ORIGINAL ARTICLE

Economic evaluation of knee arthroscopy treatment in a general hospital

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ABSTRACT

Aim The economic evaluation of medical programs applies procedures that search for and ensure the cheapest methods of medical treatment with the best feasible health results. The aim of this study was to thoroughly examine both the costs and results of medical outcomes, which were based upon two alternative methods of treatment. The purpose was to offer obtained information to the medical profession and hospital management, since they must decide on how to use the funds designed for knee arthroscopy surgery.

Methods A cost-utility analysis of two competitive treatments for knee arthroscopy was evaluated: the first one was executed by a standard department of surgery and the second one for the implementation within the framework of ambulatory treatment.

Results The direct costs of the existing knee arthroscopy surgery amount to 930.39 euro, while the alternative treatment amount to 419.80 euro. The second alternative treatment would significantly reduce labor costs, depreciation costs and material costs. The implementation of the second alternative would reduce the total cost by 54.88%.

Conclusion: Outpatient surgical procedures can bring numerous potential advantages such as lower costs and unchanged or improved medical outcomes, when compared to the classical method of outpatient treatment. The results show that the outpatient treatment does not sacrifice quality in order to reduce hospital costs.

Keywords: costs and cost analysis, quality-adjusted life years, inpatients, outpatients, health care economics and organizations

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INTRODUCTION

Due to the growth in health care costs during the last period, the necessity for rational functioning of the health care system is becoming evident to ensure the most effective use of available resources and assets in healthcare. Costs and effects of the existing alternative treatments are the key category in the evaluation of medical programs, which take into consideration every conceivable type of costs and effects for selecting the best possible solution (1). There can be a trade-off between lower costs and efficiency of the individual alternative treatment.

The most frequently used economic approaches in the evaluation of medical programs are cost-benefit analysis, cost-efficiency analysis, cost-utility analysis and cost-minimization analysis (1,2). Cost-utility analysis is applied for our purpose, as it can be described as a sort of upgrade of cost efficiency analysis. From the standpoint of health policy, analyzing different methods of treatment is the most adequate approach, since it enables us to compare the results of various alternative treatments. The ultimate goal of treatment is the improvement of health status and quality of life of the patient. This result is displayed by dimensions of quality-adjusted life years (2). Cost-utility analysis is appropriate to use when the quality of life (as it is comprehended by the patient) is the principal criterion for treatment success (2,3).

The cost-utility analysis is applied for knee arthroscopy in a single hospital with comparisons of two treatments: classical inpatient treatment and outpatient treatment. Outpatient treatment does not require that patients stay in the hospital for a prolonged period of time as is the average case for classical one-day treatments. Outpatient treatment allows for greater patient flow and reduces long patient queues, the amount of daily disturbances and the rate of absenteeism. The economic benefits of outpatient treatment are realized in reduced costs for hospital stay due to reducing the number of employees, the cancellation of night shift and turns, and the shorter time for carrying out interventions (4-6).

Outpatient treatment is generally more favorable than classical inpatient treatment (4,7,8). It can produce the same effects, but only if all directions and organizational principles of outpatient treatment model are carefully taken into consideration. Disease and mortality incidence, which is directly connected with outpatient treatment, is extremely low (< 1%) (6,9). Readmissions within thirty days after the surgery in a hospital are in the range of 0.28–1.5% (10), but the percentage can be reduced by implementing the appropriate clinical pathways by up to 72% (11).

The key contribution of this article is the applied cost-utility analysis of two different alternatives of knee arthroscopy treatment in the same hospital to reduce its costs, while taking into account the criteria of quality; namely, through the selection of alternative, cheaper methods of treatment, which can still ensure similar effects of treatment. The payer's aspect is introduced in cost-utility analysis, which is based on direct costs of the selected alternative versions of treatment, and on effects for expressing the results of treatment by quality-adjusted life years. On this basis eligibility or ineligibility of introducing the alternative method of treating knee arthroscopy is determined and the question is answered whether the new alternative treatment adequately fulfils the conditions for the implementation in hospitals.

The new method of knee arthroscopy treatment presents an opportunity to change the already existing procedures in hospitals where knee arthroscopy surgery is performed within boundaries of classical inpatient treatment. Outpatient treatment is suitable for patients whose recovery is not expected to be endangered by complications and deviations from the required protocol. The aim of this study was to thoroughly examine the costs and results of medical outcomes of the two alternative methods of treatment. In accordance with our purpose, we wish to offer obtained information to the medical profession and hospital management, since they must decide on the best use for funds designed for knee arthroscopy surgery. We also attempt to define different options that render it possible for procedures and methods of the treatment to change.

MATERIALS AND METHODS

Study design

Data on costs of each individual treatment were based on interviews with employees in the general hospital in Izola, Slovenia. The interviews were conducted between January 2013 and December

2013. General hospital information systems do not prescribe the costs per patient, but at the aggregate level. On this basis by using certain keys we calculated and redistributed all the different types of direct costs for two alternative treatments: firstly, among separate departments within the hospital, and secondly, to a specific group of procedures that are performed by particular departments.

Data on the results of treatment or on the collective standard of the quality of treatment have been obtained by the use of questionnaires, which were distributed among all the patients that underwent knee arthroscopy surgery in the observed general hospital in 2013. A questionnaire was given to 211 patients before they were discharged from the hospital, and then all of them responded with completed questionnaire within 14 days. We focus on the two selected methods of treatment: the first treatment is exercised by a classical department of surgery in a general hospital and the alternative is modelled for the outpatient treatment.

For the research purposes of this study, we obtained the consent of the person responsible for the usage of hospital information and the consent of patients. The anonymity of the obtained data and information was absolutely guaranteed. Medical data and patients' responses were used exclusively for research purposes. All patients were informed about the study in advance. Patients who were unable to give consent were not included into the study. The consent for the study was also given by the Ethics Committee of General Hospital Izola.

Methods

Cost-utility analysis was applied for determining the economic evaluation of medical programs. The new alternative treatment is considered dominant if it is simultaneously cheaper and more effective than the treatment already in use. In this case, the introduction of the new alternative into healthcare system is entirely rational. The cost-utility equation for a homogenous unit of efficiency at lower cost was defined as:

(Variables:C_1 =costs of the alternative treatment 1;C_2 =costs of the alternative treatment 2;$QALY_1$=effects of alternative treatment 1;$QALY_2$= effects of alternative treatment 2) (QALY, quality-adjusted life years).

When the ratio between the costs and effects of the alternative treatment 2 is greater than the ratio between the costs and effects of the alternative treatment 1, the alternative treatment 1 is more effective than the alternative treatment 2.

Cost of the treatment was analyzed with regards to the payer's aspect, which includes the direct costs of the individual alternative treatment in the cost-utility analysis. The direct costs were measured with a collective standard for expressing the alternative treatments; the desired effects were quality-adjusted life years.

Treatment cost calculation. The costs of the treatment from the aspect of the payer of health services included only direct costs of individual kinds of treatment, which present a burden to the health fund. The social costs outside of the healthcare system and costs of productivity loss (2) were not included in our analysis. Direct costs of individual alternative treatment were considered in the cost-utility analysis. They represent only the costs directly connected with health condition and medical treatment (3) and can be divided in three categories: direct material costs, direct labor costs and cost of depreciation. Direct costs were defined as a unit of labor costs, depreciation costs and material costs for the selected alternative treatment.

Labor costs were defined as the annual costs of labor leasing, which a health organization pays to the employees in exchange for their work. Costs of depreciation were calculated for the tangible and intangible fixed assets, which were converted into business effects during individual accounting periods. Material costs were defined as the cost for purchase of medicines, medical material costs and costs of other consumable materials.

Direct costs could be presented as a total sum of costs of the primary elements in the business process: (Variables: C = direct costs; Q_i = the amount of business element I; p_i = purchase price for one unit of business element i; n = the number of different elements of the business process.

Calculation of the treatment effects. Utility represents an individual health preference for a particular state of health condition as a factor that encompasses prolonged survival and health-connected quality of life. Its value occupies a position between 0 (the worst health condition possible) and 1 (perfect health).

For assessing the extent of quality-adjusted life years (QALY), EQ-5D instrument was selected to compare two different treatments. EQ-5D is

the least complicated instrument, which responds to different alterations in health status. EQ-5D is easily understood and realizable in a relatively short period of time. It is also very sensitive to alterations that can indicate a relatively severe deterioration of average health condition (12).

The EQ-5D is a standardized instrument, used for routine health outcome measures. This instrument is able to define the quality of life on the basis of 5 dimensions (mobility, self-care, daily activities, pain / discomfort, anxiety / depression). Each dimension can be further divided into three different categories: category "no difficulties", "several difficulties", and "severe difficulties". Different values can be assigned to each of the basic five dimensions: 1(no difficulties), 2 (several difficulties), 3 (severe difficulties). There are 3^5=243 different possible health conditions (12,13). Health outcome, with the EQ-5D instrument, can be presented as a medical profile of an individual, expressed with a single number, which describes the health condition of the selected individual.

RESULTS

The empirical results were for the observed general hospital, which supervises the extent of the implementation of acute treatments that patients experienced according to the group methodology of comparable cases. In 2013, the hospital department of surgery performed 211 knee arthroscopy surgeries. Our results cover this population of patients as a whole. All direct labor, depreciation and material costs are for knee arthroscopy surgery.

Labour costs

Labor costs are analyzed separately, based on nine different profiles of employees that actively participated in the execution of a treatment: specialists in surgery, specialists in anesthesiology, registered nurses, practical nurses, surgical nurses, anesthetic technicians, laboratory technicians, other medical workers, and other non-medical workers. The costs of labor were calculated for an individual treatment activity as the average gross salary and the average gross hourly rate for each employee profile. The latter and the time spent for the execution of knee arthroscopy surgery treatment in the hospital are used to calculate labor costs. Table 1 displays the activities and labor costs for the two treatments in the same hospital.

Table 1. Labor costs for the two alternative treatments

Department	First treatment		Second treatment	
	I	II	I	II
Reception Office	2	1.15	2	1.15
Department of Traumatology	16	37.04	8	20.92
Laboratory	2	5.90	0	0
Department of Anesthesiology	1	8.75	0	0
Department of Surgery	15	290.62	14	86.19
Surgical Critical Care	9	81.02	6	63.50
Total	45	424.48	30	171.76

I, number of activities; II, labor costs (euro)

Depreciation costs

The depreciation costs of fixed assets are estimated on the basis of the data obtained from the hospital. The depreciation costs for fixed assets are calculated for real estate values and value of equipment and other tangible fixed assets for appliances and medical equipment. The value of real estate is correlated with the size of the surface of chosen facilities, which is essential for the implementation and duration time of the chosen activities. The real estate value is calculated per one square meter. Three percent annual depreciation rate was taken into account. On the basis of the annual depreciation costs of real estate are calculated for each individual hour. This is then multiplied with the size of the surface of chosen facilities, which is used for performing the activities, and with the time needed for the execution of the chosen activities to obtain the depreciation cost of real estate for one knee arthroscopy surgery. The depreciation costs of appliances and equipment are calculated taking into account the costs of equipment and other tangible fixed assets, and the duration of their usage for individual activities. The depreciation rate of appliances is specific for each individual appliance. The 20% depreciation rate is applied for equipment. On the basis of the annual depreciation costs of appliances and equipment are calculated, the depreciation costs of appliances and equipment per hour. The obtained result was multiplied by the time necessary for performing the individual activities to obtain the depreciation costs of appliances and equipment for one knee arthroscopy surgery. Table 2 displays the activities and the depreciation costs for the knee arthroscopy surgery in the general hospital for the two selected treatments.

Material costs

To calculate the value of material costs, the collected information on the purchase prices of

Table 2. Depreciation cost of fixed assets for the two treatments

Department	First treatment		Second treatment	
	I	II	I	II
Reception Office	4	0.01	4	0.01
Department of Traumatology	24	0.13	14	0.08
Laboratory	4	0.36	0	0
Department of Anesthesiology	2	0.32	0	0
Department of Surgery	28	5.62	26	1.14
Surgical Critical Care	8	5.25	6	4.16
Total	70	11.69	30	5.39

I, number of activities; II, labor costs (euro)

medicines, medical supplies and consumable goods is used. The displayed material costs depend on the execution of the knee arthroscopy surgery in the hospital. The number of activities and value of material costs for the two selected alternative treatments are shown in Table 3.

Table 3. Material costs for the two treatments

Department	First treatment		Second treatment	
	I	II	I	II
Reception office	2	0.11	2	0.01
Department of Traumatology	11	1.45	8	1.67
Laboratory	9	14.79	0	0
Department of Anesthesiology	1	35.00	0	0
Department of Surgery	34	109.05	41	44.75
Surgical Critical Care	54	333.82	40	196.11
Total	120	494.22	91	242.62

I, number of activities; II, labor costs (euro)

Total cost of treatment

Table 4 presents the differences between the costs of the first and second alternative treatments, according to individual categories of direct costs and their alterations that are directly connected with both treatments. All categories of costs display the values of direct costs raised for the execution of one knee arthroscopy surgery.

The total direct costs of treatment for both alternative treatments consist of labor costs, depreciation costs of fixed assets and material costs. The total amount of labor costs for the first alternative treatment is equivalent to 424.49 euro, while 171.77 euro for the second alternative treatment. The introduction of the second alternative treatment would therefore reduce the costs by 59.53%. The depreciation cost of fixed assets for the first alternative treatment amounts to 11.68 euro, but only amounts to 5.39 euro for the second alternative treatment or would be reduced by 53.85%. The amount of material costs for the first treatment for a knee arthroscopy surgery is 494.22 euro, but only 242.64 euro for the second treatment or would be reduced by 50.9%.

Table 4. Costs of the two treatments

Category of costs	I	II
Labor costs	424.48	171.76
Depreciation costs	11.68	5.39
Material costs	494.22	242.64
Total	930.38	419.79

I, costs for the first treatment (euro); II, costs for the second treatment (euro)

Quality-adjusted life years

The fundamental purpose of medical service is not only to prolong the anticipated length of life, but to improve the quality of life. The quality-adjusted life years has been frequently discussed in the last few years as a measure for determining the effects of different alternative methods of treatment on the quality and quantity of life. When discussing the life quality in health economics, we aim to include those aspects of life principally connected with health. We do not consider other essential sources of contentment, like social relations, satisfaction with our work or self-affirmation.

Table 5 demonstrates the values and measures of quality-adjusted life years for the first alternative treatment. The average value of inpatient treatment when measuring quality-adjusted life years is 0.58 QALY. The median is 0.60 and the standard deviation is 0.158. The minimum value when measuring quality-adjusted life years is 0.1 QALY, the maximum value, assessed by patients, amounts to 1.0 QALY.

Table 5. Quality-adjusted life years for the first treatment

	Num.	Mean	Median	Mode	SD	Min	Max
Value	211	9.19	9.00	9	1.583	5	14
QALY	211	0.58	0.60	0.6	0.158	0.1	1.0

Num., number of observations; SD, standard deviation; Min, minimum; Max, maximum; QALY, quality-adjusted life years

We could not obtain the measure of QALY for the second alternative treatment on the grounds of interviewing selected patients, since the conducted knee arthroscopy surgeries in the observed hospital are executed only on the basis of the first inpatient treatment. The second alternative treatment, which supports the outpatient treatment, is generally in practice by the advanced health care systems (6,7,9). Outpatient treatment can have very similar effects as classical inpatient treatment. Outpatient treatment can be safer and of higher quality (17), which suggests that the QALY measures could not be lower for the

second alternative treatment. In our cost-utility analysis, we have used the same measures of QALY for the second alternative treatment than for the first inpatient treatment. Therefore, we assume that the average measure of QALY for the second alternative treatment is also 0.58 QALY.

The cost-utility analysis equation distinctly indicates that the relation between the costs and effects of the first treatment equals 1,604.12 euro/QALY, while for the second alternative treatment equals 723.79 euro/QALY. The second alternative treatment is preferable on the grounds of cost justification and also on the basis of cost-utility analysis, as it offers similar extent of efficiency as the first treatment.

DISCUSSION

Two alternative treatments for knee arthroscopy are evaluated, comparing costs and effects. A systematic analysis is needed for an effective health care management when deciding whether to implement a new type of treatment comparing the already existing treatment and the potential one. The definite goal of treatment should be to improve the patient's health condition and quality of life.

The direct costs of the existing knee arthroscopy surgery amount to 930.39 euro, while the alternative treatment costs amount to 419.80 euro. Similar results were presented by numerous other studies – they clearly show that operations performed within the frame of outpatient treatment in a hospital reduced the costs of treatment for approximately 4.000 $ per patient (14). In our case the second alternative treatment would significantly reduce labor costs, depreciation costs and material costs. Similar conclusions have been reached by several other authors, who acknowledge that outpatient treatment reduces labor costs, operating theatre costs, costs of admission and remaining indirect costs (15). Such alterations are possible because certain activities are excluded from the second alternative, and the performed activities require fewer appliances and less equipment, since hospital stays last for a shorter period of time (16). With the implementation of the second alternative the preparation of a referral for hospitalization and a referral for laboratory tests and anesthetic overview can be avoided. Blood testing, anesthesia findings and laboratory findings are no longer necessary. Consequently, otherwise necessary diagnostic analysis, analysis of deviations and decision on operation can be avoided. Patients, who are staying in a hospital, do not need to wait for the surgery to be performed. Patients would be conscious after the surgery, thus the activities needed to awaken the patient can be avoided. Costs of the implementation of anesthesia, costs of relocation to a different department and costs of observation of the patient are reduced due to the different organization of work. The implementation of the second alternative would reduce the total cost by 54.88%. Numerous other studies confirm our findings; their results acknowledge that outpatient treatment reduces average costs of treatment from 17.6% to 57.6% in comparison to classical inpatient treatment (14-16).

The quality-adjusted life years (demonstrated by the QALY) are assumed to be equal for both analyzed treatments. Outpatient treatment can offer similar effects as the classical inpatient treatment. Based on the literature, clinical results show an equal or even higher success rate of outpatient treatment, which is safer and of higher quality, due to shorter hospital stays, low mortality incidence and the low number of readmissions (6,9,17). Patients are enabled to swiftly return to their home environment, which can contribute to the satisfaction with the performed operation (18). The QALY measures thus cannot be of a lower value than the existing treatment, and the second alternative treatment should also be implemented. The QALY measure for both treatments equals 0.58.

The quality-adjusted life years are also in favor of the second alternative treatment. The cost savings, which are not a consequence of reduced quality, are of the utmost importance not only for the hospital's budget, but also for the payer of health services and for the fiscal policy. Measures, based on economic and medical principles and designed to control the costs of treatment, can play an important role in optimizing the efficiency of the health care system management and its sustainability (19).

This paper contributes to the analysis of the cost-benefit optimization of medical treatments. Between the two analyzed treatments, the second outpatient treatment for knee arthroscopy is more effective with regard to the costs.

The clinical pathway is used to describe the whole process of treatment. A written record of the process is the insurance that the patient receives required treatment under defined and monitored costs. This is necessary to ensure that the expenditures for health services are carefully monitored to ensure a carefully managed use of the available assets and auditing over the allocation of sources to achieve the cost optimization of the health care system. The approach can contribute to rationalization in health care system in the times of economic and financial hardships that have already demanded cost reductions in the health care system.

The saving of financial resources can be used for introducing new technologies, shortening the long queues and for providing health services of even higher quality. The cooperation of the whole medical team and the inclusion of the cost-utility analysis results are important analytical tools for the cost and clinical optimization to provide quality health care services.

Further studies of cost-utility could be developed for other hospitals and other medical treatments, which are carried out in the classical departments of general hospitals in Slovenia. A realization of clinical pathways on the national level would contribute to the optimization of the health care system and the standardization of medical treatments of patients with the same diagnosis or medical condition (11). The similarity of medical treatments in developed and Western European health care systems is already used within the framework of outpatient treatment, which includes monitored surgical and gynecological procedures (19). They do not require hospitalization of the patients being operated, but only postoperative observation or observation for the performed procedure. The economic evaluation of medical programs would enable us to analyze approximately three quarters of surgical procedures to be carried out within the surgical and gynecological departments in general hospitals.

In conclusion, our results show that direct costs of surgical procedure of knee arthroscopy add up to 930.39 euro when using the first alternative method of treatment. The second method of treatment in comparison costs 414.80 euro. The implementation of the second alternative method of treatment would therefore reduce total direct costs by 54.88%. The second alternative, which includes outpatient treatment, is fundamentally more cost-effective than the first method including classical inpatient treatment. If a hospital decided to implement the outpatient method of knee arthroscopy treatment, hospital cost savings would be significant, not only for the surgical department, but for the hospital as a whole.

Our analysis introduces a thorough comparison of inpatient and outpatient treatment of knee arthroscopy. We came to the conclusion that outpatient surgical procedures can bring numerous potential advantages, such as lower costs and unchanged or improved medical outcomes, when compared to the classical method of outpatient treatment, which ensures patients are hospitalized. The results show outpatient treatment does not sacrifice quality in order to reduce hospital costs. Outpatient knee arthroscopy treatment is a cost-efficient and safe alternative of treatment for patients who are not at risk for postoperative complications. In accordance with our findings, we fulfilled the main objective of our study, which was to thoroughly examine the cost and results of medical outcomes of the two chosen alternative methods of treatment.

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