ORIGINAL ARTICLE

The socioeconomic impact of hemodialysis

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Background: Hemodialysis is the most widely approach to treat End Stage Renal Disease (ESRD) patients in Greece. The purpose of the paper is to provide a microeconomic evaluation for the cost of dialysis in a public hospital setting, along with an estimate of the loss of production for these patients.
Methods: A socioeconomic prevalence-based analysis was performed attempting the micro-economic evaluation of the resources consumed in order to provide hemodialysis therapy for ESRD patients. The loss of production for the patient and family were estimated and the method used was the human capital approach.
Results: It was estimated that the healthsector cost for hemodialysis has surpassed €171 million. The potential years of productivity lost due to mortality were, according human capital approach, 2,046 years leading to a cost of €9,9 million, in 2000. The total morbidity cost due to absence from work and early retirement was estimated to be more than €273 million.
Conclusions: Results indicate that the total direct cost of hemodialysis constituted approximately 2% of the national health expenditure in Greece, providing care for 0.05% of the population. In addition to the costs imposed on the National Health System, it was estimated that production losses due to mortality and morbidity from the disease are also very significant. Organ-donation campaigns, introduction of satellite units in Greece and telemedicine are some recommendations which may hold some promise for the future and prove more cost-effective and psychologically advantageous for patients.
Hippokratia 2004, 8 (2): 81-87

One of the most dominant health policy issues over the last twenty years has been the rising cost of health care and consequently the efficiency and effectiveness needed in resource use[1]. It has been clearly established that health care technology is a major cost-driving factor[2,3], but, its appropriate utilization improves quality and the effectiveness in health care delivery. One of the important factors in determining appropriate patterns of technology utilization is the cost and the cost-effectiveness associated with its purchase, maintenance and use.

In comparison to other European countries, Greece was late to introduce, and cover through public reimbursement, provision and use of expensive health technology, innovations and treatments in the National Health Service (NHS) hospitals. Coronary Artery Bypass Grafting (CABG), for instance, was reimbursed only as late as 1993. However, recent years have seen considerable progress in technology diffusion in some areas, such as Telemedicine and Telematics[4]. In a similar fashion, Greece is characterized by one of the highest rates of hemodialysis stations for the treatment of ESRD, though unfortunately also with one of the lowest rates of kidney transplantation, and this despite the already proven effectiveness and cost-effectiveness of the method[5,6].

Hemodialysis is the most widely approach to treat ESRD, but has a very high cost (direct and indirect) and a major limitation which is associated with the duration and frequency in which it needs to be delivered. Continuous Ambulatory Peritoneal Dialysis (CAPD), on the other hand, is characterised by a high incidence of complications (hospitalisation rates among CAPD patients are higher than that for haemodialysis patients)[7]. Perhaps for this reason, there is a steady growth in the numbers of patients treated with haemodialysis[8,9]. This is also the case in Greece, where the number of patients on dialysis in Greece increases by approximately 7% each year. In 1997, there were 6,942 patients treated with in-center haemodialysis, CAPD and with a functioning kidney transplant, and by the year 2000 this number increased to 8,601 (74% of which are patients on dialysis)[10]. The number of patients on Renal Replacement Therapy (RRT) and the rate of increase for the last five years are shown in Figure 1. It is also worth mentioning that 70% of the patients are between the ages of 20-65, that is the productive age band.

Treatments usually take place in well-equipped NHS or private hospital dialysis units and are therefore expensive to deliver, which begs the question as to which

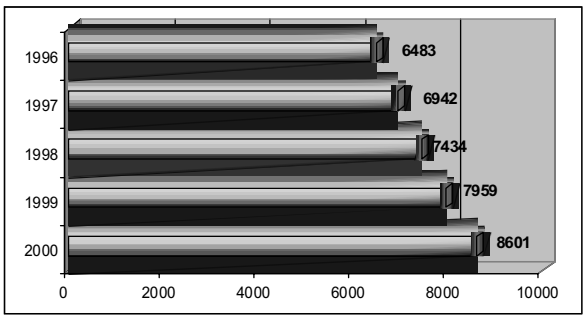

Figure 1: *Patients on RRT in Greece (1996 – 2000)*
Source: HELLENIC RENAL REGISTRY (YSE)

are the cost drivers and what are the means for reducing costs. Also, there is evidence that in-center hemodialysis is the most expensive therapy alternative[11], which raises questions as to whether is cost-effective. There are also other costs involved, as there is evidence which suggests that dialysis affects employment rates. Specifically, a recent study reported a drop in employment from 83% to 42% for in-center haemodialysis patients[12]. This type of lost productivity has been rarely included in economic analyses of ESRD, although it seems to have a substantial impact on the total cost-of-illness. The reasons for this omission probably relate to difficulties in calculating such costs, as for example, the lack of explicit economic data concerning lost productivity, the uncertainty regarding the employability of patients, the flexible work schedules employees need in order to accommodate medical treatment requirements, and various other factors.

This paper provides an evaluation of the overall cost of ESRD in Greece. It is rather comprehensive in the sense that it provides, at a very micro level[13], estimates on the direct hospital costs, as well as, on the productivity losses associated with the condition and its treatment with hemodialysis. Quite often, economic analyses fail to report and more importantly to use appropriate costing methods or to account for all the costs involved in delivering a medical intervention[14], and this leads to invalid results and consequently to wrong health policy decisions. This is why there have been many attempts recently to develop economic evaluation guidelines and standard costs for a variety of medical interventions[15]. The present study is based upon such recent guidelines on economic evaluation methodology and uses detailed data collected though a specially designed empirical study. It provides accurate estimates and information that can be used for policy and social security reimbursement. More specifically it can be used to compare this with other diseases and hence to draw health policy priorities. It can also be used to identify the costs driving factors and to inform decision makers for curtailing expenditure and costs. Finally, as it is based on a very precise costing exercise it can be used by providers for seeking certain reimbursement amounts and for policy makers to decide reimbursement rates in relation to other diseases.

Objective and Methods

This study uses a prevalence based approach to provide the cost estimates from a societal perspective. NHS related data were collected from a study performed at the Georgios Gennimatas general NHS hospital, in Athens, which includes a dialysis unit currently performing approximately 7,000 hemodialysis sessions per year, utilizing 9 stations. The unit operates six days a week for fourteen hours/day. The study lasted from January 1st, 2000 to December 31st 2000. The estimate of production loss, is a difficult but important exercise for such condition, since absence from or even loss of work are fairly common outcomes of the disease. Data regarding lost productivity and costs incurred by the patient and the family where collected from a countrywide sample of 128 patients through use of questionnaire. Mean reported gross income from national accounts was used to compute the patient's and the family's' lost production from work absence. All the data are expressed in Euro at 2000 prices.

The term "healthcare sector costs"[13], often referred to as direct costs, is used to describe the costs of items such as medical supplies, drugs, laboratory tests, salaries and wages and overhead expenses (including equipment and plant depreciation). In the present case such items were all estimated at a micro-costing level. Personnel costs were estimated using time spent performing activities and their respective salaries.

Since various hospital departments (administration, laundry, housekeeping, technical, porterage etc.) provide services, directly or indirectly, to ESRD patients and to the unit staff, a model was developed to allocate overhead expenses to the dialysis unit[16] and each session performed. Data used and the methodology are shown in Table A1 in the appendix. The cost of electricity was estimated with the help of an analytic engineering model based on the KW needed and the functioning hours of the equipment involved in treatment delivery[17]. Depreciation expenses for dialysis units and the reverse osmosis machine were estimated according to patient utilization levels for a specified period using the fixed balance method. Amortization was assumed five years for dialysis units and seven years for the water preparation system[18].

Another component that had to be calculated was the cost per inpatient day in the Nephrology ward, since hemodialysis patients are often hospitalized for the treatment of complications. Hospital costs (supplies, tests, professional fees, medication and overheads) of hemodialysis and costs of subsequent hospitalizations were added to calculate the total cost associated with hemodialysis and are depicted in Table 1.

In addition to direct costs, lost productivity for the patient and family (often refereed to as indirect costs) have a substantial impact on the total cost-of-illness. According to the Canadian Guidelines, this type of costs is the value of production lost as a result of the illness or the treatment process[14]. In the case of in-center

hemodialysis, where lost time and/or employment are a major cost component, an attempt to include these costs is essential. Therefore, an effort was made to estimate mortality and morbidity costs due to absence from work, long-term disability necessitating a change in type of work, or premature retirement. These estimations were attempted using the Human Capital Approach. [19,20,21,22,23]

Mortality is quantified in terms of life years lost in 2000. The number of potential years of life lost (PYLL) which is attributable to ESRD was estimated. In order to estimate the number of individuals who would reach the retirement age if they hadn't died from the specific disease, the number of deaths for each age band was multiplied by the probability of survival (p_x), calculated as: px = 1-qx, where qx is the probability of death for each age band according to Greek life tables.

The same methodology was employed for the estimation of production lost due to premature retirement of patients with ESRD. The years of production lost were estimated by calculating the difference between the retirement age and age of death. The mean retirement age was 65 years for men and 60 years for women. The estimations were discounted with the use of a 5%, 3% and 0% discounting rates and multiplied by the number of deaths in each age group to estimate the total productivity loss due to mortality caused by ESRD (hemodialysis patients) in 2000[13].

Morbidity also generates important production losses. The components taken into account in order to estimate the morbidity cost were: premature retirement, absence from work and reduced productivity during work. This information was also collected for the patient's family (except for the reduced productivity during work), since it was assumed that a family member often has to offer supporting services (informal care) to the patient (transportation to and from the hospital, care at home etc.). Mean gross hourly wage was used in order to calculate lost output.

Loss due to morbidity was then estimated by multiplying the number of days or hours out of work, because of sickness and invalidity caused by the disease or the specific treatment, with the mean gross income in 2000 in Greece. Finally, to calculate reduced productivity during work, patient estimates of the number of days worked with ESRD symptoms in the previous month was used according the following formula[24,25]:

$$RP_{DS} = (DW_{SX}) * (100- \%PROD_{SX}) * E_{D,} \text{ where}$$

RP_{DS}: Reduced Productivity /month based on days worked with symptoms
DW_{SX}: Days with reduced productivity during the last month
$\%PROD_{SX:}$ Percentage of reduced productivity when working with symptoms
E_D: mean daily income

Results

Health care sector costs associated with each hemodialysis treatment and per inpatient day, for those hospitalized in the Nephrology ward, is shown in Table 1. Major expenses relate to medical supplies and drugs (53%), and hemodialysis membranes represent the cost-driver factor (half of the abovementioned per cent). Staff remuneration represents 31% of the health sector cost and overhead expenses account for 6%. These data are consistent with other evaluation were health sector cost was estimated for ESRD[26,27,28].

Table 1: *Total direct costs per session and per year*

Type of cost	Cost per patient/ session (€)	%	Cost per patient/ year (€)
Medical supplies & drugs	98.2	53	15,319
Laboratory tests	10.9	6	1,700
Staff costs	56.2	31	8,767
Overhead expenses (& support department expenses)	9.7	6	1,513
Depreciation & maintenance of equipment	8.2	4	1,279
Subtotal	*183.2*	*100*	*28,578*
Hospitalization cost	5.7		896
Total	**188.9**		**29,474**

According to the data collected from 128 ESRD patients who underwent hemodialysis, 46.1% of them were hospitalized for 8.5 days/patient/year (95% CI 3,2-13,7, SD: 8,3). In order to estimate the cost per inpatient day in the Nephrology ward a cost analysis was performed following the methodology described above. The cost per hospitalized day was estimated at €229.5. Thus, in total, the average direct hospital cost per patient per year is estimated at €28,500 and the hospitalization cost per patient per year is estimated to be €896. Extrapolating these numbers on the basis of hemodialysis patients in Greece in the year 2000, it leads to an estimate of €171.8 million spent in the treatment of ESRD patients with hemodialysis.

Table 2 shows lost earnings from premature mortality in patients with ESRD who underwent hemodialysis. 706 deaths were recorded among ESRD patients in Greece in 2000. For the calculation of the potential productive years of life lost, the life tables of Greece in 2000 were used in order to estimate the actual number of productive years lost, and these were estimated at 2,034. Lost earnings, after taking into account the economic activity and unemployment rate for Greece in the year 2000, were estimated to surpass €9.9 million (3% discount rate).

As far as morbidity is concerned, 128 out of 200 pa-

Table 2: *Lost earnings from premature mortality resulting from ESRD for patient who underwent hemodialysis in Greece, 2000 (Human Capital Approach)*

Age band	Number of deaths	Number of deaths* survival probability (p_x)	Potential Years of Life Lost	Number of Potential Productive Life Years	Economic Activity Rate	Average employment rate	Mean Gross Income 1999 (€)	Annual Lost Earnings (Discount rate=0% (€thous.)	Discounted annual lost earnings (Discount rate=3% (€thous.)	Discounted annual lost earnings (Discount rate=5% (€thous.)
15-19	0	0	46	0	0,14	0,59	10,232	0	0	0
20-24	2	2	41	82	0,56	0,71	10,232	333	190	141
25-29	2	2	36	72	0,82	0,82	10,232	495	300	228
30-44	18	18	26	467	0,84	0,91	10,232	3,656	2,514	2,022
45-64	178	177	8	1.413	0,58	0,94	10,232	7,885	6,919	6,371
65 +	506	467	0	0	0,08	0,99	10,232	0	0	0
Total	706	666		2.034				**12,370**	**9,924**	**8,760**

tients (64%) responded by filling in the questionnaire. The majority of the respondents were male (57,8%) and the average age was 56.1 years (95% CI 52.2-59.9 SD:16.7) for men and 51,7 years (95% CI 47.6-55.9 SD:15.4) for women. Of the 128 respondents, 33 (25.8%) had a paid job at the time of the study, 64 (50%) were retired of which 47 (36.7%) retired prematurely due to ESRD and 31 (24.2%) were unemployed or were students.

Lost earnings from premature retirement are shown in Table 3. As mentioned above, 36.7% of the patients retired before the normal retirement age and the percentage is even bigger when housewives, students and the unemployed are excluded from the study population. On average, men retire at the age of 49.8 (95% CI 46-53.5, SD:0.6) and women at the age of 44.6 (95% CI 38.4-50.8, SD:10.7). The estimated loss of earnings due to premature retirement exceeds €264 million (3% discount rate) for the year 2000.

Of the patients who had a paid job, 21 (63.6%) reported absence from work, which resulted in an average of 19.9 hours/week (95% CI 15.7-24.1 SD:7.5). Thus, lost earnings were estimated at € 5,090 per patient per year. Applying this estimate to the national level for the year 2000 gives €4.9 million attributed to the absence of work. However, when taking compensating mechanisms into account, the earnings lost estimate is reduced to €4.3 million since 43.5% of the patients with a paid job reported that their work was compensated by colleagues during normal working hours. For these cases loss of production was considered to be zero.

Among the patients with a paid job, 39.4% reported on average that 4.8 days/month were working with ESRD symptoms and they also reported that they were on average 62.2% productive (range from 0 to 100%), resulting to a loss of earnings of €496.877. Another 43.3% (n=55) of patients was accompanied to the hospital by a family member. Of these, 50.9% (n=28) had a paid job and reported a loss of 2.4 hours (95% CI 1.9-2.9, SD:1.3) per hemodialysis treatment (three times per week) from work, due to the fact that they provided

Table 3: *Lost earnings from premature retirement resulting from ESRD for patients who underwent hemodialysis in study population and extrapolation to national level, 2000 (Human Capital Approach)*

	Sex	Number of patient prematurely	Mean number of productive years lost/patient	Total number of productive life years	Mean Gross Income, 1999 (€)	Annual Lost Earnings (Discount rate=0% (€ million)	Discounted annual lost earnings (Discount rate=3% (€ million)	Discounted annual lost (Discount rate=5% (€ million)
Study population								
	Man	33	15,2	502	10,232	5.1	4.1	3.5
	Women	14	15,4	216	10,232	2.2	1.7	1.5
	Total	47		717		**7.3**	**5.8**	**5.1**
National Level								
	Man	1.503	15,2	22.846	10,232	233.8	185.6	161.1
	Women	635	15,4	9.779	10,232	100.1	79.2	68.7
	Total	2.138		32.625		**333.9**	**264.8**	**229.8**

Table 4: *Morbidity cost for ESRD patients under hemodialysis and family members*

	Loss of production patient (or family member /year[1]	% of the respondents (n=28)	Estimation of National level € million	% of the respondents (Friction Method)	Estimation of National (Friction Method)[2] € million
A. PATIENTS					
Productivity costs due to treatment (3days/week)	5,090	16,4	4,9	10,1	4,3
Productivity costs due to unforeseen ESRD health related problems	1,889	3,9	0,4	2,2	0,2
Reduced productivity during work	857	10,2	0,5	10,2	0,5
Productivity costs due to premature retirement[2]		36,7	264,8	36,7	5,7
Subtotal		*270,6*		*10,8*	
B. FAMILY MEMBERS					
Productivity costs due to treatment (3days/week)	1,842	19,5	2,1	14	1,5
Productivity costs due to unforeseen ESRD health related problems	1,228	5,4	0,4	3,9	0,3
Subtotal		*2,5*		*1,7*	
Total			**273,1**		**12,5**

[1] The average gross income for the year 2000 was used for the estimation of the lost production (Source: Ministry of Economics).
[2] 3% discount rate was used for the estimations.

this support, resulting to a loss of €1,842 per accompanying member per year (€2.1 million for Greece). Another 72% (n=18) of accompanying members reported that their work was not compensated by colleagues during normal working hours. In this case, the loss of production for the remaining 28% of the accompanying members who reported that their work was compensated was considered to be zero and the total loss of earnings from the family members was reduced to €1.5 million.

Only 25% of the accompanying members who had a paid job (5.4% of the whole sample), reported absence from work which resulted in 2.6 days per month due to patients' unforeseen ESRD health related problems. This resulted to a loss of €0.4 million.

In summary, as shown in Table 4, the overall production loss from ESRD in patients undergoing hemodialysis and for their families was estimated to exceed €273.1 million (3% discount rate).

Discussion

It is evident from the above analysis that the cost of care for ESRD patients undergoing hemodialysis is considerable. In 2000, the direct cost of dialysis providing therapy for 0.05% of the population[29] in Greece accounted for 2% of national health expenditure. This expenditure is considerably higher than the expenditure attributed to Renal Replacement Therapy (RRT) in other countries such as Great Britain, France or the Netherlands where it consumes no more than 1-1.1% of total health expenditure [6,28,30,31]. This considerable difference should attract the attention of funding agencies and kidney disease specialists and underlines the importance of technology assessment, a scientific field that has not yet received the appropriate attention in Greece[32]. In addition to the costs imposed on the National Health System, it was estimated that ESRD imposes significant costs on society in terms of production losses due to the treatment requirements, sickness, mortality, and time spend to care for patients. It was estimated that production losses due to mortality from the disease are up to €10 million and production losses due to premature retirement and morbidity are up to €270.6 million. Additionally, the cost of informal care is up to €2.5 million. The results of the total direct cost of hemodialysis and production losses are summarized in Figure 2.

Undoubtedly, dialysis is very expensive but it is also a life-saving treatment that is presently keeping alive more than 6,300 people in Greece. Nevertheless, expenditure control may be possible. First of all, Greece could introduce satellite units for hemodialysis (for cases where it is medically possible), a dialysis mode that, could offer

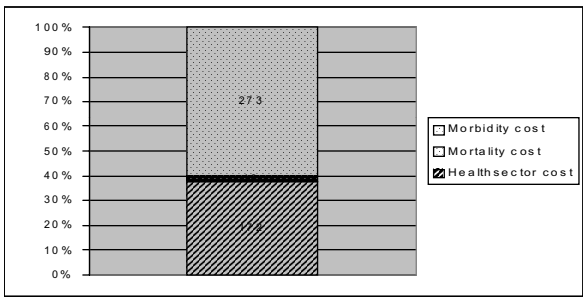

Figure 2: *Total cost of hemodialysis (in million euros) in Greece, 2000*

more flexible treatment schedules and according to the literature, may prove cost-effective and psychologically advantageous for patients[30]. For example, of the 2,272 units providing dialysis services in the USA, 1,646 were free standing and only 626 were hospital based[29]. Telemedicine may hold some promise for the future at this field. There is some evidence its use could provide safe and effective out-of-hospital hemodialysis accompanied by significant savings from reduced utilization of medical and administrative personnel. A project financed by the European Union[33] has demonstrated the feasibility of linking an out-of-hospital facility (satellite unit) to a hospital supporting control center, thus providing the possibility of acute intervention by the specialists. The supervision of each hemodialysis session with bi-directional communication links and the adoption of high security levels as well as the transferability and interoperability of these services to an actual hospital environment could offer a great deal of benefits[34].

The skill mix of the staff seems to be another tool for cost containment, since a major part of the cost is salaries and wages. Renal nurses with a higher level of education could carry out duties that medical staff has done traditionally.

A considerable saving but also an improvement of patient quality of life may lie at the development of kidney transplantation, which, according to the literature remains the most cost-effective treatment for ESRD [5,6,35]. The low transplantation rate in Greece is due largely to a shortage of organ donors. To support organ-donation activities, campaigns directed to the general population and medical professionals could prove effective. A major attempt should be made to coordinate activities in Intensive Care Units (ICU) and transplant units. This needs a special effort to provide hospital personnel with managerial and communication skills for the identification of potential donors and the approach of grieving families. Such efforts lead to the increase of donors in Spain from 14.3 per million population in 1989 to 26.8 in 1996. As the present analysis demonstrated, ESRD and hemodialysis represent a major burden not only on the NHS but to the patient and family as well. The adoption of some of the above recommendations may prove psychologically advantageous for the patients and could lead to substantial savings at a national level.

Περίληψη

***Δ. Καϊτελίδου, Π. Ν. Ζηρογιάννης, Ν. Μανιαδάκης, Λ. Λιαρόπουλος, Μ. Θεοδώρου*. Η κοινωνικοοικονομική επίδραση της αιμοκάθαρσης.** *Ιπποκράτεια 2004, 8 (2) 81-87.*

Η αιμοκάθαρση αποτελεί την πιο διαδεδομένη μέθοδο για την αντιμετώπιση της Χρόνιας Νεφρικής Ανεπάρκειας Τελικού Σταδίου (ΧΝΑΤΣ) στην Ελλάδα. Η παρούσα μελέτη, έχει ως αντικείμενο την οικονομική αποτίμηση του κόστους της αιμοκάθαρσης, καθώς και του κόστους που προκύπτει για την κοινωνία από την απώλεια παραγωγικότητας των ασθενών με ΧΝΑΤΣ.

Μεθοδολογία: Η ανάλυση διεξήχθη μέσα από κοινωνικοοικονομική οπτική γωνία και επιχειρήθηκε σε μικρο-οικονομικό επίπεδο ο υπολογισμός του κόστους της αιμοκάθαρσης καθώς και της απώλειας παραγωγικότητας των ασθενών και των συγγενών τους. Τα τελευταία είδη κόστους υπολογίστηκαν με τη μέθοδο του ανθρωπίνου κεφαλαίου. **Αποτελέσματα:** Το συνολικό κόστος του υγειονομικού τομέα για αιμοκάθαρση ξεπέρασε για το έτος 2000 τα €171 εκατ. Τα χαμένα *παραγωγικά χρόνια ζωής* λόγω θνησιμότητας ήταν σύμφωνα με τη μέθοδο του ανθρωπίνου κεφαλαίου, 2.046 έτη που οδήγησαν σε απώλεια παραγωγικότητας €9,9 εκατ. περίπου. Η συνολική απώλεια παραγωγικότητας των ασθενών και των συνοδών τους λόγω νοσηρότητας, ξεπέρασε για το έτος 2000 τα €273 εκατ.

Συμπεράσματα: Σύμφωνα με τα παραπάνω αποτελέσματα, το συνολικό κόστος της αιμοκάθαρσης αποτέλεσε περίπου το 2% των συνολικών δαπανών για την υγεία, παρέχοντας υγειονομική φροντίδα για το 0,05% του ελληνικού πληθυσμού. Εκτός όμως από το κόστος του υγειονομικού τομέα, υπάρχει και σημαντική απώλεια της παραγωγικότητας τόσο των ασθενών που πάσχουν από ΧΝΑΤΣ όσο και των συγγενών τους.

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