



Renal transplantation vs hemodialysis: cost-effectiveness analysis

Transplantacija bubrega naspram hemodijalize: analiza odnosa troškova i efikasnosti

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Abstract

Background/Aim. Chronic renal insufficiency (CRI), diabetes, hypertension, autosomal dominant polycystic kidney disease (ADPKD) are the main reasons for starting dialysis treatment in patients having kidney function failure. At present, dialysis treatments are performed in about 4,100 patients at 46 institutions in Serbia, out of which 90% are hemodialyses. At end-stage renal disease (ESRD) the only correct selection is kidney transplantation. The basic aim of the planned research was to compare ratio of costs and effects (Cost Effectiveness Analysis – CEA) of hemodialysis and kidney transplantation in patients at ESRD. **Methods.** As the main issue of treatment in patients from both groups the life quality measured by the validated McGill Questionary, was used. The study included 150 patients totally, divided into two groups. The study group consisted of 50 patients with kidney transplantation performed at the Clinical Center of Serbia and the control group consisted of 100 patients on hemodialysis at Clinical Center of Serbia, Clinical Hospital Center Zemun, Clinical Hospital Center “Zvezdara”, Clinical Center Kragujevac and Health Center “Studenica”, Kraljevo, comparable with respect to sex, age and length of treatment with the study group. **Results.** Effect of kidney transplantation in relation to hemodialysis being selection of treatment is expressed in the form of incremental ratio of costs and effects (Incremental Cost-Effectiveness Ratio – ICER). It is clear from the enclosed tables that the strategy of kidney transplantation is far more profitable considering the fact that it represents saving of EUR 132,256.25 per one year of contribution Quality Adjusted Life Years (QALY) within the period of 10 years. According to all aspects of live quality (physical symptoms and problems, physical well-being, psychological symptoms, existential well-being and support), difference is statistically important in favour of transplant patients. **Conclusion.** The costs of patient therapy by hemodialysis at end-stage renal disease is far greater than by performing therapy of transplantation and maintenance, by almost three and a half times. Difference in total quality aspects of human life (physical, emotional, social, spiritual and financial) between dialysed and transplant patients is statistically significant and by 18.12% greater in transplant patients than in patients on hemodialysis.

Key words:
dialysis; kidney failure, chronic; questionnaires; costs and cost analysis.

Apstrakt

Uvod/Cilj. Hronična bubrežna slabost (HBS), dijabetes, hipertenzija, autozomno dominantna policistična bolest bubrega (ADPBB) glavni su razlozi za otpočinjanje dijaliznih tretmana kod bolesnika sa poremećajem rada bubrega. Trenutno, oko 4 100 bolesnika u Srbiji koristi dijalizne tretmane u 46 ustanova, od kojih 90% predstavljaju hemodijalize. U terminalnoj fazi bolesti, jedini pravi izbor je transplantacija bubrega. Osnovni cilj planiranog istraživanja bio je da se uporedi odnos troškova i efekata (CEA) hemodijalize i transplantacije bubrega kod bolesnika u terminalnoj fazi bubrežne bolesti (*End Stage Renal Disease* – ESRD). **Metode.** Kao glavni ishod lečenja kod bolesnika iz obe grupe primenjen je kvalitet života meren validiranim Mek Gil upitnikom (McGill Questionary). U istraživanje je bilo uključeno ukupno 150 bolesnika, podeljenih u dve grupe: studijsku grupu od 50 osoba u koju su bili svrstani bolesnici sa transplantiranim bubrezima u Kliničkom centru Srbije i kontrolnu grupu od 100 osoba u koju su bili svrstani bolesnici na hemodijalizi u Kliničkom centru Srbije, Kliničko-bolničkom centru Zemun, Kliničko-bolničkom centru „Zvezdara“, Kliničkom centru Kragujevac i Zdravstvenom centru „Studenica“ Kraljevo, uporedivi po polu, starosti i dužini lečenja sa studijskom grupom. **Rezultati.** Efekat transplantacije bubrega u odnosu na hemodijalizu kao izbor lečenja izražen je u vidu inkrementalnog odnosa troškova i efekata (*Incremental Cost Effectiveness Ratio* – ICER). Iz priloženih tabela jasno se vidi da je strategija transplantacije bubrega daleko isplativija s obzirom na to da predstavlja uštedu od 132 256,25 evra po jednoj godini doprinosa QALY u toku perioda od 10 godina. Po svim aspektima kvaliteta života (fizički simptomi i problemi, fizičko blagostanje, psihološki problemi, egzistencijalni status i podrška okoline), razlika je statistički značajna u korist transplantiranih bolesnika. **Zaključak.** Iz izvedene kalkulacije troškova jasno je da su troškovi terapije lečenja bolesnika hemodijalizom u terminalnoj fazi bubrežne bolesti daleko veći nego terapijom transplantacije bubrega i održavanja i to za skoro tri i po puta. Razlika u ukupnim aspektima kvaliteta ljudskog života (fizički, emotivni, društveni, duhovni i finansijski) između dijaliziranih i transplantiranih bolesnika statistički je značajna i za 18,12% veća kod transplantiranih bolesnika, nego kod bolesnika na hemodijalizi.

Ključne reči:
dijaliza; bubrež; hronična insuficijencija; upitnici; cene i analiza cena

Introduction

Chronic renal insufficiency (CRI), hypertension, autosomal dominant polycystic kidney disease (ADPKD) are the main reasons for starting dialysis treatment in patients with kidney function failure¹⁻⁵. At present, dialysis treatments are performed in about 4.100 patients at 46 institutions in Serbia, out of which 90% are hemodialyses. The number of dialysis treatments per patient is 145 annually, whereas patients are often forced to travel by ambulance even up to 200 km in both directions due to insufficient dialyses capacities.

At end-stage renal disease (ESRD), kidney transplantation is the only correct selection. The first kidney transplantation in our country was performed in Belgrade in 1973⁶. The number of kidney transplantation is constantly growing, so that 100 transplantations were performed in 2007. There is no doubt any more that by introducing cyclosporin A in a threefold immunosuppressive protocol there has come both to short-term and long-term improvement in transplantation efficiency. Tacrolimus and mycophenolate mofetil bring to considerable decrease of risk from acute rejection reaction and slow down chronic rejection of allograft. Significant progress is expected from introducing sirolimus and humanized monoclonal antibodies to IL-2 receptors in standard immunosuppressive protocols⁷.

The aim of the study was to establish all costs associated with patients on hemodialysis – direct and indirect medical and non-medical expenses, as well as in patients with kidney transplantation. Besides, the aim was also to establish life quality of patients on dialysis and after kidney transplantation by applying verified McGill Questionnaire.

Results of our study confirmed findings of similar or identical studies undergone in several countries abroad on lower costs of kidney transplantation than those of hemodialysis for a certain period of patient life, and better life quality in transplant vs dialysed patients.

Methods

The study was carried out within the period from 25th April to 10th September, 2008 at the Urology and Nephrology Institute of Clinical Center of Serbia, Center for Dialysis of Clinical Hospital Center Zemun, Center for Dialysis of Clinical Hospital Centre "Zvezdara", Center for Dialysis of Clinical Center Kragujevac and Center for Dialysis of Health Center "Studenica", Kraljevo.

A total of 150 patients divided into two groups were included in the study. The study group consisted of 50 patients with kidney transplantation performed at the Clinical Center of Serbia, and the control group consisted of 100 patients on hemodialysis at the Clinical Center of Serbia, Clinical Hospital Center Zemun, Clinical Hospital Center "Zvezdara", Clinical Center Kragujevac and Health Center "Studenica", Kraljevo, comparable with respect to sex, age and length of treatment with the study group.

As the main issue of treatment in patients from both groups we used life quality measured by the validated McGill Questionnaire consisting of a part A (total life qual-

ity: physical, emotional, social, spiritual and financial) and 16 questions divided in 5 different spheres (physical symptoms, physical well-being, psychological symptoms, existential well-being and support).

For all 150 interviewed patients additional data were gathered on eventual diseases (diabetes, heart failure, angina pectoris, alcoholism, nicotine addiction, psychiatric diseases, asthma, as well as length of renal insufficiency treatment) in order to investigate whether mentioned diseases have any influence on life quality.

With respect to costs, direct treatment costs of both hemodialysis and kidney transplantation, were taken into consideration. A perspective of the Republic Health Insurance Institute (RHII) was, also, used in the study.

Discount rate of 3% per year was used on the occasion of costs calculation.

The costs were expressed in RSD and EUR (1 EUR: 80 RSD)⁸⁻¹⁰.

Study time horizon covered a ten-year period after transplantation, and ten years of treatment by hemodialysis.

The pharmaco-economic method for analysis of costs and effects (results) ratio, so-called Cost Effectiveness Analysis (CEA) was used. The effect was expressed as the number of obtained years of life being corrected with respect to quality (Quality Adjusted Life Years – QALY).

An effect of kidney transplantation in relation to hemodialysis as treatment selection was expressed in the form of Incremental Cost-Effectiveness Ratio (ICER), according to the equation: $ICER = CTR - CHD / ETR - EHD = \Delta C / \Delta E$
CTR – costs of transplant patients for a 10-year period
CHD – cost of patients on hemodialysis for a 10-year period
ETR – QALY years of life for transplant patients
EHD – QALY years of life for patients on hemodialysis

The statistical results processing was carried out with the SPSS commercial programme package (Version 10.0, SPSS Inc., Chicago, IL, USA).

Data distribution normality was evaluated by Kolmogorov-Smirnov test.

The *t* test was used for parameters having normal data distribution, whereas Mann-Whitney test was used for comparison between groups with nonparametric data distribution.

The Wald's backward model of multiple regression was used.

The values of $p < 0.05$ were considered as statistically significant.

Results

There was no statistically significant age difference between the dialysed (in average 42.92 years) and transplant (in average 40.58 years) patients ($p = 0.154$, *t* test).

There were a statistically significant difference between dialysed and transplant patients in: total quality of life ($p = 0.025$, *t* test), physical well-being ($p = 0.019$, *t* test), nervousness feeling ($p = 0.003$, *t* test), sadness feeling ($p = 0.004$, *t* test), success in achieving life ($p = 0.001$, *t* test), life preciousness estimation ($p = 0.001$, *t* test), physical symptoms ($p = 0.000$ *t* test), physical well-being ($p = 0.019$,

t test), psychological symptoms ($p = 0.006$, *t* test), existential well-being ($p = 0.000$, *t* test), and support ($p = 0.030$, *t* test) (Table 1).

Total costs per one hemodialysis treatment was calculated to be 9,185.25 RSD (Table 3). Considering that a patient on hemodialysis had, on average, 144 treatments yearly, total hemo-

Table 1
Estimation of life quality in transplant and dialysed patients at end-stage renal disease by using McGill Questionnaire Score

Parameters of life quality	McGill Questionnaire Score ($\bar{x} \pm SD$)		<i>p</i> (<i>t</i> test)
	transplant	dialysed	
Total quality	6.52 $\pm$ 2.57	5.52 $\pm$ 2.54	0.025
General physical well-being	7.14 $\pm$ 2.98	5.96 $\pm$ 2.81	0.019
Intensity of nervousness feeling	3.24 $\pm$ 3.17	4.99 $\pm$ 3.46	0.003
Intensity of sadness feeling	2.00 $\pm$ 2.45	3.40 $\pm$ 3.36	0.004
Success in achieving life aims	6.96 $\pm$ 2.66	5.21 $\pm$ 2.97	0.001
Life preciousness estimation	8.04 $\pm$ 2.55	6.41 $\pm$ 3.07	0.004
Intensity of total physical symptoms	1.65 $\pm$ 2.34	3.67 $\pm$ 3.49	0.000
Intensity of total psychological symptoms	7.14 $\pm$ 2.98	5.96 $\pm$ 2.81	0.019
Total existential well-being	6.93 $\pm$ 1.73	5.77 $\pm$ 1.91	0.000
Estimation of support	7.67 $\pm$ 2.77	6.68 $\pm$ 2.14	0.030

In the group of dialysed patients, 43% had good life quality, whereas that percent was even 68% in transplant patients (Table 2).

Table 2
Life quality in transplant vs dialysed patients at end-stage renal disease

Life quality	Patients (%)	
	transplant	dialysed
Good	68	43
Bad	32	57
Total	100	100

dialysis price was 1,322.676 RSD ($144 \times 9,185.25$). Accordingly, hemodialysis price per a patient for a 10-year period is 13,226.760 RSD ($10 \times 1,322.676$), or EUR 165,334.50.

Costs per one transplant patient for a 10-year period were calculated to be 3,915,923.15 RSD or EUR 48,949.00 (Table 4).

According to the equation for calculating ICER, its value is -10,580,496.00 RSD or -132,256.25 EUR suggesting that costs of kidney transplantation and patient maintenance therapy are considerably lower than costs of hemodialysis within a

Table 3
Total costs per one hemodialysis treatment

Costs type	Price in RSD
Consumables for hemodialysis	4,396.00
Drugs for therapy of persons on hemodialysis	3,220.00
Other hemodialysis costs	1,291.25
Operation costs	278.00
Total costs	9,185.25

Table 4
Total transplantation costs for a 10-year period

Costs Type	Price in RSD
Kidney transplantation price	390.200
Drugs for maintenance therapy for transplant patients	3,506.190
Operation costs	19,533.15
Total costs	3,915,923.15

Multiple linear regression showed that only the treatment type, dialysis or transplantation had an impact on low or high life quality (≤ 5.5 , or > 5.5 , respectively). The ratio is 2.857 (1.209–6.754), which means that transplant patients have about three times greater chance of having good life than dialysed ones.

10-year period, as well as that the difference in patient life quality is in favour of patients with kidney transplantation.

Table 5 shows that kidney transplantation strategy is far more cost-effective since it saves EUR 132,256.25 per one year of QALY contribution within 10 years period.

Table 5
Cost effectiveness analysis (CEA) of three treatment strategies of chronic renal insufficiency in the Republic of Serbia

Strategy	Costs (EUR)	Marginal costs (EUR)	QALY effect	Marginal QALY effect	CE ratio
Nothing to be done	0	–	0	–	–
Dialysis	165,334.50	165,334.50	4.83	4.83	34,230.75
Transplantation	48,949.00	-116,385.50	5.71	0.88	-132,256.25

Discussion

Health of population of both sexes in the Republic of Serbia is also influenced by passing of a socio-economic system to the process of transition which causes growth of unemployment, poverty, underemployment or temporary employment, unregistered work, growth of private enterprises having insufficiently developed knowledge about health protection and improvement of employees representing driving force of every economy. This has resulted in an increase in occupational diseases, increase of sick leave rate and permanent disablement for work¹¹.

According to the Republic Bureau of Statistics even 0.20% of population suffered from chronic renal insufficiency in 2002 year¹².

In accordance with the data of the Republic Health Insurance Institute basic costs of consumables for dialysis ranged from 1,777,670,382.55 RSD in 2005, to 2,490,010,963.38 RSD in 2006, to the final 2,747,626,544.52 RSD in 2007.

In practice, there is a great problem of providing treatment for patients on dialysis due to evident lack of capacities, equipment, and appropriate medical staff.

In our country, about 4,100 patients are treated by some of active methods of treating ESRD, of whom 90% are treated by hemodialyses, 6.3% by peritoneal dialysis, whereas transplantation is performed in only 12.3%, which is considerably less than the percentage of transplants that could be found in the EDTA Register¹³. An increase in transplant patients number (from living donors and cadaveric transplantation) has been noticeable in recent years, but, this is still insufficient to cover needs of patients being at ESRD.

In the Czech Republic, the greatest numbers of patients wait for kidney one year, and in our country it is a greater number of years¹⁴.

In the Republic of Serbia, there is an organized system based on which selection of patients for kidney is made, there is no register of transplant patients, and a waiting list is not systematized. Considering that there are about 400 new patients on dialysis in Serbia every year, it should be expected that the same number of kidney transplantation should be performed per year.

Analysis carried out by the group of authors at the University Toronto, Canada has shown that from the cost effectiveness analysis point of view, cost effectiveness ratio (QALY) is very propitious in favour of transplantation, even for patients from 65 to 70 years of age¹⁵.

During 1998, by using data from eight transplantation centers located in New York, the study showed that kidney transplantation was far more profitable than hemodialysis. Initial higher costs of transplantation were completely exceeded by hemodialysis after two years and 10 months upon surgery. For persons having right to hemodialysis due to their ESRD exclusively, transplantation should generate an average monthly saving of USD 3,800 over dialysis for two years after the mentioned turning point. Even for of older age patients, the average saving should be USD 2,400 monthly¹⁶.

Among the first cost effectiveness analyses being carried out in the USA, incremental costs per obtained year of life have been USD 7,460.00 for transplant patients, USD 12,100.00 for patients on home dialysis, and USD 33,300.00 for dialysis performed in patients being at in-patient clinic¹⁷.

In a research carried out in Hungary, it has been found out that patients with cadaveric kidney transplantation have greater probability of survival after three years upon transplantation than those on hemodialysis. Within the period of three years after transplantation, costs for transplant patients were USD 70,297.00 and three-year treatment on hemodialysis cost USD 109,197.00¹⁸.

In Japan, in 1995 there were registered 152,373 patients on dialysis, with progressive growth of 10,000 patients every year. In the same year, only 604 transplantations were performed, of which 172 were cadaveric and 432 from live donors¹⁹.

Comprehensive cost-effectiveness analyses being carried out in Japan have shown that CEA ratio for patients on dialysis is 9,546,000.00 YEN/DALY (DALY – Disability Adjusted Life Years), for patients with cadaveric transplantation it is 2,322,000.00 YEN/DALY, and 1,809,000.00 YEN/DALY for patients with kidney transplantation from live donors. Besides evidence of considerably lower costs and greater effects (benefits) for patients, it has been concluded that the number of transplantation is very small and insufficient with respect to the number of patients on dialysis²⁰.

The data obtained by a research carried out in Great Britain have shown that kidney transplantation is very cost-effective and that it represents selection of therapy for patients being at end-stage renal disease. Hemodialysis costs amount GBP 34,000 per patient annually. Out of health budget 3% is spent for hemodialysis. Costs of kidney transplantation amount GBP 20,000.00. Immunosuppressive therapy received by transplant patient amounts GBP 6,500.00 on an annual level. Profit from costs of transplant patient was GBP 191,000.00 within the period of nine years, or GBP 21,200.00 annually per patient with functional transplant kidney. Transplantation was performed in 1,775 patients in Great Britain within the period from 2000 to 2003, bringing to health treasury annual saving of GBP 37,600.00. In this country, increase of transplantation number being the result of speeding up campaign for organ donation is noticeable every year²¹.

On the basis of calculation of all direct costs in our study, hemodialysis price per one patient for 10 years period is 13,226,760.00 RSD or EUR 165,334.50, while corresponding price per one transplant patient is 3,915,923.15 RSD or EUR 48,949.00.

Out of the above stated calculation it is evident that costs of ESRD patient treatment by hemodialysis are far greater than that by kidney transplantation and maintenance therapy and they amount almost three and a half times more (3.38).

Difference in total aspects of human life quality (physical, emotional, social, spiritual and financial) between dialysed patients and transplant ones is statistically significant, and for 18.12% greater in transplant patients than in patients on hemodialysis.

With regard to ratio of generally good or bad life quality, it has been established that in dialysed patients 43% of them have good life quality, whereas that percent is even 68% in transplant patients, which represents significant difference in favour of selection of kidney transplantation as therapy of choice.

In all pharmacoeconomical studies being elaborated in many countries there has been proved an outstanding advantage of selection of patient treatment therapy at ESRD in favour of transplantation. Besides the mentioned, the number of transplanted kidneys is still insufficient regardless the development of transplantation programme.

Why more patients are not transplanted in our country? By simple calculation, provided that this insufficient transplantation rate in the Republic of Serbia is maintained, all patients being on dialysis should be transplanted within the period of 40 years.

In recent years kidney transplantation from living relatives has been dominantly performed in our country, whereas cadaveric transplantations have been practically rare. It is necessary to point out here that of all diseased persons being on waiting list for kidney transplantation 6–8% of them, at the most, have convenient living donor.

However, we create a new patient from live donor and therefore transplantation from the person with brain death diagnosis is very important. Another problem of transplantation performed from relatives is that health status often does not allow organ transplantation. Namely, kidney could be donated by completely healthy person and relatives of patients having renal disease are often of older age, and they mainly suffer from some chronic disease.

A few years ago, the Military Medical Academy, Belgrade launched an action of organ legacy. About 20,000 persons have got donor cards at this institution, but this is not sufficient for a more serious transplantation programme. According to some evaluations, it is necessary that at least two million of citizens legate their organs, so that organ transplantation should become a reality in Serbia¹⁴.

All this indicates the necessity of developing an organ donation programme which was comprehended in the world

30 years ago and where cadaveric transplantations were dominant.

Serbia is lagging behind developed countries by the number of transplantations, as well as with respect to countries in transition where Czechoslovakia and Hungary represent an excellent example of having well organized transplantation programmes.

In accordance with the mentioned, it shall be necessary to carry out well prepared and coordinated donor actions and prerequisites for the stated are as follows: registration of potential organ donor; education and appropriate population informing about benefits and necessity of intensive promotion and performing actions for organ donation; education of medical staff, physicians and nurses for maintenance of potential cadaveric donor; training of teams for organ explantation at great clinical hospital centers and mobile teams of the existing centers shall be well organised in order to be capable to work independently; providing corresponding necessary medical equipment for brain death determination; forming donator basis by issuing donor cards; establishing patients priority list for organ transplantation; improving of conditions of work and making diagnosis at existing centres; creation of national foundation for organ transplantation; adjustment of legal regulations in connection with organ donation.

A medium-term aim is to perform at least 400 transplantations in all transplantation centers in Serbia annually, so that an important profit could result from all of that both for patients and society in its entirety.

Conclusion

Our results demonstrated that the costs of patient therapy by hemodialysis at end-stage renal disease is far greater than by performing therapy of kidney transplantation and maintenance, by almost three and a half times. Difference in total quality aspects of human life (physical, emotional, social, spiritual and financial) between dialysed and transplant patients is statistically significant and by 18.12% greater in transplant patients than in patients on hemodialysis.

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