one. One alternative offers the participant a particular outcome with certainty while the other alternative offers a gamble with specified probabilities for two possible outcomes (Torrance, 1976). Illustration for this method can be seen in Figure 3.14.

In this experiment, the participants were asked to think really hard and try to imagine that they are in Health State A, and are offered a choice between two alternatives. One is associated with the certainty that the participant continues to live in Health State A. The other alternative involves a gamble (Figure 3.14) in which there is a probability (p) of attaining perfect health (utility = 1) and a complementary probability (1-p) of immediate death (utility =0). In other words, in this alternative participant should accept a (1-p) risk of death in order to have a p-chance for perfect health. The participant was asked what the value of p, such that she accepts a (1-p) % risk of death in order to obtain perfect health, was. In other words, for which probability of p, the participant is indifferent between two alternatives? The indifference probability gives the utility for Health State A. This procedure was applied to every participant for each health state. Worksheet for utility assessment of health state of NED following mastectomy can be seen in Appendix H.

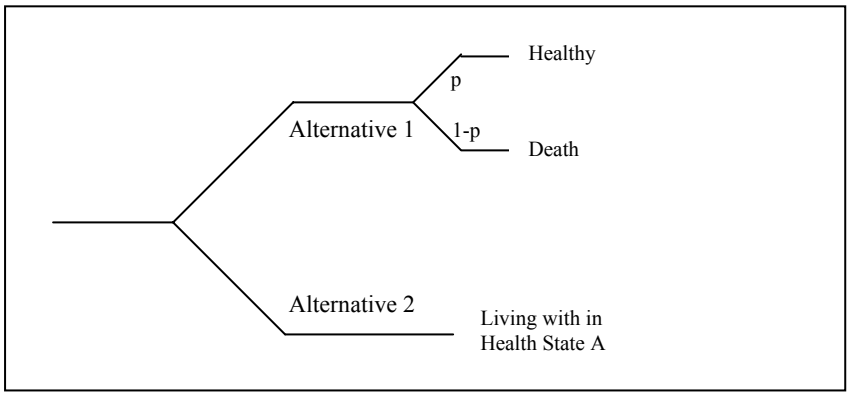



Figure 3.14. Representation of Standard Gamble Method for Obtaining Utilities

By applying this experiment it is aimed to obtain global (holistic) utility values for health states defined previously. In this experiment, this procedure was applied to each participant for twelve health states: six were for after mastectomy operation and six were for after lumpectomy operation. The health state of "Death" was not included in the experiment since its utility was assigned as 0 by default. The results of this experiment are tabulated in Table 3.6.

Table 3.6. Global Utility Results Obtained by Global Rating

| Participant | MASTECTOMY | | | | | | LUMPECTOMY | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **U1** | **U2** | **U3** | **U4** | **U5** | **U6** | **U7** | **U8** | **U9** | **U10** | **U11** | **U12** |
| **1** | 95 | 95 | 87 | 85 | 75 | 70 | 98 | 97 | 85 | 85 | 75 | 70 |
| **2** | 83 | 80 | 77 | 78 | 70 | 66 | 89 | 88 | 84 | 79 | 72 | 69 |
| **3** | 80 | 75 | 70 | 70 | 60 | 50 | 85 | 90 | 75 | 65 | 55 | 45 |
| **4** | 98 | 90 | 80 | 95 | 85 | 80 | 95 | 90 | 80 | 97 | 85 | 80 |
| **5** | 100 | 95 | 97 | 75 | 70 | 60 | 97 | 97 | 85 | 70 | 70 | 50 |
| **6** | 70 | 60 | 70 | 40 | 30 | 30 | 99 | 80 | 80 | 50 | 40 | 50 |
| **7** | 60 | 40 | 50 | 30 | 30 | 20 | 90 | 60 | 50 | 30 | 30 | 20 |
| **8** | 95 | 99 | 95 | 85 | 85 | 30 | 99 | 98 | 99 | 87 | 81 | 30 |
| **9** | 85 | 75 | 70 | 75 | 65 | 58 | 95 | 90 | 73 | 70 | 60 | 50 |
| **10** | 80 | 65 | 55 | 55 | 50 | 40 | 99 | 80 | 60 | 55 | 50 | 40 |
| **11** | 95 | 90 | 80 | 85 | 50 | 10 | 90 | 97 | 80 | 80 | 50 | 10 |
| **12** | 80 | 75 | 70 | 60 | 57 | 30 | 85 | 80 | 72 | 55 | 55 | 20 |
| **13** | 97 | 90 | 75 | 50 | 60 | 30 | 99 | 97 | 68 | 55 | 55 | 35 |
| **14** | 95 | 80 | 70 | 60 | 45 | 20 | 85 | 80 | 70 | 55 | 45 | 20 |
| **15** | 90 | 90 | 85 | 80 | 50 | 20 | 95 | 92 | 85 | 80 | 50 | 15 |

Table 3.6. (continued) Global Utility Results Obtained by Global Rating

| Participant | MASTECTOMY | | | | | | LUMPECTOMY | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | U1 | U2 | U3 | U4 | U5 | U6 | U7 | U8 | U9 | U10 | U11 | U12 |
| **16** | 95 | 98 | 96 | 97 | 90 | 92 | 90 | 89 | 88 | 89 | 87 | 86 |
| **17** | 90 | 95 | 80 | 75 | 60 | 70 | 57 | 55 | 52 | 50 | 45 | 45 |
| **18** | 80 | 99 | 75 | 99 | 50 | 50 | 50 | 50 | 40 | 45 | 10 | 15 |
| **19** | 80 | 95 | 75 | 80 | 65 | 70 | 75 | 80 | 60 | 65 | 60 | 65 |
| **20** | 85 | 80 | 78 | 75 | 70 | 68 | 67 | 66 | 65 | 63 | 62 | 60 |
| **21** | 99 | 99 | 97 | 98 | 96 | 96 | 90 | 92 | 85 | 87 | 80 | 80 |
| **22** | 98 | 99 | 96 | 100 | 90 | 92 | 88 | 85 | 60 | 65 | 50 | 53 |
| **23** | 98 | 99 | 98 | 99 | 95 | 95 | 93 | 93 | 90 | 90 | 88 | 88 |
| **24** | 99 | 100 | 98 | 99 | 95 | 97 | 95 | 96 | 92 | 94 | 86 | 86 |
| **25** | 99 | 99 | 85 | 90 | 80 | 85 | 65 | 65 | 55 | 55 | 30 | 30 |
| **26** | 75 | 95 | 70 | 90 | 50 | 55 | 40 | 35 | 30 | 25 | 15 | 10 |
| **27** | 90 | 97 | 88 | 95 | 80 | 85 | 70 | 75 | 65 | 65 | 45 | 45 |
| **28** | 70 | 98 | 65 | 95 | 40 | 80 | 30 | 40 | 32 | 32 | 5 | 6 |
| **29** | 80 | 75 | 70 | 65 | 60 | 50 | 95 | 90 | 83 | 65 | 65 | 40 |
| **30** | 90 | 85 | 30 | 20 | 10 | 5 | 65 | 60 | 45 | 20 | 15 | 5 |
| **MEAN** | 87.70 | 82.00 | 73.07 | 67.27 | 58.87 | 44.40 | 93.77 | 88.60 | 76.97 | 67.30 | 59.27 | 43.93 |

#### *3.2.2.3 Results of Global Rating*

As mentioned, 34 participants took part in this experiment but results of 4 participants were not taken into consideration during evaluations, since they performed the experiment incorrectly. Thus, totally 30 results were evaluated. Distributions of these results was depicted in Appendix K.

Examining No Evidence of Disease health states, 22 participants assigned higher utility for lumpectomy while 6 participants assigned higher utility for mastectomy. That means, according to the participants' beliefs, after surgical operation, if the health state of patient is well, body image is more important than fears about reoccurrence.

24 participants assigned higher utility and 4 participants assigned lower utility for lumpectomy if they are in health state of No Evidence of Disease but Having Hormone Therapy as an adjuvant therapy. As in NED state, during hormone therapy, participants believed that they are free of cancer and body image is more important than fears and concerns about reoccurrence of cancer. Almost all participants assigned high utilities for that health state, which means that this therapy does not affect the quality of life significantly; however, when compared with NED state, assigned values were quite lower. The reason for that may be feeling little amount of pain during the therapy and being affected physically during the therapy.

During chemotherapy, as a result of side effects, utility scores decreased for all participants. 18 of participants assigned higher utility for lumpectomy. Although there was no evidence of disease, number of participants, who preferred lumpectomy, decreased. The reason for that may be that all attributes are in their lower levels and as a result, the participants are not interested in their body image as much as the previous states. Nevertheless, lumpectomy was still preferred much more than mastectomy at this state.

As expected, in Local Recurrence state, utility scores fell down. An interesting point is that some participants assigned higher utilities for that health state than Chemotherapy although the cancer is back. Probably the reason for this is that as the participants read the probable side effects of chemotherapy, they were affected negatively and they felt worse than they felt about reoccurrence. In this health state, the most important point was that when the cancer came back, popularity of lumpectomy decreased, only 10 of them assigned higher utility to lumpectomy. This means that the participants believed that when the disease is reoccurred the patient who had mastectomy feels more comfortable while the patient who had lumpectomy is affected negatively. The breaking point is reoccurrence of disease.

In the health state of Salvaged, the utility scores were lower than Local Recurrence. At first glance, having higher utility values while the patient is ill can be considered illogical but in fact it is possible because the results of having a second surgical operation can be more adverse than having cancer with respect to quality of life. Also after the first operation, reoccurrence of the cancer may cause lack of confidence, and although she is salvaged after second operation she might not believe that she is well. Since the second operation is more severe, the levels of all attributes are very low. The utility scores for lumpectomy and mastectomy are very close. The reason is simple; the second surgical operation is always mastectomy, which means that although the patient had lumpectomy at first, if the cancer comes back, she should have mastectomy. In other words, during second surgical operation, the patient has an operation for an entire breast removal and from then on there is no superiority for lumpectomy with respect to body image.

During Metastasis stage, the assigned utility scores decreased dramatically since there is no hope to recover. Because of fears about death, and severe conditions of disease, participants believed that treatment option that she has is unimportant in that state, so most of the participants assigned the same utility values for mastectomy and lumpectomy. However, 7 participants assigned higher utility for lumpectomy. The reason may be that the people with less intense fear of death may

feel better about their body image if they have only lumpectomy. On the other hand 8 participants assigned higher utility for mastectomy. They may feel that they didn't have to give up their breast, so they were operated by lumpectomy; but the cancer comes back, so they may regret this decision and assign fewer score for lumpectomy.

An interesting result is that 5 participants assigned all utility scores between 80-100. This attitude can arise from their high level of fears about death, which may stem from risk averse behavior. When they saw probability of death in Alternative 1, they hesitated to take the risk of death, and so they accepted very low risk of death (1-p) in order to have a p-chance for perfect health. Thus, they overestimated the p value, which is the utility of health state under consideration. This result can be considered as a downside of Standard Gamble Technique.

On the other hand, 8 participants assigned utility scores between 0-20 for Metastasis, which indicated that they rejected to live in that condition and accepted a high risk of death for a chance to have perfect health.

Statistical analysis of results can be examined in Table 3.7. As seen, except for two, there are no statistically significant differences between utility values obtained by lumpectomy health states and mastectomy health states, and it is clear that similar to Multi-Attribute Utility Model results, most of the participants believe that, lumpectomy provides better quality of life.

Table 3.7. Statistical Analysis of Results Obtained from Global Rating

| PAIR | | MEAN | | MEAN DIFF | T VALUE | P VALUE |
|---|---|---|---|---|---|---|
| **Mastec.** | **Lumpec.** | **Mastec.** | **Lumpec.** | | | |
| NED | NED | 87.70 | 93.77 | -6.07 | -2.79 | 0.009 |
| NEDI | NEDI | 82.00 | 88.60 | -6.60 | -3.42 | 0.002 |
| NEDII | NEDII | 73.10 | 77.00 | -3.90 | -2.46 | 0.020 |
| Local Rec. | Local Rec. | 67.30 | 67.30 | -0.03 | -0.04 | 0.964 |
| Salvage | Salvage | 58.90 | 59.30 | -0.40 | -0.62 | 0.540 |
| Metastasis | Metastasis | 44.40 | 43.90 | 0.46 | 0.45 | 0.655 |

The comparison of general results obtained from Standard Gamble (SG) method and Multi-Attribute Utility Model (MAUM) indicates that utility scores obtained from MAUM are lower than SG method. When the participant evaluates attributes one by one she may assign lower utilities than she might holistically (SG), but when confronted with risk of death, she cannot take that risk easily, and so the worth of health state seems more valuable than otherwise. Thus, it can be concluded that MAUM results are more realistic as should be hoped and expected.

#### *3.2.2.4 Statistical Analysis of Two Sample Data*

A statistical analysis was conducted for comparing results obtained from MAUM and SG. Table 3.8 shows the descriptive statistics results for both data sets. As seen in the table, for the first two health states after mastectomy and lumpectomy, mean utility values are nearly the same in both measurements; also for the next two health states, mean values are close to each other; but for the last two health states, mean value differences are significantly higher. As the standard deviations in both measurements were compared, it was observed that standard deviations were not so similar. There was a tendency for SG values to show more variation than MAUM values.

Table 3.8. Descriptive Statistics of Utility Values

| Variable | | MAUM (N=28) | | | | GLOBAL RATING (N=30) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | MEAN | SD | MEDIAN | SE MEAN | MEAN | SD | MEDIAN | SE MEAN |
| Mastectomy | U1 | 88.00 | 7.10 | 90.00 | 1.30 | 87.70 | 10.46 | 90.00 | 1.91 |
| | U2 | 82.03 | 5.89 | 83.00 | 1.07 | 82.00 | 13.59 | 82.50 | 2.48 |
| | U3 | 63.07 | 6.68 | 64.00 | 1.22 | 73.07 | 17.46 | 72.50 | 3.19 |
| | U4 | 60.07 | 7.66 | 60.50 | 1.40 | 67.27 | 20.80 | 70.00 | 3.80 |
| | U5 | 41.20 | 9.11 | 41.00 | 1.66 | 58.87 | 20.39 | 60.00 | 3.72 |
| | U6 | 25.13 | 8.54 | 25.00 | 1.56 | 44.40 | 25.84 | 45.00 | 4.72 |
| Lumpectomy | U7 | 96.600 | 4.149 | 98.000 | 0.757 | 93.77 | 7.59 | 96.00 | 1.39 |
| | U8 | 93.367 | 4.351 | 94.500 | 0.794 | 88.60 | 10.93 | 90.00 | 2.00 |
| | U9 | 67.67 | 7.95 | 68.00 | 1.45 | 76.97 | 14.47 | 80.00 | 2.64 |
| | U10 | 61.83 | 8.25 | 61.50 | 1.51 | 67.30 | 20.30 | 68.00 | 3.71 |
| | U11 | 42.77 | 9.84 | 42.50 | 1.80 | 59.27 | 19.95 | 57.50 | 3.64 |
| | U12 | 25.13 | 8.54 | 25.00 | 1.56 | 43.93 | 25.89 | 45.00 | 4.73 |

Before validity check of this model, normality of the data obtained from both experiment was checked. In what follows, histograms of data for each health state, given in Appendix I, were examined and it was seen that their shapes were not exactly bell-shaped. Normal probability plots, sample versus normal scores of samples, were obtained in order to see normality of distributions. This plot should be approximately a straight line if the sample is from a normal population but exhibits curvature if the population is not normal. As seen in Appendix J, most of the data sets are very close to linearity. Thus, it was considered that normality assumption was meaningful and normal curves were assigned as in Appendix K. However, since the normality test yielded doubtful results for three health states, the analysis was repeated using nonparametric tests and results were compared.

The next step was to investigate if there is a statistical difference between two population means by analyzing two independent samples for each health states, sample of which MAUM was performed and the sample of which SG was

performed. It is known that both samples were drawn from the same population; thus, theoretically if the MAUM results are consistent, result of the t-test should demonstrate this fact, which means that the t-test should say that there isn't statistically significant evidence that two populations differ for each health state. According to Sincich (2003), test of hypothesis can be represented as follows:

*Null Hypothesis:* $H_0 : (\mu_1 - \mu_2) = D_0$

*Alternative Hypothesis:* $H_a : (\mu_1 - \mu_2) \neq D_0$

where $D_o$ = Hypothesis difference between the means. Since our null hypothesis is difference between the means is 0, then $D_0 = 0$

*Test statistics:*

$$z = \frac{\left(\overline{x_1} - \overline{x_2}\right) - D_0}{\sigma_{\left(\overline{x_1} - \overline{x_2}\right)}}$$

where,

$$\sigma_{\left(\overline{x_1} - \overline{x_2}\right)} = \sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}$$

*Rejection region:* $|z| > z_{\alpha/2}$

*Assumptions:* The two samples are randomly selected in an independent manner from two populations. The sample sizes $n_1$ and $n_2$ are large enough so that $\overline{x_1}$ and $\overline{x_2}$ both have approximately normal sampling distributions and so that $s_1^2$ and $s_2^2$ provide good approximations to $\sigma_1^2$ and $\sigma_2^2$. This will be true if $n_1 \geq 30$ and $n_2 \geq 30$.

The statistical significance of difference in utility values for each health state between two experiments was assessed with two-sample t-test, using statistical software package MINITAB Release 14.20. Test results are displayed in Table 3.9 and MINITAB printouts are given in Appendix L.1. According the results of six health states, p values are higher than $\alpha$ for %95 and %99 confidence intervals and so there is no statistically significant evidence that two populations are different. Thus for these health states it can be concluded that MAUM results match the SG results. On the other hand, for the rest of six health states, p values are smaller than $\alpha$, and so there is a strong evidence to reject null hypothesis and conclude that two data sets are different. Thus, for these health states it can be concluded that MAUM results do not match the SG.

Table 3.9. MINITAB Results of Pairwise Comparison by Two-Sample t-Test

| **PAIR** | | **MEAN** | | **MEAN DIFFERENCE** | **T-VALUE** | **P-VALUE** |
|---|---|---|---|---|---|---|
| **MAUM** | **GR** | **MAUM** | **GR** | | | |
| U1 | U1 | 88.00 | 87.70 | 0.30 | 0.13 | 0.897 |
| U2 | U2 | 82.03 | 82.00 | 0.03 | 0.01 | 0.990 |
| U3 | U3 | 63.07 | 73.10 | -10.03 | -2.93 | 0.006 |
| U4 | U4 | 60.07 | 67.30 | -7.23 | -1.78 | 0.084 |
| U5 | U5 | 41.20 | 58.90 | -17.70 | -4.33 | < 0.001 |
| U6 | U6 | 25.13 | 44.40 | -19.27 | -3.88 | < 0.001 |
| U7 | U7 | 96.60 | 93.77 | 2.83 | 1.79 | 0.080 |
| U8 | U8 | 93.37 | 88.60 | 4.77 | 2.22 | 0.033 |
| U9 | U9 | 67.67 | 77.00 | -9.33 | -3.09 | 0.003 |
| U10 | U10 | 61.83 | 67.30 | -5.47 | -1.37 | 0.180 |
| U11 | U11 | 42.77 | 59.30 | -16.53 | -4.06 | < 0.001 |
| U12 | U12 | 25.13 | 43.90 | -18.77 | -3.78 | 0.001 |

In order to perform two-sample t-test it was assumed that samples show normal sample distribution property; however, as mentioned there was a doubt about normality so that the analysis was repeated using nonparametric tests and the results were compared. The nonparametric Wilcoxon rank sum test (also called Mann-Whitney for independent sampling) was used to test the hypothesis that probability distributions associated with two populations are equivalent.

The results obtained from two-sample t-test, were unchanged when the analysis was repeated using the nonparametric Wilcoxon rank sum test (Mann-Whitney). Results of this test can be seen in Table 3.10 and MINITAB printouts are given in Appendix L.2.

Table 3.10. MINITAB Results of Pairwise Comparison by Mann-Whitney Test

| **PAIR** | | **MEDIAN** | | **W-VALUE** | **P-VALUE** |
|---|---|---|---|---|---|
| **MAUM** | **GR** | **MAUM** | **GR** | | |
| U1 | U1 | 90 | 90 | 954.0 | 0.5692 |
| U2 | U2 | 83 | 82.5 | 947.0 | 0.6414 |
| U3 | U3 | 64 | 72.5 | 1131.0 | 0.0014 |
| U4 | U4 | 60.5 | 70.0 | 1061.5 | 0.0309 |
| U5 | U5 | 41 | 60 | 1177.5 | 0.0001 |
| U6 | U6 | 25 | 45 | 1118.5 | 0.0027 |
| U7 | U7 | 98 | 96 | 804.5 | 0.1039 |
| U8 | U8 | 94.5 | 90 | 839.5 | 0.2675 |
| U9 | U9 | 68 | 80 | 1127.5 | 0.0017 |
| U10 | U10 | 61.5 | 68 | 1010.5 | 0.1602 |
| U11 | U11 | 42.5 | 57.5 | 1168.5 | 0.0002 |
| U12 | U12 | 25 | 45 | 1108.5 | 0.0043 |

According to these statistical results MAUM results do not entirely match the SG results but it is an expected result! It is interesting that the model results match the global ratings results especially for the no-evidence of disease health states. As the condition of the patient becomes worse, p-values become poorer. The reason for that is if assessing health state condition is similar to participants' current conditions, they can evaluate the condition more realistically. However, as the health state condition that they are assessed for becomes different from their current condition, imagining being in that remote health state and assessing the condition objectively becomes difficult. Namely, extreme states are difficult to estimate overall utility value by global rating. Because of that valuation could be different in global rating since the healthy volunteers performed the study; however as mentioned, differences between valuation obtained from patients and healthy volunteers do not affect ranking. In what follows, it is claimed that MAUM yields more realistic results since it analyzes health states in their attribute levels. This result is the one of the most crucial results obtained in this study.

#### *3.2.2.5 Statistical Analysis of One Sample Data*

In addition to the mean comparison of two samples, as mentioned at the beginning of this section, in order to assess degrees to which values of health states derived by the multi-attribute utility model were consistent with the values derived by standard gamble, a random sample was drawn from control group (Group 2) and they were also applied Multi Attribute Utility Model assessment procedures (which was applied to Group 1). So, one sub-sample performed both of the assessment methods and the results of one sample were also analyzed with paired difference experiments, in which observations are paired and the differences are analyzed. The idea is to compare population means by comparing the differences between pairs of experimental units (subjects) that were very similar prior to the experiment. Sincich (2003), points out that in many cases a paired difference experiment can provide more information about the difference between the population means than an independent samples experiment. Test results are displayed in Table 3.11 and

MINITAB printouts are given in Appendix L.3. The paired difference experiment showed that for all health states, p values are higher than $\alpha$ for %95 and %99 confidence intervals and so, there is no statistically significant evidence that two populations are different. Thus, for these health states it can be concluded that MAUM results are consistent with the results of SG.

Again, random sample from Group 2 was also considered as nonparametric and Wilcoxon rank sum test was used in order to test for a difference when the data is considered nonparametric. The results of this test are tabulated in Table 3.12 and MINITAB printouts are given in Appendix L.4. The results obtained from paired difference experiment were unchanged when the analysis was repeated using the nonparametric Wilcoxon rank sum test like the previous study. Namely, for all health states, T values are higher than $T_0$ values for %95 and %99 confidence intervals and p values are higher than $\alpha$ for %95 and %99 confidence intervals. Thus, for these health states it can be concluded that MAUM results are consistent with the results of SG method.

Table 3.11. MINITAB Results of Paired Difference Experiment

| PAIR | | MEAN | | MEAN DIFF. | T-VALUE | P-VALUE |
|---|---|---|---|---|---|---|
| **MAUM** | **GR** | **MAUM** | **GR** | | | |
| U1 | U1 | 90.18 | 88.91 | 1.27 | 0.34 | 0.739 |
| U2 | U2 | 87.00 | 83.73 | 3.73 | 0.92 | 0.377 |
| U3 | U3 | 69.64 | 72.46 | -2.82 | -0.5 | 0.625 |
| U4 | U4 | 67.55 | 69.55 | -2.00 | -0.29 | 0.781 |
| U5 | U5 | 53.00 | 60.82 | -7.82 | -1.12 | 0.291 |
| U6 | U6 | 32.27 | 46.91 | -14.64 | -1.41 | 0.189 |
| U7 | U7 | 98.09 | 92.91 | 5.18 | 3.14 | 0.011 |
| U8 | U8 | 94.91 | 89.36 | 5.55 | 1.88 | 0.089 |
| U9 | U9 | 74.73 | 78.36 | -3.63 | -0.71 | 0.493 |
| U10 | U10 | 68.64 | 69.73 | -1.09 | -0.15 | 0.881 |
| U11 | U11 | 54.09 | 60.36 | -6.27 | -0.84 | 0.420 |
| U12 | U12 | 33.18 | 46.55 | -13.36 | -1.24 | 0.244 |

Table 3.12. MINITAB Results of Wilcoxon Rank Sum Test

| PAIR | | T-VALUE | W-VALUE | P-VALUE |
|---|---|---|---|---|
| **MAUM** | **GR** | | | |
| U1 | U1 | 25 | 25 | 0.813 |
| U2 | U2 | 22 | 44 | 0.351 |
| U3 | U3 | 27 | 27 | 0.625 |
| U4 | U4 | 29.5 | 29.5 | 0.790 |
| U5 | U5 | 22 | 22 | 0.351 |
| U6 | U6 | 20 | 20 | 0.266 |
| U7 | U7 | 7 | 59 | 0.023 |
| U8 | U8 | 16.5 | 49.5 | 0.155 |
| U9 | U9 | 16.5 | 16.5 | 0.515 |
| U10 | U10 | 30 | 30 | 0.824 |
| U11 | U11 | 25 | 25 | 0.505 |
| U12 | U12 | 19.5 | 19.5 | 0.248 |

### *3.2.2.6 Simple Validation*

The common validity check for this type of decomposition model is so-called "convergent validity" (Fischer, 1977; Krabbe et al., 1997) and its measure is the correlation between the results of the methods, based on the mean values of the health states. When alternatives are characterized by a small number of attributes, information overload should not be serious problem, so it is reasonable to expect high degree of consistency between the two types of judgments.

Correlation coefficients for convergent validity were all computed based on the mean values for 12 health states and represented in Figure 3.15. This correlation analysis demonstrated that the mean utility values yielded by Multi-Attribute Model were highly correlated with the mean utility values yielded by global rating by Standard Gamble.

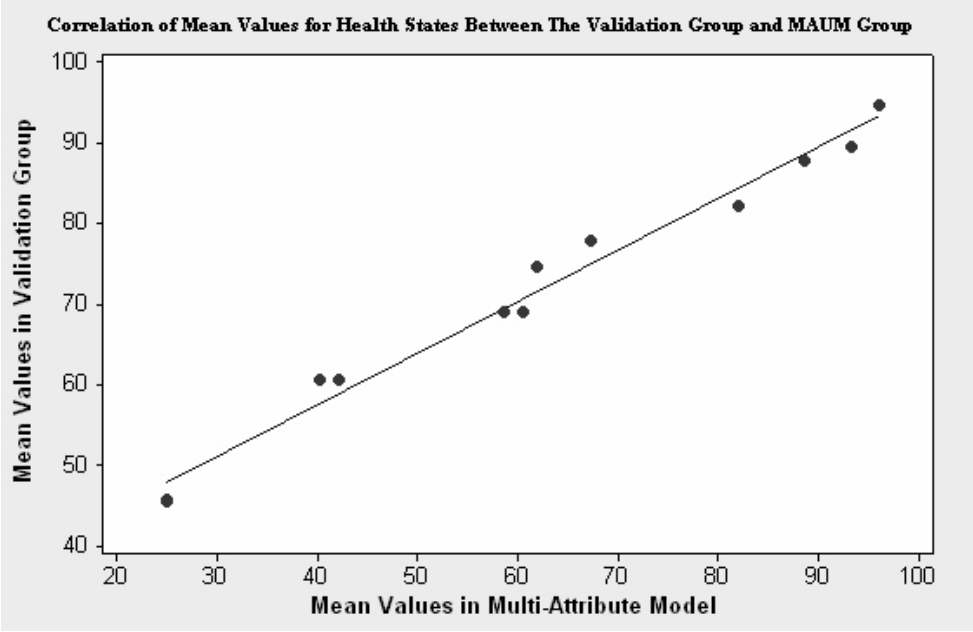



Figure 3.15. Correlation Coefficients Based on the Mean Values for 12 Health States

#### *3.2.2.7 Construct Validation*

A joint committee of the American Psychological Association, the American Education Research Association, and the National Council on Measurement in Education, in their Standards for Educational and Psychological Tests defined three basic types of validity: criterion, content, and construct (Kaplan, Bush and Berry, 1976). The criterion validity is comparison of method to be tested (predictor), with the reference method (criterion). In criterion validity the coefficient of validity is determined as the correlation coefficient between predictor and criterion; however, Kaplan, Bush and Berry (1976) argue that criterion validity is not possible for a broad health status measure because no well-accepted criterion exists that accurately measures the phenomena of interest. In this respect, the construct validity was studied for the two valuation methods.

A framework within which to conduct construct validation was proposed by Campbell and colleagues, who pointed out that in order to demonstrate construct validity it should be shown not only that a test correlates highly with other variables it would be theoretically expected to, but also that it does not correlate highly with variables with which it would be expected to differ (Campbell and Fiske, 1959; Anastasi, 1997). Campbell and Fiske (1959) proposed a systematic method for exploring this, the Multitrait-Multimethod (MTMM) Matrix method, which entails the assessment of two or more constructs by two or more methods.

They identified four classes of correlation coefficients. First one is, monotrait-monomethod reliability correlations, in which health states are measured twice for each method separately: test-retest. Second one is, convergent validity (monotrait-heteromethod) correlations, which is between measures of same health state using different methods. Third one is heterotrait-monomethod correlation, in which different health states are assessed by the same method. The last one is, heterotrait-heteromethod correlations, in which different health states are assessed by different

methods. The third one or the last one is called as discriminant validity coefficients. A synthetic MTMM matrix is represented in Appendix M.

For satisfactory construct validity, in the first place, convergent validity coefficients should be different from zero and sufficiently large to encourage further examination of validity. Second, convergent validity coefficients should be higher than discriminant validity coefficients lying in the same column and the row in the triangles.

The MTMM matrix for this study can be seen in Figure 3.16. As seen, convergent validation correlations different from zero are moderately high for all health states across the methods Multi-Attribute Utility Model and Standard Gamble (global rating) (average= 0.518). Anastasi (1997) points out that, such correlations should be moderately high but not too high, for otherwise the new test represents needless duplication (unless it is e.g. briefer, or easier to administer). In addition, because these correlation coefficients are based on the analysis of individual values for 12 health states of the two methods, such correlations are therefore always lower than correlation coefficients based on aggregated mean data (e.g. Figure 3.15). We can conclude that, these moderately high correlation coefficients can be acceptable for validity.

Secondly, convergent validity coefficients were compared with the discriminant validity coefficients. As seen in Figure 3.14, not all of the validity values meet this requirement. Some of the validity values are lower than the correlations obtained between that variable and any other variable having neither state nor method in common. However, Campbell and Fiske (1959) claimed that this requirement might seem so minimal and so obvious as to not need stating; yet an inspection of the literature shows that it is frequently not met.

In conclusion, after a series of statistical analysis and validation studies it can be concluded that Multi Attribute Utility Model results are reasonably valid. Hence, the model is ready for implementation.

| | | MAUM | | | | | | | | | | | | GLOBAL RATING | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| MAUM | 1 | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2 | -0.276 | | | | | | | | | | | | | | | | | | | | | | | |
| | 3 | 0.790 | -0.427 | | | | | | | | | | | | | | | | | | | | | | |
| | 4 | 0.308 | 0.609 | 0.080 | | | | | | | | | | | | | | | | | | | | | |
| | 5 | 0.348 | 0.165 | 0.609 | 0.115 | | | | | | | | | | | | | | | | | | | | |
| | 6 | -0.038 | 0.299 | 0.270 | 0.243 | 0.750 | | | | | | | | | | | | | | | | | | | |
| | 7 | 0.312 | 0.295 | 0.498 | 0.168 | 0.983 | 0.750 | | | | | | | | | | | | | | | | | | |
| | 8 | 0.062 | 0.374 | 0.316 | 0.224 | 0.905 | 0.925 | 0.920 | | | | | | | | | | | | | | | | | |
| | 9 | 0.328 | 0.038 | 0.624 | 0.089 | 0.906 | 0.813 | 0.865 | 0.878 | | | | | | | | | | | | | | | | |
| | 10 | 0.137 | 0.062 | 0.474 | 0.106 | 0.790 | 0.888 | 0.745 | 0.873 | 0.956 | | | | | | | | | | | | | | | |
| | 11 | 0.160 | 0.167 | 0.306 | 0.180 | 0.751 | 0.836 | 0.762 | 0.857 | 0.848 | 0.861 | | | | | | | | | | | | | | |
| | 12 | 0.191 | 0.170 | 0.384 | 0.248 | 0.762 | 0.842 | 0.753 | 0.852 | 0.879 | 0.895 | 0.982 | | | | | | | | | | | | | |
| GLOBAL RATING | 1 | 0.629 | -0.064 | 0.512 | 0.278 | 0.279 | 0.023 | 0.237 | 0.149 | 0.316 | 0.241 | 0.129 | 0.165 | | | | | | | | | | | | |
| | 2 | 0.163 | 0.696 | -0.128 | 0.363 | 0.320 | 0.121 | 0.444 | 0.350 | 0.153 | 0.055 | 0.126 | 0.073 | 0.427 | | | | | | | | | | | |
| | 3 | 0.414 | -0.041 | 0.472 | 0.142 | 0.393 | 0.224 | 0.334 | 0.310 | 0.427 | 0.391 | 0.178 | 0.211 | 0.862 | 0.384 | | | | | | | | | | |
| | 4 | 0.150 | 0.642 | -0.033 | 0.434 | 0.227 | -0.031 | 0.295 | 0.191 | 0.054 | -0.045 | -0.140 | -0.121 | 0.443 | 0.842 | 0.511 | | | | | | | | | |
| | 5 | 0.619 | -0.291 | 0.737 | -0.041 | 0.536 | 0.257 | 0.455 | 0.345 | 0.636 | 0.537 | 0.321 | 0.358 | 0.766 | 0.210 | 0.868 | 0.281 | | | | | | | | |
| | 6 | 0.487 | -0.217 | 0.653 | -0.095 | 0.549 | 0.396 | 0.485 | 0.433 | 0.723 | 0.665 | 0.456 | 0.493 | 0.600 | 0.180 | 0.728 | 0.169 | 0.932 | | | | | | | |
| | 7 | 0.365 | -0.310 | 0.637 | -0.113 | 0.512 | 0.304 | 0.402 | 0.365 | 0.639 | 0.593 | 0.304 | 0.378 | 0.468 | -0.029 | 0.714 | 0.201 | 0.859 | 0.839 | | | | | | |
| | 8 | 0.280 | -0.276 | 0.534 | -0.126 | 0.469 | 0.347 | 0.369 | 0.386 | 0.639 | 0.631 | 0.330 | 0.386 | 0.457 | -0.003 | 0.730 | 0.201 | 0.844 | 0.837 | 0.977 | | | | | |
| | 9 | 0.374 | -0.305 | 0.585 | -0.175 | 0.610 | 0.369 | 0.541 | 0.477 | 0.682 | 0.605 | 0.414 | 0.406 | 0.464 | 0.117 | 0.699 | 0.196 | 0.847 | 0.770 | 0.835 | 0.859 | | | | |
| | 10 | 0.324 | -0.270 | 0.516 | -0.171 | 0.589 | 0.425 | 0.530 | 0.499 | 0.694 | 0.641 | 0.466 | 0.456 | 0.350 | 0.090 | 0.630 | 0.154 | 0.804 | 0.783 | 0.856 | 0.890 | 0.972 | | | |
| | 11 | 0.245 | -0.337 | 0.458 | -0.257 | 0.578 | 0.416 | 0.520 | 0.503 | 0.673 | 0.627 | 0.504 | 0.471 | 0.276 | 0.016 | 0.535 | 0.044 | 0.705 | 0.671 | 0.757 | 0.803 | 0.955 | 0.957 | | |
| | 12 | 0.251 | -0.326 | 0.439 | -0.236 | 0.561 | 0.386 | 0.503 | 0.486 | 0.638 | 0.593 | 0.468 | 0.432 | 0.318 | 0.048 | 0.576 | 0.087 | 0.709 | 0.644 | 0.751 | 0.802 | 0.961 | 0.956 | 0.994 | |

Figure 3.16. MTMM (Multi-Trait Multi-Method) Matrix for Construct Validation

### 3.2.3 Additivity Discussion

As mentioned previously, the reasonable multi attribute utility functions can be additive and multiplicative if the number of attributes $n \geq 4$. In order to be able to apply these functions, necessary independence conditions should be established and verified as the first step of the study. As mentioned previously, mutual utility independence conditions are needed for using multiplicative utility function; on the other hand, additive utility independence conditions are needed for using additive utility function. Additive utility function is the specific case of the multiplicative form, and more preferable because of its relative simplicity to elicit. On the other hand verifying additive independence is a more challenging task. As Torrance (1982) mentioned the establishment and verification of the independence conditions is normally a tedious, exacting and time-consuming task.

Edwards (1986), ignored measurement theory and nonadditivities, and instead relied on simple additive models. He claimed that best thing is defining away dependencies, and suggested that fist step is to define such attributes that they are independent anyway. This way the model is always simple to deal with. As discussed in Section 3.2.1.1, the set of attributes to be used in this study was adopted from multi-status classification systems were established in the medical decision making literature. All these multi-status classification systems are based on multi attribute utility theory and use multiplicative or additive utility functions as multi-attribute utility model, as attributes in these systems are shown to be mutually independent. Additive independence has been proven for only some, not all. Hence, we need to check for additive independence condition in the specific set of attributes adopted into this study. In order to decrease dependencies among attributes, some similar and dependent attributes were grouped together and the model was re-structured as discussed in Section 3.2.1.1; but additive independence should be checked on the resultant set.

In medical decision making literature, the ideal way to check additive independency is to check whether the sum of global ratings assigned to the "corner outcomes" is 1 or not. Corner outcome is increasing any attribute's level to its best level while holding all other attributes constant at their worst level. In this study since 8 attributes were defined, there are 8 corner points, which are:

1st corner point: $(X_1^*, X_2^0, X_3^0, X_4^0, X_5^0, X_6^0, X_7^0, X_8^0)$
2nd corner point: $(X_1^0, X_2^*, X_3^0, X_4^0, X_5^0, X_6^0, X_7^0, X_8^0)$
3rd corner point: $(X_1^0, X_2^0, X_3^*, X_4^0, X_5^0, X_6^0, X_7^0, X_8^0)$
4th corner point: $(X_1^0, X_2^0, X_3^0, X_4^*, X_5^0, X_6^0, X_7^0, X_8^0)$
5th corner point: $(X_1^0, X_2^0, X_3^0, X_4^0, X_5^*, X_6^0, X_7^0, X_8^0)$
6th corner point: $(X_1^0, X_2^0, X_3^0, X_4^0, X_5^0, X_6^*, X_7^0, X_8^0)$
7th corner point: $(X_1^0, X_2^0, X_3^0, X_4^0, X_5^0, X_6^0, X_7^*, X_8^0)$
8th corner point: $(X_1^0, X_2^0, X_3^0, X_4^0, X_5^0, X_6^0, X_7^0, X_8^*)$

where,
$X_i^*$ : the best level of $i^{th}$ attribute.
$X_i^0$ : the worst level of $i^{th}$ attribute.

Application of this ideal method was impossible for this study because, the worst levels of attributes were defined as "death", which means that assigning a utility value for the best level of any attribute while considering all other attributes are in their "death" levels is meaningless.

On the other hand, a common way to check independence is, as Torrance (1982) suggested, to assume the existence of additive independence property and then to test this assumption later with the data obtained. In what follows, it is assumed that multi-attribute utility function is additive and 5-attribute additive utility function was used and overall utility values were obtained. Later, the multi-attribute utility model results was tried to be validated by global ratings. In the end of validation process, although it was concluded that the multi-attribute utility model results

were reasonably valid, there were some statistically significant differences for some states during statistical analyses. It was considered that, these differences could be arising from failure in additivity assumption. Thus, the existence of additive independence property was tested by using individual utility values and global ratings obtained from the random sample drawn from the control group (Group2)

As mentioned before, the family of functions that are typically used for aggregate (multi attribute) utility functions has the following general form:

$$U(X) = \sum_{i=1}^{n} k_i U_i(X_i) + k \sum_{i=1; j>i}^{n} k_i k_j U_i(x_i) U_j(X_j)$$

$$+ k^2 \sum_{i=1; j>,; l>j}^{n} k_i k_j k_l U_i(X_i) U_j(X_j) U_l(X_l) + \ldots + k^{n-1} k_1 k_2 \ldots k_n U_1(X_1) U_2(X_2) \ldots U_n(X_n)$$

As Keeney and Raiffa (1993) present, if $\sum_{i=1}^{n} k_i = 1$, then k = 0 and then this utility function written above reduces to an additive utility function,

$$U(X) = \sum_{i=1}^{n} k_i U_i(X_i)$$

The k values can be obtained from the equation above by using overall utility values obtained from global ratings and individual utility values and scaling constants. If the k values are near zero, we can conclude that using additive utility function is reasonable.

In what follows, the utility function expressed above was re-formulated by considering 5 attributes,

$$U(X) = \sum_{i=1}^{5} k_i U_i(X_i) + k \sum_{i=1; j>i}^{5} k_i k_j U_i(X_i) U_j(X_j)$$
$$+ k^2 \sum_{i=1; j>,; l>j}^{5} k_i k_j k_l U_i(X_i) U_j(X_j) U_l(X_l)$$
$$+ \ldots + k^4 k_1 k_2 k_3 k_4 k_5 U_1(X_1) u_2(X_2) U_3(X_3) U_4(X_4) U_5(X_5)$$

re-arrange as follows:

$$U(X) = \beta_0 + \beta_1 k + \beta_2 k^2 + \beta_3 k^3 + \beta_4 k^4$$

where,

$$\beta_0 = \sum_{i=1}^{5} k_i U_i(X_i)$$
$$\beta_1 = \sum_{i=1; j>i}^{5} k_i k_j U_i(X_i) U_j(X_j)$$
$$\beta_2 = \sum_{i=1; j>i; l>j}^{5} k_i k_j k_l U_i(X_i) U_j(X_j) U_l(X_l)$$
$$\beta_3 = \sum_{i=1; j>i; l>j; m>l}^{5} k_i k_j k_l k_m U_i(X_i) U_j(X_j) U_l(X_l) U_m(X_m)$$
$$\beta_4 = k_1 k_2 k_3 k_4 k_5 U_1(X_1) U_2(X_2) U_3(X_3) U_4(X_4) U_5(X_5)$$

The equation expressed above is quadratic. The roots of this equation give k values. In this equation, U (X) is the overall utility value obtained from global rating for any health state and β values are the constants calculated using individual utility values and scaling constants. Hence, the only unknown here is k.

This quadratic equation was written for each health state of each participant who performed the both utility assessment procedures. There are 12 health states and 15 participants' data; thus 12x15 quadratic equations were written and solved for their roots. This process was performed with using Matlab Version 7.2.0.232. All calculated k values are given in Appendix N. As examined the k values, almost all values (except 8 data among 180 data), are nearly zero. Hence we can conclude that

multi attribute utility function defined for mutually additive independent attributes nearly gave the same results with our additive utility function. Thus, it is reasonable to use additive one.

## 3.3 Probability Assignment

One of the challenges in decision analysis is to ascertain the values of the probabilities in the model. There are a number of methods of probability assignment. Empirical clinical studies and statistical data obtained from literature are the most manageable sources for probability assignment. In this study, relying on past records of Hacettepe University Oncology Hospital (HUOH) would have been the most desireable way to pursue. Unfortunately, this was not possible because the hospital records needed to estimate probabilities are not yet kept adequately. Moreover, some records are confidential documents since they include patients' personal information, and revealing them may be considered as unethical.

On the other hand, as Kassirer (1976) points out, when the literature provides unsatisfactory answers, the situation requires the "judgment of an experienced clinician," applying his "common sense" as he has done in the past. This means that it is possible to carry out decision analysis, deriving the probability values from subjective estimates. In what follows, in this study subjective probability assignment method was used in order to get transition probabilities among the health states in Markov chain.

There are a number of approaches for subjective probability assessment in conventional decision analysis approaches that are based on comparing bets or lotteries. We consulted a group of experts for assessing the transition probability values that we needed for our model to be complete. Probability estimates were based on their common evaluation. The experts used for this study are oncologists at Hacettepe University Oncology Hospital (HUOH).

As mentioned previously, transition probabilities among the health states are not constant over time. Thus, we need probability assessment for each cycle. Since a Markov chain through 10-year survival was used to model disease progression, for probability data at most 10 cycles was needed for both treatment options. There are 25 transitions in our base case, so total of 25*2*10=500 probability data was needed. Therefore, some steps had to be taken to bring this tremendous task down to manageable magnitudes. Below are assumptions and simplifications made to this end.

*Assumptions and Simplifications*

- The first and the most important assumption is that, transition probabilities among the health states are the same for mastectomy and lumpectomy. This is a safe assumption since the expert asserted that option of surgery does not affect these probabilities significantly. There definitely are some differences; such as probability of local recurrence being higher for lumpectomy, or probability of salvage after local recurrence being higher for lumpectomy. However, these differences were not taken into account at the first stage and analysis was performed by considering the same transition probabilities. Afterwards, sensitivity analysis was performed in order to observe the effect of differences in transition probabilities (see Chapter 4).

- The simulation begins in NED state after surgery. The first year, patient makes transition into every state except for Salvaged state. Transitions to NEDI or NEDII state can take place only in the first year. The reason for this is that it was assumed that these therapies are carried out if there is a risk of recurrence after surgery and if she does not accept these adjuvant therapies at the beginning of the first year, there is no reason to carry out these treatments in following years.

- Hormone therapy was assumed to last for approximately 5 years and thus a patient remains in that state at most 5 times. After that, transition probability to remain in that state and consequently in other states are 0 for following years.

- In addition, it was assumed that a patient does not have to complete treatment in order to go to another state, so during treatment of hormone therapy, a patient can make transition to any state.

- Chemotherapy was assumed to last for approximately 1 year and all assumptions made for hormone therapy are valid for chemotherapy.

- Death state was considered as death from breast cancer, so probability of death from other causes was not taken into consideration.

- For the states of Local Recurrence and Salvaged, transition probabilities were considered as constant except for the first cycle. In these states, the transition probabilities do not change unless patient makes transition to other states.

By considering the assumptions and the simplifications mentioned above, transition probabilities among health states were determined by expert opinion. All probabilities among health states were tabulated in Table 3.13. In this table cycles do not represent time of the process; instead, it represents number of times. For instance, if the patient goes into state NEDII in the forth stage of the process (t = 4) at first time, then, from Table 3.13 1$^{st}$ cycle probabilities should be considered for the transition probabilities from NEDII to the other possible states.

The transition probabilities into other states at time t is $P_t(i,j)$, where

$$P_t(i,j) = P\{Y_{t+1} = j / Y_t = i\} \qquad \forall \text{ i, j} \in S$$

$$P_t(i,j) \geq 0$$

$$\sum_{j \in S} P_t(i,j) = 1 \qquad \forall \text{ i} \in S; \forall \text{ t} \in N$$

Table 3.13. Transition Probabilities among the Health States

| | İ | NED | | | | | | NEDI | | | | | NEDII | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CYCLE | J | NED | NEDI | NEDII | LOC. R. | META. | DEAD | NEDI | NED | LOC. R. | META. | DEAD | NEDII | NED |
| | 1 | 0.05 | 0.2 | 0.75 | 0 | 0 | 0 | 0.87 | 0.05 | 0.03 | 0.04 | 0.01 | 0 | 0.42 |
| | 2 | 0.9625 | 0 | 0 | 0.0135 | 0.024 | 0.0035 | 0.81 | 0.05 | 0.05 | 0.08 | 0.01 | 0 | 0 |
| | 3 | 0.952 | 0 | 0 | 0.017 | 0.0275 | 0.0035 | 0.81 | 0.05 | 0.05 | 0.08 | 0.01 | 0 | 0 |
| | 4 | 0.952 | 0 | 0 | 0.017 | 0.0275 | 0.0035 | 0.82 | 0.05 | 0.06 | 0.06 | 0.01 | 0 | 0 |
| | 5 | 0.959 | 0 | 0 | 0.0135 | 0.024 | 0.0035 | 0 | 0.89 | 0.05 | 0.05 | 0.01 | 0 | 0 |
| | 6 | 0.969 | 0 | 0 | 0.0135 | 0.0175 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 7 | 0.976 | 0 | 0 | 0.01 | 0.014 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 8 | 0.976 | 0 | 0 | 0.0035 | 0.0205 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 9 | 0.9795 | 0 | 0 | 0.0035 | 0.017 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 1 | 0.9865 | 0 | 0 | 0 | 0.0135 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | İ | NEDII | | | | LOCAL RECURRENCE | | | | SALVAGED | | | METASTASIS | |
| | j | NEDI | META. | LOC. R. | DEAD | LOC R. | SALVA | META | DEAD | SALVA | META. | DEAD | META | DEAD |
| CYCLE | 1 | 0.41 | 0.10 | 0.05 | 0.02 | 0.15 | 0.1 | 0.7 | 0.05 | 0.20 | 0.80 | 0 | 0.90 | 0.10 |
| | 2 | 0 | 0 | 0 | 0 | 0.05 | 0 | 0.85 | 0.1 | 0.90 | 0.09 | 0.01 | 0.8 | 0.2 |
| | 3 | 0 | 0 | 0 | 0 | 0.05 | 0 | 0.85 | 0.1 | 0.90 | 0.09 | 0.01 | 0.8 | 0.2 |
| | 4 | 0 | 0 | 0 | 0 | 0.05 | 0 | 0.85 | 0.1 | 0.90 | 0.09 | 0.01 | 0.7 | 0.3 |
| | 5 | 0 | 0 | 0 | 0 | 0.05 | 0 | 0.85 | 0.1 | 0.90 | 0.09 | 0.01 | 0.7 | 0.3 |
| | 6 | 0 | 0 | 0 | 0 | 0.05 | 0 | 0.85 | 0.1 | 0.90 | 0.09 | 0.01 | 0.7 | 0.3 |
| | 7 | 0 | 0 | 0 | 0 | 0.05 | 0 | 0.85 | 0.1 | 0.90 | 0.09 | 0.01 | 0.7 | 0.3 |
| | 8 | 0 | 0 | 0 | 0 | 0.05 | 0 | 0.85 | 0.1 | 0.90 | 0.09 | 0.01 | 0.6 | 0.4 |
| | 9 | 0 | 0 | 0 | 0 | 0.05 | 0 | 0.85 | 0.1 | 0.90 | 0.09 | 0.01 | 0.5 | 0.5 |
| | 0 | 0 | 0 | 0 | 0 | 0.05 | 0 | 0.85 | 0.1 | 0.90 | 0.09 | 0.01 | 0.5 | 0.5 |

# CHAPTER 4

# ANALYSIS OF EXPERIMENTAL RESULTS

In this section, experimental results and the effects of factors on the results were analyzed. In previous sections, the Markov chain was constructed for the problem, reward and probability assessment were performed, and so, the development of this model was completed. The next step was evaluation of the model according to the data that was collected from participants, and therefore evaluation of the alternative treatments with respect to the quality adjusted life years to be gained with each.

## 4.1 Evaluation of Decision Model

As mentioned previously, evaluation of the Markov chain developed for the disease progress yields QALY, which is total number of cycles spent in each state, each multiplied by the reward for that state, since the reward was assigned to the each health state.

$$\text{QALY} = \sum_{j=1}^{7} t_j \times R_j$$

where

$t_j$ : time spent in state j.

$R_j$ : reward (utility) for state j.

Since the transition probabilities among the health states are time-dependent, it is impossible to evaluate the process with exact method. Additionally, the utility values in relation to health states should be defined as distributions with respect to data obtained from the participants. Since there was uncertainty involved in reward values, it was considered to use simulation method in order to calculate the expected utility value (QALY) generated by each treatment option.

Design and evaluation of the model were performed by making use of Treeage-Pro 2006 Suit software. The constructed model is in Figure 3.3. The configuration of the model for mastectomy option can be seen in Figure 4.1. As mentioned previously, the history is the same for the both treatment options. Thus, the basic configurations are the same and the only difference is the parameter values such as utility values.

As seen in the Figure 4.1, the model representation looks like a decision tree. In the original graphical representation of a Markov model, each state is represented by using circle and arrows represents transitions. However, Treeage does not employ this representation of a Markov model. Instead, Treeage uses “Cycle Tree” which is based on a node and a branch framework, making it easily integrated into standard decision tree structures. Sonnenberg (1993) presented a practical guide, which includes representation of Markov models in medical decision-making.

In the Figure 4.1, the seven branches emanating from Markov node enumerate the Markov states (health states). Later, the subtree emanating from each state is used to represent the possible transitions from that state. A state out of which transitions are not possible has no transition subtree, which is the absorbing state (Dead). To the right of the each transition node’s symbol is displayed the name of the state to jump to at the beginning of the next stage (terminal node).

The utilities of each health state were assigned as an incremental reward that reflected the value of being in that state for one cycle. The incremental reward was

accrued by the membership of the state at each subsequent stage of the process, starting at stage 1 and continuing until the process terminates. Instead of assigning utilities as certain numbers, they were defined as normally distributed random values with mean and standard deviations, which were, calculated in Chapter 3. Hence, for each simulation trial, a random number was generated for each utility value from the related distribution. Also, since all patients start in NED state, initial reward was assigned for that state, which was a one-time adjustment to the incremental reward that was made at the beginning of the simulation experiment. It was used to implement half cycle correction and therefore, its value was set to half of the incremental reward of NED state (Sonnenberg, 1993).

Since the stages were represented by survival years, the total reward was the quality of life for each health state is multiplied by the time spent in that state. The total reward is expressed as the quality adjusted life years (QALY) as mentioned previously. Thus, the total reward evaluated from simulation represents QALY value of that treatment option.

As seen in Figure 4.1, since all patients start in a NED state after the surgery, initial probabilities were assigned as 0, for all states except NED state. On the other hand, transition probabilities were represented by variables. Since transition probabilities vary with time, they referenced the probability tables of stage dependent values by using appropriate Markov keywords, which are called *tracker variables*. Thus, for this purpose, a tracker variable was defined for each health state. These variables count the number of visits to each possible state. For instance, a tracker variable defined for the NED state was NT. If a subject encounters a node NED containing a tracker variable definition NT=NT+1, the Treeage takes the current global value of NT for that individual's trial, add 1 to it, and store the new global value. Thus, the tracker variable NT counts the number of visits to NED state during the process and when the subject visits NED state, the program checks the tracker variable NT and according to value of NT variable, the following transition probabilities from NED state to other states were taken from related probability tables.

To sum up three different kinds of variables were defined in this program. First one was defined as an incremental reward for utility values, which were referred to appropriate distributions for each health state. The second kind of variables was defined for transition probabilities, which were referred to probability tables. And the last one was tracker variables defined for counting number of visits to each possible state during simulation.

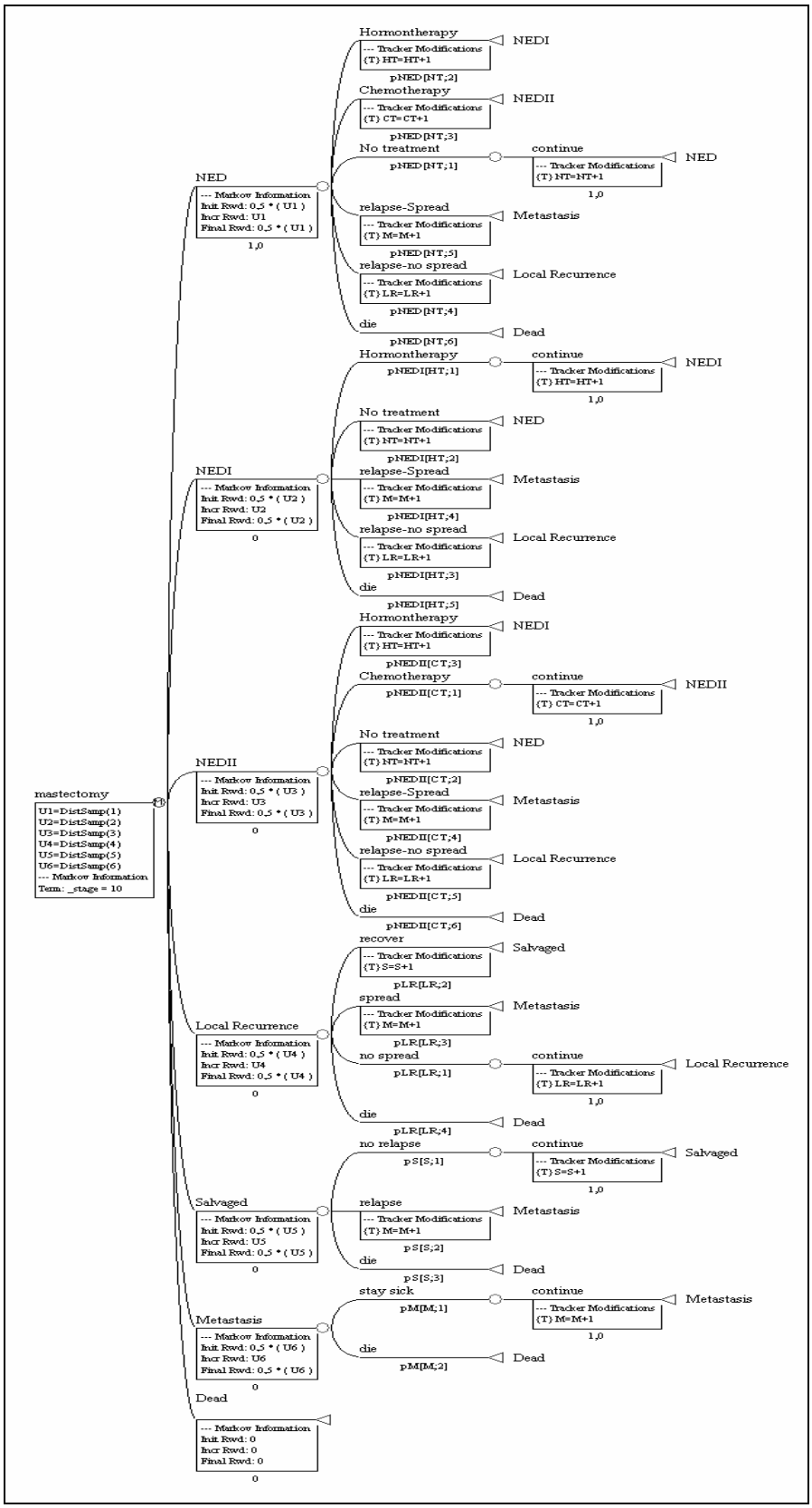
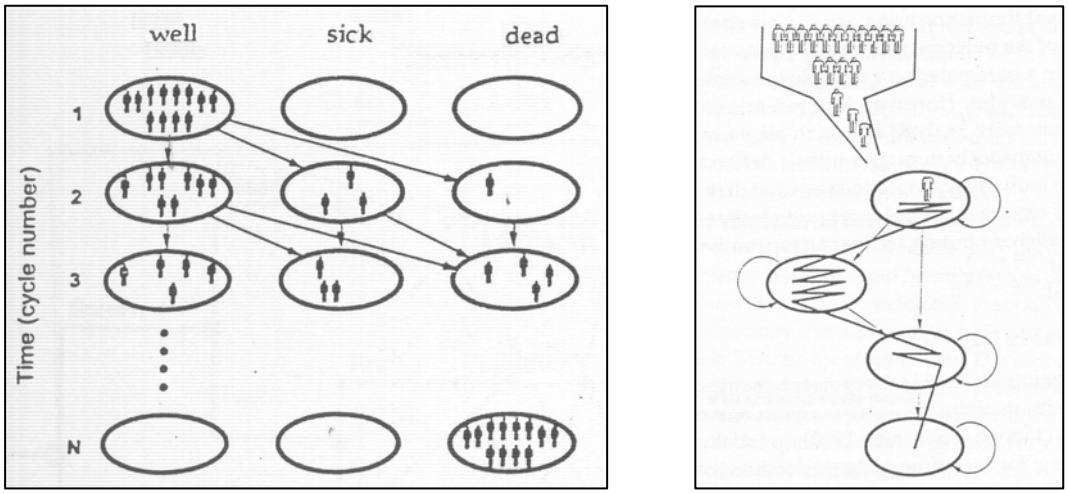



Figure 4.1. Configuration of Cycle Tree for Mastectomy

## 4.2 Results

Time-dependent Markov chains could be simulated by a cohort simulation (one trial, multiple subjects) or by a Monte Carlo simulation (many trials, single subject for each) (Chapman and Sonnenberg, 2000). Cohort simulation and Monte Carlo simulation to the Markov process are illustrated graphically in Figure 4.2.




(A) (B)

Figure 4.2. A) Cohort Simulation B) Monte Carlo Simulation

One of the important assumptions in a cohort analysis is that the model maintains no memory of previous events. However, in our model, state's transition probabilities depend on prior events. Since they vary with time, it is important to know how many times a subject visits a state previously. Thus, the simulation should allow tracking transition probabilities. In what follows, cohort analysis is not suitable for this analysis since the histories of the different components of the cohort are not maintained in this simulation type. On the other hand, Monte Carlo simulation is the most common and efficient method for introducing detailed

memory into Markov processes; because, in this simulation, one individual at a time is placed into the process, and that person is followed from state to state until a terminal state is reached and thus, one can keep track of the complete history of state membership as the individual moves through the process. Hence, the model in this study was evaluated by Monte Carlo simulation.

Monte Carlo simulation determines prognosis of a large number of individual subjects. Each subject starts in the starting state, NED state, and at the end of each cycle, a random number generator is used together with the transition probabilities to determine in which state the patient will begin the next cycle, and the subject is given reward for each cycle spent. When the subject enters the death state or satisfies the termination condition, the simulation is stopped. The process is repeated a very large number of times, and each trial generates a quality adjusted survival time. After a large number of trials, these constitute a distribution of survival values. The mean value of this distribution will be similar to the expected utility.

10-year survival was considered, so the cycle length was defined as 10 cycles, and termination condition was set as 10 stages. Total of 200 samples, recalculation of the model based on a randomly generated set of utility values from normal distribution, and 1000 trials for each sample were performed (total of $2x10^5$ trials). Firstly, the simulation was performed for mastectomy. The analysis output showed that if the subject is operated with mastectomy, mean value for the gained quality adjusted life years was 641.62. On the other hand, the data were revised according to lumpectomy option and then, the model was simulated again. The mean value for the gained quality adjusted life years was 700.72 at this time. The results showed that, as expected, quality adjusted life years for lumpectomy is higher than mastectomy. Simulation statistics were tabulated in Table 4.1 for lumpectomy and Table 4.2 for mastectomy. Since the transition probabilities were assumed to be same for each treatment option, number of visits to each health states was also same as expected. The maximum average number of visits were observed into

NED state and the minimum ones were observed into Salvaged state. The detailed text reports of 200 samples' outcomes can be examined in Appendix O.

Table 4.1. Simulation Statistics for Lumpectomy

| Statistic | Value | NEDII | NEDI | Loc. Rec. | Metastasis | NED | Salvaged |
|---|---|---|---|---|---|---|---|
| Mean | 700.72 | 0.748755 | 1.83733 | 0.194275 | 1.555685 | 5.20046 | 0.029165 |
| Std Dev | 22.79 | 0.012594 | 0.069082 | 0.013442 | 0.069153 | 0.107992 | 0.010391 |
| Min | 644.68 | 0.717 | 1.653 | 0.153 | 1.407 | 4.93 | 0.009 |
| Median | 703 | 0.749 | 1.84 | 0.194 | 1.551 | 5.191 | 0.028 |
| Max | 762.89 | 0.79 | 2.04 | 0.23 | 1.762 | 5.505 | 0.062 |

Table 4.2. Simulation Statistics for Mastectomy

| Statistic | Value | NEDII | NEDI | Loc. Rec. | Metastasis | NED | Salvaged |
|---|---|---|---|---|---|---|---|
| Mean | 641.62 | 0.752275 | 1.829435 | 0.19361 | 1.564415 | 5.19829 | 0.02913 |
| Std Dev | 32.9 | 0.013761 | 0.068402 | 0.015686 | 0.073146 | 0.119534 | 0.009774 |
| Min | 565.06 | 0.718 | 1.622 | 0.155 | 1.396 | 4.913 | 0.01 |
| Median | 641.32 | 0.751 | 1.83 | 0.195 | 1.56 | 5.199 | 0.027 |
| Max | 736.96 | 0.794 | 2.017 | 0.241 | 1.784 | 5.524 | 0.058 |

Cumulative distributions of the outcomes for 200 samples were represented in Figure 4.3 and Figure 4.4. It was observed that, the outcomes were also distributed normally. Also, QALY values versus years can be seen in Figure 4.5. The difference in the total reward between lumpectomy and mastectomy increases each year.

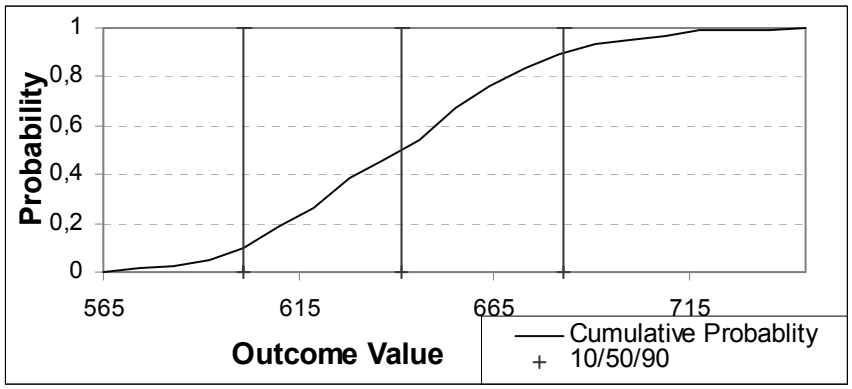



Figure 4.3. Monte Carlo Simulation at Mastectomy

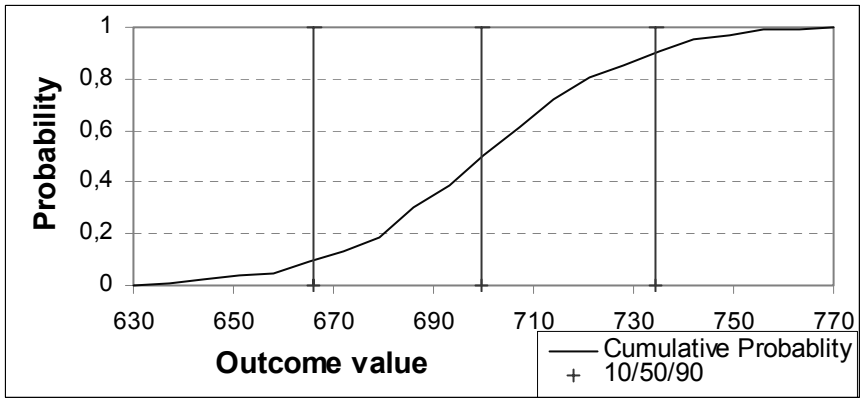



Figure 4.4. Monte Carlo Simulation at Lumpectomy

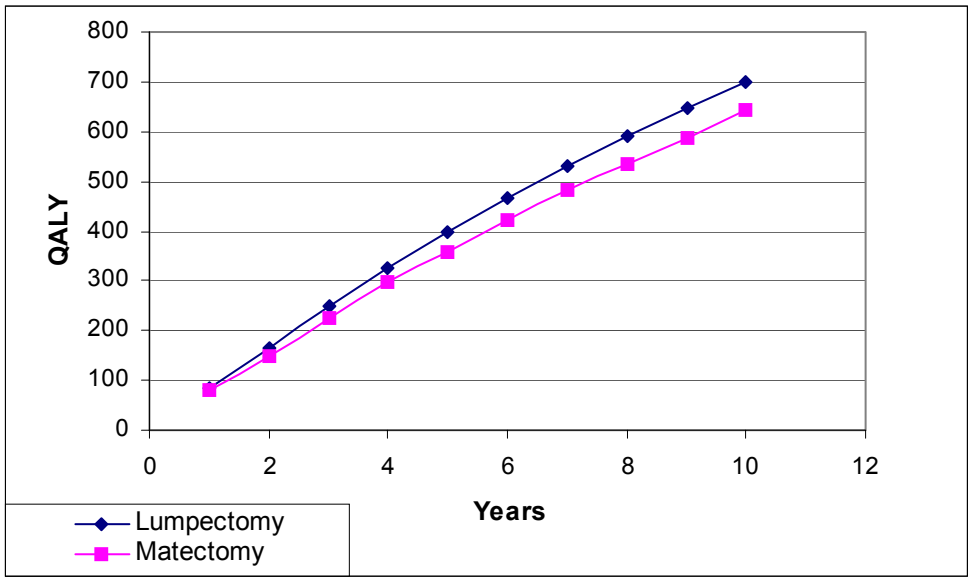



Figure 4.5. Projected Overall Quality Adjusted Life Years

## 4.3 Sensitivity Analysis

Neither probabilities nor the utilities are certain quantities. Utilities of health states were estimated on the basis of general population preferences and survey results; on the other hand, transition probabilities were estimated on the basis of experience of clinicians and literature review. Thus, it is important to study how our decision might be affected by changes in those parameters.

In this section, a series of one-way sensitivity analyses were run in order to check whether changes in the value of a variable have the anticipated effect on the results. One-way sensitivity analyses were performed on utility and probability data.

As mentioned, transition probabilities among the health states were assumed to be equal for options of mastectomy and lumpectomy for the purpose of simplification. However, it is known that the probability of transition from any state to local recurrence state (if possible) is actually higher for lumpectomy. This difference

decreases total reward for lumpectomy. On the other hand, the probability of salvaged after local recurrence is also higher for lumpectomy and as estimated, this difference increases total reward for lumpectomy. Thus, one-way sensitivity analysis was performed in order to observe the effect of the differences in those probabilities.

First of all, the transition probabilities from NED, NEDI, and NEDII states to Local Recurrence state increased 1%, 5%, 10%, 20% and 50% systematically and the differences were analyzed. The results of this analysis are shown in Table 4.3. As seen, the result was not affected up to 5%; the QALY value was still higher than that of mastectomy. However, when the change was increased to %5, the QALY value for lumpectomy became equal and when it was increased to %10, it became lower than mastectomy. It means that, threshold value was observed at 5%. Threshold value can be observed in Figure 4.6 distinctly.

Table 4.3. One-way Sensitivity Analysis for Transition Probability of Local Recurrence

| Lumpectomy | QALY | |
|---|---|---|
| Adjustment | MEAN | SD |
| Baseline | 700.72 | 22.79 |
| 1% | 687.47 | 22.82 |
| 5% | 641.11 | 25.09 |
| 10% | 596.16 | 22.2 |
| 20% | 530.56 | 28.54 |
| 50% | 409.41 | 32.4 |

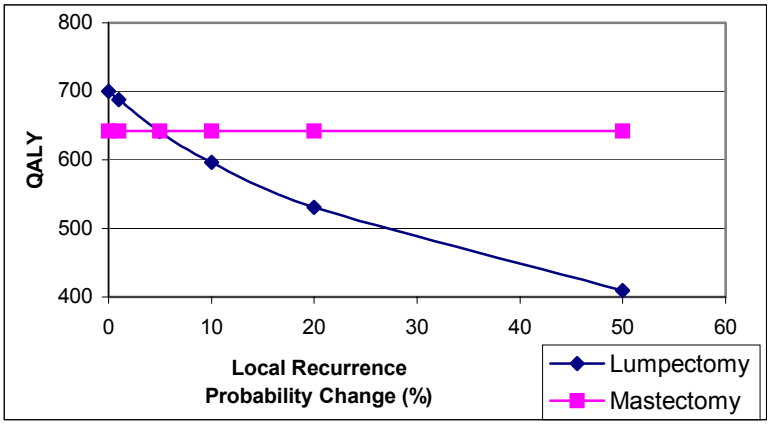



Figure 4.6. One-way Sensitivity Analysis on Local Recurrence Probability

Secondly, since the probability of salvaged after local recurrence is also higher for lumpectomy, two-way sensitivity analysis was performed on probabilities of local recurrence and salvage in order to observe the effect of these probabilities simultaneously. Transition probabilities from Local Recurrence to Salvage state increased systematically while holding local recurrence increase at specific values. The results of this analysis can be seen in Table 4.4. Since increasing transition probability from local recurrence to salvage cause increasing the total reward, it can be observed more than one threshold values at different points. In this analysis, only two threshold values were observed. First one was observed when the probability of local recurrence was increased to 5% and the probability of salvage was held at its baseline. The other one was observed when the probability of local recurrence was increased to 6% and the probability of salvage was increased to 25%. As seen from the table, the probability of salvage does not affect QALY results as much as the probability of local recurrence.

Table 4.4. Two-way Sensitivity Analysis on Local Recurrence and Salvage Probability

| | | Local Recurrence Probability Change (%) | | | |
|---|---|---|---|---|---|
| | | **4** | **5** | **6** | **7** |
| Salvage Probability Change (%) | **0** | 654.96 | **641.11** | 634.35 | 622.43 |
| | **5** | 657.29 | 645.12 | 635.76 | 623.43 |
| | **10** | 656.61 | 646.4 | 635.96 | 624.13 |
| | **15** | 657.36 | 648.8 | 637.35 | 626.66 |
| | **20** | 657.89 | 649.98 | 639.45 | 627.65 |
| | **25** | 662.63 | 650.21 | **641.17** | 627.91 |

After studying the probability data, one-way sensitivity analysis was performed on the utility data for lumpectomy and mastectomy in order to observe the effect of each utility of health states. This study was performed by evaluating QALY values for minimum and maximum utility values of health states which were observed in the public preferences. The analysis results are tabulated in Table 4.5. The model was much more sensitive for utility of no evidence of disease state, as expected. The utilities of no evidence of disease but having hormone therapy state, chemotherapy state and metastasis state also affected the model relatively. However, the model was not sensitive for the other parameters, utilities of local recurrence stage and salvaged stage.

Table 4.5. Sensitivity Analysis on Utility Values

| Health States | MEAN-Lumpectomy | | MEAN-Mastectomy | |
|---|---|---|---|---|
| Baseline | 700.72 | | 641.62 | |
| | Min | Max | Min | Max |
| U1 | 651.16 | 718.93 | 580.52 | 687.25 |
| U2 | 686.08 | 708.21 | 616.39 | 652.67 |
| U3 | 682.17 | 713.25 | 621.39 | 647.6 |
| U4 | 693.46 | 703.61 | 631.3 | 642.6 |
| U5 | 695.2 | 703.11 | 638.98 | 640.13 |
| U6 | 683.37 | 732.03 | 617.44 | 671.57 |

# CHAPTER 5

# CONCLUSIONS AND FURTHER RESEARCH AREAS

The main objective of this study was to analyze the decision context of early stage breast cancer patients in relation to two main treatment options, and to construct a decision making model that incorporates patient preferences over differing health state prospects as well as incorporating other typical complexities of such decisions situations such as uncertainty.

## 5.1 Summary of Study and Findings

In the first part of the study definition of the problem and the reasons of studying this problem were given. Then, in the second part, review of a comprehensive literature search that covers decision making techniques used in health care systems, utility assessment techniques and their applications on early breast cancer treatments were presented.

Two important steps during this development task, the disease process modeling and the outcome measure modeling, were represented in the Chapter 3. In the first section of this chapter, regardless of clinical history of the breast cancer following surgery, type of surgery is mastectomy or lumpectomy, was modeled as a Markov Tree. Natural history of the breast carcinoma was defined by seven basic health

states in the model. All events were represented as transitions from one health state to another.

Health states used in the model were characterized by transition probabilities into other states and by utilities as a measure of quality of life gained by the transitions. The multi-attribute utility model, as an outcome evaluation measure, was constructed for utility attributed to health states. Five main attributes and 3 sub-attributes were determined in order to characterize health states. Healthy volunteers assigned individual utility values and scaling constants of attributes for each health state. Overall utilities of each participant for each health state were evaluated by using their results obtained from public survey as data in the multi-attribute utility model. According to the results obtained from multi attribute utility model, average overall utility values assigned by participants were higher for lumpectomy operation, especially if there was no evidence of disease. When the cancer came back, participants did not care what surgical treatment option she was operated with, which means that after reoccurrence of disease, utility values for both treatment options were equal or very close to each other.

Another important section of this chapter was validity check of multi-attribute utility model. This process was performed by comparison between multi-attribute utility results and global ratings for each health state, which were obtained by another survey (Group 2). In the second survey standard gamble technique was used to get global ratings of each health state. Descriptive statistics showed that obtained mean utility values obtained from this method were higher than multi-attribute utility model results for most health states. Additionally, it was observed that after mastectomy and lumpectomy, for the first four health states mean utility values are nearly same or close to each other in both measurements; but for the last two health states, mean value differences are significantly higher. Then, in the next step, statistical difference between two population means was analyzed for each health states by considering samples both normally distributed and nonparametric. According to two-sample t-test and Wilcoxon rank sum test results, for six health

states, multi-attribute utility model results match global ratings. On the other hand, for the rest of six health states, values from multi-attribute utility model and global ratings do not match. An important result from this analysis was that multi-attribute utility model gave highly correlating results especially for the no-evidence of disease health states. On the other hand, as the health state got worse, consistency of results became poorer. The reason for that may be use of general population in the analysis, because if assessing health state condition is similar to participants' current conditions, they can evaluate more objectively. However, as the assessing health state condition becomes different from their current condition, imagining being in that health state and assessing the condition objectively becomes difficult.

In addition to comparison of two samples statistically, in order to perform more effective consistency check, a random sample of 15 was drawn from control group (Group 2) and they were also applied multi attribute utility model assessment procedures, so one sample was performed the both of the assessment methods and by using their results whether a subject's holistic preference judgments are consistent with an algebraic utility model was determined by "construct validation". A systematic method, Multitrait-Multimethod (MTMM) Matrix method, was performed for construct validation. In this method different classes of correlation coefficients were identified and compared with each other and some necessity conditions were looked for validation. Results were sufficient to accept that multi attribute utility method is reasonably valid.

Finally, after development of the decision model and assigning utility values and transition probabilities, the process was represented in Treeage-Pro 2006 Suit software, simulated by Monte Carlo Simulation. Results of this simulation were analyzed and necessary sensitivity analyses were performed in order to observe the effects of parameters. The output was quality adjusted life years (QALY) during 10-year survival. The runs showed that, if the subject had mastectomy, mean value for the quality adjusted life years gained (QALY-gain) was 641.62; on the other hand, if the preference was lumpectomy, the mean value for the QALY-gain was

700.44 at this time. The results showed that, quality adjusted life years for lumpectomy is higher than mastectomy on the average. That means, according to the preferences of participants, decision model points to lumpectomy for surgical operation. Since the utility values and transition probabilities were not certain in the model, one-way and two-way sensitivity analysis were performed. Threshold values for optimal decisions were: 641.11 if the probability of local recurrence was increased up to 5% and 641.17 if the probability of local recurrence was increased up to 6% while salvage probability was increased up to 25% for lumpectomy option. Secondly, effects of utility were analyzed, and observed that the model was much more sensitive to utility of no evidence of disease, relatively sensitive to the utilities of no evidence of disease but having hormone therapy stage, chemotherapy stage and metastasis stage, however, was not sensitive to utilities of local recurrence stage and salvaged stage.

In conclusion, the decision model was developed with reasonable success for early stage breast cancer patients, and tested by using general public data. The results obtained from these data showed that lumpectomy was more favorable for these participants. The most important result was that the model is applicable for determining patient preference by considering their personal parameters such as, individual utility values, and scaling constants. This model is also of help for surgeons' decisions. As Fryback (1974, 1978) and Ransohof (1976) pointed out, decision analysis improves physicians' intuition or judgment and increases the attention focused to anticipate all possible outcomes. Thus, the assessment process performed in this modeling effort prepares the mind for making a correct decision. It should be noted that we do not imply that physicians currently make bad decisions; rather, we interpret our study to show that good decisions may be improved, on the average, by making use of such decision theory concepts. This model can be applied to patients by an expert or surgeon and according to results of the model, they can decide more easily for treatment option. Needless to say, the results of the model cannot be compulsory decision; it only gives an opinion or

guides for correct decision. Briefly, the application of the decision tool is as follows:

Step 1. Assessment of Individual Utility Scales

The first step is the assessment of the person's dimensional utility function for each attribute. This is achieved by performing a survey given in Appendix C to the patient.

Step 2. Assessment of Individual Scaling Constants

The next step is, determining scaling constants in order to indicate the relative importance of all attributes. First of all, Swing Rating Method is applied, as in Appendix C, to the patient for this purpose and the attributes are ranked. After ranking procedure, relative weights are obtained by SMARTER, from Table D.1 shown in Appendix D.

Step 3. Assessment of Overall Utility Values of Health States

After the assessment of individual utility values and scaling constants, the next step is assessment of overall utility values of health states by using 8-attribute additive utility function as follows:

$$U_K = k_1 U_1(X_1{}^j) + k_2 U_2(X_2{}^j) + k_3 U_3(X_3{}^j) + k_4 U_4(X_4{}^j) + k_5 \left( k_6 U_6(X_6{}^j) + k_7 U_7(X_7{}^j) + k_8 U_8(X_8{}^j) \right)$$

All aggregate utility values for twelve health states are calculated from utility functions given in Table 3.2.

Step 4. Evaluation of the Decision Model

Final step in this tool is defining utility values and probabilities in the Markov Tree, and executing evaluation of this model. Results provide the gained quality adjusted life years for each treatment option, and the patient can see which one

provides higher QALY value with respect to her parameters, and gives her decision by considering this result.

The model is not perfect and cannot be considered as generic measure such as HUI indexes or QWB scales. We performed this study to take the first steps in this area and to attract attention for using decision theoretic techniques in health care in Turkey.

## 5.2 Limitations of the Study

There were a number of factors that defined some boundaries or limitations on this study. Below is a brief discussion of these limitations.

- **Model**

The disease progress was represented by a Markov chain and seven basic health states were designated. In the real context of such a problem, there are many more health states. For example, in reality hormone therapy can be carried on up to five years. In the model it was considered that if the patient is in the health state of NED I and in the next interval she remains in the same state, the utility of that state remains the same since she is in the same state. However, this is not entirely right. In the second year of adjuvant therapy, patient's utility is lower, so that another health state should be defined for each year of adjuvant therapy. However, it was assumed that these utility differences were negligible with respect to other transitions between health states and considered as only one state.

The principal analysis of the model focuses on early stage breast cancer patients. Patients' age interval is considered between 45-55 year-old so that they are assumed to be premenopausal. The model has been structured for defined breast cancer patients, and therefore usage of the model is limited to these patient

characteristics. Although many facets of the model are similar to other types of breast cancers, the results cannot be directly applied as a policy guideline.

- **Attributes**

Another limitation that should be considered was the attributes used in the Multi Attribute Utility Model. In order to characterize health states a number of attributes identified in the literature. A number of health status classification systems were studied and the suitable attributes for our problem were selected from these metrics (see Chapter 3). Then by consulting oncologists, some attributes were omitted since they seem irrelevant or less important than others, so that model was simplified. However, these omitted attributes could make some differences and because of that number of attributes could limit the results.

A valuable improvement to the present study would be to generate the outcome measure attributes entirely anew, tailored to our culture. For this purpose, as mentioned previously, identifying attributes is best done using the "objectives hierarchy" (due to Keeney and Raiffa (1993)) uniquely constructed for this decision context.

- **Population**

Utility assessment of the health states in the model and the validation of the model were performed on university students (a segment from general population). Ideally, the utilities of the health states ought to belong to the patients, because these are the only people who know what is really like to be in these health states and therefore the only ones capable of expressing "true" preferences over them. However, this procedure may not be considered as ethical because patients may be oversensitive and such interviews may affect their psychology negatively. Because of these reasons, sometimes physicians don't give permission for interviewing their patients. For this reason, using public preferences are considered acceptable for

making health decisions (Torrance, 1978; Boyd, 1990; Dolan, 1999; Cappelli, 2001).

Although, it is believed that the source of preference weights do not affect the base case results of comparison, the research shows that healthy volunteers underestimate the value of health state; because, assessing the health state condition objectively becomes difficult for people without direct experience of the health state. Thus, some deviations could be observed in results if early stage breast cancer patients performed the study.

- **Probabilities**

Transition probabilities in the markov model were obtained by using subjective probability assessment techniques. These probabilities were acquired by using expert judgments. Although subjective probability is scientific and accepted as a method for probability assignment, using "objective" probabilities based on hospital records could provide more realistic results. However, the data that we need was not kept entirely and reliably. We, researchers in this field, should help design ways for hospitals to keep such data for future studies to be more robust.

- **Validation**

The validity check was performed by correlating the values obtained from model and the global ratings. Standard gamble technique was preferred for the global rating because of the certain properties of this method, which were mentioned previously. However, the standard gamble was time consuming, it can only be handled in face to face interview and it required well trained members as participants with high level of education. These factors limited the characteristic of general population and the group size, which affected the study efficiency.

Additionally, during utility assessment procedure, direct rating technique was performed for assessment of individual utility values. On the other hand, during validation of process standard gamble technique was performed for global ratings. Thus, using different techniques for assigning utility in the multi attribute utility model and in the global ratings could cause some errors such that risk of death preference could affect participants' assessment in standard gamble technique. So, this point should be taken into account while validation results are studied.

- **Reliability**

Health states should ideally be measured second time with the same measurement method after a period of time, re-tested, and then we can conclude that our measurement technique is reliable if the results are consistent. Reliability is an important concept in validation such that correlation coefficients obtained from reliability data are used for construction of MTMM matrix. However, the analysis of the reliability could not be performed for this study because of practical difficulties. As mentioned previously, second measurement should be performed at least after 6 months for effective study. However, to reach same participants and perform the study is almost impossible during our study period.

## 5.3 Suggestions for Further Research

This study can be extended through a number of research studies, some of which are mentioned in this section. Naturally, the first suggestion that comes to mind is to work to eliminate the limitations that were discussed above. More detailed Markov model can be developed; more health states can be defined and observed if the detailed model affects the main results of the study. Patient characteristics can be extended and the model can be adapted to other presentations of breast cancer. Real patients can perform utility assessment and validation process, and results can be compared. More generalized multi-attribute utility model can be developed in

order to observe effect of additive independence property on the results. And finally reliability analysis can be performed in the future.

In addition to eliminating the limitations of the study, we have some other suggestions in order to extend this study. As mentioned previously, the health sector is an open area for the industrial engineers, and this study is the very first in our country. So, this instrument can be improved in order to increase its performance. This model was performed on particular university students and it reflected their preferences. However, attaining generalizable results is the purpose of scientific research, therefore, by further research, this instrument can be generalized for Turkish people like health status classification systems developed by Torrance (1982), Kaplan (1988), and the like.

In this study, breast cancer patients' preferences for health outcomes were evaluated with respect to quality adjusted life years (QALY). Using these study results, a cost effectiveness analysis can be performed. As known, cost effectiveness analysis is a very useful technique for the economic evaluation of the clinical alternatives. It examines both value consumed (costs) and value produced (health outcome), and by this analysis cost per unit health is calculated. Thus, patient preferences can be determined by considering both quality of life and cost of the treatment.

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# APPENDIX A

## ORIGINAL AND TURKISH VERSIONS OF EQ-5D

Original and Turkish versions of EQ-5D, which is one of the pre-scored multi attribute health status classification systems and developed by EuroQol group (1990), can be examined in this part. This generic measure is used in order to evaluate patient's preferences for health outcomes.

## Background

### *Introduction*

The EQ-5D consists of a questionnaire which classifies the patient into one of 243 health states (5 dimensions, each with 3 levels) and a visual analogue scale on which patients rate their own health between 0 and 100.

### *Valuing EQ-5D health states*

As well as self-rated health status, valuations can be generated for other EQ-5D health states from different groups:

- patients;
- carers;
- health professionals;
- general public.

Values for a subset of health states have been derived from the general public in Finland, Germany, the Netherlands, Norway, Spain, Sweden, the UK and the US. For all the 243 possible EQ-5D health states, values have been derived using modeling and statistical techniques.

### *purpose*

The EQ-5D generates a single numeric index of health status. It therefore can be used as a measure of health outcome in both clinical and economic evaluation.

It is recommended for use alongside other more detailed generic measures such as the SF-36, the NHP or the SIP, or disease-specific measures.

### *usage*

The EQ-5D is being widely used throughout Europe as well as in Australia, Canada and the US.

## The EuroQol Group

The EuroQol Group is an international group of researchers who co-operate in the field of measuring health-related quality of life. Membership requires active contribution to the development of the EQ-5D. The annual EuroQol meeting provides an opportunity to share results of investigations and experiences in the field.

## Information

- To obtain an EQ-5D User Guide
- To add your name to the EuroQol Group's mailing list
- Regarding membership of the EuroQol Group

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**Badia X, Fernandez E, Segura A.** Influence of socio demographic and health status variables on evaluation of health states in a Spanish population. European Journal of Public Health. Vol. 5 (1995) pp 87-93.

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# EQ - 5D

An instrument to Value Health from the EuroQol Group

## A Measure of Health-related Quality of Life from the EuroQol Group

EQ-5D

A generic, single index measure

Validated in several countries

Measuring health for clinical and economic appraisal

Supported by an international research group

## Contents

- Applicable for use in a wide range of health conditions and treatments.
- Provides a simple descriptive profile and an overall numeric estimate of health-related quality of life which can be used for both clinical and economic evaluations of health care.
- Designed for use alongside disease-specific or other generic measures of quality of life.

## Translations

The EQ-5D instrument was simultaneously developed in the following languages: *Dutch • English • Finnish • Norwegian • Swedish*

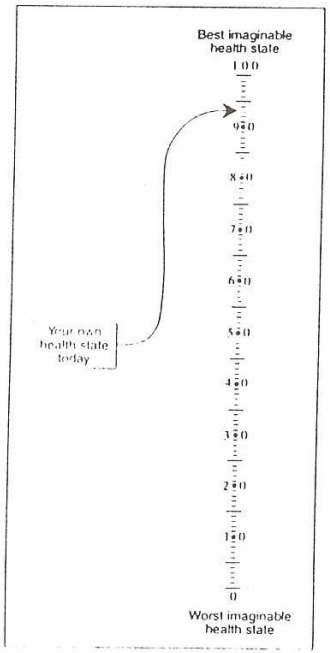
Other versions available: *Australian • Catalan • Croatian • Czech • Danish • French • German • Italian • Polish • Québécoise • Spanish • Turkish.*

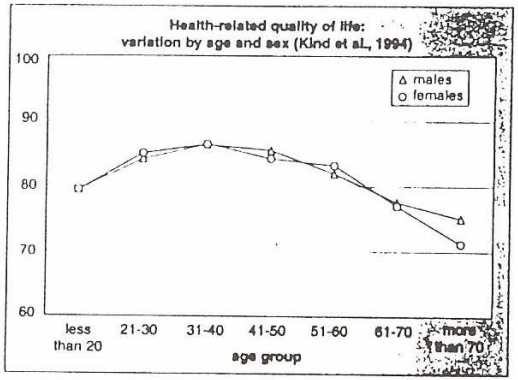
Versions in preparation: *Hebrew • Japanese • Portuguese • US.*

## EQ-5D in practice

- Designed for self-completion by patients.
- Cognitively simple, taking only a few minutes to complete, and suitable for use as a postal questionnaire.
- Classification of health based on a five-dimensional system (see below).
- Valuation on a 0 to 100 scale by means of a visual analogue scale (see figure on the right).

| | |
|---|---|
| **Mobility** | |
| I have no problems in walking about. | O |
| I have some problems in walking about. | O |
| I am confined to bed. | O |
| **Self-Care** | |
| I have no problems with self-care. | O |
| I have some problems washing or dressing myself. | O |
| I am unable to wash or dress myself. | O |
| **Usual Activities** *(eg. work, study, housework, family or leisure activities)* | |
| I have no problems with performing my usual activities. | O |
| I have some problems with performing my usual activities. | O |
| I am unable to perform my usual activities. | O |
| **Pain/discomfort** | |
| I have no pain or discomfort. | O |
| I have moderate pain or discomfort. | O |
| I have extreme pain or discomfort. | O |
| **Anxiety/depression** | |
| I am not anxious or depressed. | O |
| I am moderately anxious or depressed. | O |
| I am extremely anxious or depressed. | O |




## Areas of study in which the EQ-5D is being used to measure patient outcome

*Include the following:*

- *Cardiovascular:* heart failure, heart attack, vascular surgery.
- *Diabetes.*
- *Gastro-intestinal:* cholecystectomy, gastric ulcer, liver transplant.
- *HIV-Aids.*
- *Mental health.*
- *Neurology:* stroke, dystonia, hearing, multiple sclerosis, epilepsy.
- *Oncology:* leukaemia, breast cancer.
- *Orthopaedics:* hip fracture, hip replacement, arm fractures, MRI.
- *Population health surveys.*
- *Renal failure.*
- *Respiratory:* asthma, COPD.
- *Trauma.*
- *Urology:* TURP, incontinence.

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EQ - 5D
An instrument to value health from the EuroQol Group

# NOTES ON THE USE OF EQ-5D DEVELOPED BY THE EUROQOL GROUP
May 2000

*Clinical use of the EQ-5D*
In most clinical uses, only pages 2 and 3 of EQ-5D are used. Patients are asked to assess their own health by way of the descriptive statements on page 2 (EQ-5D self-classifier) and then on a visual analogue scale (EQ-VAS) on page 3. On page 2, answers are coded as 1 (no problem), 2 (some or moderate problems), or 3 (unable or extreme problem). These are *not* added together, but act as a description of a health state, e.g. state 22213 indicates some problems with mobility, self care and usual activities, no pain or discomfort but extremely anxious or depressed. A health state *score* is obtained from the EQ-VAS "thermometer" on page 3 by asking the respondent to draw a line from the box marked "your own health state today" to the appropriate point on the EQ-VAS. Leading zeros should be included, e.g. a health state could be rated 070. Brief demographic information is requested on page 4 of EQ-5D.

*Economic use of EQ-5D*
In the economic evaluation of health care such as cost-effectiveness analyses, Quality Adjusted Life Years (QALY's) are sometimes used to compare the results of different health programmes. QALY calculations are based on information generated from quality of life indices combined with information about the number of life years gained.

One method of using EQ-5D for economic evaluation would be to use the patients' own estimates of their quality of life derived from the page EQ-VAS as described above. However, EQ-5D health states, defined by the health state classification on page 2 may also be converted to a score using "sets of values" derived from general population samples.

Over the past few years, the EuroQol Group has been engaged in several research projects exploring this issue using different methods, for example, the EQ-5D valuation questionnaire has been used to generate values elicited from general population samples for a subset of health states in Finland, Germany, Greece, Netherlands, Spain, Sweden, UK and US. More recent research has concentrated on statistical modeling to generate values for all the 243 theoretically possible health states defined by EQ-5D.

The Business Management of the EuroQol Group acts as an intermediary supplying information on the background to research in the various countries. However to date, the research carried out as part of the MVH Project at York University, UK, using the Time Trade-Off method (TTO) has been underpinned by the most elaborate research effort. Values for the 243 possible EQ-5D health states plus unconscious are available, based on data collected from a representative survey of the UK general public[i]. Please contact Paul Kind directly for this information. His details are: Paul Kind, Centre for Health Economics, University of York, UK (Tel: +44 1904 433653, Fax: +44 1904 433644, E-mail: pk1@york.ac.uk)

*Data analysis*
An "off the shelf" software package such as SPSS, SAS or BMDP may be used to analyse EQ-5D data.

*Further information*
A full user guide is available on request from the EuroQol Business Management in Rotterdam, NL.

*Conditions for usage*
EQ-5D may be used without cost provided that the research is not being undertaken for commercial purposes, e.g. the testing of a new product by the Pharmaceutical Industry. More information on the Group's policy in these instances can be obtained from the EuroQol Business Management.

For non-commercial academic and clinical use, the EQ-5D is freely available, however the Group does require that only official language versions of EQ-5D are used and that users register their project. Free use of EQ-5D also implies that users are willing to share their knowledge with the Group regarding the application of EQ-5D as well as information that adds to the methodological knowledge of EQ-5D, e.g., issues surrounding validity and reliability. The Group is also particularly interested in demographic data, comparative data (where EQ-5D has been used alongside other instruments) and valuation data as well as data relating to the EQ-5D self-classifier and the EQ-VAS rating scale.

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[i] Dolan P. Modeling valuations for EuroQol health states. Medical Care Vol 35, No. 11, pp. 1095-1108. 1997.

April 2002

## Scoring EQ-5D: Notes

The information derived from the descriptive system (Page 2 of EQ-5D) may be converted to a score using "sets of values" derived from population samples. A number of different "sets" have been derived in different countries using different techniques. EU funding has enabled the EuroQol Group to harmonize this work with a view to producing a European set of values. Papers have been submitted to journals but until this work has been published (and in the absence of a national value set), The EQ Group would recommend using the data collected in the UK. This research carried out as part of the MVH Project at York University, UK, using the Time Trade-Off method (TTO) has been underpinned by the most elaborate research. Mean observed values for the 243 possible EQ-5D health states plus unconscious are available, based on data collected from a representative survey of the UK General public. *(Dolan P. Modeling valuations for EuroQol health states. Medical Care Vol 35, No. 11, pp. 1095-1108. 1997)*

A WORD document is available that can be used to convert the 5 dimensional 3 level system into a single index utility score calibrated in terms of the UK population survey mentioned above. An SPSS syntax file that will make matters easier is also available.

If you would like more specific details about the scoring, and/or a copy of the UK EQ-5D information package (that includes the UK value set) please contact EQ researcher Paul Kind directly. His details are: Paul Kind, Centre for Health Economics
University of York, UK. Tel: +44 1904 433653; Fax: +44 1904 433644; e-mail: pk1@york.ac.uk.

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## Scoring EQ-5D health states

Values for the 243 health states defined by the EuroQoL classification have been calculated using a regression model. The following worked example indicates how these coefficients are to be used so as to compute the estimated values for each state.

Calculating EQ-5D state scores - a worked example

| EuroQoL dimension | Level 2 | Level 3 |
|---|---|---|
| Mobility | 0.069 | 0.314 |
| Self-care | 0.104 | 0.214 |
| Usual activity | 0.036 | 0.094 |
| Pain / discomfort | 0.123 | 0.386 |
| Anxiety / depression | 0.071 | 0.236 |
| | Constant = 0.081 | N3 = 0.269 |

The arithmetic needed to recover the estimated value for any health state from this table of decrements is given by the following example:

Taking health state 1 1 2 2 3

Full health ( 1 1 1 1 1) = 1.0

Constant term (for any dysfunctional state)(subtract 0.081)

Mobility.. level 1(subtract 0)
Self-care.. level 1(subtract 0)
Usual activity.. level 2(subtract 0.036)
Pain / discomfort.. level 2(subtract 0.123)
Anxiety / depression.. level 3(subtract 0.236)

Level 3 occurs within at least 1 dimension(subtract N3 parameter 0.269).

Hence the estimated value for state 1 1 2 3 3 is given by

1.0 - 0.081 - 0.036 - 0.123 - 0.236 - 0.269 = .255

Estimated weights for EQ-5D health states

| | |
|---|---|
| 1 1 1 1 1 | 1.000 |
| 1 1 1 1 2 | 0.848 |
| 1 1 1 1 3 | 0.414 |
| 1 1 1 2 1 | 0.796 |
| 1 1 1 2 2 | 0.725 |
| 1 1 1 2 3 | 0.291 |
| 1 1 1 3 1 | 0.264 |
| 1 1 1 3 2 | 0.193 |
| 1 1 1 3 3 | 0.028 |
| 1 1 2 1 1 | 0.883 |
| 1 1 2 1 2 | 0.812 |
| 1 1 2 1 3 | 0.378 |
| 1 1 2 2 1 | 0.760 |
| 1 1 2 2 2 | 0.689 |
| 1 1 2 2 3 | 0.255 |
| 1 1 2 3 1 | 0.228 |
| 1 1 2 3 2 | 0.157 |
| 1 1 2 3 3 | -0.008 |
| 1 1 3 1 1 | 0.556 |
| 1 1 3 1 2 | 0.485 |
| 1 1 3 1 3 | 0.320 |
| 1 1 3 2 1 | 0.433 |
| 1 1 3 2 2 | 0.362 |
| 1 1 3 2 3 | 0.197 |
| 1 1 3 3 1 | 0.170 |
| 1 1 3 3 2 | 0.099 |
| 1 1 3 3 3 | -0.066 |
| 1 2 1 1 1 | 0.815 |
| 1 2 1 1 2 | 0.744 |
| 1 2 1 1 3 | 0.310 |
| 1 2 1 2 1 | 0.692 |
| 1 2 1 2 2 | 0.621 |
| 1 2 1 2 3 | 0.187 |
| 1 2 1 3 1 | 0.160 |
| 1 2 1 3 2 | 0.089 |
| 1 2 1 3 3 | -0.076 |
| 1 2 2 1 1 | 0.779 |
| 1 2 2 1 2 | 0.708 |
| 1 2 2 1 3 | 0.274 |
| 1 2 2 2 1 | 0.656 |
| 1 2 2 2 2 | 0.585 |
| 1 2 2 2 3 | 0.151 |
| 1 2 2 3 1 | 0.124 |
| 1 2 2 3 2 | 0.053 |
| 1 2 2 3 3 | -0.112 |
| 1 2 3 1 1 | 0.452 |
| 1 2 3 1 2 | 0.381 |
| 1 2 3 1 3 | 0.216 |
| 1 2 3 2 1 | 0.329 |
| 1 2 3 2 2 | 0.258 |
| 1 2 3 2 3 | 0.093 |
| 1 2 3 3 1 | 0.066 |
| 1 2 3 3 2 | -0.005 |
| 1 2 3 3 3 | -0.170 |
| 1 3 1 1 1 | 0.436 |
| 1 3 1 1 2 | 0.365 |
| 1 3 1 1 3 | 0.200 |
| 1 3 1 2 1 | 0.313 |
| 1 3 1 2 2 | 0.242 |
| 1 3 1 2 3 | 0.077 |
| 1 3 1 3 1 | 0.050 |
| 1 3 1 3 2 | -0.021 |
| 1 3 1 3 3 | -0.186 |
| 1 3 2 1 1 | 0.400 |
| 1 3 2 1 2 | 0.329 |
| 1 3 2 1 3 | 0.164 |
| 1 3 2 2 1 | 0.277 |
| 1 3 2 2 2 | 0.206 |
| 1 3 2 2 3 | 0.041 |
| 1 3 2 3 1 | 0.014 |
| 1 3 2 3 2 | -0.057 |
| 1 3 2 3 3 | -0.222 |
| 1 3 3 1 1 | 0.342 |
| 1 3 3 1 2 | 0.271 |
| 1 3 3 1 3 | 0.106 |
| 1 3 3 2 1 | 0.219 |
| 1 3 3 2 2 | 0.148 |
| 1 3 3 2 3 | -0.017 |
| 1 3 3 3 1 | -0.044 |
| 1 3 3 3 2 | -0.115 |
| 1 3 3 3 3 | -0.280 |
| 2 1 1 1 1 | 0.850 |
| 2 1 1 1 2 | 0.779 |
| 2 1 1 1 3 | 0.345 |
| 2 1 1 2 1 | 0.727 |
| 2 1 1 2 2 | 0.656 |
| 2 1 1 2 3 | 0.222 |
| 2 1 1 3 1 | 0.195 |
| 2 1 1 3 2 | 0.124 |
| 2 1 1 3 3 | -0.041 |
| 2 1 2 1 1 | 0.814 |
| 2 1 2 1 2 | 0.743 |
| 2 1 2 1 3 | 0.309 |
| 2 1 2 2 1 | 0.691 |
| 2 1 2 2 2 | 0.620 |
| 2 1 2 2 3 | 0.186 |
| 2 1 2 3 1 | 0.159 |
| 2 1 2 3 2 | 0.088 |
| 2 1 2 3 3 | -0.077 |
| 2 1 3 1 1 | 0.487 |
| 2 1 3 1 2 | 0.416 |
| 2 1 3 1 3 | 0.251 |
| 2 1 3 2 1 | 0.364 |
| 2 1 3 2 2 | 0.293 |
| 2 1 3 2 3 | 0.128 |
| 2 1 3 3 1 | 0.101 |
| 2 1 3 3 2 | 0.030 |
| 2 1 3 3 3 | -0.135 |
| 2 2 1 1 1 | 0.746 |
| 2 2 1 1 2 | 0.675 |
| 2 2 1 1 3 | 0.241 |
| 2 2 1 2 1 | 0.623 |
| 2 2 1 2 2 | 0.552 |
| 2 2 1 2 3 | 0.118 |
| 2 2 1 3 1 | 0.091 |
| 2 2 1 3 2 | 0.020 |
| 2 2 1 3 3 | -0.145 |
| 2 2 2 1 1 | 0.710 |
| 2 2 2 1 2 | 0.639 |
| 2 2 2 1 3 | 0.205 |
| 2 2 2 2 1 | 0.587 |
| 2 2 2 2 2 | 0.516 |
| 2 2 2 2 3 | 0.082 |
| 2 2 2 3 1 | 0.055 |
| 2 2 2 3 2 | -0.016 |
| 2 2 2 3 3 | -0.181 |
| 2 2 3 1 1 | 0.383 |
| 2 2 3 1 2 | 0.312 |
| 2 2 3 1 3 | 0.147 |
| 2 2 3 2 1 | 0.260 |
| 2 2 3 2 2 | 0.189 |
| 2 2 3 2 3 | 0.024 |
| 2 2 3 3 1 | -0.003 |
| 2 2 3 3 2 | -0.074 |
| 2 2 3 3 3 | -0.239 |
| 2 3 1 1 1 | 0.367 |
| 2 3 1 1 2 | 0.296 |
| 2 3 1 1 3 | 0.131 |
| 2 3 1 2 1 | 0.244 |
| 2 3 1 2 2 | 0.173 |
| 2 3 1 2 3 | 0.008 |
| 2 3 1 3 1 | -0.019 |
| 2 3 1 3 2 | -0.090 |
| 2 3 1 3 3 | -0.255 |
| 2 3 2 1 1 | 0.331 |
| 2 3 2 1 2 | 0.260 |
| 2 3 2 1 3 | 0.095 |
| 2 3 2 2 1 | 0.208 |
| 2 3 2 2 2 | 0.137 |
| 2 3 2 2 3 | -0.028 |
| 2 3 2 3 1 | -0.055 |
| 2 3 2 3 2 | -0.126 |
| 2 3 2 3 3 | -0.291 |
| 2 3 3 1 1 | 0.273 |
| 2 3 3 1 2 | 0.202 |
| 2 3 3 1 3 | 0.037 |
| 2 3 3 2 1 | 0.150 |
| 2 3 3 2 2 | 0.079 |
| 2 3 3 2 3 | -0.086 |
| 2 3 3 3 1 | -0.113 |
| 2 3 3 3 2 | -0.184 |
| 2 3 3 3 3 | -0.349 |
| 3 1 1 1 1 | 0.336 |
| 3 1 1 1 2 | 0.265 |
| 3 1 1 1 3 | 0.100 |
| 3 1 1 2 1 | 0.213 |
| 3 1 1 2 2 | 0.142 |
| 3 1 1 2 3 | -0.023 |
| 3 1 1 3 1 | -0.050 |
| 3 1 1 3 2 | -0.121 |
| 3 1 1 3 3 | -0.286 |
| 3 1 2 1 1 | 0.300 |
| 3 1 2 1 2 | 0.229 |

| | | | | | |
|---|---|---|---|---|---|
| 3 | 1 | 2 | 1 | 3 | 0.064 |
| 3 | 1 | 2 | 2 | 1 | 0.177 |
| 3 | 1 | 2 | 2 | 2 | 0.106 |
| 3 | 1 | 2 | 2 | 3 | -0.059 |
| 3 | 1 | 2 | 3 | 1 | -0.086 |
| 3 | 1 | 2 | 3 | 2 | -0.157 |
| 3 | 1 | 2 | 3 | 3 | -0.322 |
| 3 | 1 | 3 | 1 | 1 | 0.242 |
| 3 | 1 | 3 | 1 | 2 | 0.171 |
| 3 | 1 | 3 | 1 | 3 | 0.006 |
| 3 | 1 | 3 | 2 | 1 | 0.119 |
| 3 | 1 | 3 | 2 | 2 | 0.048 |
| 3 | 1 | 3 | 2 | 3 | -0.117 |
| 3 | 1 | 3 | 3 | 1 | -0.144 |
| 3 | 1 | 3 | 3 | 2 | -0.215 |
| 3 | 1 | 3 | 3 | 3 | -0.380 |
| 3 | 2 | 1 | 1 | 1 | 0.232 |
| 3 | 2 | 1 | 1 | 2 | 0.161 |
| 3 | 2 | 1 | 1 | 3 | -0.004 |
| 3 | 2 | 1 | 2 | 1 | 0.109 |
| 3 | 2 | 1 | 2 | 2 | 0.038 |
| 3 | 2 | 1 | 2 | 3 | -0.127 |
| 3 | 2 | 1 | 3 | 1 | -0.154 |
| 3 | 2 | 1 | 3 | 2 | -0.225 |
| 3 | 2 | 1 | 3 | 3 | -0.390 |
| 3 | 2 | 2 | 1 | 1 | 0.196 |
| 3 | 2 | 2 | 1 | 2 | 0.125 |
| 3 | 2 | 2 | 1 | 3 | -0.040 |
| 3 | 2 | 2 | 2 | 1 | 0.073 |
| 3 | 2 | 2 | 2 | 2 | 0.002 |
| 3 | 2 | 2 | 2 | 3 | -0.163 |
| 3 | 2 | 2 | 3 | 1 | -0.190 |
| 3 | 2 | 2 | 3 | 2 | -0.261 |
| 3 | 2 | 2 | 3 | 3 | -0.426 |
| 3 | 2 | 3 | 1 | 1 | 0.138 |
| 3 | 2 | 3 | 1 | 2 | 0.067 |
| 3 | 2 | 3 | 1 | 3 | -0.098 |
| 3 | 2 | 3 | 2 | 1 | 0.015 |
| 3 | 2 | 3 | 2 | 2 | -0.056 |
| 3 | 2 | 3 | 2 | 3 | -0.221 |
| 3 | 2 | 3 | 3 | 1 | -0.248 |
| 3 | 2 | 3 | 3 | 2 | -0.319 |
| 3 | 2 | 3 | 3 | 3 | -0.484 |
| 3 | 3 | 1 | 1 | 1 | 0.122 |
| 3 | 3 | 1 | 1 | 2 | 0.051 |
| 3 | 3 | 1 | 1 | 3 | -0.114 |
| 3 | 3 | 1 | 2 | 1 | -0.001 |
| 3 | 3 | 1 | 2 | 2 | -0.072 |
| 3 | 3 | 1 | 2 | 3 | -0.237 |
| 3 | 3 | 1 | 3 | 1 | -0.264 |
| 3 | 3 | 1 | 3 | 2 | -0.335 |
| 3 | 3 | 1 | 3 | 3 | -0.500 |
| 3 | 3 | 2 | 1 | 1 | 0.086 |
| 3 | 3 | 2 | 1 | 2 | 0.015 |
| 3 | 3 | 2 | 1 | 3 | -0.150 |
| 3 | 3 | 2 | 2 | 1 | -0.037 |
| 3 | 3 | 2 | 2 | 2 | -0.108 |
| 3 | 3 | 2 | 2 | 3 | -0.273 |
| 3 | 3 | 2 | 3 | 1 | -0.300 |
| 3 | 3 | 2 | 3 | 2 | -0.371 |
| 3 | 3 | 2 | 3 | 3 | -0.536 |
| 3 | 3 | 3 | 1 | 1 | 0.028 |
| 3 | 3 | 3 | 1 | 2 | -0.043 |
| 3 | 3 | 3 | 1 | 3 | -0.208 |
| 3 | 3 | 3 | 2 | 1 | -0.095 |
| 3 | 3 | 3 | 2 | 2 | -0.166 |
| 3 | 3 | 3 | 2 | 3 | -0.331 |
| 3 | 3 | 3 | 3 | 1 | -0.358 |
| 3 | 3 | 3 | 3 | 2 | -0.429 |
| 3 | 3 | 3 | 3 | 3 | -0.594 |

Unconscious [ -0.402 ]
Note : this value is the mean observed score. It does not result from the regression model.

Source : A1 TARIFF BASED ON UK SURVEY (1993)

```
   pute value = 1.0.

if (mob eq 2) value = value - .069.
If (mob eq 3) value = value - .314.

if (selfc eq 2) value = value - .104.
if (selfc eq 3) value = value - .214.

if (uact eq 2) value = value - .036.
if (uact eq 3) value = value - .094.

if (pain eq 2) value = value - .123.
if (pain eq 3) value = value - .386.

if (mood eq 2) value = value - .071.
if (mood eq 3) value = value - .236.

if (mob ne 1 or uact ne 1 or selfc ne 1 or pain ne 1 or mood ne 1)
 value = value - .081.

if (mob eq 3 or selfc eq 3 or uact eq 3 or mood eq 3 or pain eq 3)
 value = value - .269.

if (missing(mob) or missing(uact) or missing(selfc) or missing(pain) or missing(mood))
 value = 9.

missing values value (9).
```

# EQ - 5D

Sağlık Anketi

Turkish version

Aşağıda, her grubun karşısında bulunan kutulardan birine yandaki gibi bir işaret koyarak (☑ bu şekilde), bugünkü sağlık durumunuzu en iyi ifade eden cümleciği işaretleyiniz.

**Hareket edebilme**

Yürürken, hiç bir güçlük çekmiyorum ❑

Yürürken bazı güçlüklerim oluyor ❑

Yatalağım ❑

**Kendi Kendine Bakabilme**

Kendime bakmakta güçlük çekmiyorum ❑

Kendi kendime yıkanırken veya giyinirken bazı güçlüklerim oluyor ❑

Kendi kendime yıkanancak veya giyinebilecek durumda değilim ❑

**Olağan işler** *(örneğin ; iş, ders çalışma, ev işleri, aile içi veya boş zaman faaliyetleri)*

Olağan işlerimi yaparken herhangi bir güçlük çekmiyorum ❑

Olağan işlerimi yaparken bazı güçlüklerim oluyor ❑

Olağan işlerimi yapabilecek durumda değilim ❑

**Ağrı/Rahatsızlık**

Ağrı veya rahatsızlığım yok ❑

Orta derecede ağrı veya rahatsızlıklarım var ❑

Aşırı derecede ağrı veya rahatsızlıklarım var ❑

**Endişe / Moral Bozukluğu**

Endişeli veya moral bozukluğu içinde değilim ❑

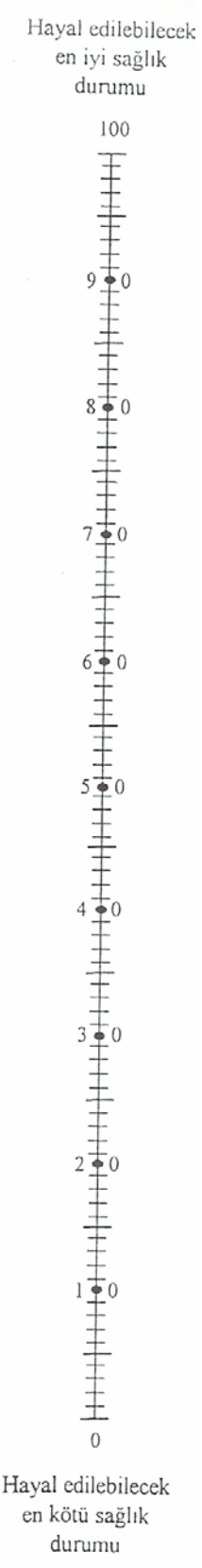
Orta derecede endişeliyim veya moralim bozuk ❑

Aşırı derecede endişeliyim veya moralim çok bozuk ❑

Sağlık durumunun ne kadar iyi veya kötü olduğunu ifade edebilmede yardımcı olabilmek için, üzerinde hayal edilebildiğiniz en iyi sağlık durumunu 100 ile, ve hayal edilebildiğiniz en kötü sağlık durumunu ise 0 ile gösterebileceğiniz, (termometreye oldukça benzeyen) bir ölçek çizdik.

Bu ölçek üzerinde, bugünkü sağlığınızın kendi düşüncenize göre ne kadar iyi veya kötü olduğunu işaretlemenizi istiyoruz. Lütfen, bunu; alttaki kutucuktan, şu anki sağlık durumunuzun ne kadar iyi veya kötü olduğunu gösteren noktaya kadar bir çizgi çizerek yapınız. Çizginiz ölçek üstündeki bir noktayı mutlaka kesmelidir.

**Bugünkü sağlık durumunuz**



# APPENDIX B

## DEFINITION OF ATTRIBUTES' LEVELS

### 1. Physical Function: Mobility and Physical Activities

Level 1. Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND having NO limitation in physical ability to lift, walk, run, jump or bend.

Level 2. Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND having SOME limitation in physical ability to lift, walk, run, jump or bend.

Level 3. Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND NEEDING mechanical aids walk or get around.

Level 4. NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND having SOME limitation in physical ability to lift, walk, run, jump or bend.

Level 5. NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND NEEDING mechanical aids walk or get around.

Level 6. NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND NOT being able to use or control the arms and legs.

### 2. Role Function Self Care (Daily Activities)

Level 1. Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND having NO limitations when playing, going to school, working or in other activities.

Level 2. Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND having SOME limitations when playing, going to school, working or in other activities.

Level 3. Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND NOT being able to play, attend school or work.

Level 4. NEEDING HELP to eat, dress, bath and go to the toilet; AND having SOME limitations when playing, going to school, working or in other activities.

Level 5. NEEDING HELP to eat, dress, bath and go to the toilet; AND NOT being able to play, attend school or work.

**3. Psychological Discomfort (Emotional)**

Level 1. Generally happy and free from worry

Level 2. Occasionally fretful, angry, irritable, anxious, depressed or suffering "night terrors"

Level 3. Often fretful, angry, irritable, anxious, depressed or suffering "night terrors"

Level 4. Almost always fretful, angry, irritable, anxious, depressed

Level 5. Extremely fretful, angry, irritable, anxious, depressed usually requiring hospitalization or psychiatric institutional care.

**4. Pain**

Level 1. Free of pain and discomfort

Level 2. Occasional pain. Discomfort relieved by nonprescription drugs or self-control activity without disruption of normal activities.

Level 3. Frequent pain. Discomfort relieved by oral medicines with occasional disruption of normal activities.

Level 4. Frequent pain; frequent disruption of normal activities. Discomfort requires prescription narcotics for relief.

Level 5. Severe pain. Pain not relieved by drugs and constantly disrupts normal activities.

**5. Social Function**

Level 1. Having an average number of friends and contacts with others.

Level 2. Having a few friends and contacts with others.

Level 3. Having no friends and contacts with others.

**6. Body Image**

Level 1. Having no concern about your appearance, do not feel like yourself and still feeling attractive

Level 2. Feeling self-conscious about your appearance, discomfort about scar, some problems on nakedness.

Level 3. Having concerns about appearance, feeling clothes don't look good and discomfort because of body changes.

Level 4. Feeling ashamed of own body, feeling does not like yourself.

**7. Fears and Concerns**

Level 1. Feeling difficulties with your illness are over and no concern about recurrence

Level 2. Having some concerns about recurrence and feeling uneasy about future health

Level 3. Feeling fear of recurrence and bothered by thoughts about the recurrence of cancer.

Level 4. Feeling fear of death.

**8. Sexual Functioning**

Level 1. Having no problems about sexual relationship and sexual attractiveness

Level 2. Some changes in libido and frequency of sexual relationship negatively.

Level 3. Problems in sexual relationship, lack of sexual interest

Level 4. Loss of libido and sexual dysfunction.

# APPENDIX C

# PUBLIC SURVEY FOR ASSESSMENT OF INDIVIDUAL UTILITY SCALES AND SCALING CONSTANTS

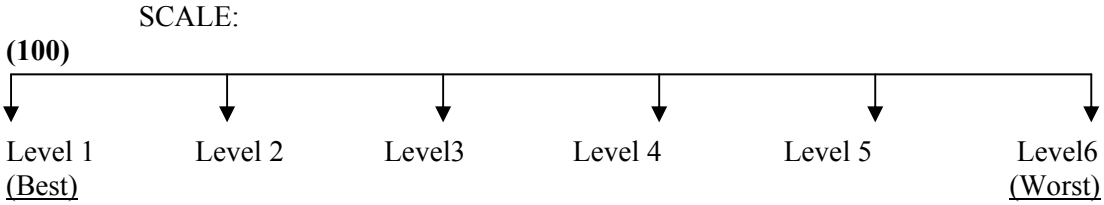
## PART I

## SINGLE DIMENSION UTILITY VALUES

Classification of any health state is based on 8 dimensional systems. Thus we can define any health state as a function of these 8 attributes. The aim of this study is to assess the one-dimensional value function for each attribute. In each page you will read about one dimension. Please read definitions and procedures carefully; after that, consider and evaluate each attribute individually.

**ATTRIBUTE 1. PHYSICAL FUNCTION**

The degree to health states which reflects patient ability for mobility and physical activities such as arm motion, walk, run, jump etc.




where:

**Level 1:** Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND having NO limitation in physical ability to lift, walk, run, jump or bend.

**Level 2:** Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND having SOME limitation in physical ability to lift, walk, run, jump or bend.

**Level 3:** Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND NEEDING mechanical aids walk or get around.

**Level 4:** NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND having SOME limitation in physical ability to lift, walk, run, jump or bend.

**Level 5:** NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND NEEDING mechanical aids walk or get around.

**Level 6:** NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND NOT being able to use or control the arms and legs.

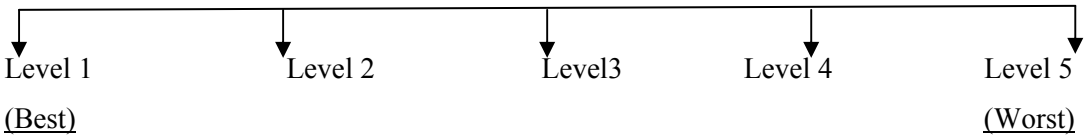
The aim of this stage of the process is to assess the one-dimensional value function for the attribute of "Physical Function". This will be done by rating the anchor points. As described, this attribute has 6 anchor points (Level 1, Level 2,…, Level 6) and the rating for the Best Level is predetermined: the rating for the Level 1 is 100 (as seen on scale). Now, please read the statements of EACH LEVEL, think carefully and **RATE (between 0–100) EACH LEVEL** (other than Level 1) according to your beliefs. For example after reading definition of Level 2, if you feel that your rating for that level is 80, write as "80" for Level 2 on scale, after definition of Level 3, if you feel that your rating for that level is 65, write as "65" for Level 3 on scale and continue like that.

**ATTRIBUTE 2. ROLE FUNCTION**

The degree to health states which reflects patient role function and daily activities such as ability level of eating, dressing, doing housework, bathing, cleaning etc.

SCALE:

**(100)**



Level 1 (Best) | Level 2 | Level3 | Level 4 | Level 5 (Worst)

where:

**Level 1:** Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND having NO limitations when playing, going to school, working or in other activities.

**Level 2:** Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND having SOME limitations when playing, going to school, working or in other activities.

**Level 3:** Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND NOT being able to play, attend school or work.

**Level 4:** NEEDING HELP to eat, dress, bath and go to the toilet; AND having SOME limitations when playing, going to school, working or in other activities.

**Level 5:** NEEDING HELP to eat, dress, bath and go to the toilet; AND NOT being able to play, attend school or work.

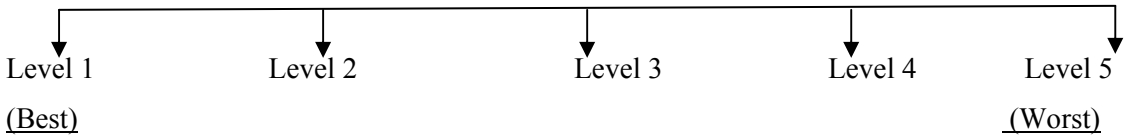
The aim of this stage of the process is to assess the one-dimensional value function for the attribute of "Role Function". This will be done by rating the anchor points. As described, this attribute has 5 anchor points (Level 1, Level 2,…, Level 5) and the rating for the Best Level is predetermined: the rating for the Level 1 is 100 (as seen on scale). Now, please read the statements of EACH LEVEL, think carefully and **RATE (between 0–100) EACH LEVEL** (other than Level 1) according to your beliefs. For example after reading definition of Level 2, if you feel that your rating for that level is 80, write as "80" for Level 2 on scale, after that reading definition of Level 3, if you feel that your rating for that level is 65, write as "65" for Level 3 on scale and continue like that.

**ATTRIBUTE 3. PSYCHOLOGICAL DISCOMFORT**

The degree to health states which reflects patient emotional feelings. For example feeling happiness, sadness or depression, being anxious or angry etc.

SCALE:

**(100)**




where:

**Level 1:** Generally happy and free from worry.

**Level 2:** Occasionally fretful, angry, irritable, anxious, depressed or suffering "night terrors".

**Level 3:** Often fretful, angry, irritable, anxious, depressed or suffering "night terrors".

**Level 4:** Almost always fretful, angry, irritable, anxious, depressed.

**Level 5:** Extremely fretful, angry, irritable, anxious, depressed usually requiring hospitalization or psychiatric institutional care.

The aim of this stage of the process is to assess the one-dimensional value function for the attribute of "Psychological Discomfort ". This will be done by rating the anchor points. As described, this attribute has 5 anchor points (Level 1, Level 2,…, Level 5) and the rating for the Best Level is predetermined: the rating for the Level 1 is 100 (as seen on scale). Now, please read the statements of EACH LEVEL, think carefully and **RATE (between 0–100) EACH LEVEL** (other than Level 1) according to your beliefs. For example after reading definition of Level 2, if you feel that your rating for that level is 80, write as "80" for Level 2 on scale, after that reading definition of Level 3, if you feel that your rating for that level is 65, write as "65" for Level 3 on scale and continue like that.

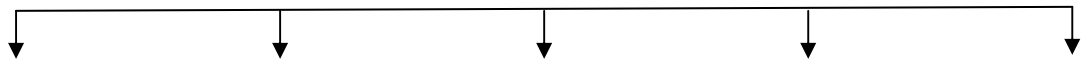
Note: The rating for the Death is 0. Consider this point during your ratings.

**ATTRIBUTE 4. PAIN**

The degree to health states that reflects pain level that patient has.

SCALE:

**(100)**



Level 1 (Best) | Level 2 | Level3 | Level 4 | Level 5 (Worst)

where:

**Level 1:** Free of pain and discomfort.

**Level 2:** Occasional pain. Discomfort relieved by nonprescription drugs or self-control activity without disruption of normal activities.

**Level 3:** Frequent pain. Discomfort relieved by oral medicines with occasional disruption of normal activities.

**Level 4:** Frequent pain; frequent disruption of normal activities. Discomfort requires prescription narcotics for relief.

**Level 5:** Severe pain. Pain not relieved by drugs and constantly disrupts normal activities.

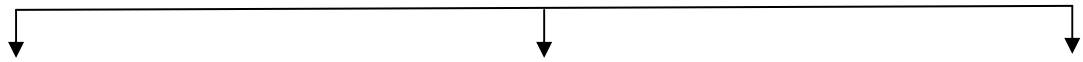
The aim of this stage of the process is to assess the one-dimensional value function for the attribute of "Pain ". This will be done by rating the anchor points. As described, this attribute has 5 anchor points (Level 1, Level 2,…, Level 5) and the rating for the Best Level is predetermined: the rating for the Level 1 is 100 (as seen on scale). Now, please read the statements of EACH LEVEL, think carefully and **RATE (between 0–100) EACH LEVEL** (other than Level 1) according to your beliefs. For example after reading definition of Level 2, if you feel that your rating for that level is 80, write as "80" for Level 2 on scale, after that reading definition of Level 3, if you feel that your rating for that level is 65, write as "65" for Level 3 on scale and continue like that.

**ATTRIBUTE 5. SOCIAL FUNCTION**

The degree to health states which reflects social activities of patient. Number of friends, relations with people, family relations, and hobbies are important criteria for determining this degree.

SCALE:

**(100)**



Level 1 (Best) | Level 2 | Level 3 (Worst)

where:

**Level 1:** Having an average number of friends and contacts with others.

**Level 2:** Having a few friends and contacts with others.

**Level 3:** Having no friends and contacts with others.

The aim of this stage of the process is to assess the one-dimensional value function for the attribute of "Social Function". This will be done by rating the anchor points. As described, this attribute has 3 anchor points (Level 1, Level 2, Level 3 ) and the rating for the Best Level is predetermined: the rating for the Level 1 is 100 (as seen on scale). Now, please read the statements of EACH LEVEL, think carefully and **RATE (between 0–100) EACH LEVEL** (other than Level 1) according to your beliefs. For example after reading definition of Level 2, if you feel that your rating for that level is 80, write as "80" for Level 2 on scale.

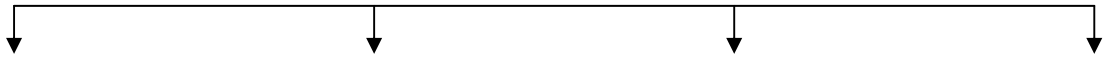
Note: The rating for the Death is 0. Consider this point during your ratings.

**ATTRIBUTE 6. BODY IMAGE**

The degree to health states which reflects patient satisfaction from her appearance. This attribute determine how disfigurement on her body affects patient such as if she feels ashamedness or avoids nakedness or feels less attractive etc.

SCALE:

**(100)**



Level 1 (Best) | Level 2 | Level3 | Level 4 (Worst)

where:

**Level 1:** Having no concern about your body appearance, like yourself and still feeling attractive.

**Level 2:** Feeling self-conscious about my appearance, discomfort about scar, some problems on nakedness.

**Level 3:** Having concerns about appearance, feeling clothes don't look good and discomfort because of body changes.

**Level 4:** Feeling ashamed of own body, feeling does not like yourself.

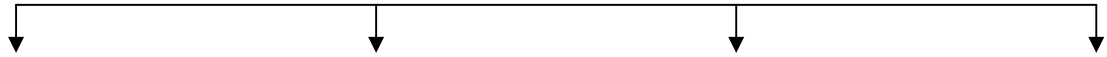
The aim of this stage of the process is to assess the one-dimensional value function for the attribute of "Body Image". This will be done by rating the anchor points. As described, this attribute has 4 anchor points (Level 1, Level 2,…, Level 4) and the rating for the Best Level is predetermined: the rating for the Level 1 is 100 (as seen on scale). Now, please read the statements of EACH LEVEL, think carefully and **RATE (between 0–100) EACH LEVEL** (other than Level 1) according to your beliefs. For example after reading definition of Level 2, if you feel that your rating for that level is 80, write as "80" for Level 2 on scale, after that reading definition of Level 3, if you feel that your rating for that level is 65, write as "65" for Level 3 on scale and continue like that.

**ATTRIBUTE 7. FEARS AND CONCERNS**

The degree to health states which reflects patient fears and concerns about reoccurrence of disease or fear of death because of cancer.

SCALE:

**(100)**



Level 1 (Best) | Level 2 | Level3 | Level 4 (Worst)

where:

**Level 1:** Feeling difficulties with your illness are over and no concern about recurrence

**Level 2:** Having some concerns about recurrence and feeling uneasy about future health

**Level 3:** Feeling fear of recurrence and bothered by thoughts about the recurrence of cancer.

**Level 4:** Feeling fear of death.

The aim of this stage of the process is to assess the one-dimensional value function for the attribute of "Fears and Concerns". This will be done by rating the anchor points. As described, this attribute has 4 anchor points (Level 1, Level 2,…, Level 4 and the rating for the Best Level is predetermined: the rating for the Level 1 is 100 (as seen on scale). Now, please read the statements of EACH LEVEL, think carefully and **RATE (between 0–100) EACH LEVEL** (other than Level 1) according to your beliefs. For example after reading definition of Level 2, if you feel that your rating for that level is 80, write as "80" for Level 2 on scale, after that reading definition of Level 3, if you feel that your rating for that level is 65, write as "65" for Level 3 on scale and continue like that.

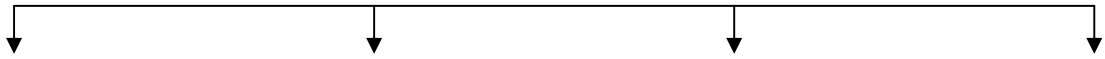
Note: The rating for the Death is 0. Consider this point during your ratings.

**ATTRIBUTE 8. SEXUAL FUNCTIONING**

The degree to health states which reflects sexual interest and functioning of patient. Frequency, satisfaction, problems during relation, dysfunction etc. are determining factors to degree.

SCALE:

**(100)**



Level 1 (Best) | Level 2 | Level 3 | Level 4 (Worst)

where:

**Level 1:** Having no problems about sexual relationship and sexual attractiveness

**Level 2:** Some changes in libido and frequency of sexual relationship negatively.

**Level 3**: Problems in sexual relationship, lack of sexual interest

**Level 4**: Loss of libido and sexual dysfunction.

The aim of this stage of the process is to assess the one-dimensional value function for the attribute of "Sexual Functioning". This will be done by rating the anchor points. As described, this attribute has 4 anchor points (Level 1, Level 2,…, Level 4) and the rating for the Best Level is predetermined: the rating for the Level 1 is 100 (as seen on scale). Now, please read the statements of EACH LEVEL, think carefully and **RATE (between 0–100) EACH LEVEL** (other than Level 1) according to your beliefs. For example after reading definition of Level 2, if you feel that your rating for that level is 80, write as "80" for Level 2 on scale, after that reading definition of Level 3, if you feel that your rating for that level is 65, write as "65" for Level 3 on scale and continue like that.

Note: The rating for the Death is 0. Consider this point during your ratings.

# PART II

## SWING-WEIGHTING

The table below was created for your health states. As you known from the previous part, we have 8 main attributes to determine health states. You read definitions of attributes in previous section. Now we aim to assess the relative contribution of individual attribute to the overall evaluation of alternatives.

As you see the “worst case” provides a benchmark and it will rank seventh (worst) overall. Now imagine that you are allowed to increase just one criterion from worst to best (its maximum level) on the relevant. Which would you choose? Please rank your option as “1” in the table.

Now imagine that you are in a situation where the maximum possible score is achieved on this criterion, but all others remain at their worst. You can now select a second criterion to be raised to the maximum level. What would it be this time? Please rank your option as “2” in the table.

If both of these criteria were raised to the maximum score, what would be the next most important swing? Go on like that and fill the “Rank” column in Table.

Table C.1. Attribute Importance Level Table.

| Attribute Swung from Worst to Best | Consequence to Compare | Rank |
|---|---|---|
| Benchmark | $(X_1^-, X_2^-, X_3^-, X_4^-, X_5^-, X_6^-, X_7^-, X_8^-)$ | 9 |
| Physical Function | $(X_1^+, X_2^-, X_3^-, X_4^-, X_5^-, X_6^-, X_7^-, X_8^-)$ | |
| Role Function | $(X_1^-, X_2^+, X_3^-, X_4^-, X_5^-, X_6^-, X_7^-, X_8^-)$ | |
| Social Function | $(X_1^-, X_2^-, X_3^+, X_4^-, X_5^-, X_6^-, X_7^-, X_8^-)$ | |
| Pain | $(X_1^-, X_2^-, X_3^-, X_4^+, X_5^-, X_6^-, X_7^-, X_8^-)$ | |
| Body Image | $(X_1^-, X_2^-, X_3^-, X_4^-, X_5^+, X_6^-, X_7^-, X_8^-)$ | |
| Fears and Concern | $(X_1^-, X_2^-, X_3^-, X_4^-, X_5^-, X_6^+, X_7^-, X_8^-)$ | |
| Sexual Function | $(X_1^-, X_2^-, X_3^-, X_4^-, X_5^-, X_6^-, X_7^+, X_8^-)$ | |
| Psychological Funct. | $(X_1^-, X_2^-, X_3^-, X_4^-, X_5^-, X_6^-, X_7^-, X_8^+)$ | |

$X_1$ = Physical Function

$X_2$ = Role Function (Daily Activities)

$X_3$ = Social Function

$X_4$ = Pain

$X_5$ = Body Image

$X_6$ = Fears and Concerns

$X_7$ = Sexual Function

$X_8$ = Psychological Function

$X_i^-$ = The worst level on $i^{th}$ attribute

$X_i^+$ = The best level on $i^{th}$ attribute

$i = 1,2,\ldots, 7$

# APPENDIX D

# ROC WEIGHTS FOR INDICATED NUMBER OF ATTRIBUTES

Table D.1. ROC Weights for Indicated Number of Attributes

| Rank | Number of Attributes | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **9** | **8** | **7** | **6** | **5** | **4** | **3** | **2** |
| **1** | .3143 | .3397 | .3704 | .4083 | .4567 | .5208 | .6111 | .7500 |
| **2** | .2032 | .2147 | .2276 | .2417 | .2567 | .2708 | .2778 | .2500 |
| **3** | .1477 | .1522 | .1561 | .1583 | .1567 | .1458 | .1111 | |
| **4** | .1106 | .1106 | .1085 | .1028 | .0900 | .0625 | | |
| **5** | .0828 | .0793 | .0728 | .0611 | .0400 | | | |
| **6** | .0606 | .0543 | .0442 | .0278 | | | | |
| **7** | .0421 | .0335 | .0204 | | | | | |
| **8** | .0262 | .0156 | | | | | | |
| **9** | .0123 | | | | | | | |

| Rank | Number of Attributes | | | | | | |
|---|---|---|---|---|---|---|---|
| | **16** | **15** | **14** | **13** | **12** | **11** | **10** |
| **1** | .2113 | .2212 | .2323 | .2446 | .2586 | .2745 | .2929 |
| **2** | .1488 | .1545 | .01608 | .1677 | .1753 | .1836 | .1929 |
| **3** | .1175 | .1212 | .1251 | .1292 | .1336 | .1382 | .1429 |
| **4** | .0967 | .0990 | .1013 | .1036 | .1058 | .1079 | .1096 |
| **5** | .0811 | .0823 | .0834 | .0844 | .0850 | .0851 | .0846 |
| **6** | .0686 | .0690 | .0692 | .0690 | .0683 | .0670 | .0646 |
| **7** | .0582 | .0579 | .0573 | .0562 | .0544 | .0518 | .0479 |
| **8** | .0492 | .0484 | .0471 | .0452 | .0425 | .0388 | .0336 |
| **9** | .0414 | .0400 | .0381 | .0356 | .0321 | .0275 | .0211 |
| **10** | .0345 | .0326 | .0302 | .0270 | .0299 | .0174 | .0100 |
| **11** | .0282 | .0260 | .0230 | .0193 | .0145 | .0083 | |
| **12** | .0226 | .0199 | .0165 | .0123 | .0069 | | |
| **13** | .0173 | .0143 | .0106 | .0059 | | | |
| **14** | .0125 | .0092 | .0051 | | | | |
| **15** | .0081 | .0044 | | | | | |
| **16** | .0039 | | | | | | |

# APPENDIX E

## INDIVIDUAL UTILITY VALUES AND RELATIVE IMPORTANCE ORDER OF ATTRIBUTES

Table E. 1. Individual Utility Values of 8 Attributes for Participant 1.

| **Participant 1** | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 |
|---|---|---|---|---|---|---|
| Physical | 100 | 85 | 60 | 40 | 20 | 2 |
| Role | 100 | 80 | 50 | 25 | 10 | - |
| Social | 100 | 60 | 20 | - | - | - |
| Pain | 100 | 75 | 50 | 10 | 2 | - |
| Body | 100 | 60 | 20 | 5 | - | - |
| Fears | 100 | 60 | 20 | 10 | - | - |
| Sex | 100 | 70 | 40 | 10 | - | - |
| Psychological | 100 | 90 | 60 | 30 | 10 | - |

Table E. 2. Individual Utility Values of 8 Attributes for Participant 2.

| **Participant 2** | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 |
|---|---|---|---|---|---|---|
| Physical | 100 | 90 | 50 | 10 | 5 | 1 |
| Role | 100 | 90 | 60 | 30 | 5 | - |
| Social | 100 | 80 | 5 | - | - | - |
| Pain | 100 | 80 | 50 | 20 | 0 | - |
| Body | 100 | 90 | 10 | 1 | - | - |
| Fears | 100 | 80 | 10 | 5 | - | - |
| Sex | 100 | 50 | 20 | 1 | - | - |
| Psychological | 100 | 70 | 30 | 5 | 1 | - |

Table E. 3. Individual Utility Values of 8 Attributes for Participant 3.

| **Participant 3** | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 |
|---|---|---|---|---|---|---|
| Physical | 100 | 85 | 60 | 50 | 30 | 10 |
| Role | 100 | 60 | 40 | 20 | 5 | - |
| Social | 100 | 95 | 60 | - | - | - |
| Pain | 100 | 80 | 70 | 40 | 20 | - |
| Body | 100 | 90 | 80 | 70 | - | - |
| Fears | 100 | 50 | 30 | 0 | - | - |
| Sex | 100 | 60 | 40 | 30 | - | - |
| Psychological | 100 | 50 | 30 | 20 | 15 | - |

Table E. 4. Individual Utility Values of 8 Attributes for Participant 4.

| **Participant 4** | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 |
|---|---|---|---|---|---|---|
| Physical | 100 | 80 | 60 | 30 | 15 | 5 |
| Role | 100 | 75 | 50 | 20 | 10 | - |
| Social | 100 | 70 | 40 | - | - | - |
| Pain | 100 | 85 | 50 | 20 | 3 | - |
| Body | 100 | 70 | 40 | 20 | - | - |
| Fears | 100 | 60 | 25 | 10 | - | - |
| Sex | 100 | 70 | 50 | 30 | - | - |
| Psychological | 100 | 90 | 60 | 25 | 15 | - |

Table E. 5. Individual Utility Values of 8 Attributes for Participant 5.

| **Participant 5** | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 |
|---|---|---|---|---|---|---|
| Physical | 100 | 75 | 60 | 50 | 30 | 10 |
| Role | 100 | 75 | 50 | 30 | 5 | - |
| Social | 100 | 85 | 10 | - | - | - |
| Pain | 100 | 90 | 60 | 20 | 5 | - |
| Body | 100 | 85 | 60 | 40 | - | - |
| Fears | 100 | 90 | 70 | 40 | - | - |
| Sex | 100 | 80 | 40 | 20 | - | - |
| Psychological | 100 | 90 | 50 | 30 | 15 | - |

Table E. 6. Individual Utility Values of 8 Attributes for Participant 6.

| **Participant 6** | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 |
|---|---|---|---|---|---|---|
| Physical | 100 | 90 | 50 | 40 | 30 | 0 |
| Role | 100 | 90 | 50 | 20 | 0 | - |
| Social | 100 | 50 | 0 | - | - | - |
| Pain | 100 | 90 | 60 | 30 | 5 | - |
| Body | 100 | 60 | 40 | 10 | - | - |
| Fears | 100 | 80 | 40 | 10 | - | - |
| Sex | 100 | 70 | 30 | 5 | - | - |
| Psychological | 100 | 80 | 40 | 30 | 5 | - |

Table E. 7. Individual Utility Values of 8 Attributes for Participant 7.

| **Participant 7** | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 |
|---|---|---|---|---|---|---|
| Physical | 100 | 60 | 30 | 20 | 10 | 0 |
| Role | 100 | 85 | 40 | 20 | 5 | - |
| Social | 100 | 90 | 10 | - | - | - |
| Pain | 100 | 85 | 55 | 25 | 0 | - |
| Body | 100 | 65 | 45 | 25 | - | - |
| Fears | 100 | 65 | 35 | 5 | - | - |
| Sex | 100 | 65 | 40 | 25 | - | - |
| Psychological | 100 | 70 | 30 | 10 | 0 | - |

Table E. 8. Individual Utility Values of 8 Attributes for Participant 8.

| **Participant 8** | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 |
|---|---|---|---|---|---|---|
| Physical | 100 | 75 | 50 | 30 | 20 | 5 |
| Role | 100 | 80 | 55 | 35 | 15 | - |
| Social | 100 | 75 | 20 | - | - | - |
| Pain | 100 | 85 | 65 | 35 | 15 | - |
| Body | 100 | 85 | 50 | 10 | - | - |
| Fears | 100 | 70 | 40 | 15 | - | - |
| Sex | 100 | 70 | 40 | 15 | - | - |
| Psychological | 100 | 85 | 65 | 35 | 10 | - |

Table E. 9. Individual Utility Values of 8 Attributes for Participant 9.

| **Participant 9** | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 |
|---|---|---|---|---|---|---|
| Physical | 100 | 75 | 50 | 30 | 10 | 0 |
| Role | 100 | 80 | 50 | 25 | 10 | - |
| Social | 100 | 60 | 20 | - | - | - |
| Pain | 100 | 80 | 50 | 25 | 10 | - |
| Body | 100 | 75 | 50 | 25 | - | - |
| Fears | 100 | 80 | 50 | 25 | - | - |
| Sex | 100 | 80 | 50 | 25 | - | - |
| Psychological | 100 | 80 | 50 | 25 | 10 | - |

Table E. 10. Individual Utility Values of 8 Attributes for Participant 10.

| **Participant 10** | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 |
|---|---|---|---|---|---|---|
| Physical | 100 | 80 | 60 | 40 | 15 | 10 |
| Role | 100 | 80 | 55 | 30 | 10 | - |
| Social | 100 | 65 | 35 | - | - | - |
| Pain | 100 | 80 | 65 | 40 | 20 | - |
| Body | 100 | 75 | 55 | 35 | - | - |
| Fears | 100 | 50 | 20 | 5 | - | - |
| Sex | 100 | 75 | 50 | 40 | - | - |
| Psychological | 100 | 75 | 50 | 25 | 15 | - |

Table E. 11. Individual Utility Values of 8 Attributes for Participant 11.

| **Participant 11** | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 |
|---|---|---|---|---|---|---|
| Physical | 100 | 80 | 50 | 35 | 25 | 15 |
| Role | 100 | 75 | 50 | 30 | 20 | - |
| Social | 100 | 85 | 50 | - | - | - |
| Pain | 100 | 90 | 50 | 30 | 10 | - |
| Body | 100 | 80 | 60 | 50 | - | - |
| Fears | 100 | 80 | 65 | 50 | - | - |
| Sex | 100 | 70 | 60 | 50 | - | - |
| Psychological | 100 | 95 | 70 | 50 | 30 | - |

Table E. 12. Individual Utility Values of 8 Attributes for Participant 12.

| **Participant 12** | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 |
|---|---|---|---|---|---|---|
| Physical | 100 | 75 | 55 | 45 | 30 | 10 |
| Role | 100 | 80 | 60 | 30 | 15 | - |
| Social | 100 | 70 | 30 | - | - | - |
| Pain | 100 | 85 | 60 | 30 | 15 | - |
| Body | 100 | 80 | 50 | 25 | - | - |
| Fears | 100 | 85 | 60 | 30 | - | - |
| Sex | 100 | 80 | 50 | 25 | - | - |
| Psychological | 100 | 80 | 50 | 35 | 20 | - |

Table E. 13. Individual Utility Values of 8 Attributes for Participant 13.

| **Participant 13** | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 |
|---|---|---|---|---|---|---|
| Physical | 100 | 60 | 40 | 20 | 10 | 5 |
| Role | 100 | 80 | 60 | 30 | 5 | - |
| Social | 100 | 90 | 30 | - | - | - |
| Pain | 100 | 90 | 70 | 50 | 40 | - |
| Body | 100 | 70 | 60 | 50 | - | - |
| Fears | 100 | 50 | 40 | 20 | - | - |
| Sex | 100 | 80 | 65 | 40 | - | - |
| Psychological | 100 | 75 | 50 | 10 | 1 | - |

Table E. 14. Individual Utility Values of 8 Attributes for Participant 14.

| **Participant 14** | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 |
|---|---|---|---|---|---|---|
| Physical | 100 | 85 | 70 | 60 | 40 | 15 |
| Role | 100 | 85 | 65 | 45 | 15 | - |
| Social | 100 | 65 | 25 | - | - | - |
| Pain | 100 | 85 | 70 | 45 | 10 | - |
| Body | 100 | 95 | 65 | 35 | - | - |
| Fears | 100 | 80 | 55 | 25 | - | - |
| Sex | 100 | 80 | 55 | 30 | - | - |
| Psychological | 100 | 85 | 65 | 40 | 15 | - |

Table E. 15. Individual Utility Values of 8 Attributes for Participant 15.

| **Participant 15** | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 |
|---|---|---|---|---|---|---|
| Physical | 100 | 90 | 40 | 35 | 25 | 5 |
| Role | 100 | 70 | 45 | 40 | 25 | - |
| Social | 100 | 50 | 5 | - | - | - |
| Pain | 100 | 80 | 45 | 15 | 5 | - |
| Body | 100 | 90 | 40 | 5 | - | - |
| Fears | 100 | 70 | 45 | 5 | - | - |
| Sex | 100 | 80 | 60 | 15 | - | - |
| Psychological | 100 | 75 | 40 | 15 | 0 | - |

Table E. 16. Individual Utility Values of 8 Attributes for Participant 16.

| **Participant 16** | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 |
|---|---|---|---|---|---|---|
| Physical | 100 | 85 | 50 | 25 | 15 | 8 |
| Role | 100 | 85 | 50 | 25 | 15 | - |
| Social | 100 | 90 | 65 | - | - | - |
| Pain | 100 | 80 | 50 | 25 | 15 | - |
| Body | 100 | 95 | 90 | 70 | - | - |
| Fears | 100 | 70 | 20 | 5 | - | - |
| Sex | 100 | 85 | 70 | 55 | - | - |
| Psychological | 100 | 95 | 85 | 40 | 20 | - |

Table E. 17. Individual Utility Values of 8 Attributes for Participant 17.

| **Participant 17** | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 |
|---|---|---|---|---|---|---|
| Physical | 100 | 80 | 65 | 40 | 25 | 5 |
| Role | 100 | 80 | 60 | 35 | 5 | - |
| Social | 100 | 80 | 20 | - | - | - |
| Pain | 100 | 70 | 45 | 25 | 5 | - |
| Body | 100 | 85 | 70 | 50 | - | - |
| Fears | 100 | 75 | 45 | 20 | - | - |
| Sex | 100 | 75 | 50 | 20 | - | - |
| Psychological | 100 | 75 | 60 | 40 | 15 | - |

Table E. 18. Individual Utility Values of 8 Attributes for Participant 18.

| **Participant 18** | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 |
|---|---|---|---|---|---|---|
| Physical | 100 | 70 | 60 | 20 | 15 | 0 |
| Role | 100 | 60 | 40 | 30 | 0 | - |
| Social | 100 | 60 | 10 | - | - | - |
| Pain | 100 | 90 | 70 | 30 | 5 | - |
| Body | 100 | 90 | 70 | 25 | - | - |
| Fears | 100 | 75 | 55 | 25 | - | - |
| Sex | 100 | 75 | 40 | 15 | - | - |
| Psychological | 100 | 85 | 60 | 30 | 10 | - |

Table E. 19. Individual Utility Values of 8 Attributes for Participant 19.

| **Participant 19** | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 |
|---|---|---|---|---|---|---|
| Physical | 100 | 80 | 60 | 40 | 20 | 1 |
| Role | 100 | 60 | 40 | 20 | 1 | - |
| Social | 100 | 85 | 10 | - | - | - |
| Pain | 100 | 80 | 50 | 20 | 1 | - |
| Body | 100 | 80 | 50 | 10 | - | - |
| Fears | 100 | 50 | 10 | 1 | - | - |
| Sex | 100 | 80 | 50 | 25 | - | - |
| Psychological | 100 | 80 | 50 | 20 | 1 | - |

Table E. 20. Individual Utility Values of 8 Attributes for Participant20.

| **Participant 20** | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 |
|---|---|---|---|---|---|---|
| Physical | 100 | 95 | 90 | 75 | 70 | 65 |
| Role | 100 | 98 | 90 | 88 | 80 | - |
| Social | 100 | 50 | 5 | - | - | - |
| Pain | 100 | 80 | 60 | 40 | 10 | - |
| Body | 100 | 90 | 80 | 70 | - | - |
| Fears | 100 | 50 | 20 | 5 | - | - |
| Sex | 100 | 80 | 60 | 40 | - | - |
| Psychological | 100 | 50 | 20 | 10 | 1 | - |

Table E. 21. Individual Utility Values of 8 Attributes for Participant 21.

| **Participant 21** | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 |
|---|---|---|---|---|---|---|
| Physical | 100 | 50 | 25 | 10 | 5 | 1 |
| Role | 100 | 50 | 10 | 5 | 1 | - |
| Social | 100 | 80 | 50 | - | - | - |
| Pain | 100 | 80 | 50 | 5 | 1 | - |
| Body | 100 | 90 | 80 | 70 | - | - |
| Fears | 100 | 50 | 5 | 1 | - | - |
| Sex | 100 | 90 | 70 | 50 | - | - |
| Psychological | 100 | 80 | 60 | 50 | 30 | - |

Table E. 22. Individual Utility Values of 8 Attributes for Participant 22.

| **Participant 22** | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 |
|---|---|---|---|---|---|---|
| Physical | 100 | 75 | 50 | 40 | 20 | 5 |
| Role | 100 | 80 | 50 | 20 | 5 | - |
| Social | 100 | 60 | 30 | - | - | - |
| Pain | 100 | 80 | 70 | 50 | 20 | - |
| Body | 100 | 90 | 70 | 50 | - | - |
| Fears | 100 | 60 | 40 | 20 | - | - |
| Sex | 100 | 80 | 60 | 40 | - | - |
| Psychological | 100 | 90 | 70 | 50 | 10 | - |

Table E. 23. Individual Utility Values of 8 Attributes for Participant 23.

| **Participant 23** | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 |
|---|---|---|---|---|---|---|
| Physical | 100 | 85 | 60 | 35 | 20 | 15 |
| Role | 100 | 80 | 40 | 20 | 5 | - |
| Social | 100 | 80 | 25 | - | - | - |
| Pain | 100 | 80 | 70 | 60 | 20 | - |
| Body | 100 | 80 | 30 | 10 | - | - |
| Fears | 100 | 80 | 30 | 5 | - | - |
| Sex | 100 | 80 | 70 | 50 | - | - |
| Psychological | 100 | 90 | 70 | 40 | 10 | - |

Table E. 24. Individual Utility Values of 8 Attributes for Participant 24.

| **Participant 24** | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 |
|---|---|---|---|---|---|---|
| Physical | 100 | 90 | 60 | 40 | 10 | 5 |
| Role | 100 | 80 | 50 | 10 | 5 | - |
| Social | 100 | 90 | 30 | - | - | - |
| Pain | 100 | 90 | 50 | 25 | 10 | - |
| Body | 100 | 90 | 50 | 20 | - | - |
| Fears | 100 | 75 | 20 | 1 | - | - |
| Sex | 100 | 90 | 70 | 50 | - | - |
| Psychological | 100 | 80 | 60 | 40 | 20 | - |

Table E. 25. Individual Utility Values of 8 Attributes for Participant 25.

| **Participant 25** | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 |
|---|---|---|---|---|---|---|
| Physical | 100 | 80 | 40 | 20 | 15 | 10 |
| Role | 100 | 40 | 30 | 15 | 10 | - |
| Social | 100 | 40 | 5 | - | - | - |
| Pain | 100 | 90 | 50 | 20 | 10 | - |
| Body | 100 | 80 | 60 | 30 | - | - |
| Fears | 100 | 50 | 30 | 20 | - | - |
| Sex | 100 | 50 | 20 | 5 | - | - |
| Psychological | 100 | 80 | 60 | 40 | 10 | - |

Table E. 26. Individual Utility Values of 8 Attributes for Participant 26.

| **Participant 26** | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 |
|---|---|---|---|---|---|---|
| Physical | 100 | 90 | 75 | 60 | 50 | 40 |
| Role | 100 | 80 | 60 | 55 | 35 | - |
| Social | 100 | 60 | 30 | - | - | - |
| Pain | 100 | 80 | 65 | 50 | 30 | - |
| Body | 100 | 80 | 60 | 50 | - | - |
| Fears | 100 | 60 | 40 | 30 | - | - |
| Sex | 100 | 80 | 60 | 50 | - | - |
| Psychological | 100 | 65 | 60 | 50 | 30 | - |

Table E. 27. Individual Utility Values of 8 Attributes for Participant 27.

| **Participant 27** | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 |
|---|---|---|---|---|---|---|
| Physical | 100 | 85 | 55 | 40 | 25 | 5 |
| Role | 100 | 75 | 45 | 30 | 10 | - |
| Social | 100 | 60 | 20 | - | - | - |
| Pain | 100 | 75 | 50 | 25 | 1 | - |
| Body | 100 | 90 | 70 | 30 | - | - |
| Fears | 100 | 85 | 60 | 35 | - | - |
| Sex | 100 | 75 | 50 | 20 | - | - |
| Psychological | 100 | 80 | 60 | 40 | 15 | - |

Table E. 28. Individual Utility Values of 8 Attributes for Participant 28.

| **Participant 28** | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 |
|---|---|---|---|---|---|---|
| Physical | 100 | 80 | 50 | 30 | 20 | 5 |
| Role | 100 | 85 | 60 | 15 | 5 | - |
| Social | 100 | 60 | 15 | - | - | - |
| Pain | 100 | 90 | 70 | 40 | 15 | - |
| Body | 100 | 90 | 60 | 25 | - | - |
| Fears | 100 | 80 | 60 | 40 | - | - |
| Sex | 100 | 90 | 60 | 30 | - | - |
| Psychological | 100 | 90 | 60 | 35 | 15 | - |

Table E. 29. Individual Utility Values of 8 Attributes for Participant 29.

| **Participant 29** | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 |
|---|---|---|---|---|---|---|
| Physical | 100 | 85 | 75 | 50 | 30 | 5 |
| Role | 100 | 80 | 60 | 40 | 10 | - |
| Social | 100 | 80 | 15 | - | - | - |
| Pain | 100 | 85 | 75 | 50 | 15 | - |
| Body | 100 | 85 | 50 | 10 | - | - |
| Fears | 100 | 85 | 65 | 35 | - | - |
| Sex | 100 | 85 | 50 | 20 | - | - |
| Psychological | 100 | 80 | 55 | 20 | 5 | - |

Table E. 30. Individual Utility Values of 8 Attributes for Participant 30.

| **Participant 30** | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 |
|---|---|---|---|---|---|---|
| Physical | 100 | 90 | 60 | 40 | 10 | 5 |
| Role | 100 | 90 | 60 | 35 | 5 | - |
| Social | 100 | 80 | 20 | - | - | - |
| Pain | 100 | 95 | 70 | 40 | 20 | - |
| Body | 100 | 85 | 50 | 20 | - | - |
| Fears | 100 | 70 | 30 | 5 | - | - |
| Sex | 100 | 60 | 20 | 5 | - | - |
| Psychological | 100 | 80 | 40 | 10 | 2 | - |

Table E. 31. Importance Order of Attributes for Participants 1 to 5.

| Rank | Attribute | | | | |
|---|---|---|---|---|---|
| | **Part. 1** | **Part.2** | **Part. 3** | **Part. 4** | **Part. 5** |
| 1 | Physical | Social | Physical | Pain | Physical |
| 2 | Role | Pain | Fears | Role | Role |
| 3 | Pain | Body | Role | Physical | Psychological |
| 4 | Psychological | Physical | Psychological | Fears | Pain |
| 5 | Social | Role | Sex | Psychological | Social |
| 6 | Body | Sex | Pain | Social | Fears |
| 7 | Fears | Fears | Body | Body | Body |
| 8 | Sex | | Social | Sex | Sex |

Table E. 32. Importance Order of Attributes for Participants 6 to 10.

| Rank | Attribute | | | | |
|---|---|---|---|---|---|
| | **Part. 6** | **Part. 7** | **Part. 8** | **Part. 9** | **Part.10** |
| 1 | Fears | Psychological | Role | Role | Fears |
| 2 | Psychological | Fears | Psychological | Pain | Physical |
| 3 | Pain | Pain | Physical | Physical | Role |
| 4 | Sex | Role | Social | Psychological | Pain |
| 5 | Social | Physical | Sex | Social | Psychological |
| 6 | Body | Social | Body | Fears | Social |
| 7 | Role | Sex | Pain | Sex | Body |
| 8 | Physical | Body | Fears | Body | Sex |

Table E. 33. Importance Order of Attributes for Participants 11 to 15.

| Rank | Attribute | | | | |
|---|---|---|---|---|---|
| | **Part. 11** | **Part. 12** | **Part. 13** | **Part. 14** | **Part. 15** |
| 1 | Physical | Physical | Psychological | Pain | Physical |
| 2 | Role | Pain | Role | Role | Role |
| 3 | Pain | Role | Physical | Physical | Psychological |
| 4 | Psychological | Psychological | Fears | Psychological | Social |
| 5 | Sex | Fears | Pain | Social | Fears |
| 6 | Social | Social | Social | Body | Pain |
| 7 | Body | Sex | Sex | Sex | Body |
| 8 | Fears | Body | Body | Fears | Sex |

Table E. 34. Importance Order of Attributes for Participants 16 to 20.

| Rank | Attribute | | | | |
|---|---|---|---|---|---|
| | **Part. 16** | **Part. 17** | **Part. 18** | **Part. 19** | **Part. 20** |
| 1 | Pain | Physical | Physical | Physical | Psychological |
| 2 | Physical | Role | Role | Role | Physical |
| 3 | Role | Psychological | Pain | Psychological | Fears |
| 4 | Social | Pain | Social | Fears | Pain |
| 5 | Psychological | Social | Psychological | Pain | Social |
| 6 | Fears | Fears | Sex | Body | Role |
| 7 | Sex | Body | Body | Social | Sex |
| 8 | Body | Sex | Fears | Sex | Body |

Table E. 35. Importance Order of Attributes for Participants 21 to 25.

| Rank | Attribute | | | | |
|---|---|---|---|---|---|
| | **Part. 21** | **Part. 22** | **Part. 23** | **Part. 24** | **Part. 25** |
| 1 | Pain | Physical | Role | Role | Physical |
| 2 | Role | Role | Physical | Physical | Role |
| 3 | Physical | Psychological | Psychological | Fears | Psychological |
| 4 | Fears | Social | Pain | Pain | Social |
| 5 | Psychological | Pain | Fears | Psychological | Sex |
| 6 | Social | Fears | Social | Body | Pain |
| 7 | Sex | Body | Sex | Social | Body |
| 8 | Body | Sex | Body | Sex | Fears |

Table E. 36. Importance Order of Attributes for Participants 26 to 30.

| Rank | Attribute | | | | |
|---|---|---|---|---|---|
| | **Part. 26** | **Part. 27** | **Part. 28** | **Part. 29** | **Part. 30** |
| 1 | Physical | Pain | Physical | Pain | Physical |
| 2 | Role | Physical | Psychological | Psychological | Role |
| 3 | Pain | Role | Role | Role | Pain |
| 4 | Fears | Psychological | Pain | Physical | Psychological |
| 5 | Body | Social | Social | Social | Social |
| 6 | Psychological | Sex | Fears | Body | Sex |
| 7 | Social | Body | Sex | Fears | Body |
| 8 | Sex | Fears | Body | Sex | Fears |

# APPENDIX F

## HEALTH STATE EVALUATIONS OF ONCOLOGISTS

A formal health state level evaluation form was designed for defining each health state with respect to identified attributes by self-completion of oncologists. Three main parts constituted this form. In the first part, introductory written information was given about health states, and oncologists were familiar to the concept. After that, definitions of attributes and their levels, on which classification of health states were based, were given. Finally, evaluation sheet was given in the last part and for each health state they were asked to mark the suitable level that reflects the condition of that health state for each attribute. In this part, you can examine evaluation sheets obtained from ten oncologists performed this task.

Table F.1. Health State Evaluation Form of 1st Oncologist

| HEALTH STATE LEVEL EVALUATION FORM | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MASTECTOMY | | | | | | LUMPECTOMY | | | | | |
| Attribute | Level | Definition | NED | NED I | NED II | Local Recurr. | Sasyaged | Metastasis | NED | NED I | NED II | Local Recurr. | Salvaged | Metastasis |
| Physical Function | 1 | Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND having NO limitation in physical ability to lift, walk, run, jump or bend | X | X | | | | | X | X | | | | |
| | 2 | Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND having SOME limitation in physical ability to lift, walk, run, jump or bend | | | X | X | | | | | X | X | | |
| | 3 | Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND NEEDING mechanical aids walk or get around | | | | | X | | | | | | X | |
| | 4 | NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND having SOME limitation in physical ability to lift, walk, run, jump or bend | | | | | | X | | | | | | X |
| | 5 | NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND NEEDING mechanical aids walk or get around | | | | | | | | | | | | |
| | 6 | NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND NOT being able to use or control the arms and legs | | | | | | | | | | | | |
| Role Function | 1 | Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND having NO limitations when playing, going to school, working or in other activities | X | X | | | | | X | X | | | | |
| | 2 | Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND having SOME limitations when playing, going to school, working or in other activities | | | X | | | | | | | | | |
| | 3 | Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND NOT being able to play, attend school or work | | | X | X | X | | | | X | X | X | |
| | 4 | NEEDING HELP to eat, dress, bath and go to the toilet; AND having NO limitations when playing, going to school, working or in other activities | | | | | | | | | | | | |
| | 5 | NEEDING HELP to eat, dress, bath and go to the toilet; AND NOT being able to play, attend school or work | | | | | | X | | | | | | X |
| Social Func. | 1 | Having an average number of friends and contacts with others | X | X | X | X | | | X | X | X | X | | |
| | 2 | Having a few friends and contacts with others | | | | | X | X | | | | | X | X |
| | 3 | Having no friends and contacts with others | | | | | | | | | | | | |
| Pain | 1 | Free of pain and discomfort | | | | | | | | | | | | |
| | 2 | Occasional pain. Discomfort relieved by nonprescription drugs or self-control activity without disruption of normal activities | | | | | | | X | | | | | |
| | 3 | Frequent pain. Discomfort relieved by oral medicines with occasional disruption of normal activities | X | X | X | X | | | X | X | X | X | | |
| | 4 | Frequent pain; frequent disruption of normal activities. Discomfort requires prescription narcotics for relief | | | | | X | | | | | | X | |
| | 5 | Severe pain. Pain not relieved by drugs and constantly disrupts normal activities | | | | | | X | | | | | | X |
| Body Image | 1 | Having no concern about my body appearance, like myself and still feeling attractive | | | | | | | X | X | X | | | |
| | 2 | Feeling self-conscious about my appearance, discomfort about scar, some problems on nakedness | | | | | | | | | | X | X | |
| | 3 | Having concerns about appearance, feeling clothes don't look good and discomfort because of body changes | X | X | X | X | X | X | | | | | | X |
| | 4 | Feeling ashamed of own body, feeling does not like herself | | | | | | | | | | | | |
| Fears & Concern | 1 | Feeling difficulties with her illness are over and no concern about recurrence | X | X | | | | | | | | | | |
| | 2 | Having some concerns about recurrence and feeling uneasy about future health | | | X | | | | X | X | X | | | |
| | 3 | Feeling fear and bothered by thoughts about the recurrence | | | | X | X | | | | | X | X | |
| | 4 | Feeling fear of death | | | | | | X | | | | | | X |

Table F.2. Health State Evaluation Form of 2nd Oncologist

| HEALTH STATE LEVEL EVALUATION FORM | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MASTECTOMY | | | | | | LUMPECTOMY | | | | | |
| Attribute | Level | Definition | NED | NED I | NED II | Local Recurr. | Sasyaged | Metastasis | NED | NED I | NED II | Local Recurr. | Salvaged | Metastasis |
| Physical Function | 1 | Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND having NO limitation in physical ability to lift, walk, run, jump or bend | X | | | | | | X | | | | | |
| | 2 | Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND having SOME limitation in physical ability to lift, walk, run, jump or bend | | X | | | | | | X | | | | |
| | 3 | Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND NEEDING mechanical aids walk or get around | | | X | | | | | | X | | | |
| | 4 | NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND having SOME limitation in physical ability to lift, walk, run, jump or bend | | | | X | | | | | | X | | |
| | 5 | NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND NEEDING mechanical aids walk or get around | | | | | X | | | | | | X | |
| | 6 | NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND NOT being able to use or control the arms and legs | | | | | | X | | | | | | X |
| Role Function | 1 | Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND having NO limitations when playing, going to school, working or in other activities | X | | | | | | X | | | | | |
| | 2 | Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND having SOME limitations when playing, going to school, working or in other activities | | X | | | | | | X | | | | |
| | 3 | Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND NOT being able to play, attend school or work | | | X | | | | | | X | | | |
| | 4 | NEEDING HELP to eat, dress, bath and go to the toilet; AND having NO limitations when playing, going to school, working or in other activities | | | | | X | | | | | | X | |
| | 5 | NEEDING HELP to eat, dress, bath and go to the toilet; AND NOT being able to play, attend school or work | | | | | | X | | | | | | X |
| Social Func. | 1 | Having an average number of friends and contacts with others | X | | | | | | X | | | | | |
| | 2 | Having a few friends and contacts with others | | X | | | | | | X | | | | |
| | 3 | Having no friends and contacts with others | | | | | | X | | | | | | X |
| Pain | 1 | Free of pain and discomfort | X | | | | | | X | | | | | |
| | 2 | Occasional pain. Discomfort relieved by nonprescription drugs or self-control activity without disruption of normal activities | | X | | | | | | X | | | | |
| | 3 | Frequent pain. Discomfort relieved by oral medicines with occasional disruption of normal activities | | | | X | | | | | X | | | |
| | 4 | Frequent pain; frequent disruption of normal activities. Discomfort requires prescription narcotics for relief | | | | | X | | | | X | | | |
| | 5 | Severe pain. Pain not relieved by drugs and constantly disrupts normal activities | | | | | | X | | | | | | X |
| Body Image | 1 | Having no concern about my body appearance, like myself and still feeling attractive | X | | | | | | X | | | | | |
| | 2 | Feeling self-conscious about my appearance, discomfort about scar, some problems on nakedness | | | X | | | | | X | | | | |
| | 3 | Having concerns about appearance, feeling clothes don't look good and discomfort because of body changes | | | | | X | | | | | | X | |
| | 4 | Feeling ashamed of own body, feeling does not like herself | | | | | | X | | | | | | X |
| Fears & Concern | 1 | Feeling difficulties with her illness are over and no concern about recurrence | X | | | | | | X | | | | | |
| | 2 | Having some concerns about recurrence and feeling uneasy about future health | | | | | X | | | | X | | | |
| | 3 | Feeling fear and bothered by thoughts about the recurrence | | | | | X | | | | | | X | |
| | 4 | Feeling fear of death | | | | | | X | | | | | | X |

Table F.3. Health State Evaluation Form of 3rd Oncologist

| HEALTH STATE LEVEL EVALUATION FORM | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MASTECTOMY | | | | | | LUMPECTOMY | | | | | |
| Attribute | Level | Definition | NED | NED I | NED II | Local Recurr. | Sasvaged | Metastasis | NED | NED I | NED II | Local Recurr. | Salvaged | Metastasis |
| Physical Function | 1 | Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND having NO limitation in physical ability to lift, walk, run, jump or bend | X | | | | | | X | | | | | |
| | 2 | Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND having SOME limitation in physical ability to lift, walk, run, jump or bend | | X | | | | | | X | X | | | |
| | 3 | Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND NEEDING mechanical aids walk or get around | | | | | | | | | X | | | |
| | 4 | NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND having SOME limitation in physical ability to lift, walk, run, jump or bend | | | X | X | | | | | | X | | |
| | 5 | NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND NEEDING mechanical aids walk or get around | | | | | X | | | | | | X | |
| | 6 | NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND NOT being able to use or control the arms and legs | | | | | | X | | | | | | X |
| Role Function | 1 | Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND having NO limitations when playing, going to school, working or in other activities | X | | | | | | X | | | | | |
| | 2 | Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND having SOME limitations when playing, going to school, working or in other activities | | X | | | | | | X | | | | |
| | 3 | Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND NOT being able to play, attend school or work | | | X | | | | | | X | | | |
| | 4 | NEEDING HELP to eat, dress, bath and go to the toilet; AND having NO limitations when playing, going to school, working or in other activities | | | | | X | | | | | | X | |
| | 5 | NEEDING HELP to eat, dress, bath and go to the toilet; AND NOT being able to play, attend school or work | | | | | | X | | | | | | X |
| Social Func. | 1 | Having an average number of friends and contacts with others | X | | | | | | X | | | | | |
| | 2 | Having a few friends and contacts with others | | X | X | X | X | | | X | X | X | | |
| | 3 | Having no friends and contacts with others | | | | | | X | | | | | X | X |
| Pain | 1 | Free of pain and discomfort | X | | | | | | X | | | | | |
| | 2 | Occasional pain. Discomfort relieved by nonprescription drugs or self-control activity without disruption of normal activities | | X | | | | | | X | | | | |
| | 3 | Frequent pain. Discomfort relieved by oral medicines with occasional disruption of normal activities | | | X | X | | | | | X | | | |
| | 4 | Frequent pain; frequent disruption of normal activities. Discomfort requires prescription narcotics for relief | | | | | X | | | | | X | X | |
| | 5 | Severe pain. Pain not relieved by drugs and constantly disrupts normal activities | | | | | | X | | | | | | X |
| Body Image | 1 | Having no concern about my body appearance, like myself and still feeling attractive | X | | | | | | X | X | | | | |
| | 2 | Feeling self-conscious about my appearance, discomfort about scar, some problems on nakedness | | X | X | | | | | | X | | | |
| | 3 | Having concerns about appearance, feeling clothes don't look good and discomfort because of body changes | | | | X | X | | | | | X | X | |
| | 4 | Feeling ashamed of own body, feeling does not like herself | | | | | | X | | | | | | X |
| Fears & Concern | 1 | Feeling difficulties with her illness are over and no concern about recurrence | X | | | | | | | | | | | |
| | 2 | Having some concerns about recurrence and feeling uneasy about future health | | X | X | X | | | X | X | X | | | |
| | 3 | Feeling fear and bothered by thoughts about the recurrence | | | | | X | | | | | X | X | |
| | 4 | Feeling fear of death | | | | | | X | | | | | | X |

Table F.4. Health State Evaluation Form of 4th Oncologist

| HEALTH STATE LEVEL EVALUATION FORM | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MASTECTOMY | | | | | | LUMPECTOMY | | | | | |
| Attribute | Level | Definition | NED | NED I | NED II | Local Recurr. | Salvaged | Metastasis | NED | NED I | NED II | Local Recurr. | Salvaged | Metastasis |
| Physical Function | 1 | Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND having NO limitation in physical ability to lift, walk, run, jump or bend | X | X | | | | | X | X | | | | |
| | 2 | Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND having SOME limitation in physical ability to lift, walk, run, jump or bend | | | X | X | | | | | X | X | | |
| | 3 | Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND NEEDING mechanical aids walk or get around | | | | | X | | | | | | X | |
| | 4 | NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND having SOME limitation in physical ability to lift, walk, run, jump or bend | | | | | | X | | | | | | X |
| | 5 | NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND NEEDING mechanical aids walk or get around | | | | | | | | | | | | |
| | 6 | NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND NOT being able to use or control the arms and legs | | | | | | | | | | | | |
| Role Function | 1 | Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND having NO limitations when playing, going to school, working or in other activities | X | X | | | | | X | X | | | | |
| | 2 | Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND having SOME limitations when playing, going to school, working or in other activities | | | X | X | X | | | | X | X | X | |
| | 3 | Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND NOT being able to play, attend school or work | | | | | | | | | | | | |
| | 4 | NEEDING HELP to eat, dress, bath and go to the toilet; AND having NO limitations when playing, going to school, working or in other activities | | | | | | | | | | | | |
| | 5 | NEEDING HELP to eat, dress, bath and go to the toilet; AND NOT being able to play, attend school or work | | | | | | X | | | | | | X |
| Social Func. | 1 | Having an average number of friends and contacts with others | X | X | X | X | | | X | X | X | X | | |
| | 2 | Having a few friends and contacts with others | | | | | X | X | | | | | X | X |
| | 3 | Having no friends and contacts with others | | | | | | | | | | | | |
| Pain | 1 | Free of pain and discomfort | | | | | | | | | | | | |
| | 2 | Occasional pain. Discomfort relieved by nonprescription drugs or self-control activity without disruption of normal activities | | | | | | | | | | | | |
| | 3 | Frequent pain. Discomfort relieved by oral medicines with occasional disruption of normal activities | X | X | X | X | | | X | X | X | X | | |
| | 4 | Frequent pain; frequent disruption of normal activities. Discomfort requires prescription narcotics for relief | | | | | X | | | | | | X | |
| | 5 | Severe pain. Pain not relieved by drugs and constantly disrupts normal activities | | | | | | X | | | | | | X |
| Body Image | 1 | Having no concern about my body appearance, like myself and still feeling attractive | | | | | | | X | X | X | | | |
| | 2 | Feeling self-conscious about my appearance, discomfort about scar, some problems on nakedness | | | | | | | | | | X | X | |
| | 3 | Having concerns about appearance, feeling clothes don't look good and discomfort because of body changes | X | X | X | X | X | X | | | | | | X |
| | 4 | Feeling ashamed of own body, feeling does not like herself | | | | | | | | | | | | |
| Fears & Concern | 1 | Feeling difficulties with her illness are over and no concern about recurrence | X | X | | | | | | | | | | |
| | 2 | Having some concerns about recurrence and feeling uneasy about future health | | | X | | | | X | X | X | | | |
| | 3 | Feeling fear and bothered by thoughts about the recurrence | | | | X | X | | | | | X | X | |
| | 4 | Feeling fear of death | | | | | | X | | | | | | X |

Table F.5. Health State Evaluation Form of 5th Oncologist

| HEALTH STATE LEVEL EVALUATION FORM | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MASTECTOMY | | | | | | LUMPECTOMY | | | | | |
| Attribute | Level | Definition | NED | NED I | NED II | Local Recurr. | Sasyaged | Metastasis | NED | NED I | NED II | Local Recurr. | Salvaged | Metastasis |
| Physical Function | 1 | Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND having NO limitation in physical ability to lift, walk, run, jump or bend | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | | |
| | 2 | Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND having SOME limitation in physical ability to lift, walk, run, jump or bend | | | | | ✓ | ✓ | | | | | ✓ | ✓ |
| | 3 | Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND NEEDING mechanical aids walk or get around | | | | | | | | | | | | |
| | 4 | NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND having SOME limitation in physical ability to lift, walk, run, jump or bend | | | | | | | | | | | | |
| | 5 | NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND NEEDING mechanical aids walk or get around | | | | | | | | | | | | |
| | 6 | NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND NOT being able to use or control the arms and legs | | | | | | | | | | | | |
| Role Function | 1 | Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND having NO limitations when playing, going to school, working or in other activities | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | | |
| | 2 | Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND having SOME limitations when playing, going to school, working or in other activities | | | | | ✓ | ✓ | | | | | ✓ | ✓ |
| | 3 | Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND NOT being able to play, attend school or work | | | | | | | | | | | | |
| | 4 | NEEDING HELP to eat, dress, bath and go to the toilet; AND having NO limitations when playing, going to school, working or in other activities | | | | | | | | | | | | |
| | 5 | NEEDING HELP to eat, dress, bath and go to the toilet; AND NOT being able to play, attend school or work | | | | | | | | | | | | |
| Social Func. | 1 | Having an average number of friends and contacts with others | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | | |
| | 2 | Having a few friends and contacts with others | | | | | ✓ | ✓ | | | | | ✓ | ✓ |
| | 3 | Having no friends and contacts with others | | | | | | | | | | | | |
| Pain | 1 | Free of pain and discomfort | ✓ | ✓ | | | | | ✓ | ✓ | | | | |
| | 2 | Occasional pain. Discomfort relieved by nonprescription drugs or self-control activity without disruption of normal activities | | | ✓ | ✓ | | | | | ✓ | ✓ | | |
| | 3 | Frequent pain. Discomfort relieved by oral medicines with occasional disruption of normal activities | | | | | ✓ | | | | | | ✓ | |
| | 4 | Frequent pain; frequent disruption of normal activities. Discomfort requires prescription narcotics for relief | | | | | | ✓ | | | | | | ✓ |
| | 5 | Severe pain. Pain not relieved by drugs and constantly disrupts normal activities | | | | | | | | | | | | |
| Body Image | 1 | Having no concern about my body appearance, like myself and still feeling attractive | | | | | | | | | | | | |
| | 2 | Feeling self-conscious about my appearance, discomfort about scar, some problems on nakedness | ✓ | | | | | | ✓ | | | | | |
| | 3 | Having concerns about appearance, feeling clothes don't look good and discomfort because of body changes | | | | | | | | | | | | |
| | 4 | Feeling ashamed of own body, feeling does not like herself | | | | | | | | | | | | |
| Fears & Concern | 1 | Feeling difficulties with her illness are over and no concern about recurrence | | | | | | | | | | | | |
| | 2 | Having some concerns about recurrence and feeling uneasy about future health | ✓ | ✓ | ✓ | | | | ✓ | ✓ | ✓ | | | |
| | 3 | Feeling fear and bothered by thoughts about the recurrence | | | | ✓ | ✓ | | | | | ✓ | ✓ | |
| | 4 | Feeling fear of death | | | | | | ✓ | | | | | | ✓ |

Table F.6. Health State Evaluation Form of 6th Oncologist

| HEALTH STATE LEVEL EVALUATION FORM | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MASTECTOMY | | | | | | LUMPECTOMY | | | | | | |
| Attribute | Level | Definition | NED | NED I | NED II | Local Recurr. | Sasvaged | Metastasis | NED | NED I | NED II | Local Recurr. | Salvaged | Metastasis |
| Physical Function | 1 | Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND having NO limitation in physical ability to lift, walk, run, jump or bend | X | | | | | | X | | | | | |
| | 2 | Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND having SOME limitation in physical ability to lift, walk, run, jump or bend | | X | | | | | | X | | | | |
| | 3 | Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND NEEDING mechanical aids walk or get around | | | X | | | | | | X | | | |
| | 4 | NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND having SOME limitation in physical ability to lift, walk, run, jump or bend | | | | X | | | | | | X | | |
| | 5 | NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND NEEDING mechanical aids walk or get around | | | | | X | | | | | | X | |
| | 6 | NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND NOT being able to use or control the arms and legs | | | | | | X | | | | | | X |
| Role Function | 1 | Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND having NO limitations when playing, going to school, working or in other activities | X | | | | | | X | | | | | |
| | 2 | Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND having SOME limitations when playing, going to school, working or in other activities | X | X | | | | | X | | | | | |
| | 3 | Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND NOT being able to play, attend school or work | | | X | | | | | | X | X | | |
| | 4 | NEEDING HELP to eat, dress, bath and go to the toilet; AND having NO limitations when playing, going to school, working or in other activities | | | X | | | | | | | | X | |
| | 5 | NEEDING HELP to eat, dress, bath and go to the toilet; AND NOT being able to play, attend school or work | | | | | | X | | | | | | X |
| Social Func. | 1 | Having an average number of friends and contacts with others | | X | | | | | X | | | | | |
| | 2 | Having a few friends and contacts with others | | | X | | | | | X | | | | |
| | 3 | Having no friends and contacts with others | | | | | | X | | | | | | X |
| Pain | 1 | Free of pain and discomfort | X | | | | | | X | | | | | |
| | 2 | Occasional pain. Discomfort relieved by nonprescription drugs or self-control activity without disruption of normal activities | | X | | | | | | X | | | | |
| | 3 | Frequent pain. Discomfort relieved by oral medicines with occasional disruption of normal activities | | | X | | | | | | X | | | |
| | 4 | Frequent pain; frequent disruption of normal activities. Discomfort requires prescription narcotics for relief | | | | | X | | | | | | X | |
| | 5 | Severe pain. Pain not relieved by drugs and constantly disrupts normal activities | | | | | | X | | | | | | X |
| Body Image | 1 | Having no concern about my body appearance, like myself and still feeling attractive | | | | | | X | X | | | | X | X |
| | 2 | Feeling self-conscious about my appearance, discomfort about scar, some problems on nakedness | | | X | | | | | | | | | |
| | 3 | Having concerns about appearance, feeling clothes don't look good and discomfort because of body changes | X | | | | | | | X | X | | | |
| | 4 | Feeling ashamed of own body, feeling does not like herself | | X | | X | | | | | | X | | |
| Fears & Concern | 1 | Feeling difficulties with her illness are over and no concern about recurrence | X | X | | | | | X | X | | | | |
| | 2 | Having some concerns about recurrence and feeling uneasy about future health | | | X | | | | | | X | | | |
| | 3 | Feeling fear and bothered by thoughts about the recurrence | | | X | | | | | | X | | | |
| | 4 | Feeling fear of death | | | | X | X | X | | | | X | X | X |

Table F.7. Health State Evaluation Form of 7th Oncologist

| HEALTH STATE LEVEL EVALUATION FORM | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MASTECTOMY | | | | | | LUMPECTOMY | | | | | |
| Attribute | Level | Definition | NED | NED I | NED II | Local Recurr. | Sasyaged | Metastasis | NED | NED I | NED II | Local Recurr. | Salvaged | Metastasis |
| Physical Function | 1 | Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND having NO limitation in physical ability to lift, walk, run, jump or bend | X | | | | | | X | | | | | |
| | 2 | Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND having SOME limitation in physical ability to lift, walk, run, jump or bend | | X | | | | | | X | | | | |
| | 3 | Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND NEEDING mechanical aids walk or get around | | | X | | | | | | X | | | |
| | 4 | NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND having SOME limitation in physical ability to lift, walk, run, jump or bend | | | | X | | | | | | X | | |
| | 5 | NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND NEEDING mechanical aids walk or get around | | | | | X | | | | | | X | |
| | 6 | NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND NOT being able to use or control the arms and legs | | | | | | X | | | | | | X |
| Role Function | 1 | Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND having NO limitations when playing, going to school, working or in other activities | X | | | | | | X | | | | | |
| | 2 | Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND having SOME limitations when playing, going to school, working or in other activities | | X | | | | | | X | | | | |
| | 3 | Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND NOT being able to play, attend school or work | | | X | | | | | | X | X | | |
| | 4 | NEEDING HELP to eat, dress, bath and go to the toilet; AND having NO limitations when playing, going to school, working or in other activities | | | | X | X | | | | | | X | |
| | 5 | NEEDING HELP to eat, dress, bath and go to the toilet; AND NOT being able to play, attend school or work | | | | | | X | | | | | | X |
| Social Func. | 1 | Having an average number of friends and contacts with others | X | X | | | | | X | | | | | |
| | 2 | Having a few friends and contacts with others | | | X | X | X | | | X | X | X | X | |
| | 3 | Having no friends and contacts with others | | | | | | X | | | | | | X |
| Pain | 1 | Free of pain and discomfort | X | | | | | | X | | | | | |
| | 2 | Occasional pain. Discomfort relieved by nonprescription drugs or self-control activity without disruption of normal activities | | X | | | | | | X | | | | |
| | 3 | Frequent pain. Discomfort relieved by oral medicines with occasional disruption of normal activities | | | X | | | | | | X | | | |
| | 4 | Frequent pain; frequent disruption of normal activities. Discomfort requires prescription narcotics for relief | | | | X | X | | | | | X | X | |
| | 5 | Severe pain. Pain not relieved by drugs and constantly disrupts normal activities | | | | | | X | | | | | | X |
| Body Image | 1 | Having no concern about my body appearance, like myself and still feeling attractive | | | | | X | X | X | | | | X | X |
| | 2 | Feeling self-conscious about my appearance, discomfort about scar, some problems on nakedness | | | X | | | | | | | | | |
| | 3 | Having concerns about appearance, feeling clothes don't look good and discomfort because of body changes | X | | | | | | | X | X | | | |
| | 4 | Feeling ashamed of own body, feeling does not like herself | | X | | X | | | | | | X | | |
| Fears & Concern | 1 | Feeling difficulties with her illness are over and no concern about recurrence | X | X | | | | | X | X | | | | |
| | 2 | Having some concerns about recurrence and feeling uneasy about future health | | | X | | | | | | X | | | |
| | 3 | Feeling fear and bothered by thoughts about the recurrence | | | | | | | | | | | | |
| | 4 | Feeling fear of death | | | | X | X | X | | | | X | X | X |

Table F.8. Health State Evaluation Form of 8th Oncologist

| HEALTH STATE LEVEL EVALUATION FORM | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MASTECTOMY | | | | | | LUMPECTOMY | | | | | |
| Attribute | Level | Definition | NED | NED I | NED II | Local Recurr. | Sasyaged | Metastasis | NED | NED I | NED II | Local Recurr. | Salvaged | Metastasis |
| Physical Function | 1 | Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND having NO limitation in physical ability to lift, walk, run, jump or bend | X | X | X | | X | | X | X | X | | X | |
| | 2 | Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND having SOME limitation in physical ability to lift, walk, run, jump or bend | | | | X | | | | | | X | | |
| | 3 | Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND NEEDING mechanical aids walk or get around | | | | | | | | | | | | |
| | 4 | NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND having SOME limitation in physical ability to lift, walk, run, jump or bend | | | | | | X | | | | | | X |
| | 5 | NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND NEEDING mechanical aids walk or get around | | | | | | | | | | | | |
| | 6 | NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND NOT being able to use or control the arms and legs | | | | | | | | | | | | |
| Role Function | 1 | Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND having NO limitations when playing, going to school, working or in other activities | X | X | | | X | | X | X | | | X | |
| | 2 | Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND having SOME limitations when playing, going to school, working or in other activities | | | | | | | | | | | | |
| | 3 | Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND NOT being able to play, attend school or work | | | X | X | | | | | X | X | | |
| | 4 | NEEDING HELP to eat, dress, bath and go to the toilet; AND having NO limitations when playing, going to school, working or in other activities | | | | | | | | | | | | |
| | 5 | NEEDING HELP to eat, dress, bath and go to the toilet; AND NOT being able to play, attend school or work | | | | | | X | | | | | | X |
| Social Func. | 1 | Having an average number of friends and contacts with others | | | | | | | | | | | | |
| | 2 | Having a few friends and contacts with others | X | X | X | X | X | | X | X | X | X | X | |
| | 3 | Having no friends and contacts with others | | | | | | X | | | | | | X |
| Pain | 1 | Free of pain and discomfort | X | X | X | | X | | X | X | X | | X | |
| | 2 | Occasional pain. Discomfort relieved by nonprescription drugs or self-control activity without disruption of normal activities | | | | X | | | | | | X | | |
| | 3 | Frequent pain. Discomfort relieved by oral medicines with occasional disruption of normal activities | | | | | | | | | | | | |
| | 4 | Frequent pain; frequent disruption of normal activities. Discomfort requires prescription narcotics for relief | | | | | | X | | | | | | X |
| | 5 | Severe pain. Pain not relieved by drugs and constantly disrupts normal activities | | | | | | | | | | | | |
| Body Image | 1 | Having no concern about my body appearance, like myself and still feeling attractive | | | | | | | | | | | | |
| | 2 | Feeling self-conscious about my appearance, discomfort about scar, some problems on nakedness | | | | | | | X | X | X | | | |
| | 3 | Having concerns about appearance, feeling clothes don't look good and discomfort because of body changes | X | X | X | | | | | | | X | | |
| | 4 | Feeling ashamed of own body, feeling does not like herself | | | | X | X | X | | | | | X | X |
| Fears & Concern | 1 | Feeling difficulties with her illness are over and no concern about recurrence | X | X | | | | | X | X | | | | |
| | 2 | Having some concerns about recurrence and feeling uneasy about future health | | | X | | | | | | X | | | |
| | 3 | Feeling fear and bothered by thoughts about the recurrence | | | | X | X | | | | | X | X | |
| | 4 | Feeling fear of death | | | | | | X | | | | | | X |

Table F.9. Health State Evaluation Form of 9th Oncologist

| HEALTH STATE LEVEL EVALUATION FORM | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MASTECTOMY | | | | | | LUMPECTOMY | | | | | |
| Attribute | Level | Definition | NED | NED I | NED II | Local Recurr. | Sasvaged | Metastasis | NED | NED I | NED II | Local Recurr. | Salvaged | Metastasis |
| Physical Function | 1 | Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND having NO limitation in physical ability to lift, walk, run, jump or bend | X | | | | | | X | | | | | |
| | 2 | Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND having SOME limitation in physical ability to lift, walk, run, jump or bend | | X | X | | | | | X | X | | | |
| | 3 | Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND NEEDING mechanical aids walk or get around | | | | X | | | | | | X | | |
| | 4 | NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND having SOME limitation in physical ability to lift, walk, run, jump or bend | | | | | | | | | | | | |
| | 5 | NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND NEEDING mechanical aids walk or get around | | | | | | X | | | | | | X |
| | 6 | NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND NOT being able to use or control the arms and legs | | | | | X | | | | | | X | |
| Role Function | 1 | Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND having NO limitations when playing, going to school, working or in other activities | X | | | | | | X | | | | | |
| | 2 | Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND having SOME limitations when playing, going to school, working or in other activities | | X | | | | | | X | | | | |
| | 3 | Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND NOT being able to play, attend school or work | | | X | X | | | | | X | X | | |
| | 4 | NEEDING HELP to eat, dress, bath and go to the toilet; AND having NO limitations when playing, going to school, working or in other activities | | | | | X | | | | | | X | |
| | 5 | NEEDING HELP to eat, dress, bath and go to the toilet; AND NOT being able to play, attend school or work | | | | | | X | | | | | | X |
| Social Func. | 1 | Having an average number of friends and contacts with others | | | | | | | | | | | | |
| | 2 | Having a few friends and contacts with others | X | X | X | X | X | X | X | X | X | X | X | X |
| | 3 | Having no friends and contacts with others | | | | | | | | | | | | |
| Pain | 1 | Free of pain and discomfort | X | X | | | | | X | X | | | | |
| | 2 | Occasional pain. Discomfort relieved by nonprescription drugs or self-control activity without disruption of normal activities | | | X | | | | | | X | | | |
| | 3 | Frequent pain. Discomfort relieved by oral medicines with occasional disruption of normal activities | | | | X | | | | | | X | | |
| | 4 | Frequent pain; frequent disruption of normal activities. Discomfort requires prescription narcotics for relief | | | | | X | X | | | | | X | X |
| | 5 | Severe pain. Pain not relieved by drugs and constantly disrupts normal activities | | | | | | | | | | | | |
| Body Image | 1 | Having no concern about my body appearance, like myself and still feeling attractive | | | | | | | | | | | | |
| | 2 | Feeling self-conscious about my appearance, discomfort about scar, some problems on nakedness | X | X | X | | | | X | X | X | | | |
| | 3 | Having concerns about appearance, feeling clothes don't look good and discomfort because of body changes | | | | X | X | X | | | | X | X | X |
| | 4 | Feeling ashamed of own body, feeling does not like herself | | | | | | | | | | | | |
| Fears & Concern | 1 | Feeling difficulties with her illness are over and no concern about recurrence | X | | | | | | X | X | | | | |
| | 2 | Having some concerns about recurrence and feeling uneasy about future health | X | X | | | | | X | | | | | |
| | 3 | Feeling fear and bothered by thoughts about the recurrence | | | X | X | X | | | | X | X | X | |
| | 4 | Feeling fear of death | | | | | | X | | | | | | X |

Table F.10. Health State Evaluation Form of 10th Oncologist

| HEALTH STATE LEVEL EVALUATION FORM | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MASTECTOMY | | | | | | LUMPECTOMY | | | | | | |
| Attribute | Level | Definition | NED | NED I | NED II | Local Recurr. | Sasvaged | Metastasis | NED | NED I | NED II | Local Recurr. | Salvaged | Metastasis |
| Physical Function | 1 | Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND having NO limitation in physical ability to lift, walk, run, jump or bend | | | | | | | ✓ | ✓ | | | | |
| | 2 | Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND having SOME limitation in physical ability to lift, walk, run, jump or bend | ✓ | ✓ | | | | | | | ✓ | | | |
| | 3 | Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND NEEDING mechanical aids walk or get around | | | ✓ | ✓ | | | | | | ✓ | | |
| | 4 | NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND having SOME limitation in physical ability to lift, walk, run, jump or bend | | | | | ✓ | | | | | | ✓ | |
| | 5 | NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND NEEDING mechanical aids walk or get around | | | | | | ✓ | | | | | | ✓ |
| | 6 | NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND NOT being able to use or control the arms and legs | | | | | | | | | | | | |
| Role Function | 1 | Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND having NO limitations when playing, going to school, working or in other activities | | | | | | | ✓ | ✓ | | | | |
| | 2 | Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND having SOME limitations when playing, going to school, working or in other activities | ✓ | ✓ | | | | | | | ✓ | | | |
| | 3 | Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND NOT being able to play, attend school or work | | | ✓ | ✓ | | | | | | ✓ | | |
| | 4 | NEEDING HELP to eat, dress, bath and go to the toilet; AND having NO limitations when playing, going to school, working or in other activities | | | | | ✓ | | | | | | ✓ | |
| | 5 | NEEDING HELP to eat, dress, bath and go to the toilet; AND NOT being able to play, attend school or work | | | | | | ✓ | | | | | | ✓ |
| Social Func. | 1 | Having an average number of friends and contacts with others | ✓ | ✓ | | | | | ✓ | ✓ | ✓ | | | |
| | 2 | Having a few friends and contacts with others | | | ✓ | ✓ | ✓ | | | | | ✓ | ✓ | |
| | 3 | Having no friends and contacts with others | | | | | | ✓ | | | | | | ✓ |
| Pain | 1 | Free of pain and discomfort | | | | | | | ✓ | ✓ | | | | |
| | 2 | Occasional pain. Discomfort relieved by nonprescription drugs or self-control activity without disruption of normal activities | ✓ | ✓ | ✓ | | | | | | ✓ | | | |
| | 3 | Frequent pain. Discomfort relieved by oral medicines with occasional disruption of normal activities | | | | ✓ | ✓ | | | | | ✓ | ✓ | |
| | 4 | Frequent pain; frequent disruption of normal activities. Discomfort requires prescription narcotics for relief | | | | | | ✓ | | | | | | ✓ |
| | 5 | Severe pain. Pain not relieved by drugs and constantly disrupts normal activities | | | | | | | | | | | | |
| Body Image | 1 | Having no concern about my body appearance, like myself and still feeling attractive | | | | | | | ✓ | ✓ | | | | |
| | 2 | Feeling self-conscious about my appearance, discomfort about scar, some problems on nakedness | ✓ | ✓ | ✓ | | | | | | ✓ | | | |
| | 3 | Having concerns about appearance, feeling clothes don't look good and discomfort because of body changes | | | | ✓ | ✓ | | | | | ✓ | ✓ | ✓ |
| | 4 | Feeling ashamed of own body, feeling does not like herself | | | | | | ✓ | | | | | | |
| Fears & Concern | 1 | Feeling difficulties with her illness are over and no concern about recurrence | | | | | | | ✓ | ✓ | | | | |
| | 2 | Having some concerns about recurrence and feeling uneasy about future health | ✓ | ✓ | | | | | | | | | | |
| | 3 | Feeling fear and bothered by thoughts about the recurrence | | | ✓ | ✓ | ✓ | | | | ✓ | ✓ | ✓ | |
| | 4 | Feeling fear of death | | | | | | ✓ | | | | | | ✓ |

# APPENDIX G

# DEFINITION OF HEALTH STATES

**Reference State: Perfect Health**

- Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND having NO limitation in physical ability to lift, walk, run, jump or bend
- Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND having NO limitations when playing, going to school, working or in other activities
- Having an average number of friends and contacts with others
- Free of pain and discomfort
- Having no concern about your body appearance, like yourself and still feeling attractive
- Feeling difficulties with your illness are over and no concern about recurrence
- Having no problems about sexual relationship and sexual attractiveness

1. **Mastectomy - No Evidence Of Disease (NED)**

- Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND having NO limitation in physical ability to lift, walk, run, jump or bend
- Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND having NO limitations when playing, going to school, working or in other activities
- Having an average number of friends and contacts with others
- Frequent pain. Discomfort relieved by oral medicines with occasional disruption of normal activities
- Having concerns about appearance, feeling clothes don't look good and discomfort because of body changes
- Feeling, difficulties with your illness are over and no concern about recurrence
- Some changes in libido and frequency of sexual relationship negatively.

2. **Mastectomy - No Evidence of Disease But Having Hormontherapy**

- Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND having SOME limitation in physical ability to lift, walk, run, jump or bend
- Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND having NO limitations when playing, going to school, working or in other activities
- Having an average number of friends and contacts with others
- Frequent pain. Discomfort relieved by oral medicines with occasional disruption of normal activities
- Having concerns about appearance, feeling clothes don't look good and discomfort because of body changes
- Feeling difficulties with your illness are over and no concern about recurrence
- Some changes in libido and frequency of sexual relationship negatively.

**3. Mastectomy - No Evidence of Disease But Having Chemotherapy**

- Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND having SOME limitation in physical ability to lift, walk, run, jump or bend
- Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND NOT being able to play, attend school or work
- Having a few friends and contacts with others
- Frequent pain. Discomfort relieved by oral medicines with occasional disruption of normal activities
- Having concerns about appearance, feeling clothes don't look good and discomfort because of body changes
- Having some concerns about recurrence and feeling uneasy about future health
- Problems in sexual relationship, lack of sexual interest

**4. Mastectomy – Local Recurrence (may be salvaged)**

- Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND having SOME limitation in physical ability to lift, walk, run, jump or bend
- Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND NOT being able to play, attend school or work
- Having a few friends and contacts with others
- Frequent pain. Discomfort relieved by oral medicines with occasional disruption of normal activities
- Having concerns about appearance, feeling clothes don't look good and discomfort because of body changes
- Feeling fear and bothered by thoughts about the recurrence
- Problems in sexual relationship, lack of sexual interest

**5. Mastectomy – Salvaged**

- Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND NEEDING mechanical aids walk or get around
- NEEDING HELP to eat, dress, bath and go to the toilet; AND having SOME limitations when playing, going to school, working or in other activities
- Having a few friends and contacts with others
- Frequent pain; frequent disruption of normal activities. Discomfort requires prescription narcotics for relief
- Having concerns about appearance, feeling clothes don't look good and discomfort because of body changes
- Feeling fear and bothered by thoughts about the recurrence
- Loss of libido and sexual dysfunction.

**6. Mastectomy – Metastasis**

- NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND having SOME limitation in physical ability to lift, walk, run, jump or bend
- NEEDING HELP to eat, dress, bath and go to the toilet; AND NOT being able to play, attend school or work
- Having a few friends and contacts with others
- Severe pain. Pain not relieved by drugs and constantly disrupts normal activities
- Having concerns about appearance, feeling clothes don't look good and discomfort because of body changes
- Feeling fear of death
- Loss of libido and sexual dysfunction.

**7. Lumpectomy - No Evidence Of Disease (NED)**

- Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND having NO limitation in physical ability to lift, walk, run, jump or bend
- Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND having NO limitations when playing, going to school, working or in other activities
- Having an average number of friends and contacts with others
- Free of pain and discomfort
- Having no concern about your body appearance, like yourself and still feeling attractive
- Having some concerns about recurrence and feeling uneasy about future health
- Having no problems about sexual relationship and sexual attractiveness

**8. Lumpectomy - No Evidence of Disease But Having Hormontherapy**

- Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND having NO limitation in physical ability to lift, walk, run, jump or bend
- Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND having NO limitations when playing, going to school, working or in other activities
- Having an average number of friends and contacts with others
- Occasional pain. Discomfort relieved by nonprescription drugs or self-control activity without disruption of normal activities
- Having no concern about your body appearance, like yourself and still feeling attractive
- Having some concerns about recurrence and feeling uneasy about future health
- Having no problems about sexual relationship and sexual attractiveness

**9. Lumpectomy - No Evidence of Disease But Having Chemotherapy**

- Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND having SOME limitation in physical ability to lift, walk, run, jump or bend
- Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND NOT being able to play, attend school or work
- Having an average number of friends and contacts with others
- Frequent pain. Discomfort relieved by oral medicines with occasional disruption of normal activities
- Having no concern about your body appearance, like yourself and still feeling attractive
- Having some concerns about recurrence and feeling uneasy about future health
- Problems in sexual relationship, lack of sexual interest

**10. Lumpectomy - Local Recurrence (may be salvaged)**

- Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND having SOME limitation in physical ability to lift, walk, run, jump or bend
- Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND NOT being able to play, attend school or work
- Having a few friends and contacts with others
- Frequent pain. Discomfort relieved by oral medicines with occasional disruption of normal activities
- Feeling self-conscious about your appearance, discomfort about scar, some problems on nakedness
- Feeling fear and bothered by thoughts about the recurrence
- Problems in sexual relationship, lack of sexual interest

**11. Lumpectomy – Salvaged**

- Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND NEEDING mechanical aids walk or get around
- NEEDING HELP to eat, dress, bath and go to the toilet; AND having SOME limitations when playing, going to school, working or in other activities
- Having a few friends and contacts with others
- Frequent pain; frequent disruption of normal activities. Discomfort requires prescription narcotics for relief
- Feeling self-conscious about your appearance, discomfort about scar, some problems on nakedness
- Feeling fear and bothered by thoughts about the recurrence
- Loss of libido and sexual dysfunction.

12. **Lumpectomy – Metastasis**

- NEEDING HELP from another person in order to get around house, yard, neighborhood or community; AND having SOME limitation in physical ability to lift, walk, run, jump or bend
- NEEDING HELP to eat, dress, bath and go to the toilet; AND NOT being able to play, attend school or work
- Having a few friends and contacts with others
- Severe pain. Pain not relieved by drugs and constantly disrupts normal activities
- Having concerns about appearance, feeling clothes don't look good and discomfort because of body changes
- Feeling fear of death
- Loss of libido and sexual dysfunction.

# APPENDIX H

# WORKSHEET FOR UTILITY ASSESSMENT

In this part, you can examine the introductory page of worksheet for utility assessment, and application of one of the health states as an example.

## WORKSHEET FOR UTILITY ASSESSMENT

Using Decision Making tools in health decisions usually requires measuring a decision maker's perception of his/her quality of life while he/she is in a certain "health state". Familiar concept of "utility" (Von Neumann-Morgenstern) is considered to be the most suitable of measures for this health related quality of life. Hence, researchers in this field utilize utility assessment techniques to obtain patients' utilities in relation to health states probable along the path of their disease progress. However, since patients usually do not feel well enough to conduct such assessment procedures on them, researchers must resort to implement these on healthy people as proxy. Standardized descriptions of health states are presented to healthy people and they are asked to think hard and imagine being in the health state that is being described to them.

In what follows, you will be asked to go through such descriptions of a number of health states during the progress of (God forbid!) breast cancer. Upon reading each one of these descriptions, you are asked to imagine being in that health state, and to answer the related questions. As unpleasant as it is to imagine having such a serious disease, we hope this feeling will be compensated by the knowledge that these studies hopefully will eventually yield better health services for all of us.

Today breast cancer is the most common cancer in women worldwide, and considerable research has especially focused on the quality of life in breast cancer patients after surgery. However in our country, health sector is an unbeaten area for such studies. Thus, your effort will contribute significantly in one of the very few studies conducted in our country

Your concentrated effort is very important for this study. There are 12 health state descriptions presented to you below to be evaluated. Please, read carefully the description of each health state, concentrate on that definition, and while answering the questions, imagine that you are in that health state.

Let's look at the descriptions of the 12 health states one by one:

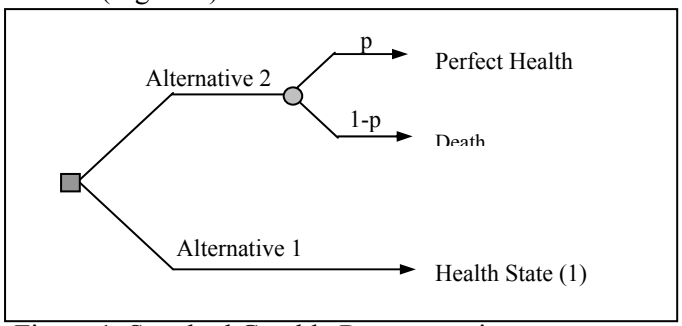
**Health State (1)- Mastectomy - No Evidence Of Disease (NED)**

**Definition:** Imagine that you have been diagnosed as having breast cancer and you had an operation for an entire breast removal (Mastectomy). There is no evidence of disease after surgery, which means that you are free of cancer but remain at risk for reoccurrence. This Health State is characterized by 7 attributes in Table 1. Perfect Health State is also defined in Table 1. in order to provide comparison.

Table 1. Description of Health State (1) & Perfect Health characterized by 7 attributes

| **Mastectomy - No Evidence Of Disease** | **Perfect Health** |
|---|---|
| *Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND having NO limitation in physical ability to lift, walk, run, jump or bend<br>*Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND having NO limitations when playing, going to school, working or in other activities<br>*Having an average number of friends and contacts with others<br>*Frequent pain. Discomfort relieved by oral medicines with occasional disruption of normal activities<br>*Having concerns about appearance, feeling clothes don't look good and discomfort because of body changes<br>*Feeling, difficulties with your illness are over and no concern about recurrence<br>*Some changes in libido and frequency of sexual relationship negatively. | *Being able to get around house, yard, neighborhood or community WITHOUT help from another person; AND having NO limitation in physical ability to lift, walk, run, jump or bend<br>*Being able to eat, dress, bath and go to the toilet WITHOUT HELP; AND having NO limitations when playing, going to school, working or in other activities<br>*Having an average number of friends and contacts with others<br>*Free of pain and discomfort<br>*Having no concern about my body appearance, like myself and still feeling attractive<br>*Feeling difficulties with your illness are over and no concern about recurrence<br>*Having no problems about sexual relationship and sexual attractiveness |

Now, imagine that you have two choices. In the first choice you live in Health State(1) for certain. In the second choice, you have a chance of living in perfect health with probability of p and a chance of death with complementary probability (1-p). Namely in this alternative you should accept a (1-p) risk of death in order to have a p-chance for perfect health. (Figure 1)




**P = ?**

Figure 1. Standard Gamble Representation

Think carefully, for which probability of (p), you are indifferent between two alternatives? In other words, what is the value of p that you accept a (1-p) % risk of death in order to obtain perfect health?

# APPENDIX I

## DOTPLOT GRAPHS OF UTILITY VALUES

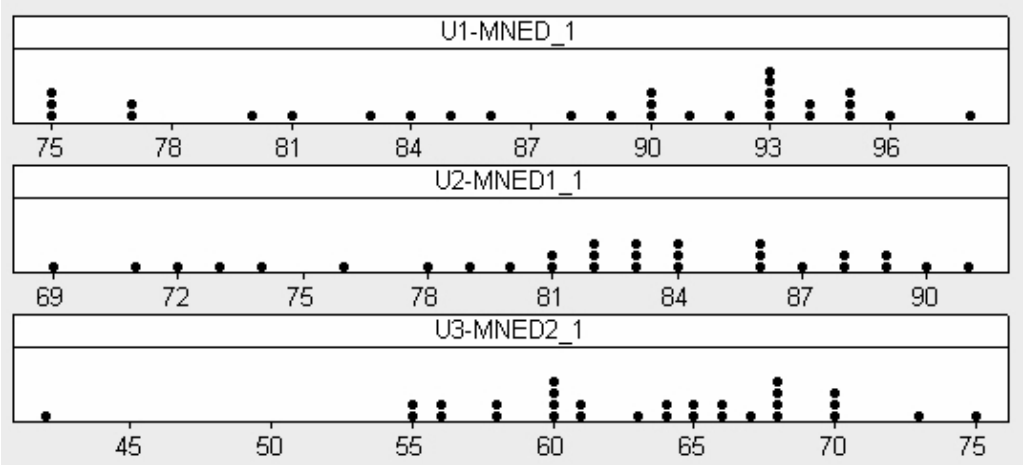



Figure I.1. Dotplot graphs of NED, NEDI, NEDII states of Mastectomy utility values obtained from MAUM.

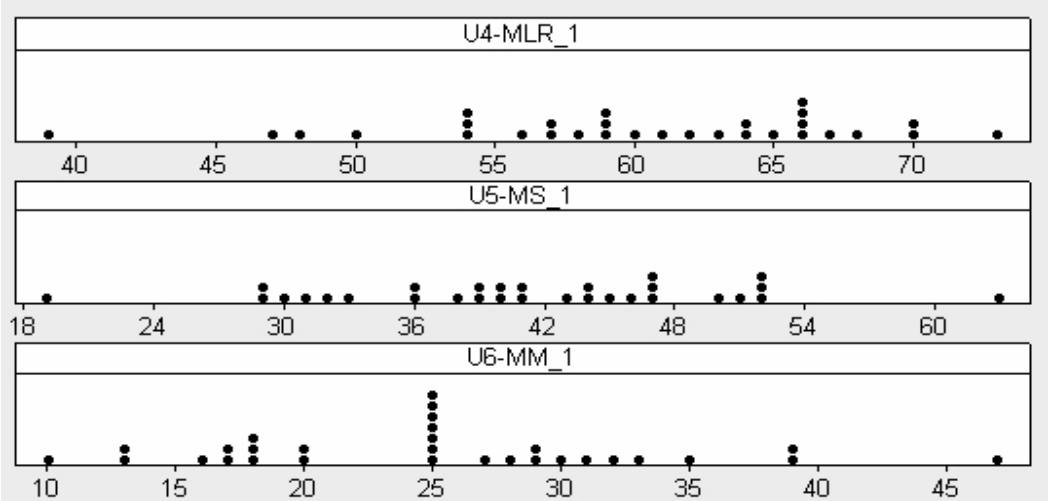



Figure I.2. Dotplot graphs of Local Recurrence, Salvaged, Metastasis states of Mastectomy utility values obtained from MAUM.

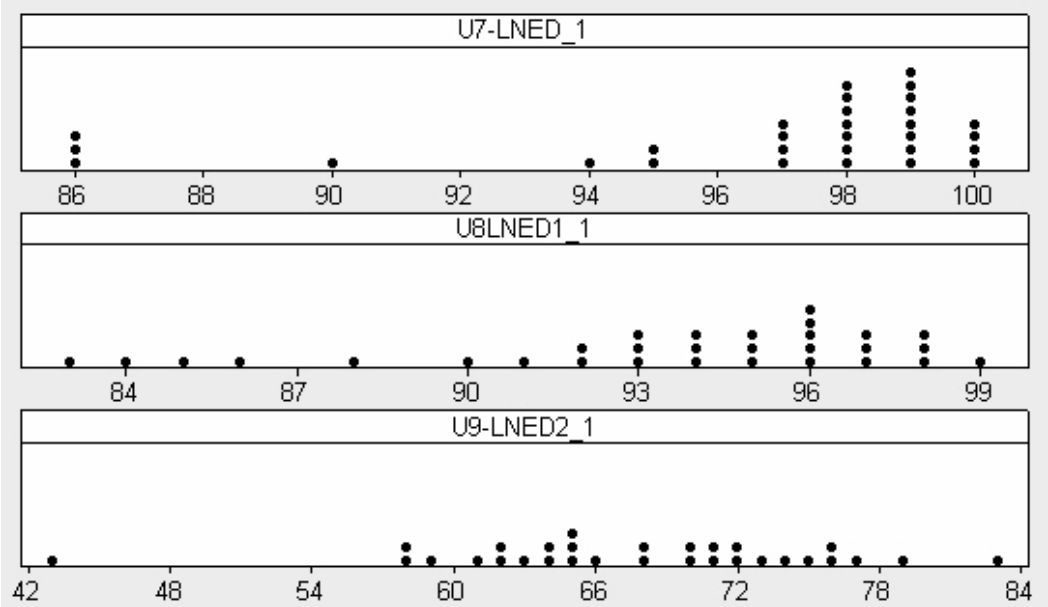



Figure I.3. Dotplot graphs of NED, NEDI, NEDII states of Lumpectomy utility values obtained from MAUM.

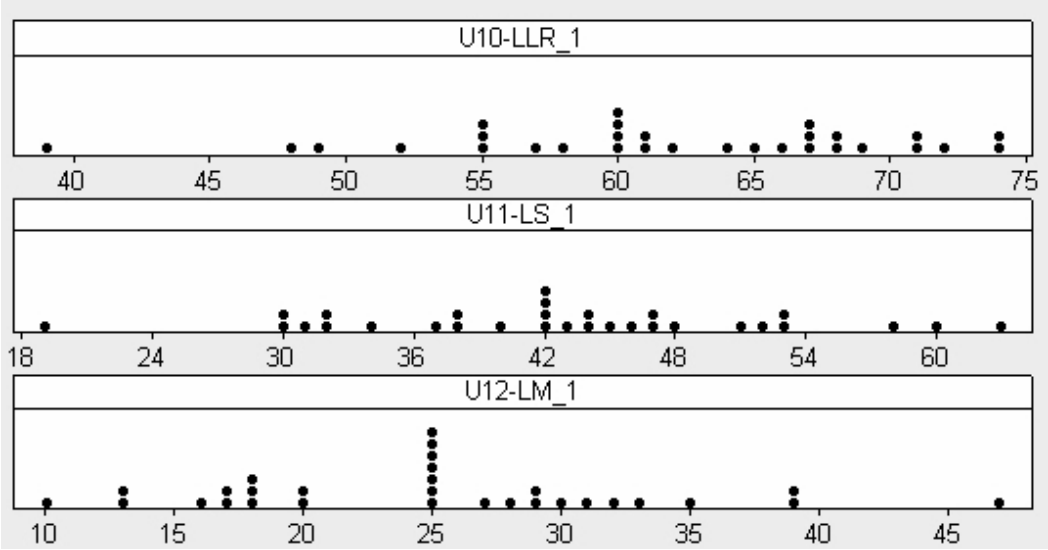



Figure I.4. Dotplot graphs of Local Recurrence, Salvaged, Metastasis states of Lumpectomy utility values obtained from MAUM.

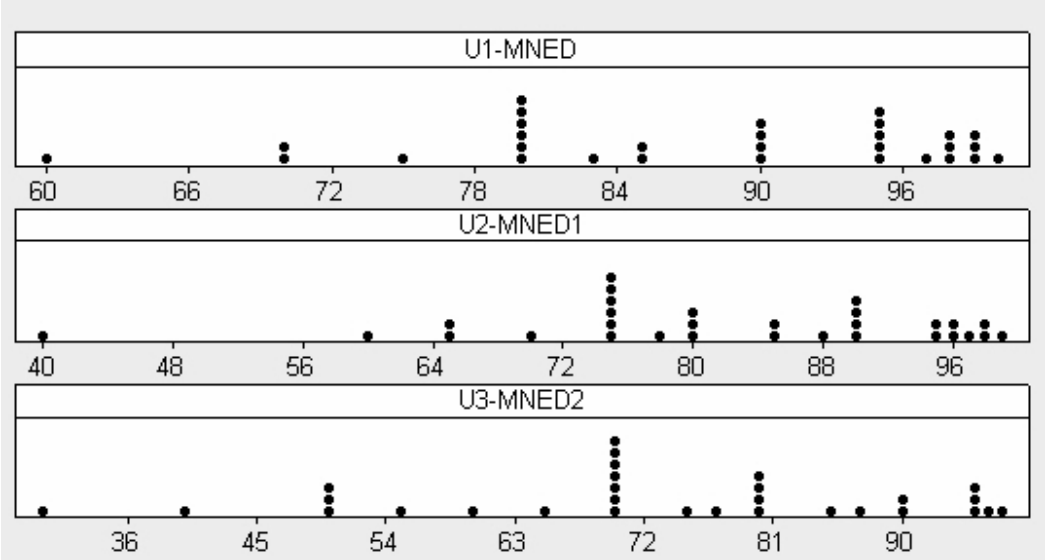



Figure I.5. Dotplot graphs of NED, NEDI, NEDII states of Mastectomy utility values obtained from Standard Gamble.

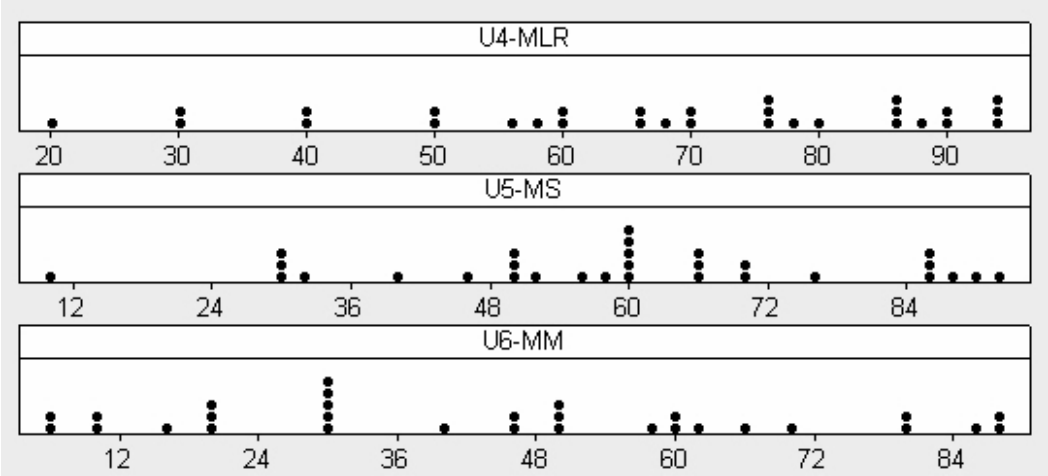



Figure I.6. Dotplot graphs of Local Recurrence, Salvaged, Metastasis states of Mastectomy utility values obtained from Standard Gamble.

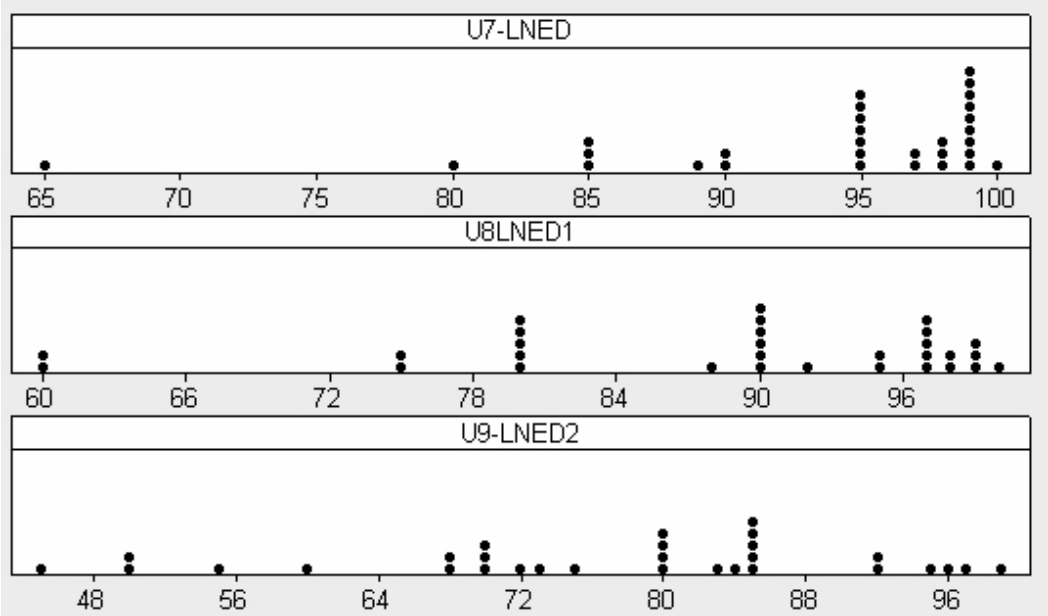



Figure I.7. Dotplot graphs of NED, NEDI, NEDII states of Lumpectomy utility values obtained from Standard Gamble.

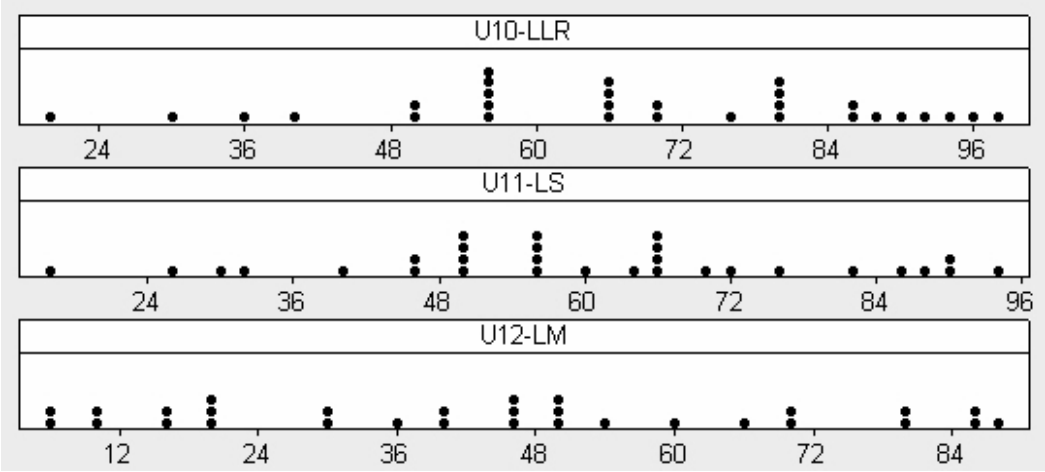



Figure I.8. Dotplot graphs of Local Recurrence, Salvaged, Metastasis states of Lumpectomy utility values obtained from Standard Gamble.

# APPENDIX J

## NORMAL PROBABILITY PLOTS

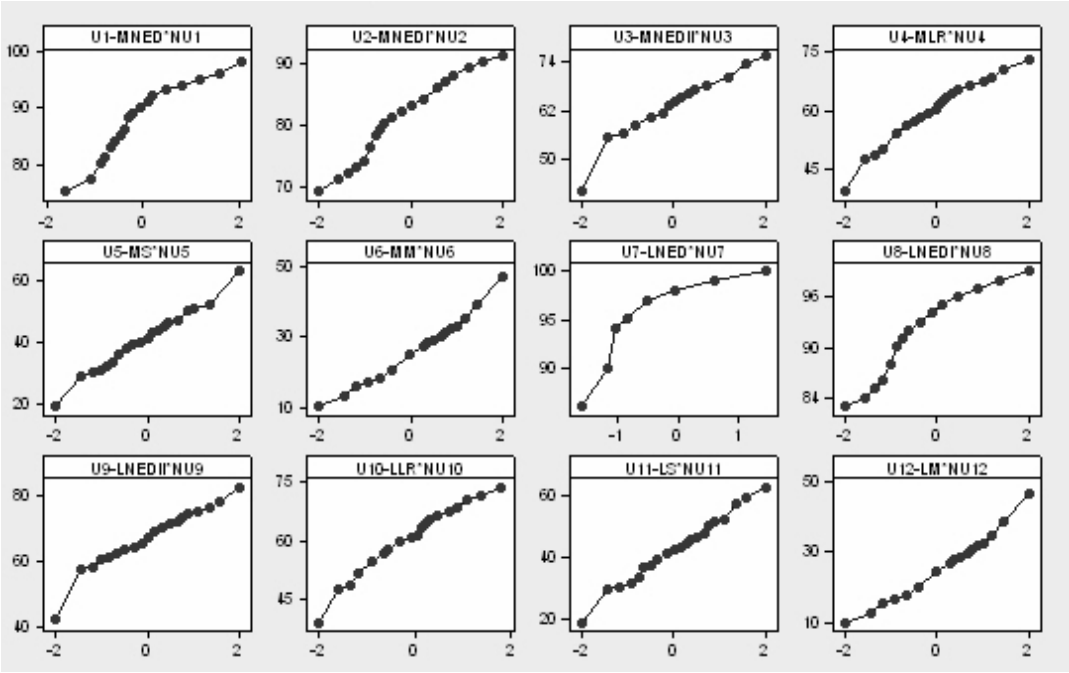



Figure J.1. Normal Probability Plots for Utility Data Sets Obtained by MAUM.

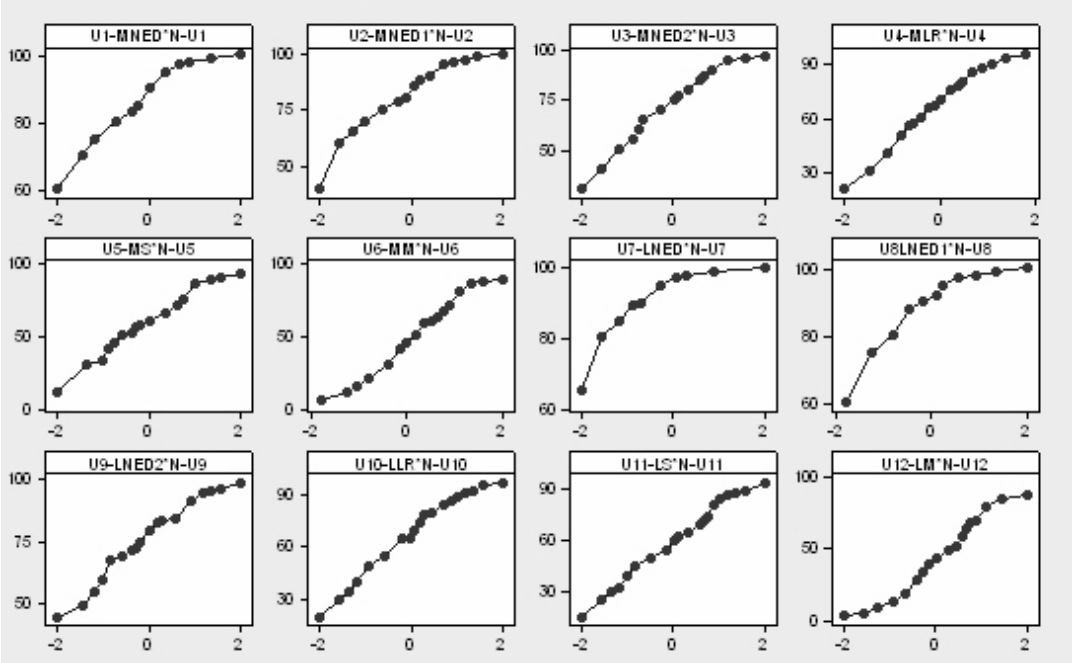



Figure J.2. Normal Probability Plots for Utility Data Sets Obtained by Validation Model

# APPENDIX K

## GRAPH SUMMARY OF UTILITY VALUES

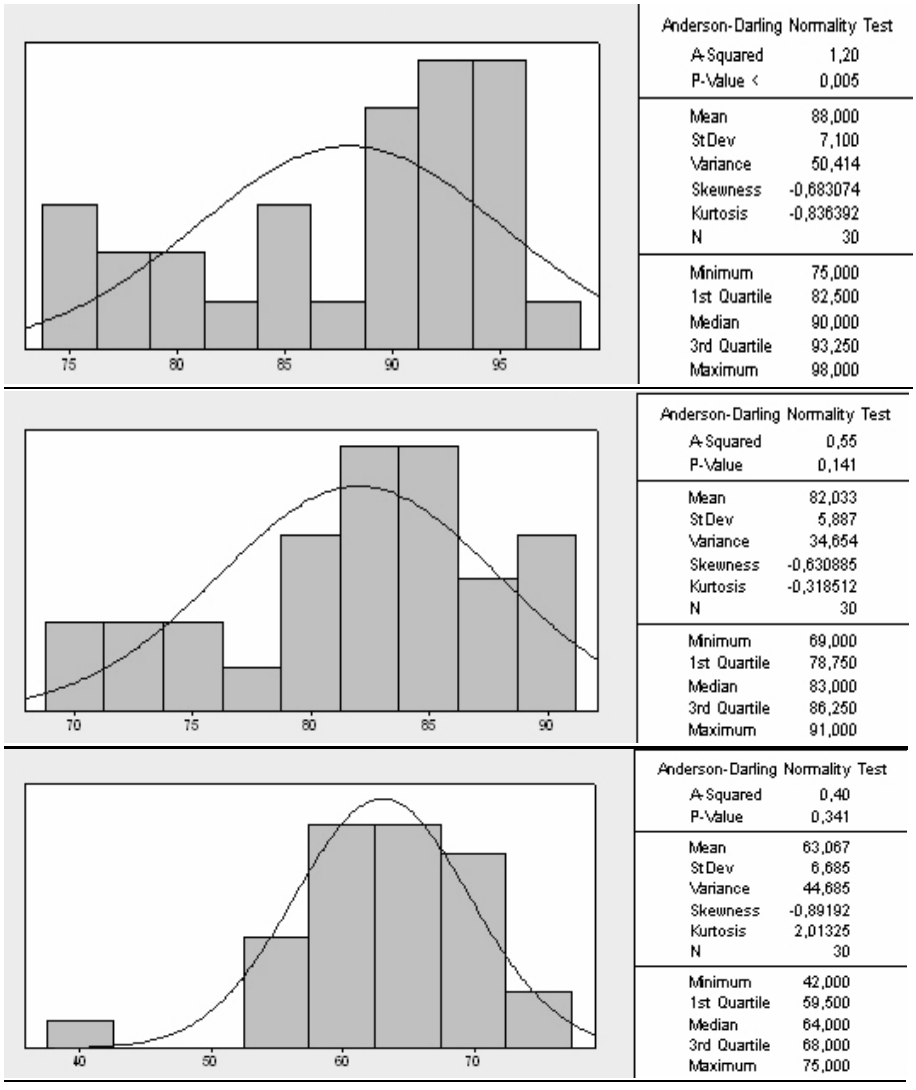



Figure K.1 Graph Summary of utility values through U1 to U3 obtained from MAUM

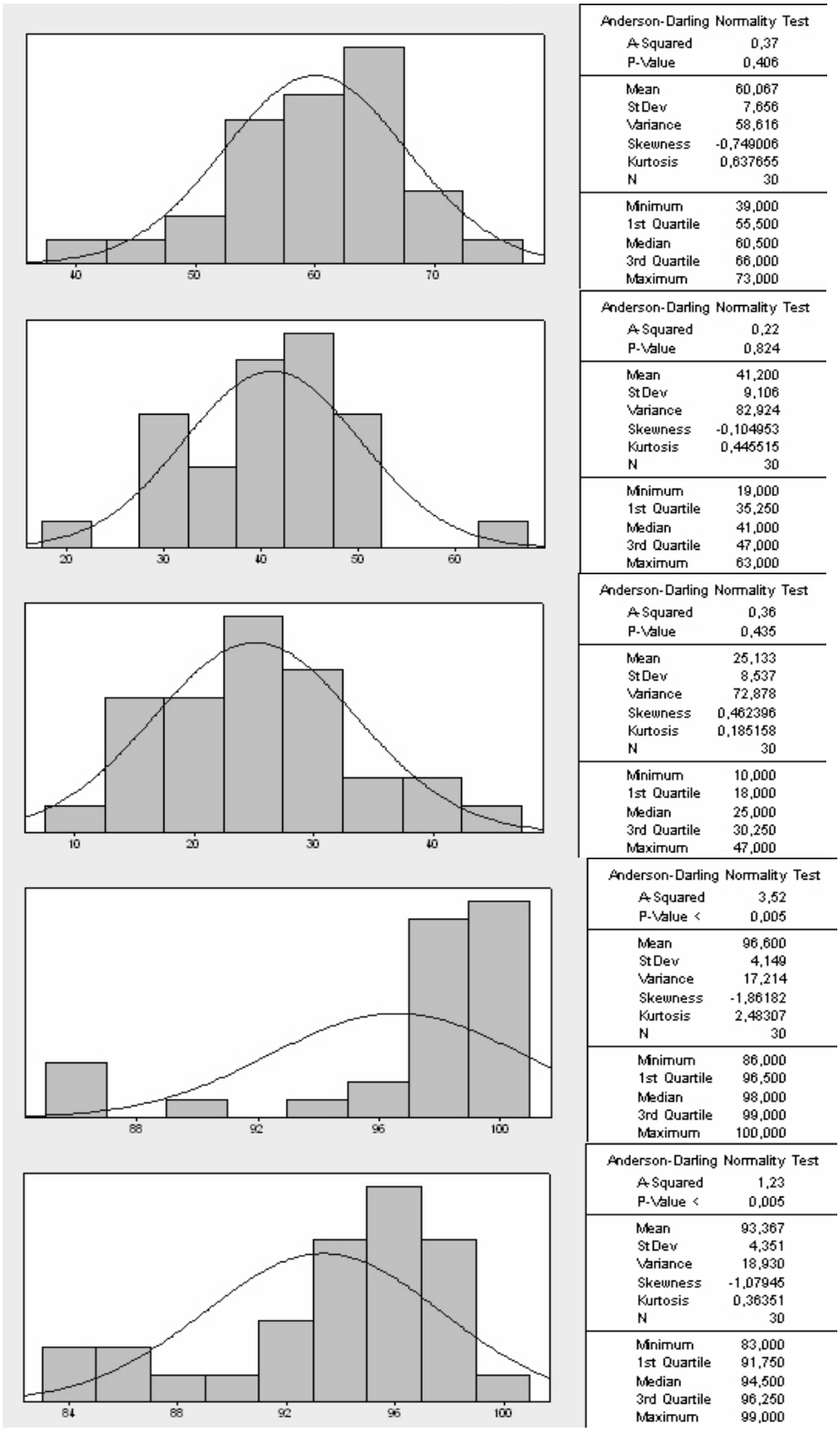



Figure K.2 Graph Summary of utility values through U4 to U8 obtained from MAUM

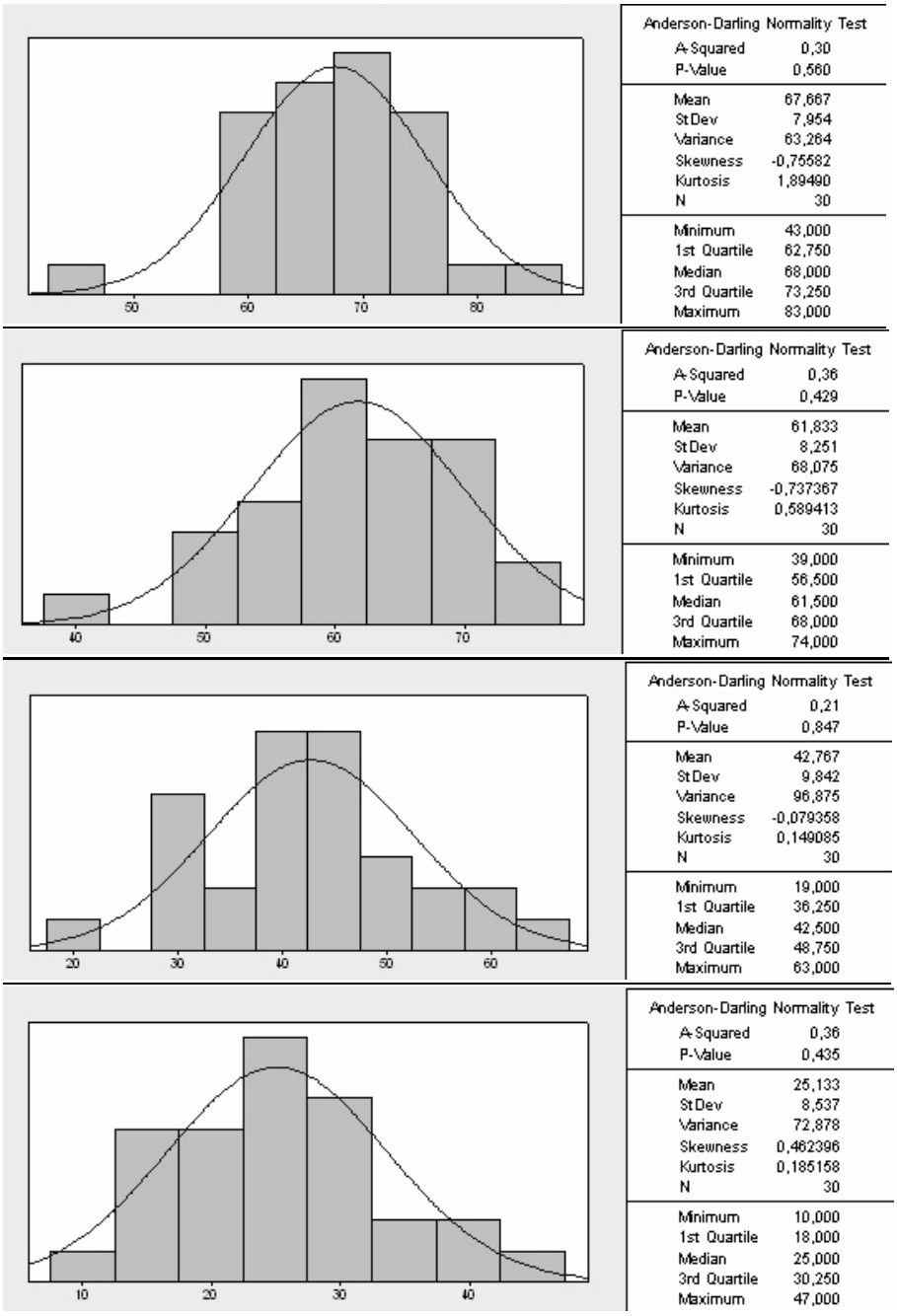



Figure K.3 Graph Summary of utility values through U9 to U12 obtained from MAUM

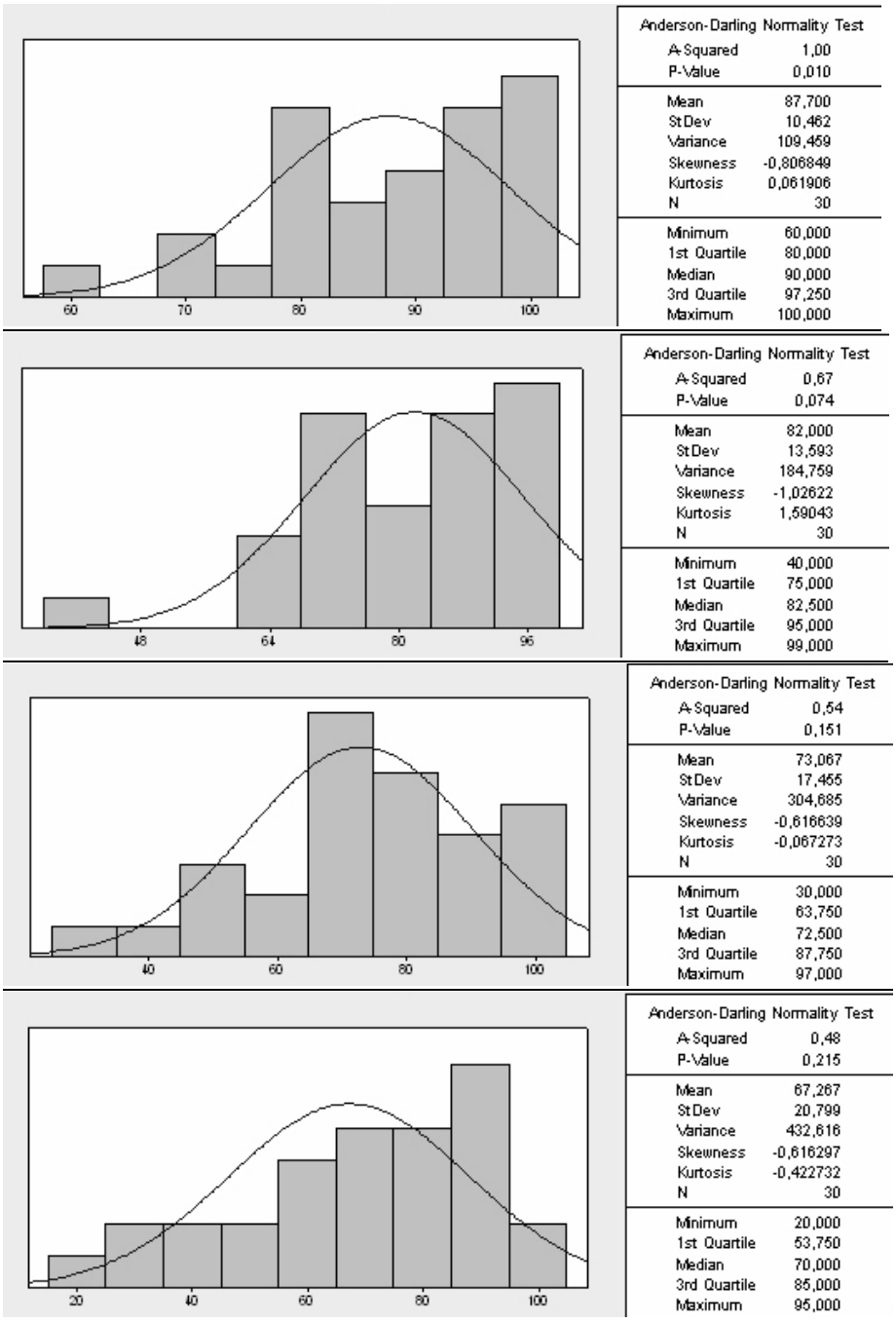



Figure K.4 Graph Summary of utility values through U1 to U4 obtained from Global Rating

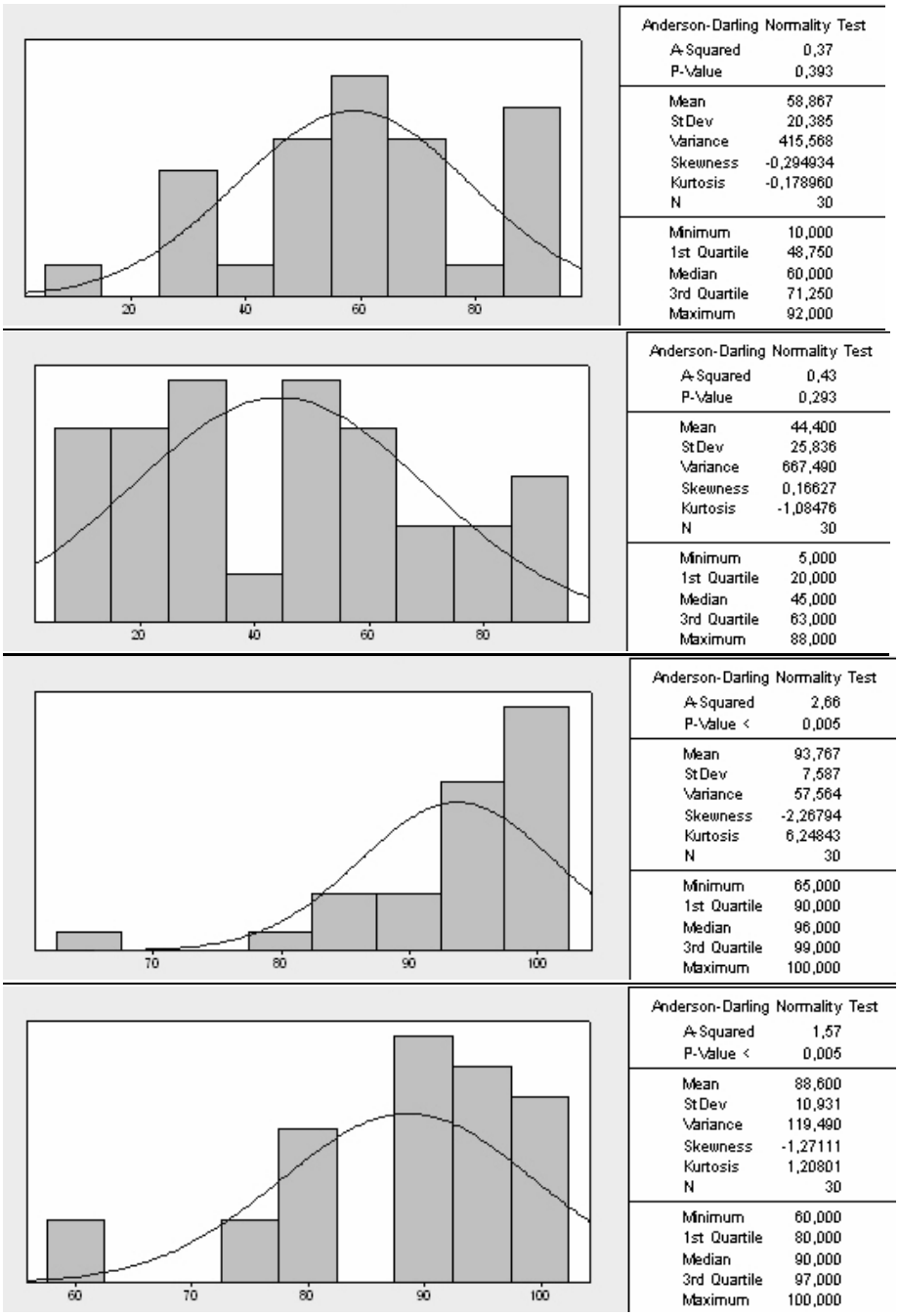



Figure K.5 Graph Summary of utility values through U5 to U8 obtained from Global Rating

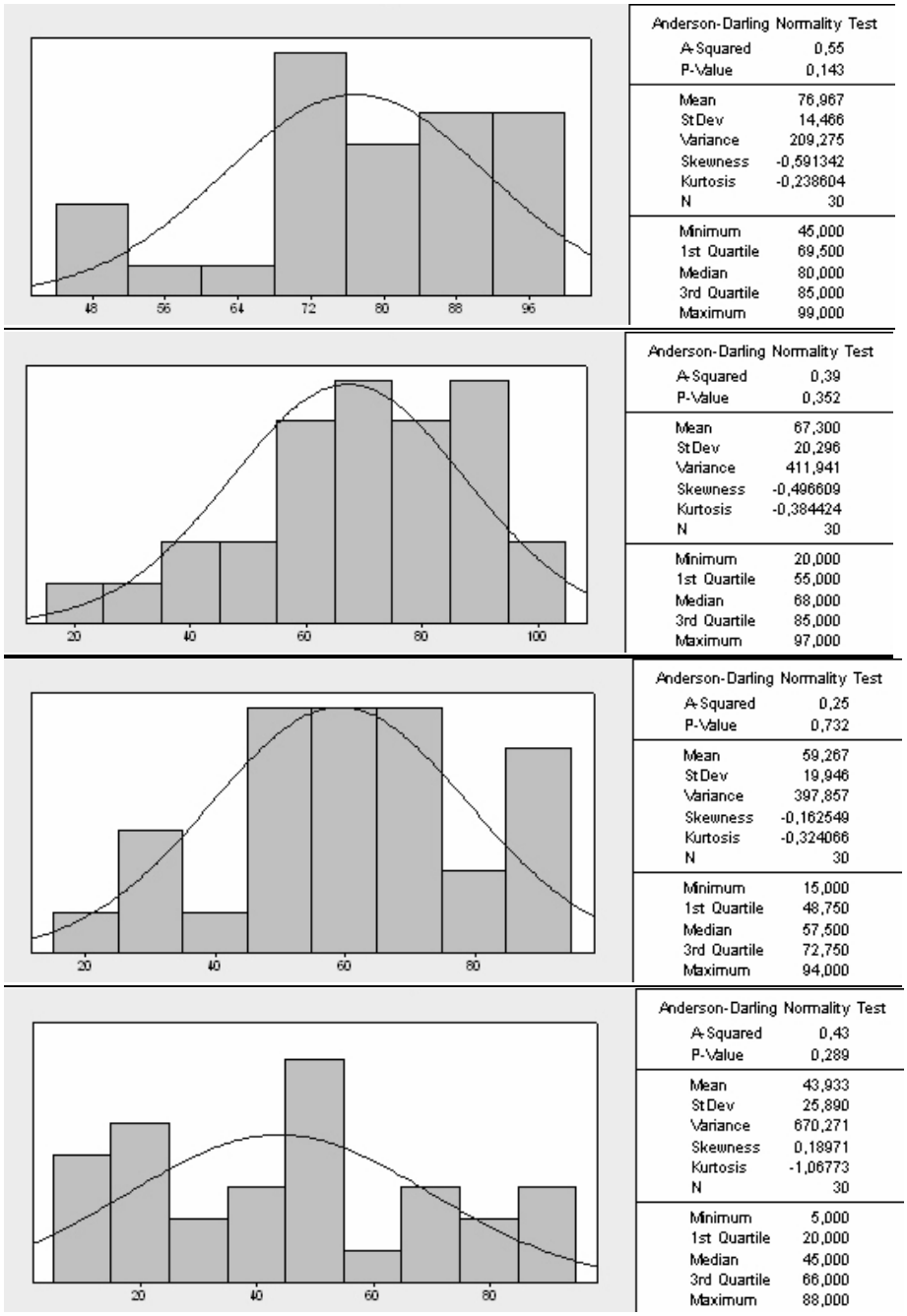



Figure K.6 Graph Summary of utility values through U9 to U12 obtained from Global Rating

# APPENDIX L

# STATISTICAL ANALYSIS RESULTS

## 1. Minitab Outputs for Two Sample T-Test

Table L.1. T-test results for Mastectomy-NED states.

**Two-Sample T-Test and CI: U1-MNED; U1-MNED_1**

```
Two-sample T for U1-MNED vs U1-MNED_1

             N   Mean  StDev  SE Mean
U1-MNED     30   87.7   10.5      1.9
U1-MNED_1   30  88.00   7.10      1.3


Difference = mu (U1-MNED) - mu (U1-MNED_1)
Estimate for difference:  -0.300000
95% CI for difference:  (-4.934467; 4.334467)
T-Test of difference = 0 (vs not =): T-Value = -0.13  P-Value = 0.897  DF
= 51
```

Table L.2. T-test results for Mastectomy-NEDI states.

**Two-Sample T-Test and CI: U2-MNED1; U2-MNED1_1**

```
Two-sample T for U2-MNED1 vs U2-MNED1_1

              N   Mean  StDev  SE Mean
U2-MNED1     30   82.0   13.6      2.5
U2-MNED1_1   30  82.03   5.89      1.1


Difference = mu (U2-MNED1) - mu (U2-MNED1_1)
Estimate for difference:  -0.033333
95% CI for difference:  (-5.503489; 5.436823)
T-Test of difference = 0 (vs not =): T-Value = -0.01  P-Value = 0.990  DF
= 39
```

Table L.3. T-test results for Mastectomy-NEDII states.

**Two-Sample T-Test and CI: U3-MNED2; U3-MNED2_1**

```
Two-sample T for U3-MNED2 vs U3-MNED2_1

             N   Mean  StDev  SE Mean
U3-MNED2    30   73.1   17.5      3.2
U3-MNED2_1  30  63.07   6.68      1.2


Difference = mu (U3-MNED2) - mu (U3-MNED2_1)
Estimate for difference:  10.00000
95% CI for difference:  (3.08547; 16.91453)
T-Test of difference = 0 (vs not =): T-Value = 2.93  P-Value = 0.006  DF =
37
```

Table L.4. T-test results for Mastectomy-Local Recurrence states.

**Two-Sample T-Test and CI: U4-MLR; U4-MLR_1**

```
Two-sample T for U4-MLR vs U4-MLR_1

           N   Mean  StDev  SE Mean
U4-MLR    30   67.3   20.8      3.8
U4-MLR_1  30  60.07   7.66      1.4


Difference = mu (U4-MLR) - mu (U4-MLR_1)
Estimate for difference:  7.20000
95% CI for difference:  (-1.00674; 15.40674)
T-Test of difference = 0 (vs not =): T-Value = 1.78  P-Value = 0.084  DF =
36
```

Table L.5. T-test results for Mastectomy-Salvaged states.

**Two-Sample T-Test and CI: U5-MS; U5-MS_1**

```
Two-sample T for U5-MS vs U5-MS_1

          N   Mean  StDev  SE Mean
U5-MS    30   58.9   20.4      3.7
U5-MS_1  30  41.20   9.11      1.7


Difference = mu (U5-MS) - mu (U5-MS_1)
Estimate for difference:  17.6667
95% CI for difference:  (9.4281; 25.9052)
T-Test of difference = 0 (vs not =): T-Value = 4.33  P-Value = 0.000  DF =
40
```

Table L.6. T-test results for Mastectomy-Metastasis states.

**Two-Sample T-Test and CI: U6-MM; U6-MM_1**

```
Two-sample T for U6-MM vs U6-MM_1

          N   Mean  StDev  SE Mean
U6-MM    30   44.4   25.8      4.7
U6-MM_1  30  25.13   8.54      1.6


Difference = mu (U6-MM) - mu (U6-MM_1)
Estimate for difference:  19.2667
95% CI for difference:  (9.1815; 29.3518)
T-Test of difference = 0 (vs not =): T-Value = 3.88  P-Value = 0.000  DF =
35
```

Table L.7. T-test results for Lumpectomy-NED states.

**Two-Sample T-Test and CI: U7-LNED; U7-LNED_1**

```
Two-sample T for U7-LNED vs U7-LNED_1

            N   Mean  StDev  SE Mean
U7-LNED    30  93.77   7.59      1.4
U7-LNED_1  30  96.60   4.15     0.76


Difference = mu (U7-LNED) - mu (U7-LNED_1)
Estimate for difference:  -2.83333
95% CI for difference:  (-6.01519; 0.34853)
T-Test of difference = 0 (vs not =): T-Value = -1.79  P-Value = 0.080  DF
= 44
```

Table L.8. T-test results for Lumpectomy-NEDI states.

**Two-Sample T-Test and CI: U8LNED1; U8LNED1_1**

```
Two-sample T for U8LNED1 vs U8LNED1_1

            N   Mean  StDev  SE Mean
U8LNED1    30   88.6   10.9      2.0
U8LNED1_1  30  93.37   4.35     0.79


Difference = mu (U8LNED1) - mu (U8LNED1_1)
Estimate for difference:  -4.76667
95% CI for difference:  (-9.11897; -0.41437)
T-Test of difference = 0 (vs not =): T-Value = -2.22  P-Value = 0.033  DF
= 37
```

Table L.9. T-test results for Lumpectomy-NEDII states.

**Two-Sample T-Test and CI: U9-LNED2; U9-LNED2_1**

```
Two-sample T for U9-LNED2 vs U9-LNED2_1

             N   Mean  StDev  SE Mean
U9-LNED2    30   77.0   14.5      2.6
U9-LNED2_1  30  67.67   7.95      1.5


Difference = mu (U9-LNED2) - mu (U9-LNED2_1)
Estimate for difference:  9.30000
95% CI for difference:  (3.22935; 15.37065)
T-Test of difference = 0 (vs not =): T-Value = 3.09  P-Value = 0.003  DF =
45
```

Table L.10. T-test results for Lumpectomy-Local Recurrence states.

**Two-Sample T-Test and CI: U10-LLR; U10-LLR_1**

```
Two-sample T for U10-LLR vs U10-LLR_1

             N   Mean  StDev  SE Mean
U10-LLR     30   67.3   20.3      3.7
U10-LLR_1   30  61.83   8.25      1.5


Difference = mu (U10-LLR) - mu (U10-LLR_1)
Estimate for difference:  5.46667
95% CI for difference:  (-2.63105; 13.56438)
T-Test of difference = 0 (vs not =): T-Value = 1.37  P-Value = 0.180  DF =
38
```

Table L.11. T-test results for Lumpectomy-Salvaged states.

**Two-Sample T-Test and CI: U11-LS; U11-LS_1**

```
Two-sample T for U11-LS vs U11-LS_1

            N   Mean  StDev  SE Mean
U11-LS     30   59.3   19.9      3.6
U11-LS_1   30  42.77   9.84      1.8


Difference = mu (U11-LS) - mu (U11-LS_1)
Estimate for difference:  16.5000
95% CI for difference:  (8.3047; 24.6953)
T-Test of difference = 0 (vs not =): T-Value = 4.06  P-Value = 0.000  DF =
42
```

Table L.12. T-test results for Lumpectomy-Metastasis states.

**Two-Sample T-Test and CI: U12-LM; U12-LM_1**

```
Two-sample T for U12-LM vs U12-LM_1

           N   Mean  StDev  SE Mean
U12-LM    30   43.9   25.9      4.7
U12-LM_1  30  25.13   8.54      1.6


Difference = mu (U12-LM) - mu (U12-LM_1)
Estimate for difference:  18.8000
95% CI for difference:  (8.6959; 28.9041)
T-Test of difference = 0 (vs not =): T-Value = 3.78  P-Value = 0.001  DF =
35
```

## 2. Minitab Outputs for Mann Whitney Test

Table L.13. Mann Whitney Test results for Mastectomy-NED states.

**Mann-Whitney Test and CI: U1-MNED; U1-MNED_1**

```
            N  Median
U1-MNED    30  90.000
U1-MNED_1  30  90.000


Point estimate for ETA1-ETA2 is 1.000
95.2 Percent CI for ETA1-ETA2 is (-4.002;5.001)
W = 954.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.5692
The test is significant at 0.5679 (adjusted for ties)
```

Table L.14. Mann Whitney Test results for Mastectomy-NEDI states.

**Mann-Whitney Test and CI: U2-MNED1; U2-MNED1_1**

```
             N  Median
U2-MNED1    30  82.500
U2-MNED1_1  30  83.000


Point estimate for ETA1-ETA2 is 2.000
95.2 Percent CI for ETA1-ETA2 is (-4.997;6.998)
W = 947.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.6414
The test is significant at 0.6410 (adjusted for ties)
```

Table L.15. Mann Whitney Test results for Mastectomy-NEDII states.

**Mann-Whitney Test and CI: U3-MNED2; U3-MNED2_1**

```
             N  Median
U3-MNED2    30   72.50
U3-MNED2_1  30   64.00


Point estimate for ETA1-ETA2 is 12.00
95.2 Percent CI for ETA1-ETA2 is (5.00;19.00)
W = 1131.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0014
The test is significant at 0.0014 (adjusted for ties)
```

Table L.16. Mann Whitney Test results for Mastectomy-Local Recurrence states.

**Mann-Whitney Test and CI: U4-MLR; U4-MLR_1**

```
            N  Median
U4-MLR     30   70.00
U4-MLR_1   30   60.50


Point estimate for ETA1-ETA2 is 10.00
95.2 Percent CI for ETA1-ETA2 is (1.00;19.01)
W = 1061.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0309
The test is significant at 0.0308 (adjusted for ties)
```

Table L.17. Mann Whitney Test results for Mastectomy-Salvaged states.

**Mann-Whitney Test and CI: U5-MS; U5-MS_1**

```
           N  Median
U5-MS     30   60.00
U5-MS_1   30   41.00


Point estimate for ETA1-ETA2 is 18.00
95.2 Percent CI for ETA1-ETA2 is (10.00;26.00)
W = 1177.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0001
The test is significant at 0.0001 (adjusted for ties)
```

Table L.18. Mann Whitney Test results for Mastectomy-Metastasis states.

**Mann-Whitney Test and CI: U6-MM; U6-MM_1**

```
           N  Median
U6-MM     30   45.00
U6-MM_1   30   25.00


Point estimate for ETA1-ETA2 is 18.50
95.2 Percent CI for ETA1-ETA2 is (4.99;32.00)
W = 1118.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0027
The test is significant at 0.0026 (adjusted for ties)
```

Table L.19. Mann Whitney Test results for Lumpectomy-NED states.

**Mann-Whitney Test and CI: U7-LNED; U7-LNED_1**

```
            N  Median
U7-LNED    30  96.000
U7-LNED_1  30  98.000


Point estimate for ETA1-ETA2 is -1.000
95.2 Percent CI for ETA1-ETA2 is (-3.000;0.001)
W = 804.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.1039
The test is significant at 0.0983 (adjusted for ties)
```

Table L.20. Mann Whitney Test results for Lumpectomy-NEDI states.

**Mann-Whitney Test and CI: U8LNED1; U8LNED1_1**

```
            N  Median
U8LNED1    30  90.000
U8LNED1_1  30  94.500


Point estimate for ETA1-ETA2 is -2.000
95.2 Percent CI for ETA1-ETA2 is (-6.001;0.999)
W = 839.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.2675
The test is significant at 0.2659 (adjusted for ties)
```

Table L.21. Mann Whitney Test results for Lumpectomy-NEDII states.

**Mann-Whitney Test and CI: U9-LNED2; U9-LNED2_1**

```
             N  Median
U9-LNED2    30   80.00
U9-LNED2_1  30   68.00


Point estimate for ETA1-ETA2 is 10.00
95.2 Percent CI for ETA1-ETA2 is (5.00;16.00)
W = 1127.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0017
The test is significant at 0.0017 (adjusted for ties)
```

Table L.22. Mann Whitney Test results for Lumpectomy-Local Recurrence states.

**Mann-Whitney Test and CI: U10-LLR; U10-LLR_1**

```
            N  Median
U10-LLR    30   68.00
U10-LLR_1  30   61.50


Point estimate for ETA1-ETA2 is 7.00
95.2 Percent CI for ETA1-ETA2 is (-2.00;16.00)
W = 1010.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.1602
The test is significant at 0.1595 (adjusted for ties)
```

Table L.23. Mann Whitney Test results for Lumpectomy-Salvaged states.

**Mann-Whitney Test and CI: U11-LS; U11-LS_1**

```
           N  Median
U11-LS    30   57.50
U11-LS_1  30   42.50


Point estimate for ETA1-ETA2 is 17.00
95.2 Percent CI for ETA1-ETA2 is (8.00;25.00)
W = 1168.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0002
The test is significant at 0.0002 (adjusted for ties)
```

Table L.24. Mann Whitney Test results for Lumpectomy-Metastasis states.

**Mann-Whitney Test and CI: U12-LM; U12-LM_1**

```
           N  Median
U12-LM    30   45.00
U12-LM_1  30   25.00


Point estimate for ETA1-ETA2 is 18.00
95.2 Percent CI for ETA1-ETA2 is (5.00;29.00)
W = 1108.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0043
The test is significant at 0.0043 (adjusted for ties)
```

## 3. Minitab Outputs for Paired T-Test

Table L.25. Paired T-Test results for Mastectomy-NED states.

**Paired T-Test and CI: U1-MNED; U1-VAL**

```
Paired T for U1-MNED - U1-VAL

             N      Mean    StDev  SE Mean
U1-MNED     15   89.5333   6.1975   1.6002
U1-VAL      15   91.4667   6.6961   1.7289
Difference  15  -1.93333  5.57375  1.43914


95% CI for mean difference: (-5.01997; 1.15331)
T-Test of mean difference = 0 (vs not = 0): T-Value = -1.34  P-Value =
0.201
```

Table L.26. Paired T-Test results for Mastectomy-NEDI states.

**Paired T-Test and CI: U2-MNED1; U2-VAL**

```
Paired T for U2-MNED1 - U2-VAL

             N      Mean    StDev  SE Mean
U2-MNED1    15   85.0667   5.4046   1.3955
U2-VAL      15   86.6667   7.9252   2.0463
Difference  15  -1.60000  7.17934  1.85370


95% CI for mean difference: (-5.57578; 2.37578)
T-Test of mean difference = 0 (vs not = 0): T-Value = -0.86  P-Value =
0.403
```

Table L.27. Paired T-Test results for Mastectomy-NEDII states.

**Paired T-Test and CI: U3-MNED2; U3-VAL**

```
Paired T for U3-MNED2 - U3-VAL

             N      Mean     StDev  SE Mean
U3-MNED2    15   70.2667    7.7687   2.0059
U3-VAL      15   75.3333   13.5524   3.4992
Difference  15  -5.06667  11.45467  2.95758


95% CI for mean difference: (-11.41005; 1.27672)
T-Test of mean difference = 0 (vs not = 0): T-Value = -1.71  P-Value =
0.109
```

Table L.28. Paired T-Test results for Mastectomy-Local Recurrence states.

**Paired T-Test and CI: U4-MLR; U4-VAL**

```
Paired T for U4-MLR - U4-VAL

             N      Mean      StDev   SE Mean
U4-MLR      15   68.6000     8.2358    2.1265
U4-VAL      15   68.3333    16.3037    4.2096
Difference  15  0.266667  15.026009  3.879699


95% CI for mean difference: (-8.054460; 8.587793)
T-Test of mean difference = 0 (vs not = 0): T-Value = 0.07  P-Value = 0.94
```

Table L.29. Paired T-Test results for Mastectomy-Salvaged states.

**Paired T-Test and CI: U5-MS; U5-VAL**

```
Paired T for U5-MS - U5-VAL

             N      Mean     StDev  SE Mean
U5-MS       15   52.2667   11.0095   2.8426
U5-VAL      15   59.8667   17.9955   4.6464
Difference  15  -7.60000  13.22228  3.41398


95% CI for mean difference: (-14.92225; -0.27775)
T-Test of mean difference = 0 (vs not = 0): T-Value = -2.23  P-Value =
0.043
```

Table L.30. Paired T-Test results for Mastectomy-Metastasis states.

**Paired T-Test and CI: U6-MM; U6-VAL**

```
Paired T for U6-MM - U6-VAL

             N      Mean     StDev  SE Mean
U6-MM       15   33.9333   13.5355   3.4948
U6-VAL      15   42.1333   29.2816   7.5605
Difference  15  -8.20000  25.32136  6.53795


95% CI for mean difference: (-22.22250; 5.82250)
T-Test of mean difference = 0 (vs not = 0): T-Value = -1.25  P-Value =
0.230
```

Table L.31. Paired T-Test results for Lumpectomy-NED states.

**Paired T-Test and CI: U7-LNED; U7-VAL**

```
Paired T for U7-LNED - U7-VAL

             N     Mean    StDev  SE Mean
U7-LNED     15  98.2000   1.7403   0.4493
U7-VAL      15  95.8667   5.4493   1.4070
Difference  15  2.33333  4.41858  1.14087


95% CI for mean difference: (-0.11359; 4.78026)
T-Test of mean difference = 0 (vs not = 0): T-Value = 2.05  P-Value =
0.060
```

Table L.32. Paired T-Test results for Lumpectomy-NEDI states.

**Paired T-Test and CI: U8-LNED1; U8-VAL**

```
Paired T for U8-LNED1 - U8-VAL

             N     Mean    StDev  SE Mean
U8-LNED1    15  95.5333   2.3865   0.6162
U8-VAL      15  93.7333   6.7662   1.7470
Difference  15  1.80000  6.12022  1.58024


95% CI for mean difference: (-1.58927; 5.18927)
T-Test of mean difference = 0 (vs not = 0): T-Value = 1.14  P-Value =
0.274
```

Table L.33. Paired T-Test results for Lumpectomy-NEDII states.

**Paired T-Test and CI: U9-LNED2; U9-VAL**

```
Paired T for U9-LNED2 - U9-VAL

             N      Mean     StDev  SE Mean
U9-LNED2    15   75.3333    7.4226   1.9165
U9-VAL      15   77.4000   13.2493   3.4209
Difference  15  -2.06667  12.36046  3.19146


95% CI for mean difference: (-8.91166; 4.77833)
T-Test of mean difference = 0 (vs not = 0): T-Value = -0.65  P-Value =
0.528
```

Table L.34. Paired T-Test results for Lumpectomy-Local Recurrence states.

**Paired T-Test and CI: U10-LLR; U10-VAL**

```
Paired T for U10-LLR - U10-VAL

             N      Mean      StDev   SE Mean
U10-LLR     15   70.2667     7.5920    1.9602
U10-VAL     15   69.6667    15.0317    3.8812
Difference  15  0.600000  13.978555  3.609247


95% CI for mean difference: (-7.141066; 8.341066)
T-Test of mean difference = 0 (vs not = 0): T-Value = 0.17  P-Value =
0.870
```

Table L.35. Paired T-Test results for Lumpectomy-Salvaged states.

**Paired T-Test and CI: U11-LS; U11-VAL**

```
Paired T for U11-LS - U11-VAL

             N      Mean     StDev  SE Mean
U11-LS      15   53.8000   10.9427   2.8254
U11-VAL     15   61.2667   17.1692   4.4331
Difference  15  -7.46667  13.17935  3.40289


95% CI for mean difference: (-14.76515; -0.16819)
T-Test of mean difference = 0 (vs not = 0): T-Value = -2.19  P-Value =
0.046
```

Table L.36. Paired T-Test results for Lumpectomy-Metastasis states.

**Paired T-Test and CI: U12-LM; U12-VAL**

```
Paired T for U12-LM - U12-VAL

             N      Mean     StDev  SE Mean
U12-LM      15   34.6000   12.8163   3.3092
U12-VAL     15   41.9333   28.5218   7.3643
Difference  15  -7.33333  25.73121  6.64377

95% CI for mean difference: (-21.58280; 6.91614)
T-Test of mean difference = 0 (vs not = 0): T-Value = -1.10  P-Value =
0.288
```

## 4. Minitab Outputs for Wilcoxon Signed Rank Test

Table L.37. Wilcoxon Signed Rank Test results for Mastectomy-NED states

**Wilcoxon Signed Rank Test: U1-DIFF**

```
Test of median = 0.000000 versus median not = 0.000000

               N
              for   Wilcoxon         Estimated
         N  Test  Statistic      P     Median
U1-DIFF  15    14       32.5  0.221     -2.500
```

Table L.38. Wilcoxon Signed Rank Test results for Mastectomy-NEDI states.

**Wilcoxon Signed Rank Test: U2-DIFF**

```
Test of median = 0.000000 versus median not = 0.000000

               N
              for   Wilcoxon         Estimated
         N  Test  Statistic      P     Median
U2-DIFF  15    14       36.5  0.331     -2.000
```

Table L.39. Wilcoxon Signed Rank Test results for Mastectomy-NEDII states.

**Wilcoxon Signed Rank Test: U3-DIFF**

```
Test of median = 0.000000 versus median not = 0.000000

               N
              for   Wilcoxon         Estimated
         N  Test  Statistic      P     Median
U3-DIFF  15    15       34.5  0.156     -4.750
```

Table L.40. Wilcoxon Signed Rank Test results for Mastectomy-Local Rec. states.

**Wilcoxon Signed Rank Test: U4-DIFF**

```
Test of median = 0.000000 versus median not = 0.000000

               N
              for   Wilcoxon         Estimated
         N  Test  Statistic      P     Median
U4-DIFF  15    15       62.5  0.910      1.250
```

Table L.41. Wilcoxon Signed Rank Test results for Mastectomy-Salvaged states.

**Wilcoxon Signed Rank Test: U5-DIFF**

```
Test of median = 0.000000 versus median not = 0.000000

               N
              for   Wilcoxon         Estimated
         N  Test  Statistic      P     Median
U5-DIFF  15    14       22.0  0.060     -6.500
```

Table L.42. Wilcoxon Signed Rank Test results for Mastectomy-Metastasis states.

**Wilcoxon Signed Rank Test: U6-DIFF**

```
Test of median = 0.000000 versus median not = 0.000000

                N
               for   Wilcoxon         Estimated
          N  Test  Statistic      P     Median
U6-DIFF  15    15       43.0  0.349     -7.000
```

Table L.43. Wilcoxon Signed Rank Test results for Lumpectomy-NED states.

**Wilcoxon Signed Rank Test: U7-DIFF**

```
Test of median = 0.000000 versus median not = 0.000000

                N
               for   Wilcoxon         Estimated
          N  Test  Statistic      P     Median
U7-DIFF  15    12       61.0  0.092      1.500
```

Table L.44. Wilcoxon Signed Rank Test results for Lumpectomy-NEDI states.

**Wilcoxon Signed Rank Test: U8-DIFF**

```
Test of median = 0.000000 versus median not = 0.000000

                N
               for   Wilcoxon         Estimated
          N  Test  Statistic      P     Median
U8-DIFF  15    15       73.0  0.478      1.000
```

Table L.45. Wilcoxon Signed Rank Test results for Lumpectomy-NEDII states.

**Wilcoxon Signed Rank Test: U9-DIFF**

```
Test of median = 0.000000 versus median not = 0.000000

                N
               for   Wilcoxon         Estimated
          N  Test  Statistic      P     Median
U9-DIFF  15    14       42.0  0.530     -1.750
```

Table L.46. Wilcoxon Signed Rank Test results for Lumpectomy-Local Rec. states.

**Wilcoxon Signed Rank Test: U10-DIFF**

```
Test of median = 0.000000 versus median not = 0.000000

                 N
                for   Wilcoxon         Estimated
           N  Test  Statistic      P     Median
U10-DIFF  15    15       64.5  0.820      2.000
```

Table L.47. Wilcoxon Signed Rank Test results for Lumpectomy-Salvaged states.

**Wilcoxon Signed Rank Test: U11-DIFF**

```
Test of median = 0.000000 versus median not = 0.000000

                 N
                for   Wilcoxon         Estimated
           N  Test  Statistic      P     Median
U11-DIFF  15    15       26.0  0.057     -7.000
```

Table L.48. Wilcoxon Signed Rank Test results for Lumpectomy-Metastasis states.

**Wilcoxon Signed Rank Test: U12-DIFF**

```
Test of median = 0.000000 versus median not = 0.000000

                 N
                for   Wilcoxon         Estimated
           N  Test  Statistic      P     Median
U12-DIFF  15    15       45.0  0.410     -5.250
```

# APPENDIX M

# A SYNTHETIC MTMM (MULTI-TRAIT MULTI-METHOD) MATRIX

**Hypothetical Multitrait-Multimethod Matrix**

| | | Method 1 | | | Method 2 | | | Method 3 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Traits* | $A_1$ | $B_1$ | $C_1$ | $A_2$ | $B_2$ | $C_2$ | $A_3$ | $B_3$ | $C_3$ |
| | $A_1$ | (.89) | | | | | | | | |
| Method 1 | $B_1$ | .51 | (.89) | | | | | | | |
| | $C_1$ | .38 | .37 | (.76) | | | | | | |
| | $A_2$ | **.57** | .22 | .09 | (.93) | | | | | |
| Method 2 | $B_2$ | .22 | **.57** | .10 | .68 | (.94) | | | | |
| | $C_2$ | .11 | .11 | **.46** | .59 | .58 | (.84) | | | |
| | $A_3$ | **.56** | .22 | .11 | **.67** | .42 | .33 | (.94) | | |
| Method 3 | $B_3$ | .23 | **.58** | .12 | .43 | **.66** | .34 | .67 | (.92) | |
| | $C_3$ | .11 | .11 | **.45** | .34 | .32 | **.58** | .58 | .60 | (.85) |

*Note*. Letters A, B, C refer to traits, subscripts 1, 2, 3 to methods. Validity coefficients (monotrait-heteromethod) are the three diagonal sets of boldface numbers; reliability coefficients (monotrait-monomethod) are the numbers in parentheses along principal diagonal. Solid triangles enclose heterotrait-monomethod correlations; broken triangles enclose heterotrait-heteromethod correlations.

(From Campbell & Fiske, 1959, p. 82. Copyright 1959 by the American Psychological Association. Reprinted by permission.)

Figure M.1. Hypothetical Multitrait-Multimethod Matrix

# APPENDIX N

# K (RELATIVE IMPORTANCE WEIGHT) VALUES IN MULTIPLICATIVE UTILITY FUNCTION

Table N. 1 Constant k Values in Multiplicative Utility Function

| Participant | Health States | | k Values | Participant | Health States | | k Values | Participant | Health States | | k Values |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Mastectomy | 1 | 0.0014 | 2 | Mastectomy | 1 | 0.0025 | 3 | Mastectomy | 1 | 0.0007 |
| | | 2 | 0.0022 | | | 2 | 0.0056 | | | 2 | 0.0023 |
| | | 3 | 0.0016 | | | 3 | 0.0220 | | | 3 | 0.0084 |
| | | 4 | 0.0017 | | | 4 | 0.0228 | | | 4 | 0.0090 |
| | | 5 | 0.0056 | | | 5 | 0.0448 | | | 5 | 0.0217 |
| | | 6 | 0.0271 | | | 6 | 0.1813 | | | 6 | 0.1231 |
| | Lumpectomy | 7 | 0.0001 | | Lumpectomy | 7 | 0.0005 | | Lumpectomy | 7 | 0.0006 |
| | | 8 | 0.0011 | | | 8 | 0.0016 | | | 8 | 0.0009 |
| | | 9 | 0.0006 | | | 9 | 0.0179 | | | 9 | 0.0068 |
| | | 10 | 0.0017 | | | 10 | 0.0222 | | | 10 | 0.0081 |
| | | 11 | 0.0055 | | | 11 | 0.0426 | | | 11 | 0.0200 |
| | | 12 | 0.0271 | | | 12 | 0.1813 | | | 12 | 0.1231 |
| | | | | | | | | | | | |
| Participant | Health States | | k Values | Participant | Health States | | k Values | Participant | Health States | | k Values |
| 4 | Mastectomy | 1 | -0.0018 | 5 | Mastectomy | 1 | 0.0008 | 6 | Mastectomy | 1 | 0.0010 |
| | | 2 | -0.0043 | | | 2 | 0.0012 | | | 2 | -0.0002 |
| | | 3 | 0.0034 | | | 3 | 0.0033 | | | 3 | 0.0086 |
| | | 4 | 0.0055 | | | 4 | -0.0130 | | | 4 | 0.0160 |
| | | 5 | 0.0213 | | | 5 | 0.0131 | | | 5 | 0.0013 |
| | | 6 | 0.0771 | | | 6 | 0.0115 | | | 6 | -0.0815 |
| | Lumpectomy | 7 | -0.0044 | | Lumpectomy | 7 | 0.0000 | | Lumpectomy | 7 | -0.0026 |
| | | 8 | -0.0058 | | | 8 | -0.0005 | | | 8 | -0.0002 |
| | | 9 | -0.0002 | | | 9 | -0.0040 | | | 9 | 0.0055 |
| | | 10 | 0.0039 | | | 10 | -0.0096 | | | 10 | 0.0112 |
| | | 11 | 0.0176 | | | 11 | 0.0061 | | | 11 | -0.0008 |
| | | 12 | 0.0735 | | | 12 | 0.0270 | | | 12 | -0.0815 |

Table N. 1 (Continued). Constant k Values in Multiplicative Utility Function

| Participant | Health States | | k Values | Participant | Health States | | k Values | Participant | Health States | | k Values |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 | Mastectomy | 1 | 0.0018 | 8 | Mastectomy | 1 | 0.0022 | 9 | Mastectomy | 1 | 0.0011 |
| | | 2 | 0.0023 | | | 2 | 0.0020 | | | 2 | -0.0013 |
| | | 3 | 0.0015 | | | 3 | 0.0060 | | | 3 | 0.0018 |
| | | 4 | 0.0018 | | | 4 | 0.0019 | | | 4 | -0.0061 |
| | | 5 | 0.0068 | | | 5 | 0.0138 | | | 5 | -0.0079 |
| | | 6 | 0.0115 | | | 6 | 0.0703 | | | 6 | -0.0330 |
| | Lumpectomy | 7 | -0.0005 | | Lumpectomy | 7 | -0.0003 | | Lumpectomy | 7 | 0.0002 |
| | | 8 | -0.0002 | | | 8 | 0.0013 | | | 8 | -0.0020 |
| | | 9 | 0.0009 | | | 9 | 0.0065 | | | 9 | 0.0033 |
| | | 10 | 0.0007 | | | 10 | 0.0040 | | | 10 | -0.0061 |
| | | 11 | 0.0062 | | | 11 | 0.0120 | | | 11 | -0.0080 |
| | | 12 | 0.0110 | | | 12 | 0.0703 | | | 12 | -0.0330 |
| | | | | | | | | | | | |
| Participant | Health States | | k Values | Participant | Health States | | k Values | Participant | Health States | | k Values |
| 10 | Mastectomy | 1 | -0.0003 | 11 | Mastectomy | 1 | -0.0031 | 12 | Mastectomy | 1 | -0.0025 |
| | | 2 | -0.0003 | | | 2 | -0.0046 | | | 2 | -0.0013 |
| | | 3 | -0.0119 | | | 3 | -0.0037 | | | 3 | 0.0056 |
| | | 4 | -0.0118 | | | 4 | -0.0062 | | | 4 | -0.0030 |
| | | 5 | 0.0090 | | | 5 | -0.0028 | | | 5 | -0.0062 |
| | | 6 | -0.0158 | | | 6 | 0.0051 | | | 6 | -0.6207 |
| | Lumpectomy | 7 | -0.0003 | | Lumpectomy | 7 | -0.0013 | | Lumpectomy | 7 | -0.0009 |
| | | 8 | 0.0011 | | | 8 | -0.0015 | | | 8 | -0.0023 |
| | | 9 | -0.0123 | | | 9 | -0.0003 | | | 9 | 0.0033 |
| | | 10 | -0.0119 | | | 10 | -0.0062 | | | 10 | -0.0033 |
| | | 11 | 0.0174 | | | 11 | 0.0006 | | | 11 | 0.0085 |
| | | 12 | -0.0158 | | | 12 | -0.0084 | | | 12 | -0.6207 |
| | | | | | | | | | | | |
| Participant | Health States | | k Values | Participant | Health States | | k Values | Participant | Health States | | k Values |
| 13 | Mastectomy | 1 | 0.0034 | 14 | Mastectomy | 1 | 0.0050 | 15 | Mastectomy | 1 | 0.0002 |
| | | 2 | 0.0042 | | | 2 | 0.0040 | | | 2 | -0.0002 |
| | | 3 | 0.0040 | | | 3 | -0.0050 | | | 3 | -0.0047 |
| | | 4 | -0.0130 | | | 4 | -0.0034 | | | 4 | -0.0131 |
| | | 5 | 0.0014 | | | 5 | -0.0179 | | | 5 | 0.0023 |
| | | 6 | -0.2561 | | | 6 | -0.1498 | | | 6 | -0.0027 |
| | Lumpectomy | 7 | 0.0003 | | Lumpectomy | 7 | -0.0029 | | Lumpectomy | 7 | 0.0001 |
| | | 8 | 0.0003 | | | 8 | -0.0038 | | | 8 | 0.0005 |
| | | 9 | 0.0007 | | | 9 | -0.0093 | | | 9 | -0.0055 |
| | | 10 | -0.0138 | | | 10 | -0.0036 | | | 10 | -0.0089 |
| | | 11 | -0.0131 | | | 11 | -0.0116 | | | 11 | 0.0015 |
| | | 12 | -0.2561 | | | 12 | -0.1498 | | | 12 | -0.0027 |

# APPENDIX O

# A TEXT REPORTS OF SAMPLE SIMULATION RUNS

Table O.1. Text Report of Mastectomy

| Sample | Value | CT | HT | LR | M | NT | S | Dist(u1) | Dist(u2) | Dist(u3) | Dist(u4) | Dist(u5) | Dist(u6) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 699.574 | 0.768 | 1.875 | 0.195 | 1.552 | 5.171 | 0.039 | 97.268 | 89.933 | 68.026 | 52.567 | 41.748 | 25.693 |
| 2 | 665.236 | 0.720 | 1.849 | 0.194 | 1.491 | 5.285 | 0.035 | 88.518 | 88.569 | 70.768 | 60.751 | 41.316 | 26.182 |
| 3 | 648.878 | 0.744 | 1.770 | 0.189 | 1.575 | 5.371 | 0.029 | 93.643 | 70.281 | 57.420 | 50.932 | 41.198 | 26.352 |
| 4 | 676.362 | 0.748 | 1.825 | 0.200 | 1.693 | 5.135 | 0.051 | 96.291 | 83.011 | 68.764 | 67.147 | 43.162 | 22.459 |
| 5 | 688.248 | 0.763 | 1.907 | 0.222 | 1.618 | 4.990 | 0.019 | 101.315 | 84.733 | 58.404 | 57.730 | 39.308 | 25.463 |
| 6 | 608.583 | 0.748 | 2.017 | 0.200 | 1.650 | 5.026 | 0.019 | 80.369 | 83.658 | 63.813 | 49.191 | 39.721 | 24.469 |
| 7 | 588.605 | 0.751 | 1.835 | 0.176 | 1.515 | 5.242 | 0.025 | 84.360 | 64.878 | 59.918 | 49.867 | 43.211 | 25.633 |
| 8 | 607.486 | 0.746 | 1.864 | 0.204 | 1.644 | 5.062 | 0.027 | 83.315 | 79.214 | 65.882 | 48.751 | 39.083 | 25.871 |
| 9 | 602.749 | 0.728 | 1.914 | 0.157 | 1.555 | 5.195 | 0.028 | 82.388 | 77.935 | 60.784 | 57.574 | 43.061 | 22.976 |
| 10 | 658.860 | 0.771 | 1.987 | 0.197 | 1.584 | 4.990 | 0.025 | 92.344 | 88.134 | 63.911 | 36.330 | 42.805 | 23.255 |
| 11 | 614.541 | 0.743 | 1.929 | 0.219 | 1.569 | 5.082 | 0.056 | 80.092 | 83.597 | 68.005 | 67.138 | 40.164 | 26.554 |
| 12 | 650.607 | 0.739 | 1.794 | 0.181 | 1.623 | 5.134 | 0.025 | 92.638 | 74.847 | 78.085 | 67.244 | 41.946 | 25.510 |
| 13 | 668.752 | 0.744 | 1.789 | 0.214 | 1.775 | 5.011 | 0.024 | 95.875 | 87.154 | 65.271 | 52.606 | 42.498 | 25.176 |
| 14 | 660.616 | 0.766 | 1.798 | 0.167 | 1.481 | 5.332 | 0.040 | 91.530 | 78.373 | 64.051 | 74.293 | 39.076 | 27.535 |
| 15 | 676.089 | 0.727 | 1.946 | 0.210 | 1.513 | 5.020 | 0.033 | 97.773 | 82.062 | 64.510 | 61.632 | 39.988 | 26.193 |
| 16 | 607.186 | 0.761 | 1.915 | 0.196 | 1.538 | 5.152 | 0.024 | 85.291 | 70.494 | 65.157 | 50.223 | 42.650 | 25.279 |
| 17 | 647.970 | 0.770 | 1.764 | 0.182 | 1.461 | 5.158 | 0.028 | 90.969 | 89.684 | 56.427 | 53.972 | 41.623 | 24.958 |
| 18 | 620.984 | 0.759 | 1.786 | 0.212 | 1.675 | 5.083 | 0.039 | 87.460 | 82.285 | 56.207 | 55.306 | 43.450 | 24.590 |
| 19 | 667.236 | 0.735 | 1.917 | 0.207 | 1.679 | 5.000 | 0.046 | 95.614 | 81.455 | 70.221 | 66.077 | 39.357 | 23.466 |
| 20 | 635.568 | 0.740 | 1.773 | 0.208 | 1.612 | 5.117 | 0.054 | 88.868 | 86.817 | 53.680 | 71.090 | 41.028 | 24.366 |
| 21 | 676.320 | 0.741 | 1.840 | 0.202 | 1.571 | 5.204 | 0.039 | 93.824 | 83.339 | 73.371 | 65.188 | 38.939 | 24.607 |
| 22 | 613.687 | 0.727 | 1.824 | 0.202 | 1.454 | 5.263 | 0.052 | 83.158 | 75.275 | 69.847 | 73.389 | 42.530 | 24.740 |
| 23 | 650.713 | 0.773 | 1.694 | 0.197 | 1.709 | 4.999 | 0.025 | 97.182 | 81.955 | 60.523 | 63.130 | 39.230 | 23.265 |
| 24 | 653.530 | 0.735 | 1.874 | 0.207 | 1.593 | 4.925 | 0.030 | 98.936 | 77.027 | 59.934 | 67.625 | 40.630 | 24.066 |
| 25 | 631.048 | 0.760 | 1.891 | 0.164 | 1.533 | 5.323 | 0.026 | 81.138 | 88.562 | 62.161 | 70.083 | 39.280 | 23.832 |
| 26 | 670.832 | 0.742 | 1.873 | 0.217 | 1.601 | 5.114 | 0.039 | 93.733 | 86.468 | 59.778 | 60.598 | 42.612 | 26.841 |
| 27 | 661.616 | 0.757 | 1.836 | 0.173 | 1.520 | 5.225 | 0.028 | 89.185 | 87.569 | 62.611 | 78.833 | 39.535 | 28.158 |
| 28 | 618.598 | 0.785 | 1.855 | 0.196 | 1.451 | 5.115 | 0.036 | 82.031 | 84.782 | 68.387 | 66.389 | 43.823 | 25.915 |
| 29 | 609.062 | 0.754 | 1.845 | 0.192 | 1.588 | 5.172 | 0.026 | 86.073 | 76.380 | 51.912 | 62.715 | 39.998 | 24.087 |
| 30 | 660.231 | 0.752 | 1.783 | 0.183 | 1.607 | 5.292 | 0.014 | 92.950 | 82.740 | 59.167 | 58.898 | 38.665 | 23.291 |
| 31 | 658.559 | 0.743 | 1.938 | 0.188 | 1.512 | 5.275 | 0.022 | 91.197 | 78.077 | 63.792 | 54.830 | 41.961 | 26.077 |
| 32 | 619.678 | 0.753 | 1.999 | 0.184 | 1.546 | 5.028 | 0.026 | 88.238 | 73.683 | 62.033 | 55.928 | 40.868 | 25.538 |
| 33 | 658.798 | 0.748 | 1.830 | 0.155 | 1.398 | 5.524 | 0.015 | 91.393 | 75.450 | 59.869 | 57.363 | 44.379 | 24.820 |
| 34 | 652.461 | 0.738 | 1.860 | 0.202 | 1.583 | 5.202 | 0.029 | 95.407 | 72.890 | 55.861 | 66.869 | 40.752 | 24.668 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | 669.387 | 0.758 | 1.744 | 0.197 | 1.602 | 5.069 | 0.035 | 95.421 | 85.608 | 69.610 | 66.354 | 40.725 | 26.618 |
| 36 | 604.556 | 0.756 | 1.838 | 0.184 | 1.498 | 5.344 | 0.022 | 81.299 | 74.645 | 62.779 | 62.497 | 42.069 | 24.948 |
| 37 | 589.838 | 0.747 | 1.806 | 0.188 | 1.716 | 5.135 | 0.045 | 79.056 | 78.589 | 62.652 | 65.905 | 40.399 | 24.656 |
| 38 | 613.951 | 0.733 | 1.845 | 0.212 | 1.504 | 5.177 | 0.036 | 79.647 | 84.436 | 71.311 | 69.448 | 43.430 | 26.177 |
| 39 | 600.535 | 0.734 | 1.951 | 0.176 | 1.452 | 5.181 | 0.033 | 83.201 | 76.119 | 60.553 | 42.905 | 41.468 | 22.607 |
| 40 | 651.911 | 0.749 | 1.876 | 0.199 | 1.478 | 5.301 | 0.031 | 86.271 | 90.183 | 67.409 | 46.567 | 40.883 | 22.048 |
| 41 | 600.313 | 0.742 | 1.869 | 0.190 | 1.575 | 5.264 | 0.023 | 79.409 | 79.755 | 57.033 | 64.921 | 42.294 | 25.604 |
| 42 | 688.348 | 0.743 | 1.846 | 0.212 | 1.584 | 5.214 | 0.046 | 99.831 | 80.307 | 59.796 | 55.473 | 39.934 | 25.164 |
| 43 | 635.709 | 0.739 | 1.945 | 0.184 | 1.502 | 5.208 | 0.020 | 84.285 | 88.638 | 55.174 | 64.593 | 40.023 | 24.932 |
| 44 | 615.806 | 0.747 | 1.890 | 0.211 | 1.601 | 5.075 | 0.038 | 85.506 | 82.152 | 56.470 | 51.321 | 42.138 | 23.771 |
| 45 | 614.486 | 0.718 | 1.786 | 0.171 | 1.625 | 5.304 | 0.034 | 81.974 | 80.141 | 67.087 | 61.656 | 38.614 | 25.310 |
| 46 | 647.449 | 0.753 | 1.739 | 0.189 | 1.596 | 5.147 | 0.023 | 91.732 | 80.801 | 75.558 | 48.954 | 43.319 | 24.242 |
| 47 | 702.051 | 0.754 | 1.796 | 0.200 | 1.645 | 5.104 | 0.021 | 102.936 | 84.325 | 62.080 | 67.995 | 42.046 | 25.943 |
| 48 | 594.871 | 0.723 | 1.802 | 0.170 | 1.574 | 5.279 | 0.043 | 79.142 | 79.594 | 59.074 | 68.195 | 42.656 | 25.308 |
| 49 | 663.585 | 0.753 | 1.802 | 0.198 | 1.554 | 5.150 | 0.018 | 97.682 | 78.334 | 56.479 | 75.119 | 42.117 | 23.905 |
| 50 | 623.045 | 0.749 | 1.835 | 0.193 | 1.620 | 5.330 | 0.026 | 83.952 | 79.317 | 54.423 | 57.511 | 38.610 | 27.041 |
| 51 | 625.585 | 0.736 | 1.804 | 0.194 | 1.420 | 5.290 | 0.034 | 81.407 | 86.091 | 71.588 | 66.337 | 44.984 | 25.697 |
| 52 | 638.494 | 0.750 | 1.778 | 0.209 | 1.638 | 5.141 | 0.038 | 89.441 | 84.492 | 57.029 | 58.356 | 43.586 | 25.064 |
| 53 | 612.760 | 0.757 | 1.793 | 0.199 | 1.602 | 5.085 | 0.021 | 87.442 | 76.316 | 58.606 | 62.970 | 39.656 | 25.646 |
| 54 | 607.932 | 0.784 | 1.622 | 0.210 | 1.652 | 5.217 | 0.021 | 86.301 | 76.245 | 63.636 | 49.944 | 39.823 | 23.777 |
| 55 | 620.039 | 0.745 | 1.753 | 0.206 | 1.565 | 5.099 | 0.029 | 86.191 | 83.331 | 60.700 | 61.248 | 39.194 | 26.967 |
| 56 | 620.468 | 0.763 | 1.850 | 0.176 | 1.602 | 5.102 | 0.030 | 82.106 | 93.333 | 51.071 | 60.893 | 40.049 | 26.155 |
| 57 | 654.853 | 0.763 | 1.718 | 0.199 | 1.784 | 5.149 | 0.022 | 92.214 | 83.863 | 63.118 | 68.208 | 37.641 | 24.943 |
| 58 | 664.617 | 0.746 | 1.831 | 0.180 | 1.444 | 5.338 | 0.023 | 92.208 | 79.578 | 67.041 | 65.459 | 41.855 | 25.353 |
| 59 | 642.023 | 0.741 | 1.791 | 0.208 | 1.635 | 5.106 | 0.030 | 89.396 | 84.406 | 65.874 | 59.182 | 44.268 | 25.331 |
| 60 | 637.123 | 0.755 | 1.870 | 0.220 | 1.531 | 5.193 | 0.038 | 88.495 | 80.141 | 65.073 | 47.021 | 42.302 | 23.360 |
| 61 | 625.067 | 0.760 | 1.783 | 0.165 | 1.535 | 5.309 | 0.037 | 85.063 | 81.287 | 62.311 | 53.860 | 40.511 | 24.461 |
| 62 | 621.679 | 0.751 | 1.829 | 0.178 | 1.574 | 5.175 | 0.023 | 86.843 | 74.017 | 68.938 | 58.595 | 42.877 | 26.376 |
| 63 | 645.101 | 0.764 | 1.750 | 0.206 | 1.528 | 5.278 | 0.021 | 85.282 | 87.871 | 76.122 | 52.922 | 41.485 | 24.656 |
| 64 | 620.972 | 0.734 | 1.811 | 0.206 | 1.624 | 5.198 | 0.036 | 84.955 | 81.466 | 61.133 | 60.439 | 39.352 | 24.402 |
| 65 | 573.464 | 0.761 | 1.779 | 0.201 | 1.684 | 5.144 | 0.058 | 80.891 | 64.458 | 63.751 | 62.301 | 42.004 | 25.029 |
| 66 | 675.607 | 0.734 | 1.865 | 0.184 | 1.396 | 5.378 | 0.023 | 91.054 | 83.989 | 64.772 | 78.908 | 39.975 | 27.790 |
| 67 | 685.820 | 0.778 | 1.856 | 0.176 | 1.457 | 5.366 | 0.020 | 89.343 | 93.037 | 69.786 | 59.870 | 43.014 | 26.674 |
| 68 | 619.957 | 0.777 | 1.637 | 0.215 | 1.636 | 5.242 | 0.031 | 83.156 | 85.227 | 65.625 | 62.751 | 37.520 | 26.715 |
| 69 | 663.403 | 0.768 | 1.770 | 0.191 | 1.607 | 5.157 | 0.026 | 92.830 | 88.498 | 64.158 | 64.664 | 40.554 | 23.072 |
| 70 | 637.079 | 0.741 | 1.837 | 0.196 | 1.437 | 5.229 | 0.027 | 88.093 | 78.179 | 69.697 | 61.260 | 41.144 | 25.722 |
| 71 | 609.103 | 0.738 | 1.852 | 0.215 | 1.499 | 5.331 | 0.026 | 79.444 | 82.472 | 61.136 | 60.798 | 38.728 | 24.250 |
| 72 | 658.613 | 0.757 | 1.827 | 0.216 | 1.560 | 5.171 | 0.041 | 91.451 | 84.177 | 58.452 | 66.470 | 42.035 | 27.410 |
| 73 | 601.380 | 0.761 | 1.770 | 0.192 | 1.606 | 5.240 | 0.047 | 77.626 | 80.830 | 70.631 | 58.944 | 38.971 | 28.722 |
| 74 | 644.742 | 0.764 | 1.794 | 0.177 | 1.481 | 5.502 | 0.027 | 85.153 | 78.703 | 71.701 | 72.772 | 38.184 | 23.376 |
| 75 | 677.237 | 0.740 | 1.906 | 0.193 | 1.551 | 5.288 | 0.024 | 94.216 | 79.105 | 65.381 | 65.326 | 42.550 | 26.269 |
| 76 | 696.576 | 0.743 | 1.807 | 0.202 | 1.454 | 5.409 | 0.020 | 97.612 | 83.303 | 59.223 | 45.972 | 40.982 | 28.209 |
| 77 | 698.439 | 0.766 | 1.781 | 0.166 | 1.494 | 5.341 | 0.019 | 97.711 | 82.277 | 71.371 | 56.465 | 39.535 | 28.346 |
| 78 | 667.486 | 0.751 | 1.906 | 0.197 | 1.579 | 5.104 | 0.030 | 99.033 | 74.058 | 60.734 | 57.736 | 41.962 | 25.092 |
| 79 | 667.087 | 0.752 | 1.855 | 0.156 | 1.458 | 5.272 | 0.022 | 94.729 | 83.213 | 54.384 | 56.072 | 41.033 | 25.475 |
| 80 | 647.785 | 0.760 | 1.854 | 0.191 | 1.493 | 5.277 | 0.018 | 91.573 | 74.752 | 61.586 | 53.568 | 41.254 | 27.047 |
| 81 | 658.152 | 0.752 | 1.724 | 0.179 | 1.494 | 5.291 | 0.016 | 96.756 | 78.876 | 48.945 | 45.898 | 41.956 | 27.008 |
| 82 | 606.850 | 0.767 | 1.842 | 0.202 | 1.682 | 4.927 | 0.026 | 84.220 | 83.650 | 58.548 | 62.222 | 45.240 | 26.069 |
| 83 | 620.196 | 0.759 | 1.822 | 0.172 | 1.519 | 5.345 | 0.021 | 82.578 | 79.633 | 68.499 | 54.825 | 41.768 | 23.988 |
| 84 | 620.035 | 0.751 | 1.852 | 0.186 | 1.491 | 5.280 | 0.019 | 80.811 | 90.335 | 49.759 | 66.378 | 41.067 | 26.204 |
| 85 | 620.747 | 0.740 | 1.712 | 0.197 | 1.534 | 5.378 | 0.040 | 83.627 | 76.397 | 69.673 | 65.671 | 42.070 | 25.997 |
| 86 | 624.352 | 0.756 | 1.722 | 0.196 | 1.550 | 5.229 | 0.031 | 88.173 | 78.861 | 62.592 | 52.568 | 40.591 | 23.775 |
| 87 | 674.746 | 0.753 | 1.895 | 0.192 | 1.591 | 5.154 | 0.045 | 90.441 | 89.090 | 72.862 | 63.659 | 38.365 | 26.171 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 88 | 650.046 | 0.747 | 1.863 | 0.203 | 1.550 | 5.327 | 0.040 | 84.741 | 87.887 | 68.711 | 55.411 | 39.507 | 24.269 |
| 89 | 649.283 | 0.719 | 1.914 | 0.173 | 1.500 | 5.318 | 0.014 | 89.912 | 76.560 | 66.040 | 74.897 | 41.631 | 23.062 |
| 90 | 642.967 | 0.758 | 1.818 | 0.182 | 1.775 | 4.953 | 0.023 | 91.909 | 85.221 | 65.602 | 49.462 | 42.128 | 24.221 |
| 91 | 636.108 | 0.769 | 1.752 | 0.212 | 1.545 | 5.175 | 0.024 | 88.314 | 85.419 | 59.367 | 67.145 | 41.550 | 24.196 |
| 92 | 661.388 | 0.729 | 2.001 | 0.185 | 1.514 | 5.235 | 0.027 | 88.603 | 88.494 | 57.893 | 52.940 | 41.616 | 24.895 |
| 93 | 702.365 | 0.755 | 1.851 | 0.198 | 1.556 | 5.180 | 0.027 | 101.431 | 87.261 | 54.330 | 51.406 | 42.130 | 26.915 |
| 94 | 626.714 | 0.744 | 1.862 | 0.187 | 1.593 | 5.058 | 0.054 | 89.422 | 79.294 | 59.869 | 66.059 | 43.080 | 22.955 |
| 95 | 645.101 | 0.782 | 1.748 | 0.189 | 1.447 | 5.375 | 0.034 | 91.285 | 75.750 | 58.904 | 56.257 | 40.941 | 24.755 |
| 96 | 704.094 | 0.751 | 1.753 | 0.188 | 1.481 | 5.280 | 0.016 | 101.704 | 86.988 | 59.674 | 61.428 | 40.576 | 24.592 |
| 97 | 612.841 | 0.750 | 1.828 | 0.187 | 1.614 | 5.338 | 0.022 | 75.032 | 91.822 | 62.098 | 75.210 | 43.286 | 26.435 |
| 98 | 648.004 | 0.761 | 1.761 | 0.213 | 1.641 | 5.161 | 0.017 | 91.869 | 82.041 | 55.983 | 68.128 | 43.632 | 25.970 |
| 99 | 627.409 | 0.748 | 1.873 | 0.170 | 1.558 | 5.279 | 0.021 | 83.495 | 85.395 | 57.854 | 71.662 | 41.179 | 23.266 |
| 100 | 666.691 | 0.730 | 1.854 | 0.192 | 1.591 | 5.033 | 0.032 | 93.055 | 94.058 | 57.783 | 64.437 | 41.415 | 24.975 |
| 101 | 627.140 | 0.750 | 1.820 | 0.215 | 1.556 | 5.249 | 0.033 | 88.321 | 69.026 | 73.281 | 61.867 | 39.504 | 23.940 |
| 102 | 633.199 | 0.777 | 1.868 | 0.187 | 1.575 | 5.265 | 0.022 | 85.575 | 77.655 | 64.773 | 60.604 | 42.256 | 27.456 |
| 103 | 714.410 | 0.724 | 1.878 | 0.201 | 1.479 | 5.246 | 0.024 | 100.210 | 88.103 | 71.709 | 67.398 | 41.133 | 23.464 |
| 104 | 672.420 | 0.759 | 1.798 | 0.201 | 1.546 | 5.210 | 0.021 | 94.237 | 86.315 | 68.513 | 51.417 | 42.900 | 23.536 |
| 105 | 592.743 | 0.747 | 1.757 | 0.184 | 1.592 | 5.286 | 0.024 | 81.625 | 73.024 | 61.175 | 73.179 | 42.862 | 23.238 |
| 106 | 605.263 | 0.739 | 1.831 | 0.207 | 1.523 | 5.142 | 0.028 | 84.578 | 77.741 | 58.083 | 49.523 | 41.583 | 25.981 |
| 107 | 687.088 | 0.760 | 1.813 | 0.185 | 1.565 | 5.095 | 0.025 | 100.507 | 83.217 | 69.240 | 60.312 | 39.997 | 23.638 |
| 108 | 714.726 | 0.763 | 1.889 | 0.196 | 1.473 | 5.367 | 0.017 | 96.543 | 90.552 | 70.511 | 60.675 | 41.027 | 23.952 |
| 109 | 655.159 | 0.743 | 1.885 | 0.188 | 1.607 | 5.004 | 0.036 | 91.153 | 86.307 | 70.006 | 67.085 | 39.225 | 25.160 |
| 110 | 687.445 | 0.739 | 1.757 | 0.234 | 1.525 | 5.134 | 0.035 | 96.354 | 94.769 | 64.870 | 54.495 | 41.351 | 25.059 |
| 111 | 598.128 | 0.756 | 1.765 | 0.178 | 1.667 | 5.136 | 0.021 | 79.605 | 86.568 | 58.959 | 51.289 | 40.761 | 26.326 |
| 112 | 657.577 | 0.736 | 1.798 | 0.195 | 1.527 | 5.212 | 0.030 | 94.578 | 82.499 | 61.320 | 57.126 | 38.515 | 21.130 |
| 113 | 640.673 | 0.757 | 1.738 | 0.209 | 1.686 | 5.170 | 0.028 | 90.451 | 76.917 | 71.739 | 64.723 | 37.703 | 24.054 |
| 114 | 633.968 | 0.739 | 1.825 | 0.195 | 1.522 | 5.235 | 0.016 | 83.851 | 88.460 | 63.385 | 63.338 | 41.424 | 25.974 |
| 115 | 681.180 | 0.777 | 1.882 | 0.164 | 1.497 | 5.262 | 0.026 | 95.535 | 80.701 | 67.713 | 70.746 | 40.810 | 24.069 |
| 116 | 653.245 | 0.750 | 1.756 | 0.167 | 1.542 | 5.309 | 0.022 | 90.532 | 80.308 | 67.243 | 64.310 | 40.455 | 26.307 |
| 117 | 680.598 | 0.760 | 1.929 | 0.201 | 1.577 | 5.078 | 0.031 | 93.902 | 85.680 | 73.715 | 56.815 | 39.344 | 27.151 |
| 118 | 668.732 | 0.768 | 1.703 | 0.194 | 1.585 | 5.230 | 0.033 | 92.730 | 86.253 | 72.555 | 69.054 | 43.562 | 24.039 |
| 119 | 619.576 | 0.767 | 1.771 | 0.194 | 1.610 | 5.216 | 0.025 | 85.485 | 83.480 | 56.228 | 56.555 | 44.066 | 23.090 |
| 120 | 624.794 | 0.742 | 1.998 | 0.190 | 1.679 | 5.135 | 0.015 | 80.503 | 87.977 | 62.876 | 69.581 | 37.405 | 23.020 |
| 121 | 683.818 | 0.768 | 1.801 | 0.174 | 1.458 | 5.336 | 0.033 | 101.461 | 75.471 | 54.288 | 57.711 | 39.183 | 23.005 |
| 122 | 637.841 | 0.757 | 1.675 | 0.183 | 1.604 | 5.330 | 0.019 | 88.413 | 78.773 | 63.310 | 80.875 | 40.288 | 25.179 |
| 123 | 621.799 | 0.752 | 1.805 | 0.201 | 1.539 | 5.200 | 0.039 | 88.077 | 74.883 | 58.017 | 67.126 | 42.114 | 25.126 |
| 124 | 672.313 | 0.781 | 1.820 | 0.200 | 1.604 | 5.242 | 0.031 | 90.404 | 90.330 | 65.386 | 57.808 | 42.705 | 25.528 |
| 125 | 675.187 | 0.760 | 1.765 | 0.207 | 1.583 | 5.268 | 0.026 | 91.946 | 91.438 | 67.680 | 55.185 | 41.643 | 23.459 |
| 126 | 621.046 | 0.750 | 1.821 | 0.200 | 1.513 | 5.149 | 0.020 | 87.499 | 77.534 | 61.228 | 66.715 | 42.366 | 24.720 |
| 127 | 611.068 | 0.762 | 1.860 | 0.185 | 1.478 | 5.205 | 0.031 | 82.885 | 83.523 | 55.862 | 50.099 | 41.871 | 24.458 |
| 128 | 598.410 | 0.777 | 1.744 | 0.193 | 1.618 | 5.345 | 0.024 | 81.249 | 75.176 | 59.211 | 50.579 | 43.071 | 24.992 |
| 129 | 627.338 | 0.773 | 1.751 | 0.174 | 1.598 | 5.124 | 0.035 | 90.930 | 75.927 | 58.467 | 64.184 | 42.219 | 25.516 |
| 130 | 610.995 | 0.749 | 1.813 | 0.184 | 1.487 | 5.351 | 0.033 | 83.696 | 70.259 | 69.120 | 63.353 | 41.400 | 25.096 |
| 131 | 631.712 | 0.731 | 1.883 | 0.178 | 1.561 | 5.257 | 0.024 | 90.406 | 68.853 | 63.630 | 57.759 | 39.312 | 25.663 |
| 132 | 594.055 | 0.747 | 1.875 | 0.188 | 1.565 | 4.986 | 0.025 | 83.823 | 75.336 | 62.860 | 64.675 | 41.126 | 25.136 |
| 133 | 676.366 | 0.748 | 1.858 | 0.205 | 1.606 | 5.058 | 0.051 | 95.947 | 85.412 | 65.790 | 54.954 | 40.474 | 27.519 |
| 134 | 617.625 | 0.748 | 1.824 | 0.226 | 1.553 | 5.138 | 0.035 | 90.216 | 75.876 | 49.238 | 49.150 | 40.695 | 23.048 |
| 135 | 673.102 | 0.736 | 1.973 | 0.185 | 1.568 | 5.105 | 0.042 | 90.364 | 90.730 | 65.498 | 67.737 | 40.794 | 26.349 |
| 136 | 669.437 | 0.755 | 1.745 | 0.200 | 1.564 | 5.169 | 0.023 | 100.236 | 73.399 | 61.019 | 66.699 | 41.313 | 25.990 |
| 137 | 633.559 | 0.758 | 1.839 | 0.208 | 1.553 | 5.260 | 0.031 | 84.487 | 86.158 | 58.226 | 62.861 | 39.816 | 24.879 |
| 138 | 736.960 | 0.766 | 1.729 | 0.188 | 1.471 | 5.507 | 0.017 | 100.508 | 92.264 | 69.494 | 73.527 | 39.598 | 24.270 |
| 139 | 651.236 | 0.751 | 1.793 | 0.190 | 1.560 | 5.081 | 0.020 | 93.863 | 83.421 | 57.944 | 64.573 | 40.007 | 25.914 |
| 140 | 687.497 | 0.745 | 1.840 | 0.186 | 1.518 | 5.238 | 0.035 | 93.861 | 96.412 | 50.715 | 52.054 | 42.164 | 28.257 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 141 | 586.203 | 0.758 | 1.839 | 0.178 | 1.625 | 5.166 | 0.018 | 77.652 | 75.143 | 68.983 | 70.031 | 39.016 | 25.890 |
| 142 | 572.031 | 0.747 | 1.832 | 0.202 | 1.693 | 4.977 | 0.041 | 75.565 | 79.809 | 69.187 | 72.400 | 44.635 | 23.426 |
| 143 | 682.893 | 0.755 | 1.824 | 0.164 | 1.535 | 5.349 | 0.029 | 92.262 | 90.543 | 65.042 | 67.408 | 41.950 | 23.200 |
| 144 | 646.918 | 0.766 | 1.749 | 0.193 | 1.707 | 5.112 | 0.014 | 90.345 | 89.941 | 56.534 | 59.991 | 42.796 | 24.524 |
| 145 | 649.554 | 0.736 | 1.869 | 0.165 | 1.513 | 5.403 | 0.013 | 85.429 | 84.869 | 64.652 | 55.982 | 41.677 | 26.469 |
| 146 | 569.451 | 0.759 | 1.812 | 0.174 | 1.522 | 5.353 | 0.025 | 65.958 | 89.555 | 71.940 | 53.754 | 38.644 | 27.735 |
| 147 | 583.108 | 0.739 | 1.808 | 0.197 | 1.658 | 5.070 | 0.018 | 78.841 | 74.272 | 78.339 | 53.526 | 41.580 | 24.439 |
| 148 | 650.922 | 0.764 | 1.826 | 0.168 | 1.464 | 5.326 | 0.030 | 86.660 | 93.903 | 55.054 | 49.316 | 42.281 | 24.086 |
| 149 | 617.198 | 0.736 | 1.809 | 0.182 | 1.526 | 5.463 | 0.025 | 80.333 | 82.383 | 55.809 | 59.283 | 42.714 | 26.432 |
| 150 | 711.556 | 0.786 | 1.793 | 0.200 | 1.677 | 5.129 | 0.027 | 104.319 | 82.442 | 67.512 | 58.806 | 40.371 | 25.489 |
| 151 | 661.004 | 0.739 | 1.765 | 0.166 | 1.557 | 5.333 | 0.015 | 88.056 | 94.885 | 66.993 | 56.368 | 39.142 | 21.507 |
| 152 | 651.020 | 0.745 | 1.758 | 0.189 | 1.552 | 5.242 | 0.014 | 92.936 | 79.875 | 58.970 | 50.190 | 39.174 | 27.127 |
| 153 | 619.577 | 0.782 | 1.717 | 0.176 | 1.584 | 5.274 | 0.043 | 87.830 | 79.488 | 50.030 | 60.187 | 39.452 | 23.408 |
| 154 | 576.504 | 0.749 | 1.754 | 0.172 | 1.565 | 5.330 | 0.021 | 75.286 | 76.772 | 62.267 | 72.490 | 43.250 | 25.442 |
| 155 | 606.771 | 0.764 | 1.918 | 0.221 | 1.663 | 5.010 | 0.020 | 82.676 | 78.533 | 67.037 | 61.785 | 41.745 | 24.159 |
| 156 | 594.682 | 0.754 | 1.840 | 0.173 | 1.580 | 5.232 | 0.019 | 82.246 | 73.439 | 56.818 | 64.101 | 41.269 | 24.418 |
| 157 | 602.857 | 0.756 | 1.846 | 0.224 | 1.638 | 5.197 | 0.037 | 76.925 | 84.242 | 68.187 | 71.064 | 41.968 | 23.700 |
| 158 | 643.342 | 0.761 | 1.799 | 0.193 | 1.558 | 5.167 | 0.033 | 90.115 | 78.002 | 67.403 | 70.741 | 43.557 | 26.264 |
| 159 | 610.789 | 0.748 | 1.893 | 0.241 | 1.602 | 5.042 | 0.045 | 85.333 | 73.296 | 66.823 | 58.778 | 35.757 | 26.230 |
| 160 | 601.467 | 0.755 | 1.739 | 0.192 | 1.525 | 5.369 | 0.034 | 79.470 | 80.916 | 55.373 | 55.953 | 37.492 | 28.430 |
| 161 | 635.020 | 0.769 | 1.840 | 0.210 | 1.583 | 5.086 | 0.027 | 79.539 | 97.137 | 76.259 | 62.274 | 41.947 | 25.705 |
| 162 | 651.209 | 0.748 | 1.904 | 0.191 | 1.604 | 4.938 | 0.029 | 93.018 | 86.036 | 57.604 | 72.595 | 37.589 | 25.554 |
| 163 | 608.269 | 0.736 | 1.892 | 0.205 | 1.557 | 5.097 | 0.035 | 85.441 | 75.810 | 57.176 | 58.865 | 40.242 | 25.821 |
| 164 | 654.429 | 0.751 | 1.849 | 0.178 | 1.729 | 5.054 | 0.026 | 92.552 | 80.582 | 63.304 | 63.720 | 41.182 | 28.759 |
| 165 | 637.732 | 0.755 | 1.750 | 0.206 | 1.628 | 5.122 | 0.021 | 88.460 | 87.934 | 63.438 | 56.207 | 41.314 | 23.557 |
| 166 | 611.386 | 0.754 | 1.854 | 0.225 | 1.515 | 5.118 | 0.016 | 83.010 | 81.640 | 66.736 | 45.386 | 41.295 | 25.403 |
| 167 | 636.451 | 0.759 | 1.936 | 0.202 | 1.511 | 5.053 | 0.038 | 90.618 | 77.126 | 66.232 | 58.958 | 42.841 | 23.552 |
| 168 | 655.140 | 0.749 | 1.874 | 0.203 | 1.501 | 5.149 | 0.018 | 90.760 | 84.896 | 61.984 | 79.950 | 42.346 | 23.867 |
| 169 | 641.788 | 0.750 | 1.807 | 0.199 | 1.569 | 5.285 | 0.045 | 85.470 | 89.141 | 58.603 | 57.571 | 43.774 | 24.645 |
| 170 | 565.061 | 0.751 | 1.879 | 0.202 | 1.585 | 5.061 | 0.010 | 71.776 | 84.686 | 66.761 | 58.936 | 38.098 | 22.758 |
| 171 | 625.739 | 0.794 | 1.861 | 0.171 | 1.646 | 5.114 | 0.025 | 91.687 | 70.823 | 52.764 | 60.362 | 42.452 | 26.428 |
| 172 | 654.390 | 0.726 | 1.936 | 0.180 | 1.503 | 5.288 | 0.021 | 87.325 | 84.659 | 68.422 | 49.664 | 43.079 | 25.234 |
| 173 | 645.255 | 0.754 | 1.903 | 0.177 | 1.474 | 5.252 | 0.029 | 91.480 | 72.573 | 61.341 | 79.915 | 35.823 | 25.284 |
| 174 | 631.934 | 0.752 | 1.977 | 0.167 | 1.532 | 5.144 | 0.044 | 91.499 | 69.370 | 60.510 | 74.471 | 43.120 | 23.498 |
| 175 | 662.481 | 0.758 | 1.801 | 0.200 | 1.549 | 5.281 | 0.032 | 92.635 | 81.465 | 63.714 | 59.207 | 42.299 | 24.104 |
| 176 | 661.883 | 0.752 | 1.895 | 0.200 | 1.585 | 5.075 | 0.029 | 94.813 | 84.778 | 55.865 | 56.920 | 41.223 | 24.508 |
| 177 | 610.487 | 0.747 | 1.771 | 0.184 | 1.482 | 5.277 | 0.038 | 83.833 | 75.737 | 63.694 | 70.342 | 42.208 | 25.462 |
| 178 | 635.264 | 0.747 | 1.883 | 0.199 | 1.493 | 5.253 | 0.033 | 83.382 | 86.841 | 64.102 | 59.262 | 41.664 | 25.782 |
| 179 | 637.470 | 0.754 | 1.847 | 0.191 | 1.507 | 5.186 | 0.042 | 83.258 | 90.245 | 71.476 | 54.319 | 43.793 | 25.305 |
| 180 | 597.767 | 0.762 | 1.867 | 0.187 | 1.544 | 5.080 | 0.021 | 77.029 | 91.644 | 58.739 | 60.304 | 42.035 | 24.993 |
| 181 | 633.919 | 0.748 | 1.877 | 0.219 | 1.734 | 4.913 | 0.026 | 89.543 | 80.995 | 66.734 | 56.275 | 38.687 | 27.180 |
| 182 | 646.073 | 0.744 | 1.719 | 0.209 | 1.566 | 5.383 | 0.021 | 92.663 | 70.207 | 66.461 | 59.267 | 39.729 | 23.265 |
| 183 | 676.845 | 0.744 | 1.748 | 0.196 | 1.556 | 5.381 | 0.033 | 96.056 | 78.113 | 63.403 | 55.852 | 39.240 | 25.360 |
| 184 | 709.626 | 0.763 | 1.841 | 0.200 | 1.452 | 5.370 | 0.048 | 101.511 | 80.022 | 62.477 | 64.011 | 41.852 | 23.875 |
| 185 | 648.986 | 0.739 | 1.890 | 0.212 | 1.642 | 5.012 | 0.047 | 94.214 | 76.706 | 61.622 | 69.791 | 44.003 | 25.651 |
| 186 | 711.054 | 0.769 | 1.868 | 0.196 | 1.425 | 5.266 | 0.035 | 98.297 | 88.727 | 75.324 | 64.341 | 43.466 | 22.915 |
| 187 | 642.522 | 0.747 | 1.767 | 0.207 | 1.532 | 5.257 | 0.017 | 93.776 | 67.336 | 65.302 | 62.852 | 42.931 | 26.796 |
| 188 | 595.998 | 0.777 | 1.860 | 0.200 | 1.574 | 5.090 | 0.030 | 78.688 | 80.844 | 69.166 | 58.177 | 39.895 | 25.335 |
| 189 | 607.139 | 0.741 | 1.751 | 0.187 | 1.629 | 5.209 | 0.026 | 83.855 | 74.376 | 69.397 | 55.692 | 44.608 | 25.734 |
| 190 | 641.321 | 0.785 | 1.874 | 0.172 | 1.460 | 5.199 | 0.033 | 91.623 | 78.557 | 50.694 | 68.310 | 41.871 | 25.119 |
| 191 | 637.866 | 0.761 | 1.924 | 0.223 | 1.519 | 5.175 | 0.046 | 84.500 | 88.074 | 60.533 | 62.082 | 43.730 | 23.005 |
| 192 | 647.717 | 0.760 | 1.848 | 0.210 | 1.504 | 5.263 | 0.032 | 86.591 | 85.474 | 67.489 | 66.860 | 42.237 | 23.412 |
| 193 | 631.198 | 0.739 | 1.958 | 0.214 | 1.618 | 5.138 | 0.036 | 80.721 | 88.806 | 70.612 | 67.625 | 38.931 | 23.390 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 194 | 617.200 | 0.771 | 1.732 | 0.202 | 1.572 | 5.160 | 0.052 | 88.785 | 74.445 | 59.709 | 61.390 | 38.841 | 24.555 |
| 195 | 605.530 | 0.744 | 1.810 | 0.206 | 1.592 | 5.134 | 0.024 | 83.284 | 76.664 | 69.068 | 64.497 | 40.728 | 24.289 |
| 196 | 650.033 | 0.758 | 1.808 | 0.208 | 1.542 | 5.211 | 0.050 | 91.737 | 79.560 | 67.893 | 50.126 | 40.021 | 23.167 |
| 197 | 669.728 | 0.753 | 1.931 | 0.176 | 1.522 | 5.312 | 0.025 | 87.986 | 92.024 | 65.503 | 54.110 | 40.422 | 22.737 |
| 198 | 656.640 | 0.734 | 1.799 | 0.211 | 1.741 | 5.000 | 0.029 | 95.239 | 80.560 | 68.324 | 61.686 | 40.834 | 25.282 |
| 199 | 734.930 | 0.750 | 1.794 | 0.189 | 1.542 | 5.294 | 0.022 | 108.266 | 82.858 | 61.177 | 65.263 | 40.114 | 24.991 |
| 200 | 587.731 | 0.756 | 1.805 | 0.205 | 1.639 | 5.158 | 0.010 | 77.915 | 85.366 | 53.249 | 65.683 | 41.283 | 23.198 |

Table O.2. Text Report of Lumpectomy

| Sample | Value | CT | HT | LR | M | NT | S | Dist(u1) | Dist(u2) | Dist(u3) | Dist(u4) | Dist(u5) | Dist(u6) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 752.440 | 0.749 | 1.866 | 0.197 | 1.563 | 5.177 | 0.027 | 101.324 | 95.776 | 73.357 | 78.930 | 46.779 | 36.685 |
| 2 | 679.703 | 0.750 | 1.835 | 0.192 | 1.536 | 5.221 | 0.028 | 96.636 | 89.821 | 66.110 | 72.489 | 63.101 | 12.882 |
| 3 | 686.981 | 0.747 | 1.845 | 0.189 | 1.551 | 5.179 | 0.034 | 91.767 | 87.680 | 70.533 | 65.060 | 44.256 | 35.901 |
| 4 | 713.902 | 0.752 | 1.844 | 0.194 | 1.517 | 5.293 | 0.031 | 97.005 | 96.496 | 70.591 | 55.771 | 20.235 | 22.401 |
| 5 | 688.523 | 0.753 | 1.849 | 0.192 | 1.515 | 5.241 | 0.028 | 92.473 | 93.071 | 62.358 | 64.457 | 31.405 | 29.236 |
| 6 | 688.328 | 0.750 | 1.842 | 0.196 | 1.550 | 5.174 | 0.033 | 96.288 | 96.424 | 62.321 | 61.252 | 34.375 | 17.412 |
| 7 | 685.688 | 0.752 | 1.844 | 0.189 | 1.545 | 5.180 | 0.030 | 96.972 | 89.900 | 66.774 | 64.015 | 39.253 | 18.885 |
| 8 | 732.246 | 0.750 | 1.856 | 0.191 | 1.587 | 5.166 | 0.027 | 98.591 | 92.450 | 73.178 | 62.258 | 38.952 | 38.504 |
| 9 | 659.941 | 0.745 | 1.836 | 0.189 | 1.550 | 5.243 | 0.025 | 94.328 | 92.068 | 66.197 | 55.131 | 51.120 | 4.897 |
| 10 | 664.313 | 0.753 | 1.820 | 0.187 | 1.561 | 5.195 | 0.031 | 91.921 | 96.422 | 58.907 | 59.159 | 56.036 | 16.128 |
| 11 | 695.039 | 0.755 | 1.819 | 0.197 | 1.584 | 5.147 | 0.032 | 91.690 | 99.008 | 69.762 | 72.756 | 25.714 | 29.523 |
| 12 | 691.379 | 0.751 | 1.826 | 0.194 | 1.532 | 5.267 | 0.025 | 94.065 | 95.589 | 64.795 | 56.261 | 29.071 | 22.526 |
| 13 | 680.564 | 0.745 | 1.831 | 0.195 | 1.514 | 5.242 | 0.027 | 97.679 | 90.821 | 59.102 | 51.083 | 18.686 | 15.484 |
| 14 | 672.882 | 0.758 | 1.830 | 0.191 | 1.589 | 5.138 | 0.037 | 88.784 | 90.658 | 76.558 | 78.041 | 50.355 | 28.602 |
| 15 | 751.142 | 0.745 | 1.846 | 0.196 | 1.529 | 5.226 | 0.031 | 104.130 | 96.696 | 66.205 | 68.694 | 43.796 | 29.964 |
| 16 | 714.481 | 0.746 | 1.832 | 0.197 | 1.571 | 5.184 | 0.033 | 100.595 | 94.060 | 81.638 | 68.531 | 48.754 | 14.032 |
| 17 | 679.395 | 0.751 | 1.801 | 0.188 | 1.541 | 5.263 | 0.026 | 91.770 | 95.266 | 66.898 | 44.101 | 33.875 | 24.226 |
| 18 | 679.942 | 0.746 | 1.808 | 0.200 | 1.534 | 5.282 | 0.033 | 94.261 | 89.829 | 68.138 | 47.301 | 48.410 | 20.374 |
| 19 | 694.347 | 0.745 | 1.835 | 0.206 | 1.544 | 5.174 | 0.033 | 95.025 | 96.012 | 68.541 | 65.843 | 49.940 | 22.011 |
| 20 | 702.414 | 0.746 | 1.832 | 0.197 | 1.554 | 5.208 | 0.035 | 96.597 | 90.934 | 86.698 | 54.769 | 29.207 | 20.079 |
| 21 | 699.897 | 0.756 | 1.783 | 0.197 | 1.581 | 5.209 | 0.030 | 95.416 | 89.934 | 72.556 | 66.407 | 23.275 | 30.603 |
| 22 | 705.487 | 0.747 | 1.852 | 0.202 | 1.560 | 5.206 | 0.032 | 91.925 | 98.412 | 77.311 | 62.129 | 36.569 | 29.070 |
| 23 | 739.771 | 0.751 | 1.808 | 0.196 | 1.532 | 5.241 | 0.028 | 101.342 | 96.154 | 60.789 | 59.416 | 58.189 | 36.289 |
| 24 | 658.907 | 0.757 | 1.808 | 0.195 | 1.546 | 5.268 | 0.022 | 88.485 | 86.835 | 63.615 | 61.673 | 58.661 | 28.382 |
| 25 | 709.812 | 0.749 | 1.855 | 0.192 | 1.544 | 5.238 | 0.023 | 97.935 | 88.478 | 82.885 | 62.991 | 48.960 | 21.888 |
| 26 | 723.648 | 0.754 | 1.849 | 0.203 | 1.561 | 5.183 | 0.035 | 96.536 | 94.349 | 76.079 | 67.112 | 43.215 | 33.413 |
| 27 | 769.356 | 0.754 | 1.835 | 0.198 | 1.575 | 5.181 | 0.029 | 107.162 | 87.903 | 86.177 | 68.343 | 41.310 | 36.199 |
| 28 | 698.313 | 0.754 | 1.848 | 0.196 | 1.543 | 5.193 | 0.028 | 95.325 | 91.734 | 58.754 | 62.435 | 49.812 | 32.960 |
| 29 | 677.461 | 0.751 | 1.833 | 0.190 | 1.548 | 5.197 | 0.028 | 90.008 | 96.209 | 71.315 | 62.576 | 30.720 | 24.019 |
| 30 | 652.150 | 0.749 | 1.811 | 0.197 | 1.566 | 5.215 | 0.032 | 86.717 | 99.357 | 63.062 | 66.730 | 41.838 | 16.262 |
| 31 | 705.121 | 0.754 | 1.809 | 0.193 | 1.533 | 5.237 | 0.034 | 96.945 | 87.377 | 68.703 | 54.562 | 46.045 | 33.700 |
| 32 | 665.380 | 0.748 | 1.815 | 0.200 | 1.573 | 5.180 | 0.033 | 92.676 | 93.016 | 69.127 | 56.352 | 47.128 | 14.893 |
| 33 | 635.671 | 0.749 | 1.836 | 0.198 | 1.545 | 5.189 | 0.029 | 88.784 | 86.586 | 62.154 | 65.694 | 41.095 | 15.512 |
| 34 | 718.714 | 0.746 | 1.839 | 0.194 | 1.532 | 5.215 | 0.028 | 97.609 | 94.233 | 54.636 | 56.945 | 34.607 | 39.593 |
| 35 | 745.569 | 0.750 | 1.842 | 0.191 | 1.569 | 5.159 | 0.028 | 105.022 | 87.993 | 70.576 | 56.885 | 44.562 | 37.552 |
| 36 | 748.406 | 0.749 | 1.857 | 0.196 | 1.531 | 5.242 | 0.029 | 100.782 | 99.948 | 65.834 | 65.492 | 56.542 | 32.619 |
| 37 | 646.785 | 0.752 | 1.852 | 0.178 | 1.531 | 5.228 | 0.029 | 92.852 | 85.777 | 57.155 | 44.352 | 40.182 | 14.557 |
| 38 | 707.438 | 0.751 | 1.851 | 0.184 | 1.555 | 5.193 | 0.034 | 97.272 | 95.903 | 62.300 | 53.227 | 49.090 | 27.420 |
| 39 | 712.815 | 0.757 | 1.834 | 0.201 | 1.590 | 5.180 | 0.027 | 105.634 | 91.611 | 56.597 | 52.465 | 38.762 | 15.381 |
| 40 | 720.531 | 0.746 | 1.834 | 0.194 | 1.540 | 5.225 | 0.026 | 99.139 | 95.082 | 75.620 | 67.244 | 58.614 | 22.340 |
| 41 | 705.784 | 0.751 | 1.816 | 0.185 | 1.529 | 5.274 | 0.031 | 97.527 | 94.252 | 64.656 | 57.935 | 22.259 | 23.835 |
| 42 | 706.699 | 0.745 | 1.834 | 0.187 | 1.543 | 5.235 | 0.023 | 100.425 | 86.898 | 66.131 | 71.793 | 56.018 | 23.320 |
| 43 | 729.560 | 0.745 | 1.809 | 0.197 | 1.587 | 5.195 | 0.033 | 101.444 | 94.859 | 62.942 | 66.163 | 47.327 | 30.707 |
| 44 | 695.971 | 0.752 | 1.859 | 0.190 | 1.562 | 5.199 | 0.027 | 92.353 | 93.249 | 75.841 | 72.298 | 63.733 | 27.140 |
| 45 | 693.413 | 0.746 | 1.842 | 0.194 | 1.546 | 5.201 | 0.029 | 97.775 | 90.620 | 64.345 | 62.485 | 41.699 | 21.127 |
| 46 | 644.192 | 0.748 | 1.828 | 0.193 | 1.549 | 5.203 | 0.033 | 84.850 | 90.933 | 74.154 | 62.778 | 45.050 | 21.644 |
| 47 | 699.949 | 0.752 | 1.787 | 0.190 | 1.525 | 5.237 | 0.024 | 95.065 | 95.744 | 62.055 | 72.430 | 32.423 | 29.017 |
| 48 | 726.878 | 0.753 | 1.866 | 0.199 | 1.541 | 5.214 | 0.033 | 102.552 | 94.539 | 58.401 | 58.715 | 18.059 | 25.625 |
| 49 | 723.523 | 0.751 | 1.842 | 0.191 | 1.516 | 5.263 | 0.032 | 96.419 | 97.568 | 56.426 | 64.251 | 54.526 | 37.178 |
| 50 | 643.117 | 0.757 | 1.781 | 0.197 | 1.571 | 5.196 | 0.027 | 84.359 | 93.894 | 63.163 | 55.149 | 36.808 | 27.871 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 51 | 678.992 | 0.752 | 1.825 | 0.185 | 1.582 | 5.179 | 0.027 | 95.315 | 92.692 | 67.996 | 60.676 | 36.047 | 16.757 |
| 52 | 682.273 | 0.751 | 1.843 | 0.202 | 1.573 | 5.165 | 0.030 | 94.523 | 87.110 | 52.933 | 77.022 | 27.900 | 32.794 |
| 53 | 725.174 | 0.747 | 1.873 | 0.194 | 1.535 | 5.182 | 0.029 | 102.961 | 96.308 | 66.951 | 54.558 | 55.836 | 18.678 |
| 54 | 717.062 | 0.752 | 1.824 | 0.194 | 1.549 | 5.199 | 0.031 | 100.752 | 96.971 | 59.033 | 54.344 | 42.274 | 24.904 |
| 55 | 731.320 | 0.751 | 1.802 | 0.198 | 1.552 | 5.233 | 0.032 | 104.908 | 87.976 | 76.867 | 48.521 | 28.879 | 23.819 |
| 56 | 710.287 | 0.746 | 1.824 | 0.197 | 1.533 | 5.221 | 0.031 | 99.597 | 90.970 | 70.155 | 64.132 | 21.564 | 23.602 |
| 57 | 662.238 | 0.754 | 1.799 | 0.200 | 1.543 | 5.250 | 0.027 | 89.744 | 90.758 | 77.829 | 53.685 | 50.595 | 17.347 |
| 58 | 701.314 | 0.741 | 1.850 | 0.198 | 1.536 | 5.221 | 0.027 | 96.802 | 89.310 | 62.571 | 57.753 | 48.777 | 30.897 |
| 59 | 680.789 | 0.749 | 1.857 | 0.191 | 1.565 | 5.163 | 0.032 | 94.447 | 90.759 | 57.027 | 49.542 | 39.137 | 28.652 |
| 60 | 744.149 | 0.756 | 1.809 | 0.199 | 1.539 | 5.229 | 0.035 | 100.021 | 99.453 | 84.480 | 68.920 | 38.081 | 26.225 |
| 61 | 714.535 | 0.752 | 1.827 | 0.192 | 1.532 | 5.243 | 0.027 | 95.677 | 96.494 | 73.035 | 64.191 | 38.544 | 28.210 |
| 62 | 736.195 | 0.754 | 1.829 | 0.205 | 1.552 | 5.222 | 0.029 | 103.385 | 94.894 | 65.772 | 62.946 | 40.825 | 25.501 |
| 63 | 728.201 | 0.746 | 1.835 | 0.195 | 1.547 | 5.208 | 0.028 | 99.977 | 96.051 | 66.257 | 59.072 | 20.910 | 30.899 |
| 64 | 702.557 | 0.757 | 1.835 | 0.198 | 1.562 | 5.223 | 0.032 | 96.119 | 93.733 | 68.552 | 46.972 | 41.934 | 26.399 |
| 65 | 725.407 | 0.749 | 1.842 | 0.198 | 1.538 | 5.209 | 0.032 | 104.092 | 92.532 | 62.722 | 59.575 | 50.225 | 21.652 |
| 66 | 686.892 | 0.749 | 1.844 | 0.192 | 1.504 | 5.264 | 0.030 | 87.493 | 98.042 | 65.262 | 49.134 | 42.886 | 36.710 |
| 67 | 711.353 | 0.753 | 1.813 | 0.194 | 1.565 | 5.174 | 0.035 | 100.583 | 85.861 | 73.157 | 54.463 | 58.714 | 29.392 |
| 68 | 695.144 | 0.752 | 1.841 | 0.200 | 1.559 | 5.194 | 0.026 | 96.564 | 96.581 | 56.789 | 49.075 | 41.248 | 23.973 |
| 69 | 681.807 | 0.751 | 1.865 | 0.198 | 1.558 | 5.123 | 0.026 | 97.022 | 95.067 | 68.106 | 64.280 | 51.354 | 10.448 |
| 70 | 694.128 | 0.745 | 1.839 | 0.191 | 1.547 | 5.199 | 0.030 | 93.562 | 93.363 | 61.724 | 63.076 | 44.182 | 32.401 |
| 71 | 708.137 | 0.747 | 1.817 | 0.198 | 1.583 | 5.196 | 0.027 | 95.948 | 88.961 | 52.869 | 66.807 | 53.262 | 44.124 |
| 72 | 719.757 | 0.752 | 1.861 | 0.198 | 1.586 | 5.171 | 0.024 | 97.461 | 98.608 | 72.345 | 60.563 | 49.164 | 25.500 |
| 73 | 703.198 | 0.754 | 1.836 | 0.190 | 1.566 | 5.182 | 0.031 | 92.045 | 99.289 | 63.248 | 71.676 | 21.445 | 34.701 |
| 74 | 741.421 | 0.753 | 1.880 | 0.203 | 1.561 | 5.186 | 0.027 | 102.630 | 97.527 | 66.959 | 72.516 | 44.766 | 25.285 |
| 75 | 679.454 | 0.747 | 1.860 | 0.200 | 1.542 | 5.177 | 0.035 | 94.099 | 99.056 | 52.448 | 62.679 | 43.214 | 17.943 |
| 76 | 673.378 | 0.745 | 1.856 | 0.189 | 1.548 | 5.158 | 0.030 | 94.670 | 87.863 | 67.215 | 48.613 | 32.710 | 22.762 |
| 77 | 739.859 | 0.743 | 1.844 | 0.206 | 1.590 | 5.122 | 0.031 | 101.009 | 86.395 | 74.671 | 61.142 | 53.386 | 45.942 |
| 78 | 746.930 | 0.742 | 1.861 | 0.195 | 1.533 | 5.213 | 0.028 | 101.026 | 93.155 | 71.814 | 82.635 | 45.087 | 36.460 |
| 79 | 704.797 | 0.752 | 1.823 | 0.194 | 1.583 | 5.212 | 0.027 | 96.977 | 95.218 | 63.308 | 62.992 | 49.958 | 25.432 |
| 80 | 702.645 | 0.749 | 1.841 | 0.200 | 1.528 | 5.199 | 0.028 | 94.029 | 102.668 | 57.469 | 70.230 | 35.797 | 26.237 |
| 81 | 665.926 | 0.746 | 1.856 | 0.200 | 1.556 | 5.191 | 0.036 | 93.022 | 96.201 | 51.982 | 61.745 | 44.125 | 15.140 |
| 82 | 739.618 | 0.754 | 1.829 | 0.190 | 1.539 | 5.226 | 0.028 | 105.311 | 90.391 | 78.464 | 61.088 | 45.508 | 21.826 |
| 83 | 702.681 | 0.745 | 1.825 | 0.199 | 1.571 | 5.169 | 0.026 | 95.852 | 92.088 | 74.772 | 58.349 | 40.009 | 28.963 |
| 84 | 720.624 | 0.748 | 1.862 | 0.195 | 1.533 | 5.212 | 0.030 | 101.353 | 93.669 | 59.132 | 62.071 | 55.407 | 25.525 |
| 85 | 684.714 | 0.751 | 1.841 | 0.195 | 1.507 | 5.238 | 0.030 | 98.332 | 83.109 | 63.242 | 58.976 | 46.045 | 21.781 |
| 86 | 709.994 | 0.742 | 1.849 | 0.191 | 1.568 | 5.184 | 0.030 | 97.216 | 99.736 | 71.175 | 52.797 | 33.892 | 21.154 |
| 87 | 660.564 | 0.752 | 1.816 | 0.192 | 1.554 | 5.220 | 0.031 | 89.105 | 90.115 | 65.557 | 49.980 | 29.197 | 26.867 |
| 88 | 691.115 | 0.753 | 1.832 | 0.190 | 1.542 | 5.196 | 0.025 | 94.399 | 94.096 | 59.166 | 55.311 | 30.778 | 29.969 |
| 89 | 724.051 | 0.758 | 1.809 | 0.189 | 1.534 | 5.236 | 0.022 | 95.403 | 98.141 | 75.768 | 82.978 | 46.934 | 31.140 |
| 90 | 692.768 | 0.749 | 1.815 | 0.195 | 1.562 | 5.169 | 0.027 | 96.853 | 86.844 | 71.075 | 44.381 | 45.777 | 30.049 |
| 91 | 711.163 | 0.750 | 1.860 | 0.206 | 1.524 | 5.234 | 0.030 | 101.360 | 82.047 | 66.788 | 74.787 | 32.534 | 26.845 |
| 92 | 658.262 | 0.755 | 1.830 | 0.191 | 1.532 | 5.274 | 0.028 | 89.290 | 89.641 | 55.805 | 51.792 | 49.449 | 26.173 |
| 93 | 695.069 | 0.752 | 1.876 | 0.196 | 1.542 | 5.188 | 0.029 | 97.410 | 99.533 | 61.757 | 49.506 | 41.246 | 13.529 |
| 94 | 717.790 | 0.754 | 1.835 | 0.194 | 1.555 | 5.218 | 0.027 | 103.365 | 94.618 | 55.637 | 71.964 | 52.201 | 17.568 |
| 95 | 672.121 | 0.752 | 1.853 | 0.193 | 1.524 | 5.234 | 0.028 | 86.751 | 97.097 | 70.308 | 69.940 | 47.571 | 25.234 |
| 96 | 709.871 | 0.755 | 1.817 | 0.200 | 1.562 | 5.229 | 0.030 | 95.086 | 87.409 | 71.948 | 59.830 | 32.394 | 39.492 |
| 97 | 734.622 | 0.757 | 1.815 | 0.191 | 1.504 | 5.239 | 0.028 | 102.044 | 91.093 | 58.837 | 64.697 | 29.238 | 38.240 |
| 98 | 692.179 | 0.745 | 1.864 | 0.199 | 1.544 | 5.215 | 0.029 | 93.458 | 95.156 | 70.907 | 63.926 | 24.994 | 22.077 |
| 99 | 712.156 | 0.750 | 1.832 | 0.192 | 1.539 | 5.241 | 0.030 | 97.871 | 92.963 | 62.652 | 69.817 | 42.932 | 28.502 |
| 100 | 737.535 | 0.755 | 1.823 | 0.197 | 1.557 | 5.202 | 0.028 | 105.240 | 93.141 | 56.534 | 56.165 | 60.330 | 30.189 |
| 101 | 733.714 | 0.750 | 1.841 | 0.200 | 1.558 | 5.191 | 0.030 | 100.030 | 96.263 | 81.749 | 52.275 | 53.321 | 26.780 |
| 102 | 751.979 | 0.756 | 1.820 | 0.196 | 1.533 | 5.213 | 0.029 | 101.717 | 94.121 | 76.479 | 67.835 | 35.245 | 38.029 |
| 103 | 718.734 | 0.750 | 1.835 | 0.197 | 1.562 | 5.228 | 0.033 | 95.706 | 96.953 | 64.523 | 53.834 | 64.530 | 35.093 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 104 | 751.252 | 0.757 | 1.819 | 0.192 | 1.542 | 5.229 | 0.022 | 102.445 | 102.068 | 69.182 | 63.213 | 40.093 | 29.040 |
| 105 | 681.466 | 0.750 | 1.849 | 0.193 | 1.544 | 5.240 | 0.026 | 93.151 | 89.810 | 64.512 | 51.274 | 39.272 | 26.582 |
| 106 | 683.041 | 0.750 | 1.824 | 0.195 | 1.556 | 5.177 | 0.028 | 93.890 | 95.783 | 59.337 | 62.823 | 35.934 | 24.044 |
| 107 | 708.073 | 0.756 | 1.808 | 0.188 | 1.577 | 5.186 | 0.030 | 99.292 | 85.494 | 58.189 | 57.661 | 38.013 | 38.442 |
| 108 | 721.255 | 0.743 | 1.901 | 0.196 | 1.546 | 5.162 | 0.035 | 96.036 | 95.502 | 61.029 | 66.107 | 51.015 | 38.619 |
| 109 | 704.871 | 0.754 | 1.866 | 0.197 | 1.584 | 5.155 | 0.029 | 99.678 | 92.983 | 60.655 | 69.981 | 51.349 | 21.393 |
| 110 | 694.288 | 0.749 | 1.857 | 0.199 | 1.569 | 5.161 | 0.020 | 93.817 | 94.916 | 71.375 | 64.462 | 31.530 | 25.436 |
| 111 | 696.013 | 0.745 | 1.853 | 0.191 | 1.543 | 5.203 | 0.027 | 89.761 | 98.432 | 75.344 | 61.774 | 40.102 | 31.308 |
| 112 | 693.888 | 0.753 | 1.806 | 0.200 | 1.571 | 5.201 | 0.025 | 95.605 | 92.709 | 75.597 | 73.019 | 20.297 | 19.936 |
| 113 | 670.628 | 0.744 | 1.833 | 0.191 | 1.532 | 5.255 | 0.025 | 97.616 | 90.677 | 74.412 | 63.365 | 42.161 | -1.664 |
| 114 | 691.377 | 0.754 | 1.828 | 0.205 | 1.569 | 5.153 | 0.030 | 90.920 | 100.702 | 56.486 | 66.426 | 45.601 | 33.477 |
| 115 | 661.421 | 0.755 | 1.839 | 0.200 | 1.541 | 5.232 | 0.026 | 96.538 | 86.959 | 70.720 | 56.030 | 51.816 | 2.870 |
| 116 | 691.949 | 0.745 | 1.827 | 0.189 | 1.531 | 5.219 | 0.027 | 99.093 | 93.125 | 72.238 | 80.257 | 55.312 | 6.706 |
| 117 | 680.116 | 0.760 | 1.813 | 0.198 | 1.548 | 5.175 | 0.038 | 99.366 | 84.112 | 73.118 | 56.880 | 34.614 | 14.035 |
| 118 | 698.579 | 0.755 | 1.793 | 0.200 | 1.629 | 5.151 | 0.024 | 95.433 | 97.249 | 72.236 | 61.283 | 28.021 | 23.964 |
| 119 | 714.313 | 0.752 | 1.840 | 0.190 | 1.517 | 5.225 | 0.032 | 103.730 | 86.415 | 60.166 | 61.218 | 49.270 | 23.466 |
| 120 | 696.756 | 0.745 | 1.852 | 0.188 | 1.549 | 5.206 | 0.027 | 99.198 | 90.702 | 76.962 | 60.754 | 46.380 | 12.148 |
| 121 | 690.708 | 0.758 | 1.824 | 0.192 | 1.520 | 5.225 | 0.024 | 95.762 | 92.105 | 55.737 | 58.009 | 32.384 | 28.307 |
| 122 | 696.044 | 0.756 | 1.832 | 0.199 | 1.570 | 5.142 | 0.030 | 99.386 | 92.472 | 65.449 | 74.565 | 30.348 | 17.247 |
| 123 | 682.639 | 0.750 | 1.837 | 0.189 | 1.538 | 5.204 | 0.032 | 99.617 | 90.061 | 55.004 | 62.165 | 45.469 | 13.749 |
| 124 | 716.299 | 0.747 | 1.825 | 0.188 | 1.556 | 5.247 | 0.027 | 98.675 | 96.674 | 48.644 | 66.093 | 39.716 | 32.009 |
| 125 | 707.470 | 0.748 | 1.876 | 0.195 | 1.538 | 5.184 | 0.029 | 96.430 | 92.676 | 63.065 | 69.567 | 55.435 | 30.601 |
| 126 | 692.298 | 0.747 | 1.870 | 0.184 | 1.511 | 5.250 | 0.032 | 96.450 | 92.745 | 69.487 | 68.950 | 44.087 | 14.143 |
| 127 | 698.442 | 0.749 | 1.764 | 0.191 | 1.562 | 5.232 | 0.030 | 96.423 | 96.929 | 70.622 | 55.794 | 41.376 | 21.104 |
| 128 | 736.173 | 0.753 | 1.815 | 0.192 | 1.564 | 5.219 | 0.033 | 101.611 | 91.797 | 67.371 | 69.193 | 46.611 | 34.260 |
| 129 | 703.517 | 0.746 | 1.858 | 0.194 | 1.544 | 5.223 | 0.029 | 96.499 | 98.045 | 58.468 | 59.537 | 43.209 | 23.472 |
| 130 | 709.868 | 0.750 | 1.839 | 0.196 | 1.532 | 5.235 | 0.026 | 101.474 | 89.467 | 55.974 | 54.913 | 35.948 | 25.904 |
| 131 | 700.894 | 0.756 | 1.800 | 0.199 | 1.585 | 5.193 | 0.031 | 96.097 | 92.776 | 49.810 | 61.125 | 37.926 | 37.469 |
| 132 | 701.584 | 0.756 | 1.814 | 0.191 | 1.527 | 5.218 | 0.027 | 94.887 | 87.972 | 79.020 | 70.047 | 65.141 | 30.325 |
| 133 | 685.448 | 0.750 | 1.811 | 0.201 | 1.553 | 5.226 | 0.027 | 96.682 | 88.389 | 57.577 | 67.859 | 33.302 | 24.270 |
| 134 | 733.804 | 0.758 | 1.814 | 0.198 | 1.580 | 5.186 | 0.029 | 103.722 | 92.482 | 76.263 | 60.254 | 45.179 | 23.870 |
| 135 | 703.979 | 0.753 | 1.862 | 0.193 | 1.523 | 5.221 | 0.029 | 93.617 | 100.113 | 62.616 | 53.679 | 30.597 | 28.828 |
| 136 | 715.249 | 0.750 | 1.811 | 0.192 | 1.548 | 5.200 | 0.030 | 93.036 | 94.215 | 65.801 | 58.908 | 57.047 | 46.791 |
| 137 | 682.842 | 0.753 | 1.852 | 0.183 | 1.552 | 5.195 | 0.026 | 94.101 | 94.624 | 66.522 | 54.183 | 36.462 | 19.900 |
| 138 | 722.044 | 0.751 | 1.846 | 0.203 | 1.581 | 5.118 | 0.029 | 98.406 | 88.495 | 78.720 | 55.807 | 46.115 | 38.077 |
| 139 | 630.445 | 0.755 | 1.811 | 0.202 | 1.500 | 5.215 | 0.032 | 86.378 | 87.364 | 56.570 | 57.738 | 39.487 | 22.315 |
| 140 | 711.994 | 0.748 | 1.834 | 0.184 | 1.531 | 5.216 | 0.034 | 99.871 | 94.894 | 77.628 | 64.754 | 50.697 | 14.796 |
| 141 | 692.582 | 0.753 | 1.807 | 0.189 | 1.557 | 5.193 | 0.029 | 94.179 | 93.923 | 70.824 | 66.385 | 53.300 | 25.564 |
| 142 | 715.393 | 0.749 | 1.835 | 0.196 | 1.577 | 5.185 | 0.024 | 95.860 | 96.049 | 60.051 | 69.495 | 35.310 | 36.874 |
| 143 | 690.647 | 0.745 | 1.833 | 0.195 | 1.547 | 5.207 | 0.030 | 91.067 | 97.735 | 66.779 | 53.892 | 62.663 | 30.112 |
| 144 | 657.250 | 0.740 | 1.861 | 0.194 | 1.576 | 5.146 | 0.031 | 98.635 | 94.501 | 57.963 | 46.661 | 30.550 | -2.868 |
| 145 | 707.056 | 0.750 | 1.806 | 0.190 | 1.558 | 5.230 | 0.029 | 98.436 | 87.801 | 74.812 | 58.493 | 39.159 | 27.076 |
| 146 | 677.194 | 0.752 | 1.842 | 0.189 | 1.521 | 5.204 | 0.032 | 94.847 | 85.367 | 63.275 | 52.466 | 34.872 | 27.533 |
| 147 | 729.465 | 0.748 | 1.834 | 0.192 | 1.581 | 5.199 | 0.029 | 99.467 | 94.971 | 72.261 | 55.880 | 52.302 | 31.639 |
| 148 | 688.035 | 0.750 | 1.792 | 0.195 | 1.559 | 5.286 | 0.028 | 97.231 | 85.350 | 65.020 | 64.478 | 33.735 | 22.262 |
| 149 | 715.791 | 0.755 | 1.827 | 0.194 | 1.547 | 5.215 | 0.025 | 96.799 | 97.351 | 64.783 | 67.048 | 51.860 | 29.565 |
| 150 | 713.753 | 0.751 | 1.827 | 0.197 | 1.530 | 5.201 | 0.029 | 97.284 | 86.843 | 73.106 | 75.317 | 45.968 | 35.747 |
| 151 | 733.344 | 0.750 | 1.855 | 0.189 | 1.527 | 5.225 | 0.028 | 99.374 | 101.853 | 66.523 | 66.397 | 58.486 | 25.440 |
| 152 | 694.780 | 0.751 | 1.816 | 0.198 | 1.538 | 5.230 | 0.027 | 92.326 | 94.765 | 67.254 | 55.693 | 51.484 | 32.125 |
| 153 | 658.846 | 0.755 | 1.840 | 0.182 | 1.485 | 5.289 | 0.030 | 89.521 | 89.314 | 49.634 | 56.124 | 48.399 | 28.566 |
| 154 | 688.348 | 0.756 | 1.821 | 0.197 | 1.562 | 5.235 | 0.028 | 99.484 | 86.500 | 60.584 | 53.470 | 47.462 | 18.857 |
| 155 | 708.205 | 0.750 | 1.823 | 0.195 | 1.563 | 5.199 | 0.028 | 96.922 | 99.248 | 59.454 | 57.615 | 46.566 | 26.708 |
| 156 | 717.678 | 0.746 | 1.823 | 0.190 | 1.536 | 5.283 | 0.031 | 96.770 | 94.183 | 66.270 | 59.929 | 39.234 | 31.816 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 157 | 736.304 | 0.753 | 1.832 | 0.189 | 1.559 | 5.216 | 0.028 | 94.851 | 98.667 | 79.250 | 47.579 | 46.776 | 42.366 |
| 158 | 682.764 | 0.750 | 1.844 | 0.198 | 1.515 | 5.212 | 0.030 | 95.723 | 89.724 | 55.727 | 56.403 | 44.582 | 25.685 |
| 159 | 707.407 | 0.750 | 1.831 | 0.194 | 1.538 | 5.237 | 0.031 | 97.414 | 95.516 | 64.978 | 69.442 | 46.894 | 22.518 |
| 160 | 708.968 | 0.750 | 1.831 | 0.202 | 1.546 | 5.202 | 0.029 | 97.785 | 83.131 | 76.321 | 50.772 | 46.460 | 36.356 |
| 161 | 704.822 | 0.751 | 1.850 | 0.196 | 1.576 | 5.170 | 0.030 | 95.986 | 97.158 | 69.701 | 55.402 | 34.832 | 24.952 |
| 162 | 677.714 | 0.753 | 1.808 | 0.199 | 1.550 | 5.215 | 0.031 | 90.952 | 92.676 | 68.649 | 64.926 | 65.119 | 25.998 |
| 163 | 684.498 | 0.752 | 1.865 | 0.199 | 1.569 | 5.133 | 0.028 | 98.495 | 93.713 | 48.416 | 50.959 | 51.662 | 20.632 |
| 164 | 683.958 | 0.752 | 1.806 | 0.195 | 1.543 | 5.227 | 0.027 | 95.828 | 98.270 | 64.561 | 54.555 | 38.421 | 12.521 |
| 165 | 702.247 | 0.748 | 1.835 | 0.187 | 1.549 | 5.211 | 0.028 | 97.208 | 95.160 | 60.905 | 61.410 | 40.176 | 25.059 |
| 166 | 677.846 | 0.756 | 1.832 | 0.196 | 1.561 | 5.182 | 0.032 | 94.491 | 94.335 | 66.804 | 54.929 | 37.066 | 16.637 |
| 167 | 664.018 | 0.749 | 1.833 | 0.191 | 1.542 | 5.232 | 0.025 | 92.996 | 83.056 | 55.895 | 67.248 | 37.051 | 27.495 |
| 168 | 688.921 | 0.753 | 1.819 | 0.187 | 1.555 | 5.293 | 0.025 | 91.386 | 88.662 | 76.663 | 53.082 | 48.076 | 30.346 |
| 169 | 667.819 | 0.746 | 1.886 | 0.199 | 1.562 | 5.173 | 0.024 | 93.071 | 94.547 | 65.052 | 75.938 | 49.481 | 9.499 |
| 170 | 722.767 | 0.751 | 1.857 | 0.191 | 1.566 | 5.147 | 0.028 | 104.873 | 87.388 | 63.734 | 60.180 | 55.362 | 26.216 |
| 171 | 697.942 | 0.750 | 1.856 | 0.195 | 1.568 | 5.184 | 0.033 | 94.376 | 91.695 | 61.520 | 75.171 | 30.619 | 32.491 |
| 172 | 666.901 | 0.743 | 1.841 | 0.195 | 1.531 | 5.262 | 0.036 | 92.002 | 97.081 | 60.678 | 56.232 | 44.178 | 11.651 |
| 173 | 699.881 | 0.747 | 1.839 | 0.198 | 1.544 | 5.158 | 0.027 | 100.529 | 91.572 | 62.129 | 54.650 | 54.359 | 20.686 |
| 174 | 667.760 | 0.751 | 1.805 | 0.199 | 1.582 | 5.181 | 0.030 | 89.759 | 91.676 | 64.595 | 73.954 | 61.288 | 26.634 |
| 175 | 714.028 | 0.743 | 1.860 | 0.194 | 1.577 | 5.191 | 0.030 | 98.884 | 89.614 | 75.106 | 67.596 | 37.942 | 26.153 |
| 176 | 684.208 | 0.746 | 1.843 | 0.196 | 1.561 | 5.190 | 0.029 | 94.509 | 80.218 | 63.070 | 65.123 | 49.673 | 37.835 |
| 177 | 692.110 | 0.750 | 1.823 | 0.186 | 1.521 | 5.223 | 0.028 | 100.220 | 90.310 | 64.435 | 55.522 | 37.589 | 14.310 |
| 178 | 753.185 | 0.753 | 1.839 | 0.194 | 1.547 | 5.218 | 0.027 | 105.286 | 96.533 | 75.605 | 60.487 | 35.374 | 24.905 |
| 179 | 671.918 | 0.749 | 1.886 | 0.194 | 1.535 | 5.189 | 0.031 | 92.205 | 92.166 | 52.130 | 74.551 | 50.938 | 23.758 |
| 180 | 698.623 | 0.756 | 1.823 | 0.188 | 1.559 | 5.178 | 0.030 | 95.691 | 90.780 | 64.269 | 42.174 | 44.078 | 35.168 |
| 181 | 673.093 | 0.749 | 1.829 | 0.196 | 1.541 | 5.256 | 0.027 | 92.304 | 94.381 | 71.485 | 66.501 | 36.786 | 12.509 |
| 182 | 695.607 | 0.748 | 1.808 | 0.201 | 1.578 | 5.183 | 0.039 | 95.656 | 90.274 | 76.585 | 53.399 | 46.968 | 26.063 |
| 183 | 711.404 | 0.744 | 1.838 | 0.196 | 1.545 | 5.238 | 0.027 | 96.940 | 91.890 | 67.879 | 55.143 | 45.174 | 31.281 |
| 184 | 649.858 | 0.750 | 1.840 | 0.199 | 1.553 | 5.181 | 0.027 | 90.439 | 86.597 | 61.158 | 59.301 | 30.146 | 21.756 |
| 185 | 694.832 | 0.755 | 1.849 | 0.195 | 1.545 | 5.170 | 0.031 | 98.164 | 98.304 | 59.501 | 63.063 | 48.491 | 14.526 |
| 186 | 678.580 | 0.746 | 1.795 | 0.187 | 1.538 | 5.212 | 0.037 | 96.494 | 89.902 | 65.409 | 53.579 | 49.420 | 18.324 |
| 187 | 673.094 | 0.757 | 1.794 | 0.199 | 1.581 | 5.170 | 0.033 | 92.901 | 90.293 | 72.733 | 61.677 | 50.306 | 21.296 |
| 188 | 682.729 | 0.753 | 1.836 | 0.194 | 1.532 | 5.200 | 0.028 | 91.347 | 94.700 | 57.833 | 70.898 | 43.588 | 30.769 |
| 189 | 734.320 | 0.756 | 1.839 | 0.196 | 1.539 | 5.213 | 0.029 | 100.457 | 93.629 | 92.230 | 66.494 | 49.469 | 21.093 |
| 190 | 700.978 | 0.744 | 1.868 | 0.195 | 1.517 | 5.259 | 0.026 | 92.834 | 92.032 | 75.433 | 41.059 | 54.979 | 32.009 |
| 191 | 712.312 | 0.748 | 1.839 | 0.199 | 1.597 | 5.127 | 0.030 | 96.020 | 90.871 | 80.174 | 47.203 | 48.762 | 35.779 |
| 192 | 640.187 | 0.754 | 1.813 | 0.196 | 1.567 | 5.183 | 0.028 | 87.669 | 81.718 | 68.850 | 57.679 | 36.568 | 26.700 |
| 193 | 685.961 | 0.747 | 1.793 | 0.200 | 1.568 | 5.251 | 0.025 | 93.089 | 91.673 | 62.470 | 66.145 | 52.699 | 28.300 |
| 194 | 702.336 | 0.749 | 1.863 | 0.188 | 1.508 | 5.260 | 0.035 | 95.773 | 92.978 | 78.518 | 67.564 | 40.306 | 18.085 |
| 195 | 680.191 | 0.749 | 1.825 | 0.202 | 1.570 | 5.172 | 0.030 | 98.371 | 90.473 | 64.314 | 66.821 | 35.908 | 12.163 |
| 196 | 714.342 | 0.748 | 1.853 | 0.191 | 1.551 | 5.199 | 0.030 | 94.723 | 100.439 | 62.746 | 67.611 | 46.778 | 31.534 |
| 197 | 721.932 | 0.745 | 1.830 | 0.198 | 1.542 | 5.198 | 0.026 | 101.182 | 91.493 | 75.463 | 49.880 | 21.243 | 26.322 |
| 198 | 702.277 | 0.748 | 1.854 | 0.190 | 1.544 | 5.218 | 0.029 | 94.035 | 95.900 | 92.711 | 59.552 | 43.935 | 16.039 |
| 199 | 657.386 | 0.746 | 1.856 | 0.195 | 1.558 | 5.183 | 0.026 | 91.478 | 98.990 | 64.264 | 62.349 | 23.838 | 5.559 |
| 200 | 738.949 | 0.745 | 1.851 | 0.191 | 1.534 | 5.226 | 0.031 | 102.581 | 91.060 | 77.138 | 57.292 | 37.020 | 29.357 |