LAPPEENRANTA UNIVERSITY OF TECHNOLOGY

School of Industrial Engineering and Management

COST-EFFECTIVENESS ANALYSIS IN SOUTH KARELIA CENTRAL HOSPITAL

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ABSTRACT

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The target organization of this study, otherwise South-Karelia Social and Health Care District (Eksote) provides health, senior, family and social welfare services. South Karelia Central Hospital provides special health care and offers health services from all of the most important medical specialties. Eksote has in use 15D instrument to measure the health-related quality of life (HRQoL) of their patients before and after their interventions for observing the health effects of the medical care. Furthermore, 15D allows measuring the effectiveness and cost-effectiveness of health care when comparing these before and after results of the 15D measurements and adding the costs of the interventions into this research.

The main purposes of this study were to analyze the effectiveness and cost-effectiveness of medical care in South Karelia Central Hospital by using the gathered 15D data to calculate effectiveness and cost-effectiveness ratios and to analyze the reliability and availability of the data. Study has been conducted using literature review and quantitative research methods.

The results indicate that from the patients within the eight units selected to this study the 15D change information was available from the 52 %, the 15D change and the cost information from 38 % and the information of quality-adjusted life years (QALYs) produced and the cost information from 35 %. The effectiveness and cost-effectiveness of medical care were greatest at the units of Pain Outpatient Clinic and Rheumatic Diseases Outpatient Clinic. The most effective medical care is given in the unit where the average price of one produced QALY is the highest (Orthopedics). However, the calculated standard deviations pointed out that there are great variances in the effectiveness and cost-effectiveness within the units also.

TIIVISTELMÄ

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Tutkimuksen kohdeorganisaatio eli Etelä-Karjalan sosiaali- ja terveyspiiri (Eksote) tarjoaa terveys-, perhe- sekä vanhusten että sosiaalihuollon palveluita. Etelä-Karjalan keskussairaala antaa erikoissairaanhoitoa sekä tarjoaa palveluita kaikilta tärkeimmiltä lääketieteen erikoisaloilta. Eksotella on käytössään 15D-mittari "terveyteen liittyvän elämänlaadun" mittaamiseen potilailta sekä ennen heidän saamiaan hoitojaan että hoitojen jälkeen. 15D-informaatio mahdollistaa sairaanhoidon vaikuttavuuden sekä kustannusvaikuttavuuden arvioinnin, kun 15D-mittarilla mitattuja ennen ja jälkeen arvoja verrataan keskenään, sekä lisätään tarkasteluun hoidon kustannukset.

Tutkimuksen päätarkoitus oli analysoida Etelä-Karjalan keskussairaalan tarjoaman sairaanhoidon vaikuttavuutta ja kustannusvaikuttavuutta käyttämällä mitattua ja kerättyä 15D dataa vaikuttavuuden ja kustannusvaikuttavuuden tunnuslukujen laskemiseksi sekä analysoida kerätyn datan luotettavuutta ja saatavuutta. Tutkimus on tehty käyttäen kuvailevaa kirjallisuuskatsausta sekä kvantitatiivisia tutkimusmenetelmiä.

Tulokset osoittavat että tutkimukseen valittujen kahdeksan yksikön potilaiden 15D muutokset olivat saatavissa 52 % potilaista, 15D muutokset sekä kustannukset 38 % potilaista ja hoitojen avulla saavutetut laatupainotetut elinvuodet (QALYt) sekä kustannukset 35 % potilaista. Sairaanhoidon vaikuttavuus ja kustannusvaikuttavuus olivat suurimmat Kipupoliklinikalla sekä Reumatautien poliklinikalla. Vaikuttavin sairaanhoito annettiin sillä osastolla (Ortopedia), jossa yhden QALYn tuottamisen hinta on suurin. Lasketut keskihajonnat kuitenkin osoittivat, että myös jokaisen yksikön sisällä on suuria vaihteluja vaikuttavuudessa sekä kustannusvaikuttavuudessa.

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Helsinki, 18.5.2013

Riku Penttilä

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LIST OF ABBREVIATIONS

CEA	Cost-effectiveness analysis
CUA	Cost-utility analysis
DRG	Diagnosis related group
Eksote	South Carelia Social and Health Care District
HRQoL	Health-related quality of life
NELLI	National Electronic Library Interface
QALY	Quality-adjusted life year

LIST OF SYMBOLS

I	One (1)
II	Two (2)
III	Three (3)
IV	Four (4)
Σ	Sum
Σr_i	Total amount of ratios
$\Sigma \mathrm{p_i}$	Total amount of patients
c	Costs
I	Importance
I_j	Importance on dimension j
$I_j(x_j)$	Relative importance attached to level
j	Dimension

n	Number
P_Q	Price of QALY
Q	Qaly
Q_g	QALYs gained
$R_{\%}$	Data quality ratio
SD	Standard deviation
v	15D score
v_h	15D score of patient h
v_{h_1}	15D score of first 15D measurement of patient h
v_{h_2}	15D score of second 15D measurement of patient h
V	15D change
$V_€$	15D change per costs
$\overline{V_\iota}$	Average 15D change of the unit
w	Value
w_j	Value on dimension *j*
$w_j(x_j)$	Value placed on level x of dimension *j*
x	Level or variable
x_j	Level on dimension *j*
$\overline{x}$	Average
y	Year
y_n	Number of years

1 INTRODUCTION

1.1 Background

Räsänen states in her dissertation (2006, 8) that systematically collected effectiveness and cost-effectiveness data of health care will be in center stage when the special health care is being organized in the future. Reasons for this impression, according to Räsänen (2006, 8), are the limited resources of health care and quick development of health technologies, which both require evaluation and prioritization of operations. This creates a demand for effectiveness and cost-effectiveness analyses of treatments produced in health care organizations.

The basic idea of cost-effectiveness analysis (CEA) is to compare at least two interventions or operations with each other and evaluate them as for health and welfare effects and by their use of resources (Kustannusvaikuttavuus – tutkimusryhmä 2013). CEA informs health care decision-makers where to allocate limited resources of health care (Phillips, 2009b, 1). Cost-utility analysis (CUA) is one form of cost-effectiveness analysis, which compares health effects and costs of treatments with each other by the help of Quality-adjusted life years (QALYs) gained by health care and monetary values of the care (Räsänen 2006, 22). Räsänen.

South-Karelia Social and Health Care District (Eksote) is a federation of nine municipalities, which are: Lappeenranta, Lemi, Luumäki, Imatra, Parikkala, Rautjärvi, Ruokolahti, Savitaipale and Taipalsaari. Population in Eksote area is about 133 000. Eksote includes South Carelia hospital district and South Carelia special care district. Eksote's mission is to provide health services, family and social welfare services and services for senior citizens that promote the health, wellbeing and the ability of residents to function well in everyday life. Eksote's services are: outpatient care, dental care, mental health and intoxicant services, laboratory and imaging services, medical care, rehabilitation center, hospital services, family services, adult social services, disability services and elderly services. Eksote makes municipality-specific service contracts by the service needs of the population for every municipality. (Eksote 2013)

Eksote has in use a health-related quality of life (HRQoL) instrument called 15D, to measure the quality of life of their patients before and after their interventions and to observe the health effects of the care provided to patients. Furthermore, 15D allows measuring the effectiveness and cost-effectiveness of health care when comparing these before and after results of 15D measurements done to patients and adding the costs of the treatments into this research. Since 2008, Eksote has systematically measured the HRQoL of their patients and compiled these statistics added with patient-specific information about, e.g. costs of the treatments. Although this data contains information from nearly 8 000 patients, it has been unanalyzed. Therefore, there’s been a demand for analysis of this patient data and this master’s thesis has been done to solve this problem.

1.2 Objectives and research questions

This thesis can be considered as a general overview of the gathered effectiveness data in Eksote. The main purpose of this study was to analyze the previously measured and collected 15D and cost data by calculating effectiveness and cost-effectiveness ratios for different units at Eksote. The secondary purpose was to analyze the reliability of the gathered data and point out possible strengths and weaknesses of the data and analyze the measurement process in general. This thesis also takes a stand on how Eksote should develop their medical care effectiveness and cost-effectiveness measuring in future. Research questions can be derived from the objectives of the study as follows:

The main research question of this thesis is:

- How to generate as realistic view as possible of the health care's cost-effectiveness in South Karelia Central Hospital by unifying the gathered patient-specific 15D data and the costs of medical care?

The main question can be divided into sub questions:

- How to measure the effectiveness and cost-effectiveness within the limits of this data?
- What do the calculated ratios tell about the effectiveness and cost-effectiveness of health care in the medical units chosen to the study? Are there any differences between the units?
- What are the considerations associated with the reliability and availability of the data?
- What should be done in the future to create reliable and specific cost-effectiveness information for the decision makers?

1.3 Scope of the study

This study concentrates on analyzing the health care effectiveness and cost-effectiveness in Eksote by utilizing the previously collected data and exploring the reliability of this data. Calculated ratios indicate the effectiveness and cost-effectiveness on unit-level, otherwise on different wards and outpatient clinics. These ratios allow basic effectiveness comparison between units, but they rule out all treatment-specific comparison. It would demand much wider study and, in some respects, a wider data to analyze effectiveness of separate interventions, e.g. on specialties.

Effectiveness and cost-effectiveness analyses are made on the assumption that the data used in effectiveness calculations is valid. In this connection, it means that all the prices of the treatments and all the 15D scores measured from the patients are equally reasonable. The database of nearly 8 000 patients is so wide that it would have been impossible to check the accuracy of the data in the limits of this master's thesis.

1.4 Research methods

This master's thesis is divided into theoretical and empirical part. The theoretical part is executed as a one form of descriptive literature review, which is termed as a narrative literature review. According to Salminen (2011, 6), some typical characteristics for a narrative literature review are: It gives an extensive picture of the subject in matter and it unifies heterogeneous information into continuous event, while simultaneously seeking a result to be as readable as possible. To supplement the theoretical information put together by narrative literature review, there were also two small interviews conducted about the use of 15D at Eksote in practice. These features mentioned above can be found in the theoretical part of this master's thesis, where information about different subjects related to the empirical part of this study are put together to form a concise and relevant theoretical framework for reader to better understand the subject.

The empirical part of this study is conducted as a quantitative research, which uses analyses of descriptive statistics. Quantitative research is a method tendency of scientific research which is based on representing and interpreting the subject by statistics and numbers (Määrällinen tutkimus 2013). Trochim (2006) states that descriptive statistics are used for: To describe the basic features of the data used in studies by producing simple summaries, to present quantitative descriptions in a manageable form and to help summarizing large amounts of data in a reasonable way. The empirical part of this master's thesis comprises effectiveness and cost-effectiveness analyses and a general quality analysis of the data used for these effectiveness analyses. All of these analyses are calculated by using simple mathematics such as addition, subtraction, division and multiplication and methods of descriptive statistics, such as central tendency (arithmetic mean) and statistical dispersion (standard deviation).

1.5 Structure

The structure of this study follows the common structure of a scientific paper. Only notable difference in the features of this thesis in comparison to an ordinary scientific article is that, the theoretical part does not include that much specific information about previous studies of cost-effectiveness analysis in health care, e.g. previous study reports are not analyzed. Whereas, the theoretical part of this study offers just general information about how cost-effectiveness analysis is carried on in general; e.g. how the analysis is executed, what units are measured and why cost-effectiveness analysis is useful tool for health care organizations.

This master's thesis contains 6 main chapters. First chapter introduces reader to the study and provides background information to get more familiar with the reasons why this study is made. For more detailed information, there are chapters two and three, which contain theories and principles for reader to better understand the theoretical framework of the subject. Fourth chapter explains how this study was executed and the results of this thesis are introduced in the fifth chapter. Sixth and last chapter contains a brief summary of the research, discussion about the study and propositions for further research.

2 COST-EFFECTIVENESS ANALYSIS IN HEALTH CARE

Cost-effectiveness analysis (CEA) in health care compares the costs and health effects of medical treatments to assess the extent to which it can be regarded as providing value for money (Phillips 2009b, 1). According to Räsänen (2006, 21) in CEA, it's necessary to identify, measure and value both costs and health outcomes. Health outcomes are measured as one-dimensional units, for example life years gained by intervention. CEA reveals the relationship between costs and effects, otherwise resources and health benefits. CEA has also a modified form, which is called cost-utility analysis, CUA (Räsänen 2006, 22). CUA is being introduced more precise below in the text.

According to Räsänen et al. (2006, 26) health care investments have been traditionally made without specific observation and detailed information on the health gains produced to patients by medical care. This tradition leads to problems nowadays, when the budgets everywhere, also in public healthcare, are meager. Now, when medical care decisions should be made in the most cost-effective way, there's great demand of effectiveness data for the decision making units in health care organizations. Phillips states (2009b, 1) that cost-effectiveness analysis informs decision-makers who have to determine where to allocate the limited resources of health care.

2.1 Problems of measuring health

Kuusi states (2008, 1) that the main criteria in health care effectiveness is contributing health, but what makes it difficult, is the determination of health and determination how to measure the progression of health gained by medical treatment. There are various interpretations to determine health and several health measuring technologies. In his report (2008, 1), Kuusi finds out three main alternatives to measure health, which are functional approach, biomedical state of health and a kind of mix of experiences from physical, mental and social welfare.

According to functional approach, health is able to be measured by the ability to manage various exercises, like moving, seeing and hearing. Functional measuring is, nonetheless, considered as insufficient way of measuring. Kuusi (2008, 1) finds biomedical measuring to be more generic way to measure health, because patient could, for example, have a malignant tumor that does not effect on patient's functions, but clearly influences on the life of the patient. This is a perspective, what functional measuring does not take into account. The third way of measuring health, which combines physical, mental and social experiences, can be described as the most extensive technique, because it combines elements from both, functional and biomedical interpretations. Painkillers and mood medicines usually look for their legitimacy by this mixed health measuring custom. Good example of this is a patient who is going to die, but gets relief to pains via painkillers. That should be considered as a successful treatment, when the patient's health is being made as good as it is possible to make, because in this case, the medical care is not supposed to cure patient who has fatal disease, but to get he/she feel more comfortable.

Kuusi states in his report (2008, 1) that the most indisputable fact about lack of health in generally, is the number of deaths. Death is being interpreted differentially in every one of these three health measuring methods. In functional and biomedical point of views, death is being considered as a failure of health care. But death can be also a relief for the patients themselves if they are in great pains and their diseases cannot be cured medically. So, in cases like this, the experienced welfare can be a great tragedy or even a positive solution, depending on how health is being observed.

Kuusi has put together (2008, 2) five features of health by using assessments from Finnish experts of health care:

- Health turns out as a present or upcoming ability to function.
- Health can't be detached from experiencing it, because health turns out also by the lack of pains and suffering. Disorders that have been

objectively studied and interpreted as the same may still cause variously experienced torment for different people. Health is also a cultural phenomenon, which is connected to, what is considered as normal in community. For example, in the case of pains, what one should just take without complaining.

- Health care can promote health by preventing diseases and disorders and taking a hand to those in early stage. In this manner, future sufferings and lacks in ability to function are prevented.
- Health care can advance health by taking care of those who are suffering with disorders and curing them. Taking care also concerns those, who can't be healed by any treatments.
- Health care can promote health by avoiding early death, but also by creating conditions for peacefully death, which is approved by the patient himself.

These health features combine all of the three interpretations of health, which have been demonstrated earlier. Kuusi (2008, 2) also states that any of these 5 features does not rule out each other and all of the operations used in health care are related into these five statements. Still, there is not just one widely accepted way to interpret and measure health. So, when measuring health, the first step is to define health and then it is possible to start planning how it is possible to measure health through that interpretation.

2.2 Effectiveness indicators of health care

Effectiveness of health care is being measured by different indicators. Main reasons for this are the different views of defining health. Biomedical measurement is based on identified diseases and on problematic in terms of health (Kuusi, 2008, 3). Kuusi (2008, 3) has created a codification of a Delfoi-process where 40 Finnish health care experts were heard about the future of Finnish health care. A narrow majority of these experts were of the opinion that the solution of evaluating the effectiveness of health care in Finland will rest in future on the functional health interpretation.

There are several indicators created for the health measurement on the basis of the functional and experienced health. Internationally used indicators are SF-36, EQ-5D, HUI and 15D. These indicators enable the comparativeness of specialties by the help of quality-adjusted life years (QALY) (Kuusi, 2008, 5). According to Philips (2009a, 1) QALY takes into account both the quality and quantity of life generated by healthcare interventions. It is the arithmetic product of life expectancy and a measure of the quality of the remaining life-years. Seppälä et al. pointed out (2008, 5) that despite of some criticism the most important health outcome measure is QALY and it is increasingly used in developed countries to measure the effectiveness of health care. And based on this fact, Seppälä et al. (2008, 5) also suggested that QALY should be a good candidate for measuring health on national level.

All of the health care effectiveness indicators mentioned above, are using different weighting on measuring the ability of functioning and on the experienced health. EQ-5D has been constantly developed in Europe and it weights the most on the experienced health. The EQ-5D descriptive system comprises the following five dimensions: mobility, self-care, usual activities, pain/discomfort and anxiety/depression (Rabin et al. 2011, 3). Another indicator which weights the experienced health is SF-36. SF-36 examines health on eight scales: physical functioning, role-physical, bodily pain, general health, vitality, social functioning, role-emotional and mental health. HUI and 15D are effectiveness indicators that take experienced health into account, but they weight more on measurable functioning. HUI’s (Health Utilies Index) dimensions are: vision, hearing, speech, ambulation, dexterity, emotion, cognition and pain. In Finland, the most known and used health effectiveness instrument is 15D. (Kuusi 2008, 5)

2.3 15D - The health-related quality of life instrument

15D is a generic 15-dimensional self-administered instrument for measuring HRQoL (health-related quality of life) among adults. 15D instrument is developed by Harri Sintonen, professor of health economics, and he holds the copyright for it. 15D is used to measure health for people aged 16 and above. There are also own versions of instrument developed for children (17D) and adolescents (16D). 15D-instrument combines the advantages of a profile and a preference-based single index measure. Instrument uses a set of utility and preference weights to generate the 15D score, which is a single index number on a 0-1 scale. (15D©-instrument 2012)

In practice, 15D is a questionnaire (see appendix I) given to patients, which the patients themselves fill in. In the questionnaire there are 15 questions related to patient's health and for every question, there are five alternative answers given. The patient picks one answer for every question which best describes his/her present health status and the 15D score is calculated on the basis of these answers. The dimensions of 15D instrument are: mobility, vision, hearing, breathing, sleeping, eating, speech, mental, function, discomfort and symptoms, depression, distress, vitality and sexual activity. According to Seppälä et al. (2008, 6) the breadth of coverage of different health states is one of the good sides of instrument. As an example, Seppälä et al. (2008, 6) compared 15D instrument into the EQ-5D instrument by the amount of health states which these instruments can classify. 15D is able to create 5^{15} health states with 15 dimensions with 5 levels each, when 5-dimensional 3-level EQ-5D can only produce 3^5 health states.

In addition to the fact that 15D is comprehensive instrument, it is also easy to use: Sintonen (1994, 21) discovered that it takes about 5-10 minutes to complete the 15D-questionnaire. The questionnaire is rather quick to complete and filling the questionnaire sheet doesn't require monitoring. As it points out on appendix I, there is a brief info for filling the form before the questions in the 15D questionnaire. By the help of this information, patients can easily fill the questionnaire by themselves. Sintonen also states (1994, 21) that in postal patient surveys the response rate has varied from 65 % to 80 % and in Finland it is possible to get a response rate of over 80 % for a postal survey with two reminders

The valuation system in of the 15D is based on an application of the multiattribute utility theory. Patient's overall HRQoL, otherwise, 15D score is calculated from the health state descriptive system by using a set of population based preference and utility weights. 15D score obtained, is a single number between zero and one. In this scale, zero stands for patient being dead, 0.0162 means that patient is unconscious or comatose and number 1 signifies that patient is perfectly healthy. According to 15D internet-pages (Properties of the valuation system 2011), the change of more than 0.03 in the 15D-score is such in the sense that people can feel the difference. Weight coefficients for each dimension are obtained by multiplying the level value by the importance weight of the dimension at that level (Valuation system, 2012). With the weights, which are generally used in Finland, the normal population usually gets a score of about 0.93 and hospital patient usually scores between of 0.7 and 0.9 in 15D measurement. 15D score of 0.3 to 0.5 is considered as patient being on round-the-clock care. (Kuusi 2008, 6)

$$v_h = \sum I_j \left(x_j\right) \left[w_j\left(x_j\right)\right] \tag{1}$$

15D score calculation can be mathematically expressed as above on Equation (1). In Equation (1), v_h is the value *v*, or 15D score that is calculated for patient *h* by the answers that he/she has given in the 15D questionnaire. In this equation, $I_j\left(x_j\right)$ is the relative importance, which people attach to various levels of dimension *j*, where *j* = 1, 2, 3,…, 15. The numerical value for $w_j\left(x_j\right)$ is the average value that patients place on various levels of dimension *j*. (Valuation system, 2012)

As Seppälä et al. has pointed out (2008, 8), while the 15D score, otherwise the HRQoL, explains the patient's current state of health-related quality of life, it does not take account a time dimension. QALY is developed to measure overall functional capacity combined with time and helps to solve this problem caused by the lack of time perspective of HRQoL. 15D scores are most valid to QALY calculations from the three of the most widely used preference-based generic instruments, or 15D, HUI and EQ-5D (Properties of the valuation system 2011). Simply, QALY's calculated by a single 15D measurement, are a product of a HRQoL, otherwise the 15D score of that single measurement, multiplied with life-expectancy of the patient.

$$Q_g = \left(v_{h_2} - v_{h_1} \right) \times y_n \qquad (2)$$

Another way to use QALYs by the help of 15D requires two 15D measurements as we can see from Equation (2). According to Kuusi (2008, 6) QALYs gained by medical treatments (Q_g) can be simply calculated from 15D scores if there are two results from different 15D measurements: one before the treatment and one after the treatment. The 15D score (v_{h_1}) patient gained before medical treatment is deducted from the 15D score (v_{h_2}), which is measured after the patient's treatment and the remainder is multiplied by the number of years (y_n), which the change of 15D score is expected to be effective.

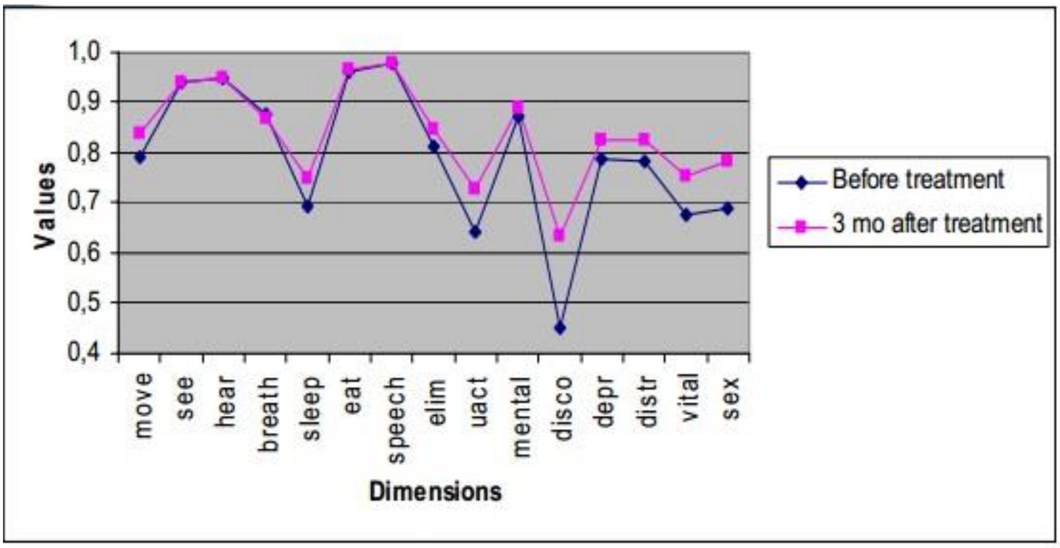

Figure 1. HRQoL of neurosurgical interventions (Kekomäki 2005, 4)

Kuusi presents a simple example of QALY calculation in his study (2008, 6), by the help of Kekomäki's (2005, 4) Figure of HRQoL of back pain patients before and after a neurosurgical intervention (Figure 1): "If a patient can be estimated to benefit for his/her treatment for 10 years, thus his/her condition rises from the 15D value of 0.6 to 0.7, the treatment produces 1 QALY (*10 x 0.1 = 1*)". According to Räsänen et al. (2006, 27) by way of QALYs, the quality of life can be expressed by indicator that takes into account both, the length of life and the change in the quality of life. Räsänen et al. (2006, 27) also found out that in the last years, the QALY has been recognized as the currently most important indicator of health care effectiveness.

2.4 Cost-utility analysis

According to Räsänen (2006, 22) Cost-utility analysis (CUA) is similar to CEA, but it differs from CEA by the units used in the analysis. In CUA the cost of the studied intervention, or medical treatment is related to the change in the quality of life, which is resulting from the treatment. McCabe (2009, 1) explains that the primary outcome of CUA is the cost per QALY. And based on to this context, Räsänen suggests in his study (2006, 22) that it would be more reasonable and illustrative to use the term cost-QALY analysis instead of cost-utility analysis in the first place. Simply, analyzing cost-utility, is dividing the costs of medical treatment by the QALYs gained by the patient in the same intervention.

CUA was developed to help decision-makers when comparing the value of alternative interventions that have different health benefits. CUA also facilitates comparisons between different medical treatments without recourse to placing monetary values on different health states. Cost-utility analysis tells what value is attached to certain health state and in this manner facilitates the transparency of resource allocation process. (McCabe 2009, 1)

Kuusi presents a conclusion in his study (2008, 7), which claims that it is possible to define a general criterion for publicly funded medical treatment, based on the resources available for the medical care. In Finland, this criterion is calculated by dividing the changes in 15D scores by the costs (Equation 3) and/or dividing the costs by the QALYs gained or lost as a result of the intervention done to patient, as on the Equation (4) (Kuusi 2008, 7). As we can see, this general criterion for medical treatment is calculated by the help of CUA. Kuusi also states (2008, 7) that it is possible, via political decision, to impose a minimum CUA rate for the medical care and it could be, for example, *QALY / 50000 €* and the medical treatments, which CUA rates are above that, will be executed.

$$P_Q = \frac{c}{Q} \tag{3}$$

$$V_{€} = \frac{V}{c} = \frac{(v_2 - v_1)}{c} \tag{4}$$

The calculation of costs per QALY ratio, otherwise, the price for producing one quality-adjusted life year (P_Q) by the help of medical interventions, is presented on Equation (3) above, where the costs of the interventions, c, are being divided by the QALYs brought about (Q). On Equation (4), there is being presented the calculation of 15D change per cost ratio, $V_{€}$, where the change in 15D score, V, is being divided by the costs of intervention, c.

2.5 Effectiveness measurement at Eksote

As stated before, since 2008 Eksote has systematically collected 15D data, i.e. 15D scores and other related patient-specific information for the purposes of effectiveness research. This procurement of data is being done by the help of 15D software, which has been developed as a joint venture between Eksote and Corame, which is an online service firm. The target of their collaboration was to develop system where all necessary data of health care treatments done to patients is collected and stored. In this context, the necessity is being evaluated from the 15D perspective. This kind of electronic measuring of the effectiveness of health care has made possible to take account of the patient’s subjective experience of their own quality of life before and after interventions. (Helvola 2013a; 15D elämänlaatumittari 2013)

2.5.1 Measurement in practice

When patient first time visits the hospital, his/her information is logged into the system. This personal information includes: Name, social security number, date of birth, sex and date of the visit. Next the patient fills in the 15D questionnaire (Appendix I) for the first time. The 15D form can be filled out electronically at hospital’s computer or manually on paper, which is the most common way to complete the questionnaire. Completed paper forms are then stored into the database by nurses or the forms are posted to Corame for storing. When the answers from the first 15D questionnaire have been stored, the system calculates the first 15D score for the patient and registers it into the database. At the first visit, the patient is also asked that how he/she would like to complete the second 15D questionnaire, which is usually held approximately six months after the patient’s treatment(s) or treatment period(s) are over and the intervention is considered to be done. Alternatives given to patient to complete this second questionnaire are: via e-mail, mail or phone. Comparing to e-mail and mail inquiries, the phone inquiry is rarely used and it is designed for people who have, e.g. difficulties with their vision. The second 15D questionnaire is conducted by Corame, whereas the first questionnaire is on Eksote’s responsibility. (Helvola 2013a; Helvola 2013b)

When the patient’s answers from the second 15D questionnaire are entered into the system at Corame, the patient’s second 15D score is calculated automatically. The software also calculates the remainder between the first and the second 15D score, if there is any difference between them in the first place, and by using this remainder the software calculates QALYs gained (or lost) as a consequence of the treatment(s) received by the patient. (Helvola 2013a)

2.5.2 Features of the software

As mentioned above, this 15D software calculates 15D scores before and after the treatments and the QALYs gained by treatments. This software also calculates the total price of the treatments done to patient by using information from patient's referrals, diagnoses and operations which all are entered into hospital's data systems. This information is in important role when observing, e.g. cost-effectiveness. According to Helvola (2013) there is, nonetheless, one exception being made in the 15D measuring customs that should be taken into consideration when studying or contrasting the costs between units from the 15D database: At the outpatient surgery, the first 15D questionnaire is completed not until the actual operation done to patient. Hence, this course of action leaves the patient's first visit at the hospital without a cost effect, which skews the total cost statistics a bit. (Corame Oy 2012)

Other notable outputs of the software to mention are different summaries, graphs and observations which can be defined in detail. These features allow observing the collected 15D data closely, e.g. by age groups, DRG (Diagnosis Related Group) groups, genders or even by all of them combined together. Information about isolated patients can be searched from the database by their name or social security number, which can used to evaluate the treatments without directly asking from the patients themselves. By contemplating all of these properties which this 15D system offers, it can be said that this software allows good tools for analyzing the effects, effectiveness and cost-effectiveness of health care. (Corame Oy 2012)

3 COSTS AND PRICING IN HEALTH CARE

A key factor in service production and procurement is product. Product determines what is being produced and acquired. In medical care, products contain a variety of services which are divided into sub-groups, such as basic services and sub services. Basic services in medical care are: visits on outpatient clinic, periods of treatment and consultations for outside organizations. Sub services are services that are either directly or indirectly allocated into basic services. Hospital's operations can be productized in many different ways, but the most common way internationally, is to group patients by diagnoses and operations. This type of grouping is called DRG, Diagnosis Related Groups. (FCG Tietojohtaminen Oy, 2013, 3-4)

Follow-up needs for allocating costs and billing in hospitals are different than, for example, when contrasting the clinical functions in hospitals. Proper cost allocation and billing for every patient is the key to assuring that every unit gets fair and reasonable compensation for the resources used when giving the medical care at issue. Cost allocation is based on analyzing the data that is produced and gathered in the same time when hospital is giving medical care to patient. Huge reservoirs of patient-specific information are processed for billing and management and to monitor the production of services. By the help of this data, patients are grouped into DRG –groups and, thereafter, the demanded resources for the care of the patients are concluded. This productization system creates the basis for: ordering new services, billing the produced services, evaluating the validity of billing and evaluating the quality and effectiveness of operations. (FCG Tietojohtaminen Oy, 2013, 3)

Billing in public health care is based on the number of services, both produced and productized. Health care services are priced at average costs of each service product, added with safe margin. Safe margin is added to prevent from unprofitable result, in case there turns up some unexpected costs related to the service production processes. Nonetheless, the prices of health care services are still considered as cost prices, because public health care is not supposed to create profit. Cost price philosophy is hard to obey in a case of single service product, but on a hospital or joint municipal board level, zero result financially is possible and so it is considered as the aim of the economic operation in hospitals. (FCG Tietojohtaminen Oy, 2013, 66)

3.1 Diagnosis Related Groups - DRG

DRG is a special health care's patient classification system, which is capitalized on productizing and invoicing special health care services and on monitoring special health care's costs and quality (FCG Tietojohtaminen Oy, 2013, 4). The DRG system which is used in Finland is called NordDRG. The system is upheld by the Nordic countries and it is maintained and updated by Nordic Casemix Centre. There is a new version of the NordDRG-grouper released every year, and for that reason, there are separate versions of the program in use at health care districts of Finland. DRG-grouper is computer software which capitalizes on all the data of patients recorded into hospital's data systems. Grouping takes place immediately when patient's treatment period or visit is over. DRG-grouper picks from the data, for example, codes that contain information about: diagnoses, operating room procedures, radiology examinations and procedures. (FCG Tietojohtaminen Oy, 2013, 4; Nordic Casemix Centre 2013)

Main goal in DRG-grouping is to create, both economically and medically, homogeneous patient groups from all patients of medical care (Etelä-Karjalan sosiaali- ja terveyspiiri, 2013, 4). DRG-grouping is based on main diagnosis groups, which are divided into sub-groups in accordance with primary diagnosis. Some of these DRG-groups are so called complicated groups, which are higher by their costs and prices than non-complicated groups. Factors that make some groups complicated are, e.g. patient's side diagnoses, emergency surgery, cardiac emergency surgery and for some cases, the length of an operation. Otherwise, patient's DRG-group is being determined by three factors: main diagnose, side diagnose and operations. The reason for patient's present treatment is considered as the main diagnose and the side diagnose is considered as the basic reason why patient is being under medical care in general. On the perspective of operations, the operation that demands the most resources is being named as the main operation. All the rest of operations done to patient, are named as side operations. Every operation is being marked into hospital's database, but only the main operation and first four of the side operations, are the ones that takes count when DRG-grouper is defining the right DRG-group to patient. (Etelä-Karjalan sosiaali- ja terveyspiiri, 2013, 4; FCG Tietojohtaminen Oy, 2013, 4)

3.2 Pricing of health care at Eksote

There are three main aspects that are analyzed when the price of medical care is being determined at Eksote. The pricing of health care provided to patients is based on: outpatient visits, DRG -treatment periods and on the number of days health care is given. Unit prices for each type of health care methods are predetermined for one year at a time by the board of directors of Eksote. The pricing process of medical care is managed by the finance department of Eksote. Finance department determines and calculates the prices for health care by using DRG-prices and price - & cost statistics from previous years. (Etelä-Karjalan sosiaali- ja terveyspiiri, 2013, 2)

All the member municipalities of South Karelia Social and Health Care District except the town of Imatra are invoiced by the calculated relative amount of total costs of health care in Eksote at any given year. Town of Imatra, whereas, is invoiced by matching principle for the medical care Eksote has given to their residents added with additional cost for the common expenses of the district. For other Eksote member municipalities, these common expenses are divided and invoiced by the relative amount of all costs of medical care at Eksote. (Etelä-Karjalan sosiaali- ja terveyspiiri, 2013, 3)

Outpatient care in Eksote is priced by the competence classification of the care and by the costs of care given to patient. Performances that are invoiced in outpatient care are: dispensary outpatient clinic visits, series of care visits and certain examinations and operations. DRG-based pricing is in use for day surgery and for somatic bed patients. These prices are calculated using the classic –weight rates of University hospitals and special field -specific costs that are defined in the budget. Exceptions are made for those DRG-groups that have been planned to serve more than 24 treatment periods per year and for those whom treatment periods are the most demanding. These groups have their own prices calculated by the Eksote finance department. The rest of the patients in these DRG-groups are invoiced by average price of the treatments given, multiplied with weighted coefficient. These DRG –invoicing groups are divided into four groups which are: very expensive -, expensive -, average priced - and inexpensive treatment periods. (Etelä-Karjalan sosiaali- ja terveyspiiri, 2013, 2)

There are also treatments that are invoiced by the number of care days. Each treatment in this billing group have their own price for one day of medical care and the patients are invoiced by the total amount of care days. Medical care types involved in care day invoicing are: psychiatry ward, demanding rehabilitation and patients whom require round-the-clock surveillance or statutory treatment. Care day billing is also applied to for prolonged treatment and queuing into follow-up treatment. Prolonged treatment is a treatment that lasts 20 days or more. Care day prices at Eksote in 2013 for one day varies from 499 euros (dermatopathy and venereal diseases) to 821 euros (children’s diseases). (Etelä-Karjalan sosiaali- ja terveyspiiri, 2013, 2)

4 METHODS AND DATA

This study can be divided into two different parts. First part was a narrative literature review to create a theoretical framework of the subjects dealt with the second part. The purpose of the literature review was to provide information for both the author and the reader to understand the basics of productization, costing, pricing and measuring effectiveness and cost-effectiveness in health care, and to be more precise, in Finnish health care, in which Eksote also includes. On the basis of the literature review it is easier to understand why certain analyses were used in the second part of this thesis and how the units for these analyses were collected and measured. Second part was a combination of effectiveness analysis, CEA and CUA of the health care produced at Eksote and a quality analysis of the 15D data collected and used in these effectiveness analyses.

4.1 Execution of the literature review

Searches for the literature and additional information were made by using Google and Google Scholar search engines and NELLI (National Electronic Library Interface) information retrieval system of Lappeenranta University of Technology. There was no particular timeframes used in the searches, but most weight was given to studies, articles and websites that were dated from the year 2000 to date. Only article older than that, which is used in this review, retains theory of the 15D instrument. The vast majority of the found studies of the cost-effectiveness in health care were conducted in the 2000s and 2010s. Apart from the sources found by search engines and NELLI information retrieval system, some of the sources and information used in the review were received from Eksote. These sources consisted information related to practical actions, e.g. the use of 15D in Eksote and pricing of health care in Eksote. The total number of references used in this study is 26.

Information retrieval for the theoretical part was conducted both in Finnish and English. Main English search words used in retrieval were: 15D, DRG, cost effectiveness analysis, cost utility analysis, QALY and health care. In proportion, the Finnish search words were: 15D, elämänlaatu, elämänlaatumittari, DRG hinnoittelu, kustannusvaikuttavuus, vaikuttavuus and sairaanhoito. All of these search words mentioned above were used both alone and also in different kind of combinations with each other. At first, main weight was given to studies, articles and information written in English but when searches in Finnish were made it turned out that there were good general studies of the cost-effectiveness research in health care written also in Finnish. Based to this observation, in this master's thesis there are used sources written in both, English and Finnish.

All of the sources found were quickly browsed through and if there were several articles, studies or websites retaining same information, the newest and most trustworthy one was picked to be used as a reference in this thesis. The reliability evaluation was made by the author of this thesis and the basis of the assessment was author(s) of the source(s), e.g. what were the titles of the authors, what kind of researches they have published before and how much information about them could be found by a simple search on Google search engine. Many of the articles and studies found via Google Scholar and NELLI were concerning on some specific diseases and theirs cost-effectiveness. Those studies and articles were not used in the literature review of this thesis because the main objective of this thesis was to conduct a general analysis of cost-effectiveness and effectiveness of health care in Eksote. Those disease-specific analyses could be used as help in the future if Eksote decides to carry out effectiveness and cost-effectiveness analyses for separate interventions.

4.2 Effectiveness study

The empirical part of this thesis, or the effectiveness study, consists of effectiveness, cost-effectiveness and data quality analyses. The starting point for these analyses has been the 15D data of 7 816 patients, which Eksote and Corame has gathered and registered into the database from the beginning of year 2008 to December 13, 2012. This data contains various types of information about the patients of Eksote and it is introduced more specifically in the theoretical part of this thesis. In the viewpoint of this effectiveness study, most important information of the data are the 15D scores, prices of the treatments and QALYs gained by treatments. These particulars are used to calculate and measure the effectiveness and cost-effectiveness of health care and the reliability of the data.

4.2.1 Statistics

All the data used in the effectiveness studies of this master's thesis were analyzed by Microsoft Excel spreadsheet application. The reason to choose this software were that the data package, which contained all the gathered 15D information by the date of 13th December 2012, was received from Corame in Excel format and after exploring this data from the perspective of how the analysis should be done in general and what are the needs of the analyses, it pointed out that the effectiveness calculations could fairly be committed in Excel.

At first, the effectiveness analyses -related main parts of the data, that is to say, the patients' first and second 15D scores, patients' gained and lost QALYs as results of the treatments and the prices of the patients' treatments were scrutinized. By the help of this scrutiny there were found some misplaced data, e.g. cost information and 15D scores located in wrong cells. This data was relocated into their correct places. The number of the misplaced data was not too substantial, but it was found justified to make the data more precise, because it could be made effortlessly. After this general observation of the data, the data was divided according to medical units into their own sheets in Excel for the further researches. After the division of the medical care units, the total numbers of patients, cost information, baseline 15D scores, post-treatment 15D scores and the QALYs were calculated per medical care unit by using COUNT function in Excel. COUNT function counts the number of cells containing data in the determined range. These total numbers were used in the data quality analysis later on the study and are presented more precisely in the section of data quality analysis.

The changes in 15D scores, which are used in the effectiveness analyses of health care in this thesis, were calculated in Excel by using the combination of IF function and subtraction. By the help of IF function it was possible to verify that there were both the baseline and the end-study 15D scores from the patient to calculate the exact 15D change. When 15D changes were calculated for every patient, the actual 15D change for every unit were calculated by using the AVERAGE function to calculate the arithmetic mean of 15D changes in units. These arithmetic means were used to indicate the effectiveness of health care in the medical units when observing and contrasting the effectiveness between the medical units where 15D measuring is being made. As a part of effectiveness analyses there were also standard deviations calculated to observe how much there exists variation from the calculated unit-specific score of 15D change in comparison to the 15D data of which these unit-specific 15D changes were calculated. Standard deviations were calculated in Excel by using STDEV function.

The cost-effectiveness analyses were performed as cost per QALY and 15D change per costs analyses. Cost per QALY ratios were calculated by using IF, AVERAGE and SUM functions and division. By using the IF function it was possible to verify that there were both the cost, or the price information and the QALY information available from the patient. By using the SUM function these costs and QALYs were both separately totaled up for every medical unit. And by dividing these total costs by the sum of QALYs produced, are the cost / QALY ratios obtained to describe the costs that results from producing one additional quality-adjusted life year for the patient. In this connection, it’s worth pointing out that because costs per QALY ratios were calculated for every unit by dividing two different singular quantities, in other words, the total of costs by the total of QALYs, there are no standard deviations calculated for these cost / QALY ratios. Reasons for this are that the standard deviation for singular quantity is not calculable and these two totals, otherwise, the total costs of treatments and total amount of QALYs gained by treatments are not being analyzed anywhere in this study so it was found unnecessary to present the standard deviations of these quantities either.

In the 15D change per cost analyses the IF function is used to verify that there exists all necessary information for calculating the ratio for patient, in other words, it checks that there is the baseline 15D score and the post-treatment 15D score to calculate the 15D change for the patient and also the prices of treatments done to patient. When the IF function notices that the patient qualifies for the ratio at issue, it calculates the 15D change per cost ratio for the patient. After the patient-specific calculations, the 15D changes per costs ratios were calculated for every medical unit by using the AVERAGE function. This function calculates the arithmetic mean from the set of patients which have the patient-specific 15D change / cost ratios calculated by tallying up the ratios and then dividing this total by the number of quantities. The result of this calculation is the average and it is the 15D change per cost ratio and it is used in this master’s thesis to represent the cost-effectiveness of the medical care in the unit at issue. Similarly as in effectiveness analysis, there were also standard deviations calculated by using the Excel’s STDEV function as a part of the analysis to observe the degree of variation in the unit-specific 15D change per cost ratios.

4.2.2 Selection of the medical care units for the study

The 15D data has been gathered in following 20 distinct medical entities of Eksote:

- Day Surgery
- Cardiovascular Surgery
- Luumäki Health Center’s Senior Health Clinic
- Incontinence Surgery
- Radiel Survey
- Gynecological Oncology
- Surgery Outpatient Clinic’s urological patients
- Cancer Treatment Unit
- Respiratory Medicine Outpatient Clinic
- Ophthalmology Outpatient Clinic
- Cardiac Unit
- Orthopedics
- Physical and Rehabilitation Medicine Outpatient Clinic
- Pain Outpatient Clinic
- Otorhinolaryngology Outpatient Clinic
- Gynecological Department
- Gynecological Outpatient Clinic
- Rehabilitation Outpatient Clinic,
- Rheumatic Diseases Outpatient Clinic
- Surgery Outpatient Clinic’s shoulder patients

As we can see from the listing above, 15D data has been gathered in different wards, units and in some cases, from some certain patient groups. These medical entities and health care units contains variable amount of patients as we can see below from the Table 1. These units/entities where 15D measuring is being done in Eksote differ so much from each other by the amount of patients included, that it created a demand for outlining more precisely the field of which the effectiveness and cost-effectiveness research is being done. By outlining the observed group of medical entities on the strength of patient amounts, it is possible to create a more homogeneous and valid set for contrasting the effectiveness and cost-effectiveness of these medical units.

Table 1. The division of the patients into medical entities & units

Medical entities / Health Care Units	Number of patients
Orthopedics	1981
Day surgery	1666
Gynecological Department	1332
Physical and Rehabilitation Medicine Outpatient Clinic	499
Pain Outpatient Clinic	450
Cardiac Unit	431
Rheumatic Diseases Outpatient Clinic	279
Ophthalmology Outpatient Clinic	267
Rehabilitation Outpatient Clinic	203
Radiel Survey	159
Gynecological Outpatient Clinic	125
Surgery Outpatient Clinic's urological patients	112
Gynecological Oncology	83
Incontinence Surgery	78
Respiratory Medicine Outpatient Clinic	67
Luumäki Health Center's Senior Health Clinic	38
Otorhinolaryngology Outpatient Clinic	17
Cancer Treatment Unit	10
Surgery Outpatient Clinic's shoulder patients	10
Cardiovascular Surgery	9
Total number of patients in the data	*7816*

The medical entities which were included into the actual cost-effectiveness and effectiveness analyses were: Orthopedics, Day Surgery, Gynecological Department, Physical and Rehabilitation Medicine Outpatient Clinic, Pain Outpatient Clinic, Rheumatic Diseases Outpatient Clinic, Rehabilitation Outpatient Clinic and Respiratory Outpatient Clinic. These eight units which were picked for the study still represent the majority of the data, because these groups in one contain so many patients. The rest of the medical entities were excluded from the actual study, because they were either too small by the amount of patients included or they were lacking too much cost data. The elect medical care units for the further effectiveness and cost-effectiveness research and the lack percentages of the cost data for every unit are presented below in the Table 2. The elect medical care units are presented in bold.

Table 2. Lacks in cost data

Medical entities / Health Care Units	Number of patients	Number of cost informations	Lack-%
Orthopedics	**1981**	**1352**	**32 %**
Day surgery	**1666**	**1101**	**34 %**
Gynecological Department	**1332**	**1008**	**24 %**
Physical and Rehabilitation Medicine Outpatient Clinic	**499**	**451**	**10 %**
Pain Outpatient Clinic	**450**	**323**	**28 %**
Cardiac Unit	431	166	61 %
Rheumatic Diseases Outpatient Clinic	**279**	**229**	**18 %**
Ophthalmology Outpatient Clinic	267	123	54 %
Rehabilitation Outpatient Clinic	**203**	**161**	**21 %**
Radiel Survey	159	11	93 %
Gynecological Outpatient Clinic	125	52	58 %
Surgery Outpatient Clinic's Urological patients	112	7	94 %
Gynecological Oncology	83	47	43 %
Incontinence Surgery	78	2	97 %
Respiratory Medicine Outpatient Clinic	**67**	**62**	**7 %**
Luumäki Health Center's Senior Health Clinic	38	0	100 %
Otorhinolaryngology Outpatient Clinic	17	7	59 %
Cancer Treatment Unit	10	10	0 %
Surgery Outpatient Clinic's Shoulder patients	10	0	100 %
Cardiovascular Surgery	9	4	56 %

Cost data was included as a criterion into this undertaken unit selection, because calculating cost-effectiveness ratios require specific cost information. It was found necessary to measure effectiveness and cost-effectiveness of medical units with as much patients as possible that still lack as little as possible in cost information to create valid and realistic view of the subject, otherwise the cost-effectiveness in South Karelia Central Hospital.

4.2.3 Data quality analysis

The main purpose for data quality analysis was to check how valid and precise the gathered 15D data was and what conclusions can be drawn by the results of the analysis. Data analysis was made by separately counting the total number of patients, 15D changes per cost ratios and cost per QALY ratios from all of the eight medical units chosen to the final study. These total amounts were later on used to calculate data quality ratios to describe the quality of the data used in this study.

$$\sum_{i=1}^{n} x_i = x_1 + x_2 + \dots + x_n \qquad (5)$$

Total number of individual patients and ratios of the units were calculated by using addition, which can be mathematically expressed as above on Equation (5). Σx stands for the total amount of patients, 15D changes per cost ratios or cost per QALY ratios and x_1 is the first patient or ratio, x_2 is the second patient or ratio and x_n is last patient or ratio in the range, which in this case is the observed medical unit. After these additions the total amount of patients from each unit were used as a divisor when dividing the total amount of 15D change per cost ratios and cost per QALY ratios of the medical units to get the quality ratios mentioned above.

$$R_{\%} = \left(\frac{\Sigma r_i}{\Sigma \mathrm{p_i}} \right) \times 100\ \% \tag{6}$$

Data quality ratio calculations can be expressed mathematically as above on Equation (6). In this equation, the total amount of 15D changes, 15D changes per cost ratios or the cost per QALY ratios, depending on which ratios is being observed, is represented as Σr_i and is used as a dividend in the calculations. The total amount of patients is described as $\Sigma \mathrm{p_i}$ and is used as divisor. The quotients are then multiplied with $100\ \%$ to get the percentages to describe the data quality, in other words the calculability rates of the ratio, which is presented as $R_{\%}$ on the equation above. These data quality ratios were calculated separately for every of the eight observed units of this study to present the quality of the 15D data. These ratios were also used to compare the quality of the data between the units.

4.2.4 Effectiveness analysis

The purpose of effectiveness analysis in this study was to observe the effects of medical care in the eight medical units which have been selected previously and to compare the 15D changes between these units. Effectiveness analysis is being conducted to explore what kind of possible changes in patients' health-related quality of life are being achieved by medical interventions in Eksote, if there are any changes in the first place, and to explore in which of these eight medical care units the interventions are the most medically significant and in which unit the least significant.

Effectiveness analysis was made by calculating the effectiveness of medical care for every patient separately by using the first and second 15D scores. After these calculations the average change of 15D score was calculated for medical units by using the patient-specific 15D changes and after these unit-specific average 15D changes had been determined, standard deviations were calculated to give more depth for the effectiveness analysis as a whole.

$$V_i = v_2 - v_1 \tag{7}$$

The change in 15D scores, otherwise, the effectiveness of medical intervention done to patient i can be expressed mathematically as above in Equation (7), where the first 15D score of the patient is presented as v_1, the second 15D score is presented as v_2 and the change of 15D score of the patient i is presented as V_i. The change of patients 15D score, in other words, the effectiveness of the medical intervention is calculated by using a simple subtraction.

$$\overline{V_i} = \frac{\Sigma V_i}{n} = \frac{V_1 + V_2 + \ldots + V_n}{n} \tag{8}$$

The unit-specific effectiveness of the medical interventions was calculated as an average of the patient-specific changes in 15D scores. This can be expressed mathematically as above in Equation (8), where $\overline{V_i}$ is the 15D change of the unit and it is calculated by summing up the patient specific 15D changes, where V_1 is the 15D change of the first patient in the data, V_2 is the 15D change of the second patient in the data and V_n is the 15D change of the last patient included in the unit-specific data range where the calculation is being made of. The divisor n is the serial number, in other words, the number of patients of the unit from which the unit-specific 15D change is being calculated.

$$SD = \sqrt{\Sigma \frac{(x - \bar{x})^2}{(n-1)}} \tag{9}$$

The standard deviation SD, can be expressed mathematically as above in Equation (9), where x takes on each value in the set, $\bar{x}$ is the average of the set and n is the number of the values. (STDEV, 2013).

The unit-specific 15D changes, which are being represented later on, have been multiplied with 10^3 to get the results into a more readable and understandable form. This means that when usually the change of 0,03 or more in the 15D scores is considered medically significant, in this thesis the borderline for medically significant 15D change is $0{,}03 * 10^3 = 30$.

4.2.5 Cost-effectiveness analyses

In this master's thesis, the cost-effectiveness analysis has been made in two parts with two different analyses. One part is cost-utility analysis, or cost-QALY analysis, where has been determined the average unit-specific prices for production of one QALY, in other words, the unit prices for one QALY has been calculated for every medical entity. The other part is a form of cost-effectiveness analysis, where has been calculated the average amount of 15D change which can be produced to patients with one million euros. The main purpose for these analyses was to explore what is the price level when improving the health-related quality of life of the patients in these medical units, in which of these units the quality of life is the cheapest or the most expensive to improve and what happens to the quality of life of the patients when costs are being formed in a first place.

$$P_Q = \frac{\sum_{j=i}^{n} c_j}{\sum_{j=i}^{n} Q_j} = \frac{(c_1 + c_2 + \cdots + c_n)}{(Q_1 + Q_2 + \cdots Q_n)} \tag{10}$$

The calculation of the unit-specific average price of one QALY can be expressed mathematically as above in Equation (10), where P_Q is the average price of QALY in the unit, c_1 is the costs of first patient in the unit, c_2 is the costs of second patient in the unit, c_n is the costs of the last patient in the unit, $Q_1$is the number of QALYs gained/lost by the first patient due to intervention, Q_2 is the number of QALYs gained/lost by the second patient due to intervention and Q_n is the number of QALYs gained/lost by last patient in the unit due to intervention. When doing this same calculation for the every one of the eight units in the data, the unit prices for one QALY are gained.

$$V_€ = \left(\frac{V_1}{c_1} + \frac{V_2}{c_2} + \cdots + \frac{V_n}{c_n} \right) \times 10^6 \tag{11}$$

The unit-specific average 15D change per million euros can be expressed mathematically as above in Equation (11), where $V_€$ is the average change in 15D score in the unit per million euros. At the beginning, the patients' changes in 15D scores are divided by the costs of their medical treatments, where V_1 is the first patient's change in 15D score and c_1 are the costs of the first patient's interventions, V_2 is the second patient's 15D change and c_2 are the costs of second patient's interventions and V_n is the last patient's 15D change of the unit and c_n are the costs of the last patient in the unit. These patient specific 15D change per cost ratios are then aggregated and after that, the total is multiplied by 10^6 to get result, otherwise, the change in 15D score per investment of million euros in the unit.

Cost per QALY ratio and 15D change per cost ratio are calculated differently, because cost / QALY ratio expresses a kind of a price for the production of one quality-adjusted life year, whereas 15D change / cost ratio expresses the effectiveness of the medical care as a result of an investment of one million euros. So, where cost / QALY ratio represents the price of a QALY, it has to be calculated in a way, which does not result in negative prices. That is the reason to first sum up all the costs of the interventions and all gained/lost QALYs which have resulted from the interventions done in medical entity at issue. And just after that, the total costs of the interventions are divided by the total of QALYs and as a result of this division, the quotient, or in the other words, the cost / QALY ratio is gained. But, when 15D change per cost ratio describes the result of an investment into medical care interventions, the result can be also negative and that is the reason why it can be calculated as a total of quotients and after that it can be multiplied with a 10^6 to get result into a correct magnitude.

5 RESULTS

5.1 Data quality

As we can see from the Table 3 below, from the total amount of 6 477 patients which were included in this study, the 15D changes could be calculated from 3 383 patients, which in percentages is 52 %. This means that only a slim majority of the patients has conducted the first and second 15D questionnaire or their both 15D scores have been successfully saved into the 15D database. In the Table 3, all the eight observed medical units are listed from the largest to smallest by their number of patients. The numbers of the patients of every medical unit are under the title *n (patients)* and the numbers of 15D changes, which could be calculated, are under the title *n (15D change)*. The last column in the table, which is titled *%*, tells the percentage of 15D changes which were available.

Table 3. Number of 15D changes in comparison to number of patients

Medical unit	n (patients)	n (15D change)	%
Orthopedics	1981	1078	54 %
Day surgery	1666	891	53 %
Gynecological Department	1332	776	58 %
Physical and Rehabilitation Medicine Outpatient Clinic	499	228	46 %
Pain Outpatient Clinic	450	142	32 %
Rheumatic Diseases Outpatient Clinic	279	138	49 %
Rehabilitation Outpatient Clinic	203	97	48 %
Respiratory Medicine Outpatient Clinic	67	33	49 %
Total	*6477*	*3383*	*52 %*

The three largest medical units by patient number which are included in this study, otherwise, Orthopedics, Day Surgery and Gynecological Department; all got higher answer percentage than 52 %, which was the calculability or availability rate of the whole data. From the rest five units, the 15D changes could be calculated only from under the half of the patients. Gynecological Department got the highest 15D questionnaire answer rate by its 58 % and lowest answer percentage was in Pain Outpatient Clinic, which was 32 %.

Table 4 points out that 15D per cost ratios could be calculated from 2 429 patients, which represent only 38 % of the patients included in the 15D data. This means that 4 218 patients didn't have their first or second 15D score or the costs of their medical care recorded into database. Some patient information did lack in both, the 15D scores and cost information. The medical units are listed from the largest to smallest by their total number of patients in the Table 4. The numbers of patients are under the title *n (patients)*. The following column to the right of the *n (patients),* which is titled *n (15D / cost),* tells the number of patients from which the 15D change per cost ratio could be calculated, otherwise, the number of patients which have their first and second 15D scores and their medical care's costs recorded into database. The last column on the right side is titled *%*, and it tells the percentage of which the 15D change per cost ratio could be calculated when compared into the total number of patients. The lowest rate in the 15D change per cost ratio in comparison to the total amount of patients was *22 %*, which was calculated from the Pain Outpatient Clinic. This means that *78 %* of the information of patients recorded into database from the unit had lacked in either cost information or 15D information. The highest accuracy rate got Respiratory Medicine Outpatient Clinic, which had 45 % percentage of the information needed in calculating the 15D change per cost ratio right, but it doesn't elevate the 15D per cost ratio calculability of the whole data any higher, because there only 67 patient total in this medical unit.

Table 4. Number of 15D per cost ratios in comparison to number of patients

Medical unit	n (patients)	n (15D / cost)	%
Orthopedics	1981	734	37 %
Day surgery	1666	571	34 %
Gynecological Department	1332	582	44 %
Physical and Rehabilitation Medicine Outpatient Clinic	499	211	42 %
Pain Outpatient Clinic	450	98	22 %
Rheumatic Diseases Outpatient Clinic	279	122	44 %
Rehabilitation Outpatient Clinic	203	81	40 %
Respiratory Medicine Outpatient Clinic	67	30	45 %
Total	*6477*	*2429*	*38 %*

Table 5 below, which presents the calculability of the cost per QALY ratio, has the same structure as the Tables 3 and 4, which have been presented earlier in this study. The medical units researched in this study are listed by the number of patients from largest to smallest under the title *n (patients)*. The number of the cost per QALY ratios that could be calculated from every unit are listed in the column *n (cost / QALY)*. The proportions of cost / QALY ratios to total number of patients for every medical unit are listed under the title *%*, on the right side of the table. When comparing the total proportion of cost / QALY ratios and the total proportion of 15D change / cost ratios to the total number of patients included in this study, we can see that the cost / QALY ratios can be calculated from even smaller amount of patients (35 %) than the 15D change / cost ratio, which was calculable from 38 percent of the patients. The highest ratio for calculating the cost / QALY ratios is in the Rheumatic Disease Outpatient Clinic where the ratio is calculable from the 43 % of the patients. Pain Outpatient Clinic possesses again the lowest calculability ratio of 22 %.

Table 5. Number of cost per QALY ratios in comparison to number of patients

Medical unit	n (patients)	n (Cost / QALY)	%
Orthopedics	1981	716	36 %
Day surgery	1666	513	31 %
Gynecological Department	1332	526	39 %
Physical and Rehabilitation Medicine Outpatient Clinic	499	205	41 %
Pain Outpatient Clinic	450	98	22 %
Rheumatic Diseases Outpatient Clinic	279	120	43 %
Rehabilitation Outpatient Clinic	203	80	39 %
Respiratory Medicine Outpatient Clinic	67	26	39 %
Total	*6477*	*2284*	*35 %*

From the Figure 2 we can get an overall view of the calculability rates, in other words, the availability of the information which is needed when calculating the effectiveness and cost-effectiveness ratios. The graphs describe the proportions of 15D change ratios, 15D change / cost ratios and cost / QALY ratios to the total number of patients in medical units. As it was pointed out earlier, the availability of the data needed when calculating the average 15D changes for the medical units was better than the availability of the data needed when calculating the cost-effectiveness ratios. The calculability of the 15D change per cost ratios and cost per QALY ratios was almost equal.

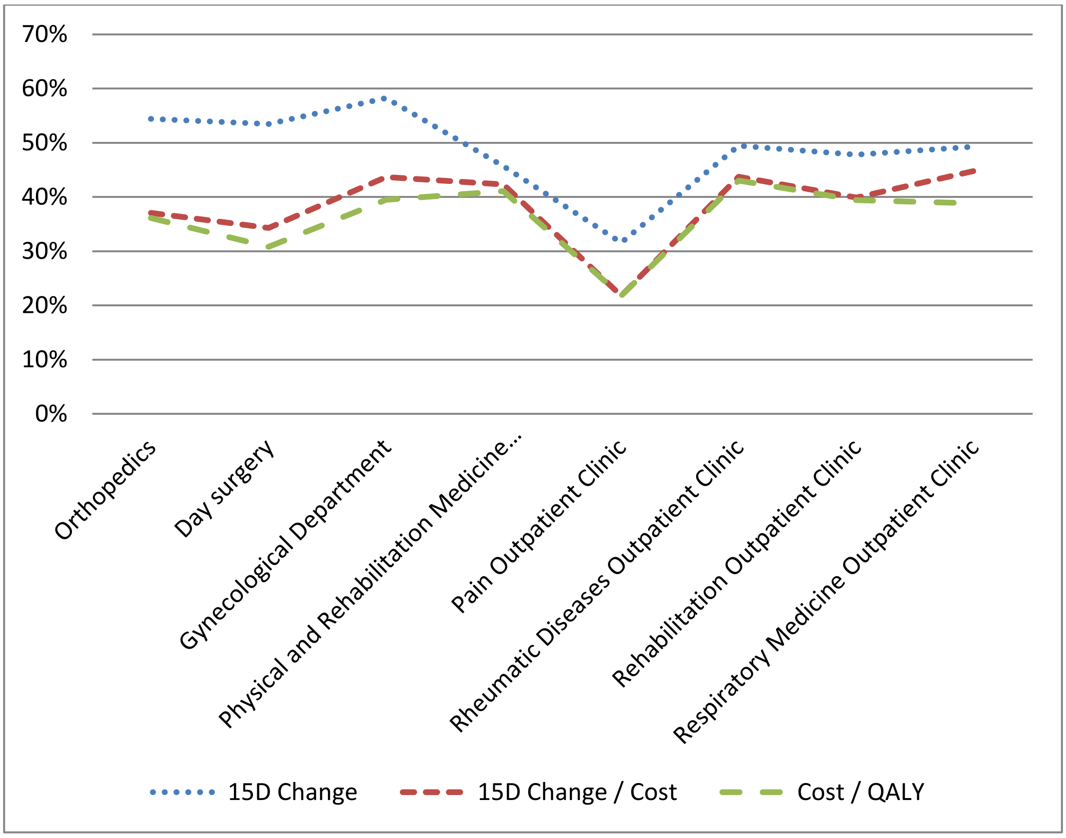

Figure 2. Calculability of the effectiveness and cost-effectiveness ratios

5.2 Medical care effectiveness

The effectiveness of medical care, in other words, the average 15D changes of the patients in Eksote's eight medical units selected to this study are presented in the Appendix II and in the Figure 3 below. In the Appendix II, the changes in 15D scores are being listed from lowest to highest under the title *Average 15D change*. The standard deviations in the 15D scores and numbers of observations are being listed on the right side of the table under the titles *SD* (standard deviations) and *N* (number of observations). Both the standard deviations and the average 15D scores have been multiplied by 10^3, to get the figures into a more understandable and readable form. The mean scores and deviations are presented at the bottom of the table in the Appendix II. In Figure 3 both the results from effectiveness analyses and standard deviations of 15D scores for every medical unit are presented in a bar chart.

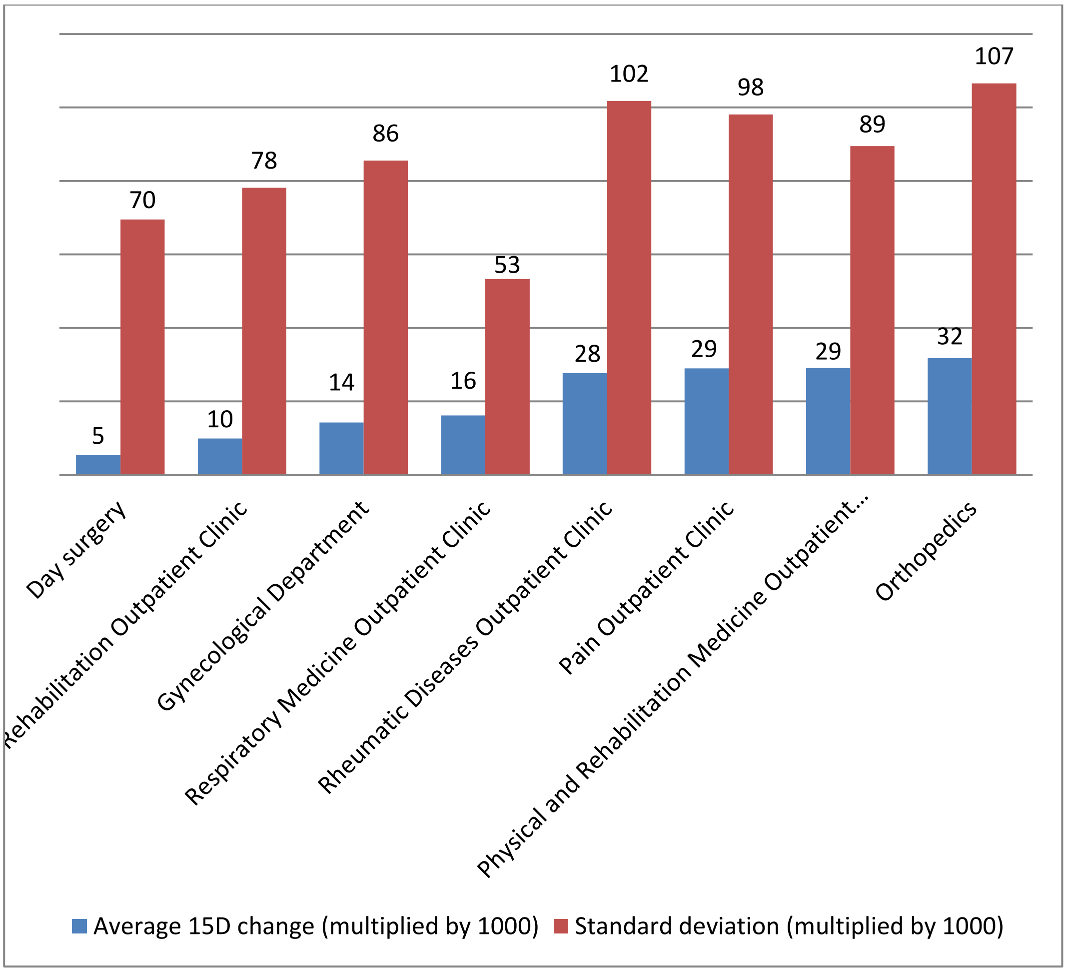

Figure 3. Average 15D changes and standard deviations in the medical units

The results point out that, the medical care is the most effective at the unit of Orthopedics, which was the only unit to get a score (32) that is being considered as medically significant (>30). Rheumatic Diseases Outpatient Clinic (28), Pain Outpatient Clinic (29) and Physical and Rehabilitation Medicine Outpatient Clinic (29), were close but didn't achieve the limit of 30, which may be considered as a eligible stage in the effectiveness of health care. But as the standard deviations, which varied from 53 (Respiratory Medicine Outpatient Clinic) to 107 (Orthopedics), point out there is a wide range in the effectiveness of the interventions and it means that there are medically significant effectiveness achieved by interventions in every unit observed in this study. But on the other hand, some interventions and medical care in some units are not being effective at all on the point of view of 15D-instrument, like we can see from the Figure 3 above, where the average 15D changes, or the effectiveness of medical care, are being contrasted. As the Figure 3 points out, the average scores of the interventions in Day Surgery. Rehabilitation Outpatient Clinic, Gynecological Department and Respiratory Medicine Outpatient Clinic are far away from the score of 30, which is considered to be as the limit of medically significant change in HRQoL.

5.3 Medical care cost-effectiveness

5.3.1 Results of the cost-utility analysis

The results of the cost-utility analysis, in other words, the cost per QALY analysis are presented in the Appendix III and in the Figure 4 below. In the Appendix III the costs per QALYs are listed from the lowest to highest and on the right side of the table the numbers of observations are listed under the title *n*. As we can see from the table of the Appendix III and from the Figure 4, the prices of the produced quality-adjusted life years varies a lot between the medical units. The cheapest life years produced to patients were at Rheumatic Diseases Outpatient Clinic (843 €/pc) and Pain Outpatient Clinic (934 €/pc) and the most expensive QALYs to produce were at Day Surgery (10 723 €/pc), Orthopedics (10 929 €/pc) and Gynecological Department (8760 €/pc) where one QALY is over ten times more expensive than in the cheapest units.

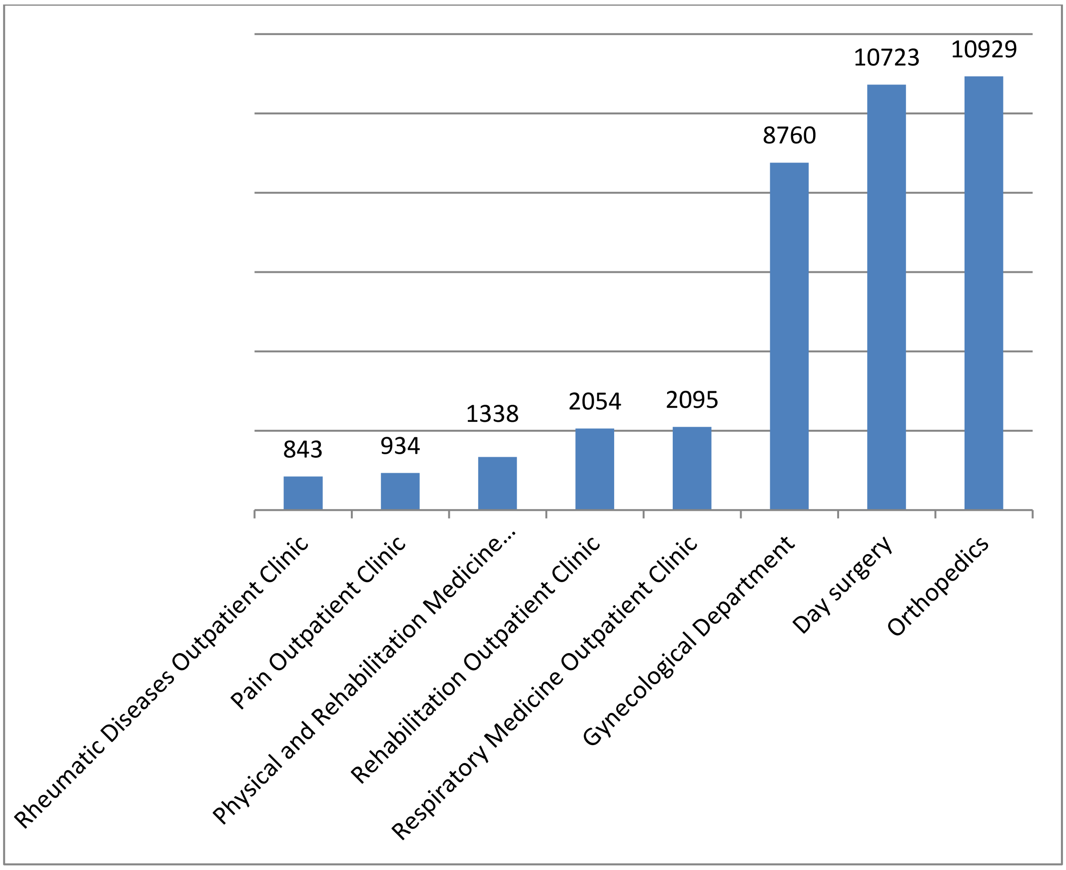

Figure 4. Average costs per QALY in medical units

5.3.2 Results of the cost-effectiveness analysis

The results of the cost-effectiveness analysis are presented in the Appendix IV and in the Figure 5 below. In the Appendix IV, under the title of *15D change per million euros,* is a column where the ratios are listed from the smallest ratio to the greatest one. On the right side of the table, there are columns titled *SD* and *n*, in which are the standard deviations for the ratios of every medical unit and the unit-specific total numbers of the observations used in the cost-effectiveness analysis. The average changes of 15D scores per euros were multiplied in this analysis with 10^6 to get the figures into a more distinct and readable form. As the ratios and standard deviations of the Figure 5 point out, there are, again, great variances in the figures between the medical units. The cost-effectiveness of medical care in the Day surgery is even negative (change of -0,56 in 15D scores per million euros used to the medical care interventions). The two most cost-effective ratios are from Pain Outpatient Clinic (change of 60,69 in 15D scores per million euros invested in interventions) and from Physical and Rheumatic Diseases Outpatient Clinic (change of 59,40 in 15D scores per million euros invested in medical care). The standard deviations are again very large, which means that there occurs variance inside the 15D data of the units also.

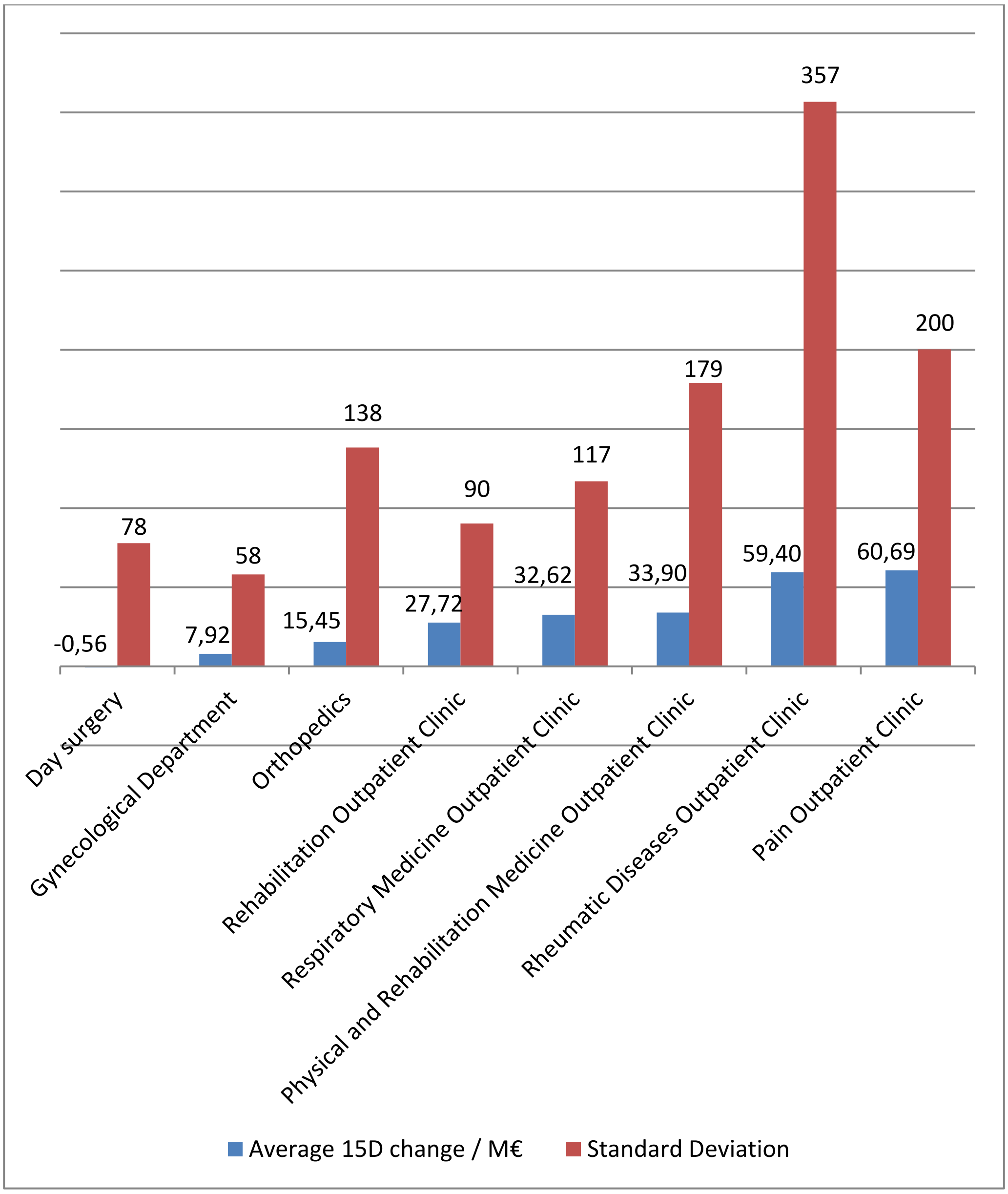

Figure 5. Average 15D changes per million euros and standard deviations

Comparison between the standard deviations of average 15D change and average 15D change per million euros is presented in the Figure 6 below. From the table we can see that the deviations are much alike within the most of the units. The largest deviations in the average 15D changes per million euros invested in medical care intervention are in the Rheumatic Diseases Outpatient Clinic, Physical and Rehabilitation Medicine Outpatient Clinic and Pain Outpatient Clinic, where are also the biggest deviation differences between these effectiveness and cost-effectiveness ratios. The smallest deviations are in Rehabilitation Outpatient Clinic, Day surgery and in Gynecological Department. This scrutiny between ratios indicates that in some units of this study, the deviations grow when the costs come in to the exploration, whereas in some units the deviations decrease.

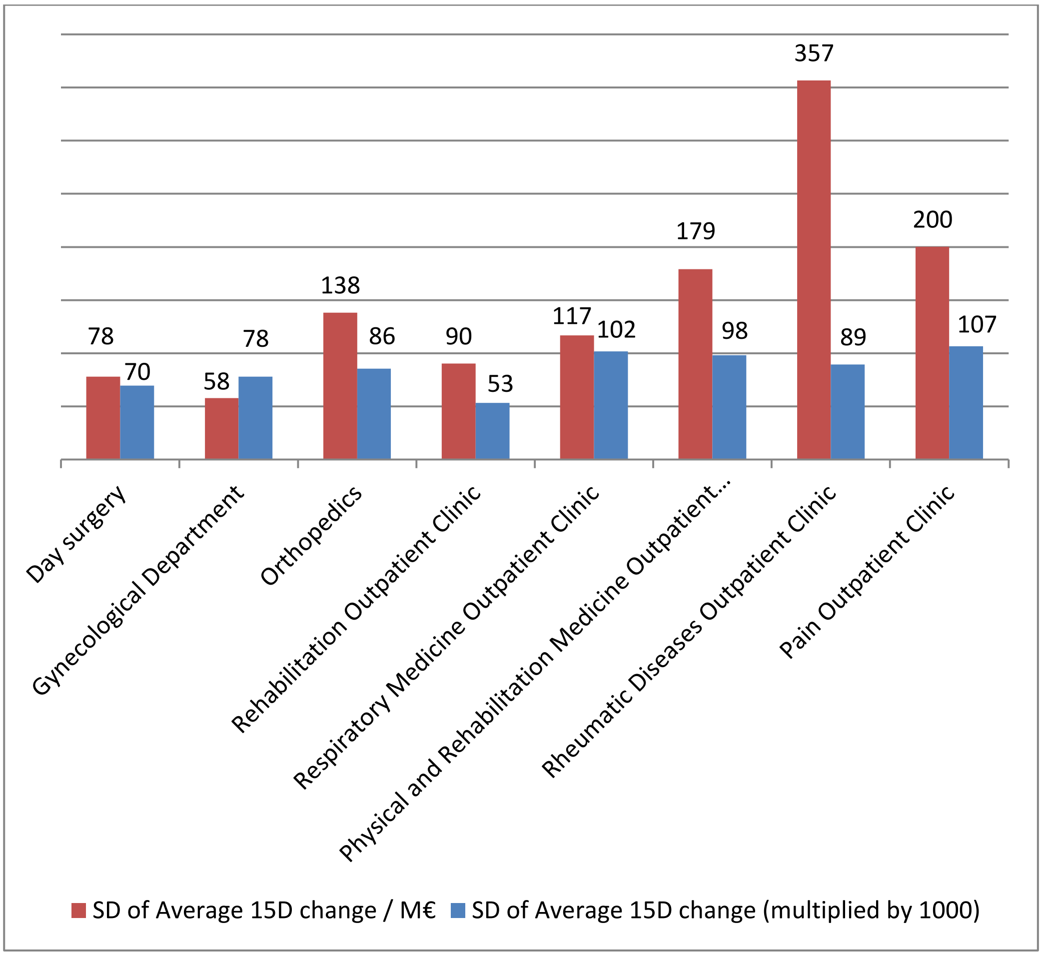

Figure 6. Comparison between the standard deviations

6 DISCUSSION

6.1 Conclusions

There are some reasons known to explain the low calculability of the 15D changes. One reason is that there has been a change of software platform which resulted to that the gathered 15D data had to be entered manually into the new system and it might be possible that some of the data has been misplaced during the process. This kind of misplacing is also occurring nowadays when the information is registered manually into system, as it was found out when the data was scrutinized through in the beginning of this study. For example, if the date of the first 15D questionnaire or the patient's email address is entered incorrectly into the system, the second questionnaire can't be send in right time or into right address. But when half of the important patient data is not in the database, misplacing seems not to be the only reason for the weak quality of the data. Other reason for why the 15D scores are lacking are that the patients may have died between completing the first and second 15D questionnaire, but obviously there aren't that much mortality within the patients of these eight medical units. Last reason which affects to 15D change calculability rate is the most obvious one: if there hasn't yet been six months from completing the medical care, the second questionnaire hasn't been sent yet for the patient to complete and therefore the second 15D score is not available. And of course there are still some patients who don't have time or interest to answer the second questionnaire and obviously these people can't be forced to do so, and therefore their 15D score from the second 15D questionnaire remains to be unavailable. To put it briefly, there are various reasons which seem to lower the availability of the data needed when calculating the 15D scores and analyzing the effectiveness and cost-effectiveness of health care in Eksote, but it should still be considered that what can be done in the future to get the calculability rates higher, because only within the units of this study nearly half of the 15D data, otherwise, the 15D changes of 3 094 patients are not available for observing the effectiveness and cost-effectiveness of medical care.

From the eight medical units which have been selected for this effectiveness and cost-effectiveness study of medical care, the 15D change ratio can be calculated from 3 383 (52 %) patients, the 15D change per cost ratio can be calculated from 2 429 (38 %) patients and the cost per QALY ratio can be calculated from 2 284 patients (35 %). So, from the gathered 15D data of these eight medical entities, there can be calculated total of 8 096 different effectiveness and cost-effectiveness ratios which can be used to analyze the effectiveness and cost-effectiveness of health care in Eksote. Still, it should be remembered that although the over 8 000 ratios is a good amount, by matching the data more accurate, the number of ratios could be doubled and there are still 11 335 ratios that can't be calculated because of the lacks in cost data and in 15D scores and QALYs within these eight medical care units chosen to this study. It means that 58 % from the total of 19 431 ratios which could be calculated in ideal situation when all of the collected data would be available, are not available at the moment. In summary, although it was noticed in the beginning of this effectiveness and cost-effectiveness study when the eight medical units were chosen to the actual study, that there are lacks in cost data in every one of the medical units where the 15D data is being gathered in Eksote, it now pointed out when the lacks in cost data were combined with the lacks of 15D scores and lacks of QALYs, that the quality of the data is not as good as it was first considered to be and far as good as it could be.

One notable thing which was acknowledged when analyzing the quality of the data is that the 15D change is more calculable than 15D change per cost ratio and cost per QALY ratio. This could mean that there are more lacks in costs than in 15D scores and QALYs in the data, but it can't be regarded as a truth before careful observation. It is possible that there are lacks in the patients cost data when the patients 15D change is calculable or there exists gained or lost QALY figures in the data, and the other way round. Still, the calculability graphs in the Figure 2 of 15D change per cost ratios has parallels with cost per QALY ratios which could mean that the lack of cost information is the main reason for the low percentages of the calculability of the cost-effectiveness ratios. Still, Figure 2 also points out that there exist small differences between the calculability of the 15D change per cost ratios and the cost per QALY ratios although there usually are both 15D change and QALY information available from the patient, if these effectiveness information are available in the first place. An explanatory factor for these differences in the data availability rates could be the differences in notation practices of the data package used in this study: If the 15D change between the first and second 15D measurement is zero, in other words there isn't change in the patient's HRQoL due to the medical intervention, the amount of QALYs gained or lost as a result of the medical care, which in this case is zero, has not been entered into the data as a numeral (=0), but the cell has been left empty. As a result of this procedure, the HRQoL changes of zero are being interpreted differently when analyzing the cost-effectiveness of health care: The zero QALYs have not been taken into account, whereas the change of zero in 15D scores have been taken into account because the 15D changes of the patients have been calculated separately as they weren't calculated ready just like the QALYs were. It was decided in the beginning of the study that all the data is considered to be equally valid, so it was considered not to change manually the empty QALY cells into zeros in order to keep the data equally homogenous.

From the Figure 3 we can see that the standard deviations are more alike between the medical units than the 15D changes were. When deviations are so large and similar in every unit, it may tell that the changes in 15D scores are not that much dependent on the medical unit where the intervention is being done than on the patient itself. When patient is being evaluating his/her own quality of life how it's being experienced there might be many things that have effect on the experiencing, especially when the 15D instrument takes so many dimensions of life and health into account, like we can see from the appendix I. It would take a whole new and wider study and more medical expertise to analyze how different diseases effect on experienced health on these 15 dimensions, but it can be said that when there is a at least six month period between the health evaluations, many things can happen and the patient might not be able to evaluate his/her own experienced health as objectively as it should be evaluated.

As we noticed from Figure 6 where the standard deviation of the average 15D change was contrasted to the standard deviation of the average 15D change per investment of million euros into medical care interventions, some of the deviations changed a lot when the costs were included into the study (for example: Physical and Rehabilitation Medicine Outpatient Clinic), some deviations remained almost unchangeable (for example: Day Surgery) and some deviations became even smaller (for example: Rehabilitation Outpatient Clinic). This could signify that the in some units the costs vary a lot (growth of deviation) and in some units the costs are very similar (decrease of deviation and immutable deviation). Still, it must be said that even if the deviations remained the same or decreased they are still very large and this means that there are lots of variance in the effectiveness and costs of the interventions in the medical units of this study. Some patient’s HRQoL changes a lot as a result of the intervention, some doesn’t notice difference at all and some even experience that their quality of life has suffered due to an intervention or during the six months period before answering the second 15D questionnaire.

As the results of the effectiveness analysis of this study indicated, the medical care in the units of Day surgery, Rehabilitation Outpatient Clinic, Gynecological department and Respiratory Medicine Outpatient Clinic is considered as clearly medically ineffective from the point of view of 15D-instrument. The medical care in the other four of the units observed in this study, otherwise Orthopedics, Physical and Rehabilitation Outpatient Clinic, Pain Outpatient Clinic and Rheumatic Diseases Outpatient Clinic, can be considered as medically effective or at least the care provided in these units is very close to be medically effective. This interpretation about effective medical care leads to question: Can medical units which differ by their treatments and customs be compared by their effectiveness and cost-effectiveness without any kind of standardization of the practices? It might be very difficult to say that some medical units give more effective medical care than others if the comparison is being made between units that provide medical care which is totally different from each other. So, the effectiveness and cost-effectiveness information produced by 15D-instrument might be more useful to be used in comparison between alike medical units from different hospitals. This kind of bench-marking information produced by cost-effectiveness and effectiveness comparison between hospitals might be used when developing and improving health care customs and operations in the hospitals.

When looking the Figure 4 it looks like there could be formed two different sub groups from these eight medical units, when the costs of the QALYs get bigger by over 6 000 Euros when moving from the unit which produces the fifth cheapest QALY (Respiratory Medicine Outpatient Clinic) into the unit which produces the third expensive one (Gynecological Department). There is quite a difference between the prices of the most expensive and the cheapest quality-adjusted life year. On the basis of cost-utility analysis, it looks like that when Orthopedics produce one quality-adjusted life year to patient, in Rheumatic Diseases Outpatient Clinic can be produced (*10 929 € / 843 € ~ 12,96*) nearly 13 QALYs with the same amount of money. When we contrast these cost per QALY ratios to the limits which have been presented in the literature of the field (30 000 – 50 000 euros), we can notice that the prices for QALYs calculated in this study for the medical care in the units of Eksote, are below that limit. But because the comparability between the costs used in this study and costs used when calculating those limits have not been verified, this kind of comparison might not be reasonable.

When we compare Figure 4: Average costs per QALYs in medical units, and the Figure 3: Average 15D changes and standard deviations in the medical units, we can notice that the most expensive QALYs are produced in the same medical unit

(Orthopedics), where the effectiveness of medical care, in other words, the average change in 15D score is the highest. The three cheapest units to produce QALYs are produced in the units of Rheumatic Diseases Outpatient Clinic, Pain Outpatient Clinic and Physical and Rehabilitation Medicine Outpatient Clinic, which all ranked in the top four of the effectiveness study also. And now, when we look in the Figure 5, we can see that the units of Rheumatic Diseases Outpatient Clinic and Pain Outpatient Clinic were also the two most cost-effective units when observing the average 15D change caused by an medical care investment of one million euros. So, when comparing the results of the effectiveness analysis, cost-effectiveness analysis and cost-utility analysis, it can be said that Rheumatic Diseases Outpatient Clinic and Pain Outpatient Clinic are the two most effective and cost-effective units included in this study. The most ineffective and cost-ineffective medical care is being given in the unit of Day Surgery. Of course there is a possibility that there could be some patients, who have had interventions with very high costs and low results in comparison with the other patients in the unit, but when we look at the Appendixes I, II and III, we notice that the effectiveness, cost-effectiveness and cost-utility ratios have been calculated on the basis of 891 (15D change), 513 (cost per QALY) and 571 (15D change per M€) observations, so it would demand really high costs for a small group of patients that it would raise the average price of QALY as high as it is now and the average 15D change as low as it is now.

By observing the columns of the Figure 5, it can be noticed that there doesn't feature similar gap in the cost-effectiveness between the medical units when analyzing the cost-effectiveness of health care by using the 15D change per costs ratios, like there was when the cost-effectiveness analysis was made by calculating the costs per QALY ratios, which are presented in alike bar chart in the Figure 4. This might be explained by the facts that these ratios are not calculated in a same way, like it was presented previously in the section of Methods and Data and that there are different amount of observations included into these analyses. When comparing the Figure 5 of average 15D change per M€

and the Figure 3 of average change in 15D score, it points out that the columns are much alike, but the columns of Orthopedics and Physical and Rehabilitation Medicine Outpatient Clinic are relatively lower in the 15D change per M€ than in change in 15D score. This may be a sign of the high costs of interventions within these two units.

On the basis of the effectiveness and cost-effectiveness analyses, it can be said that the most effective and cost-effective medical care is being given at the medical units of Pain Outpatient Clinic and Rheumatic Diseases Outpatient Clinic and the two next effective and cost-effective medical units are Orthopedics and Physical and Rehabilitation Medicine Outpatient Clinic, but the number of observations are also lower within the top two units.

6.2 Summary

The main research question of this thesis was:

- How to generate as realistic view as possible of the health care's cost-effectiveness in South Karelia Central Hospital by unifying the gathered patient-specific 15D data and the costs of medical care?

The answer for the main research question is:

- Realistic view of the cost-effectiveness in the South Karelia Central Hospital can be created by using the priority parts of the collected 15D data which are the patients' first and second 15D scores, the total amount of QALYs which patients' have gained or lost as a result of the medical care given to the them and the costs of their medical interventions. By calculating the effectiveness and cost effectiveness ratios by using these particulars it is possible to create comparable and equally valid information about the cost-effectiveness of health care in Eksote.

The main question was divided into sub questions as follows

Question:

- How to measure the effectiveness and cost-effectiveness within the limits of this data?

Answer:

- By calculating the average 15D change ratio to represent the effectiveness of health care, and by calculating the average 15D change per million euros and the costs per QALY ratios to represent the cost-effectiveness of health care.

Question:

- What do the calculated ratios tell about the effectiveness and cost-effectiveness of health care in the medical units chosen to the study? Are there any differences between the units?

Answer:

- The ratios tell that the effectiveness and cost-effectiveness of health care varies a lot between the units and on the basis of the results. The calculated standard deviations pointed out that there were lots of variance in the effectiveness and cost-effectiveness of medical care also within the units. The most effective and cost-effective medical care is being given in Pain Outpatient Clinic and in Rheumatic Diseases Outpatient Clinic. The least effective and cost-effective health care is being given in Day Surgery.

Question:

- What are the considerations associated with the reliability and availability of the data?

Answer:

- The availability of the data pointed out to be weaker than expected and the reliability of the data suffers of the lacks in the 15D data, but there are no suspicions related to reliability of the results of effectiveness and cost-effectiveness analyses. There was no arguments found out that the effectiveness and cost-effectiveness ratios would not be relevant because the costs were considered to be equally valid and the 15D scores just tell from the patients' point of view that the how their health-related quality of life has changed after they have received medical care.

Question:

- What should be done in the future to create reliable and specific cost-effectiveness information for the decision makers?

Answer:

- The data availability should be improved. The main missions in the future should be that all of the costs of the interventions should be registered into the database and 15D scores should be gathered from the patients and registered into the 15D database. When the data from all of the patients is available it is possible to create comprehensive disease- and unit-specific information about the cost-effectiveness of health care for the decision makers.

6.3 Further research

In the light of the results from the data quality analysis it seems that the low availability of the 15D data and the low calculability of the effectiveness and cost-effectiveness ratios are results from the lacks in both cost data and 15D score data. When the low 15D change calculability rate is combined with the missing costs, the availability of the relevant data leaves to be something between 35% and 52%, depending on the calculability ratio which is being observed. But when the costs of the interventions are known, they should also be available to be registered into the database without a struggle. When all of the costs are registered into the database the availability of the relevant data gets better and this might be the easiest way to get the data quality better. On the basis of the data quality analysis, the other option to improve the quality of the data is to get the 15D answer rates higher and try to make sure that the answers are being registered correctly into the database.

Eksote and Corame should consider together how to work the effectiveness and cost-effectiveness calculability rate and data availability rate higher and how to be sure that the data is collected and registered properly, because the cost data and medical care effectiveness information are in the key role, if the purpose of this kind of 15D measurement is to research the effectiveness and cost-effectiveness of medical care in Eksote, and further, to produce valid information for the decision making. All of the users of the system should be hearing how to use the software properly: How to fill the 15D questionnaires, how to register the answers from the questionnaires properly into the system and how to check that all the other data is also being registered properly. In this connection the other important data is being considered to be the patients’ personal information (names, dates, addresses, etc.) and for example the procedures and diagnoses, which are in the key role when the costs of the interventions are being determined for the patients’. The patients should be also made aware that how important it is to answer for all of the questionnaires and answer truthfully. One good and practical way to improve the benefits of this kind of measuring process might be to name a person in charge for the 15D measuring process. This person should take the responsibility for the execution, and to improve and check the validity of the data as often as necessary. Person in charge should also train and instruct the software users to use the software properly.

By improving the data availability and the calculability of the effectiveness and cost-effectiveness ratios in the future, this kind of effectiveness and cost-effectiveness measurement will likely to provide practical and profitable information for the decision making when the cost-effectiveness will be in key role in the future when allocating the limited resources of health care as it is considered and predicted to be in the literature of the field. It is always justified to look for solutions that help to improve the cost-effectiveness and effectiveness, if the resources are not unlimited. And when the 15D is considered to be suitable indicator for the measuring the effectiveness and cost-effectiveness of health care, it might be reasonable to improve the weaknesses of the measuring process and continue the measurement aiming to provide useful information in the future.

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QUALITY OF LIFE QUESTIONNAIRE (15D©)

Please read through all the alternative responses to each question before placing a cross (x) against the alternative which best describes **your present health status**. Continue through all 15 questions in this manner, giving only **one** answer to each.

QUESTION 1. MOBILITY
1 ( ) I am able to walk normally (without difficulty) indoors, outdoors and on stairs.
2 ( ) I am able to walk without difficulty indoors, but outdoors and/or on stairs I have slight difficulties.
3 ( ) I am able to walk without help indoors (with or without an appliance), but outdoors and/or on stairs only with considerable difficulty or with help from others.
4 ( ) I am able to walk indoors only with help from others.
5 ( ) I am completely bed-ridden and unable to move about.

QUESTION 2. VISION
1 ( ) I see normally, i.e. I can read newspapers and TV text without difficulty (with or without glasses).
2 ( ) I can read papers and/or TV text with slight difficulty (with or without glasses).
3 ( ) I can read papers and/or TV text with considerable difficulty (with or without glasses).
4 ( ) I cannot read papers or TV text either with glasses or without, but I can see enough to walk about without guidance.
5 ( ) I cannot see enough to walk about without a guide, i.e. I am almost or completely blind.

QUESTION 3. HEARING
1 ( ) I can hear normally, i.e. normal speech (with or without a hearing aid).
2 ( ) I hear normal speech with a little difficulty.
3 ( ) I hear normal speech with considerable difficulty; in conversation I need voices to be louder than normal.
4 ( ) I hear even loud voices poorly; I am almost deaf.
5 ( ) I am completely deaf.

QUESTION 4. BREATHING
1 ( ) I am able to breathe normally, i.e. with no shortness of breath or other breathing difficulty.
2 ( ) I have shortness of breath during heavy work or sports, or when walking briskly on flat ground or slightly uphill.
3 ( ) I have shortness of breath when walking on flat ground at the same speed as others my age.
4 ( ) I get shortness of breath even after light activity, e.g. washing or dressing myself.
5 ( ) I have breathing difficulties almost all the time, even when resting.

QUESTION 5. SLEEPING
1 ( ) I am able to sleep normally, i.e. I have no problems with sleeping.
2 ( ) I have slight problems with sleeping, e.g. difficulty in falling asleep, or sometimes waking at night.
3 ( ) I have moderate problems with sleeping, e.g. disturbed sleep, or feeling I have not slept enough.
4 ( ) I have great problems with sleeping, e.g. having to use sleeping pills often or routinely, or usually waking at night and/or too early in the morning.
5 ( ) I suffer severe sleeplessness, e.g. sleep is almost impossible even with full use of sleeping pills, or staying awake most of the night.

QUESTION 6. EATING
1 ( ) I am able to eat normally, i.e. with no help from others.
2 ( ) I am able to eat by myself with minor difficulty (e.g. slowly, clumsily, shakily, or with special appliances).
3 ( ) I need some help from another person in eating.
4 ( ) I am unable to eat by myself at all, so I must be fed by another person.
5 ( ) I am unable to eat at all, so I am fed either by tube or intravenously.

QUESTION 7. SPEECH
1 ( ) I am able to speak normally, i.e. clearly, audibly and fluently.
2 ( ) I have slight speech difficulties, e.g. occasional fumbling for words, mumbling, or changes of pitch.
3 ( ) I can make myself understood, but my speech is e.g. disjointed, faltering, stuttering or stammering.
4 ( ) Most people have great difficulty understanding my speech.
5 ( ) I can only make myself understood by gestures.

QUESTION 8. ELIMINATION
1 ( ) My bladder and bowel work normally and without problems.
2 ( ) I have slight problems with my bladder and/or bowel function, e.g. difficulties with urination, or loose or hard bowels.
3 ( ) I have marked problems with my bladder and/or bowel function, e.g. occasional 'accidents', or severe constipation or diarrhea.
4 ( ) I have serious problems with my bladder and/or bowel function, e.g. routine 'accidents', or need of catheterization or enemas.
5 ( ) I have no control over my bladder and/or bowel function.

QUESTION 9. USUAL ACTIVITIES
1 ( ) I am able to perform my usual activities (e.g. employment, studying, housework, free-time activities) without difficulty.
2 ( ) I am able to perform my usual activities slightly less effectively or with minor difficulty.
3 ( ) I am able to perform my usual activities much less effectively, with considerable difficulty, or not completely.
4 ( ) I can only manage a small proportion of my previously usual activities.
5 ( ) I am unable to manage any of my previously usual activities.

QUESTION 10. MENTAL FUNCTION
1 ( ) I am able to think clearly and logically, and my memory functions well
2 ( ) I have slight difficulties in thinking clearly and logically, or my memory sometimes fails me.
3 ( ) I have marked difficulties in thinking clearly and logically, or my memory is somewhat impaired.
4 ( ) I have great difficulties in thinking clearly and logically, or my memory is seriously impaired.
5 ( ) I am permanently confused and disoriented in place and time.

QUESTION 11. DISCOMFORT AND SYMPTOMS
1 ( ) I have no physical discomfort or symptoms, e.g. pain, ache, nausea, itching etc.
2 ( ) I have mild physical discomfort or symptoms, e.g. pain, ache, nausea, itching etc.
3 ( ) I have marked physical discomfort or symptoms, e.g. pain, ache, nausea, itching etc.
4 ( ) I have severe physical discomfort or symptoms, e.g. pain, ache, nausea, itching etc.
5 ( ) I have unbearable physical discomfort or symptoms, e.g. pain, ache, nausea, itching etc.

QUESTION 12. DEPRESSION
1 ( ) I do not feel at all sad, melancholic or depressed.
2 ( ) I feel slightly sad, melancholic or depressed.
3 ( ) I feel moderately sad, melancholic or depressed.
4 ( ) I feel very sad, melancholic or depressed.
5 ( ) I feel extremely sad, melancholic or depressed.

QUESTION 13. DISTRESS
1 ( ) I do not feel at all anxious, stressed or nervous.
2 ( ) I feel slightly anxious, stressed or nervous.
3 ( ) I feel moderately anxious, stressed or nervous.
4 ( ) I feel very anxious, stressed or nervous.
5 ( ) I feel extremely anxious, stressed or nervous.

QUESTION 14. VITALITY
1 ( ) I feel healthy and energetic.
2 ( ) I feel slightly weary, tired or feeble.
3 ( ) I feel moderately weary, tired or feeble.
4 ( ) I feel very weary, tired or feeble, almost exhausted.
5 ( ) I feel extremely weary, tired or feeble, totally exhausted.

QUESTION 15. SEXUAL ACTIVITY
1 ( ) My state of health has no adverse effect on my sexual activity.
2 ( ) My state of health has a slight effect on my sexual activity.
3 ( ) My state of health has a considerable effect on my sexual activity.
4 ( ) My state of health makes sexual activity almost impossible.
5 ( ) My state of health makes sexual activity impossible.

Medical unit	Average 15D change	SD	n
Day surgery	5	70	891
Rehabilitation Outpatient Clinic	10	78	97
Gynecological Department	14	86	776
Respiratory Medicine Outpatient Clinic	16	53	33
Rheumatic Diseases Outpatient Clinic	28	102	138
Pain Outpatient Clinic	29	98	142
Physical and Rehabilitation Medicine Outpatient Clinic	29	89	228
Orthopedics	32	107	1078
Mean	*20*	*85*	*423*
Total			*3383*

Medical unit	Costs per QALY (€/pc)	n
Rheumatic Diseases Outpatient Clinic	843	120
Pain Outpatient Clinic	934	98
Physical and Rehabilitation Medicine Outpatient Clinic	1338	205
Rehabilitation Outpatient Clinic	2054	80
Respiratory Medicine Outpatient Clinic	2095	26
Gynecological Department	8760	526
Day surgery	10723	513
Orthopedics	10929	716
Mean	4710	286
Total		2284

Medical unit	15D change per million euros	SD	n
Day surgery	-0,56	78	571
Gynecological Department	7,92	58	582
Orthopedics	15,45	138	734
Rehabilitation Outpatient Clinic	27,72	90	81
Respiratory Medicine Outpatient Clinic	32,62	117	30
Physical and Rehabilitation Medicine Outpatient Clinic	33,90	179	211
Rheumatic Diseases Outpatient Clinic	59,40	357	122
Pain Outpatient Clinic	60,69	200	98
Mean	29,64	152	304
Total			2429