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Factors Associated to Vascular Access Choice Renal Failure Patient: The Greek Experience

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Abstract

Objective: In this study, we evaluated vascular access in Hemodialysis (HD) patients on Greek society by measure several factors, including the various types and the cost of vascular access under the current economic crisis.

Methods: We recorded the characteristics and the cost of 2.586 HD patients, having in mind the hospitalization days and the form of vascular access. This specimen represents the 27,1% total patients in Greece, according the Greek Department of Coordination and Control Program for ESRD (YSE). The calculated cost included consumables, drugs, food, medical and administrative salaries, all covered by the state insurance in case vascular access is performed in public hospitals, while there is a fee payable from the same patients in case vascular access is performed in private clinics.

Results: The mean patient age of our specimen was 68,7±14,1 years. 58,1% of the specimen is undergoing dialysis for a period of 1-5 years. 60,1% of the whole group prefers a private clinic, while the

rest 39,9% a public hospital. Most common ESRD cause is diabetes with 19,8%, while "unknown" holds 33% of our group. Regarding vascular access, 58,3% have fistula, 25,5% use double lumen permanent catheter, while the rest 16,2%use graft. The major part of the mean cost for HD vascular access is covered by patients' insurance and an amount by the patient. Mean one-time cost for each type of vascular access was €616,8±299,7for Catheter, €1.197,4±296,6 for Graft and €908±298,6 for Fistula respectively. State insurance is covering 99,6% of our patients, while only 0,4% has a private one.

Conclusion: Patients with end-stage renal insufficiency due to the economic crisis make their vascular access to a public hospital instead of a private clinic.

Keywords: Vascular access; Insurance cost; State cost; Health economics; Hemodialysis

Introduction

End-Stage Renal Disease (ESRD) appears to be increasing worldwide in incidence, prevalence, morbidity, mortality, and, especially, in cost. According to the United States Renal Data System, there were 124,411 new diagnoses of End-Stage Renal Disease (ESRD) in 2015, highlighting the growing impact of kidney failure. The prevalence of the condition has been steadily increasing, with approximately 20,000 new cases added annually. Due to the recent global economic crisis, there are several studies in progress addressing the overall cost, but at the same time, they also emphasize the value of dialysis procedure, as a determinant of Vascular Access (VA) [1-2]. To date, the cost of vascular access has not been sufficiently studied at an international level regarding all parameters involved [3]. In a multicenter study, Pisoni et al. reported that European patients used 80% Arteriovenous Fistula (AVF) and 10% Arteriovenous Graft (AVG), in contrast, in US 24% used AVF and 58% AVG according to Dialysis outcomes and practice patterns study [4-14]. In Greece, the main funding source for dialysis is patient insurance, the vast majority of which is public. The cost of vascular access is usually covered by both public and patient insurance. The type of vascular access varies across countries [15]. To achieve the best possible patient outcomes in hemodialysis, it is widely accepted that the optimal vascular access device is a well-functioning Arteriovenous Fistula (AVF) [4,12-40]. Various VA guidelines state clearly that for patients requiring chronic hemodialysis, the preferred type of access is a native AVF [40]. Once an AVF has matured and been used for dialysis, the subsequent failure rate is low, with most patients enjoying long-term fistula function for many years [4,13,16]. Under the current economic crisis, it is of major and pressing importance to analyze and estimate the reality and economic cost for each type of vascular access in hemodialysis, not only for saving money and identify ways that may decrease the annual ESRD budget, but also ensure the best possible treatment for the next generations [3,16].

The aim of this cohort study is to evaluate the choice of vascular access and its association with various factors, including the different types of vascular access and the total cost associated with each type.

Methods

We compared data from a sample of 1,166 hemodialysis patients treated in public hospitals in Greece and 1,420 patients undergoing hemodialysis in a private clinic, for a total of 2,586 patients. These two groups account for 27.1% of the total

hemodialysis patients in Greece (2,586 out of 9,544, as reported by the Greek Department of Coordination and Control Program for ESRD - YSE). In our sample, 70.5% of patients undergo Hemodialysis (HD), 6.1% undergo Hemodiafiltration (HDF), and 23.4% undergo hemodiafiltration on Line (HDF on Line). There were no patients in our sample undergoing home hemodialysis. For the selected sample, we considered all available demographic characteristics, including sex, age, type of renal disease, employment status, and the distance from the dialysis unit. We also examined the relationship between these factors and the type of vascular access. The vascular access cost per patient was calculated based on the actual procedure (depending on whether a patient has a fistula, graft, or catheter), as well as the cost of hospitalization days. All cost parameters were covered by the patient's state or private insurance. Results are presented as percentages and means with standard deviation. Comparison of basic parameters between the two groups has been performed by using the chi-square and student t-test of SPSS software for Windows version 22.0 (SPSS Inc., Chicago, IL, USA). For retrieving the average total cost per patient for each type of vascular access (Graft, Fistula and Catheter), we used a direct analysis with values procured by the directors of both, private and public, hospitals. All hospitals gave us their data anonymously.

Results

Table 1 shows the baseline characteristics of the patient sample. There is an analogy of almost 1:3, as men are presented with 63,7% and women with the rest 36,3%. The p-value shows us the grade of connection between the type of vascular access and the hemodialysis method. Regarding this form of vascular access, 58,3% have fistula, 25,5% use catheter, while the rest 16,2% use graft. Going further, and taking in consideration the type of hemodialysis, from HD patients, 54,9% have fistula, 29,9% use catheter and 15,2% have graft, while for HDF we calculated 54,8%, 26,8% and 28,5% respectively. Regarding HDF online patients, we recorded 69,5% for fistula, 12,2% for catheter and 18,3% for graft ($\chi^2(4) = 75,9$ and $p<0,001$). Depending on the type of vascular access, we recorded that diabetes continues to be the first known ESRD cause for all types, while second place was Glomerulonephritis for AVFs and AVGs, and Nephropathy for AVCs patients. We also recorded a high value for "unknown" cause **(Table 1)** ($\chi^2(14) = 67,2$ and $p<0,001$). From our specimen, we recorded a percentage of 68,7% that didn't need to be hospitalized for any reason, while for the rest 27,2% the period of hospitalization varies from 1 to more than 20 days per year. There was no evidence of hospitalization days or causes for the rest of 4,1% of patients. Being more specific, for 27,1% of our sample, infection was the most frequent cause of hospitalization, that causes serious problem to their vascular access at 14,2% of them. Cost and type of vascular access could change during treatment due to type of infection. In relation to vascular access, in condition in the first cause for all groups with AVFs having 13,7% and at least one day hospitalization per year, AVCs reaching 15,1% and AVGs at 14,6% in their respective groups. ($\chi^2(32) = 79,0$ and $p<0,001$). It's important to notice here that only 4,6% of our total specimen of 2.586 patients has carried out the vascular access to a private clinic and that most smokers use fistula.

When analyzing the cost, we must proceed carefully, as the approach varies depending on the combination

of vascular access type and the type of medical unit (private or public). First, there is a one-time cost covered by insurance for all forms of vascular access. This cost depends on the type of vascular access. In a public hospital, the cost for a graft placement is €700, plus one day of hospitalization (€150), resulting in a total cost of €850. The surgical placement of a catheter costs a median of €150, plus one day of hospitalization (€150), for a total of €300. Finally, the median cost for a fistula placement is €425, and with the additional €150 for hospitalization, the total cost per patient is €575. In a private clinic, the cost for a graft placement is also €700, plus one day of hospitalization (€150), but we must also account for the surgery cost, which amounts to a median of €600. This brings the total cost to €1,450. For the catheter placement, the cost is a median of €150, plus one day of hospitalization (€150), and €600 for the surgery, resulting in a final total cost of €900. Similarly, the cost for fistula placement in a private clinic is the same as in the public sector (€575), with an additional €600 for surgery, bringing the total cost to €1,175. For both sectors, the average one-time cost for each type of vascular access was €616.8 ± €299.7 for catheters, €1,197.4 ± €296.6 for grafts, and €908 ± €298.6 for fistulas. State insurance covers 99.6% of our patients, while only 0.4% has private insurance.

Table 1: Baseline Characteristics of HD Patients in Greece.

Patients Characteristics	**PATIENTS FULL SAMPLE**	**FISTULA**	**CATHETER**	**GRAFT**	**p value**
Patients (n)	2.586	1.507	661	418	
Sex (%**men**)	63,7%	67,4%	57,8%	60,0%	p<0,001 **[1]**
Mean age (**years**)	68,7 ± 14,1	67,5 ± 14,2	71,5 ± 14,1	68,5 ± 13,2	p<0,001 **[2]**
Length of time in dialysis (Dialysis vintage)					p<0,001 **[3]**
1-5	1.503 (58,1%)	852 (56,5%)	434 (65,7%)	217 (51,9%)	
6-10	725 (28,0%)	420 (27,9%)	161 (24,4%)	144 (34,4%)	
11-20	284 (11,0%)	185 (12,3%)	51 (7,7%)	48 (11,5%)	
Over 20	74 (2,9%)	50 (3,3%)	15 (2,3%)	9 (2,2%)	
Cause of kidney disease [n (%)]					p<0,001 **[4]**
Diabetes	510 (19,7%)	251 (16,7%)	162 (24,5%)	97 (23,2%)	
Glomerulonephritis	276 (10,7%)	175 (11,6%)	55 (8,3%)	46 (11,0%)	
Nephropathy	206 (8,0%)	95 (6,3%)	70 (10,6%)	41 (9,8%)	
PKD	213 (8,2%)	141 (9,4%)	47 (7,1%)	25 (6,0%)	
Hypertension	127 (4,9%)	86 (5,7%)	24 (3,6%)	17 (4,1%)	
Other	400 (15,5%)	255 (16,9%)	92 (13,9%)	53 (12,7%)	
Unknown	854 (33,0%)	504 (33,4%)	211 (31,9%)	139 (33,3%)	
Group of KMs (%)					p<0,142 **[5]**

1-20 Km	2.041 (78,9%)	1.171 (77,7%)	535 (89,9%)	335 (80,1%)	
21-50 Km	354 (13,7%)	212 (14,1%)	81 (12,3%)	61 (14,6%)	
51-100 Km	165 (6,4%)	104 (6,9%)	39 (5,9)	22 (5,3%)	
Over 100 Km	26 (1,0%)	20 (1,3%)	6 (0,9%)	0 (0%)	
Mean distance (**km**)	16,1 ± 24,3	17,2 ± 26,9	14,9 ± 21,3	14,1 ± 17,9	
Worker (%)					p<0,181 **[6]**
No	2.399 (92,8%)	1.387 (92,0%)	623 (94,3%)	389 (93,1%)	
Yes	187 (7,2%)	120 (8,0%)	38 (5,7%)	29 (6,9%)	
Smoker (%)					p<0,037 **[7]**
Ex	321 (12,4%)	175 (11,6%)	80 (12,1%)	66 (15,8%)	
No	1.747 (67,6%)	1.006 (66,8%)	464 (70,2%)	277 (66,3%)	
Yes	518 (20,0%)	326 (21,6%)	117 (17,7%)	75 (17,9%)	
Vascular Access (%)					
Catheter	661 (25,5%)	-	-	-	
Graft	418 (16,2%)	-	-	-	
Fistula	1.507 (58,3%)	-	-	-	
Type of HD (%)					p<0,001 **[8]**
HD	1.823 (70,5%)	1.000 (66,4%)	545 (82,5%)	278 (66,5%)	
HDF	157 (6,1%)	86 (5,7%)	42 (6,4%)	29 (6,9%)	
HDF on Line	606 (23,4%)	421 (27,9%)	74 (11,2%)	111 (26,6%)	

HD = hemodialysis; HDF= hemodiafiltration; HDF on Line= hemodiafiltration on line; PKD = polycystic kidney disease; (1): p values represents the statistical significance between dialysis and type of vascular access ($\chi^2(2) = 21,1$ and $p < 0,001$); (2): p values represents the statistical significance between age of our specimen patients and type of vascular access ($\chi^2(162) = 234,6$ and $p<0,001$); (3): p values represents the statistical significance between dialysis vintage and type of vascular access ($\chi^2(6) = 30,7$and $p<0,001$); (4): p values represents the statistical significance between ESRD cause and type of vascular access ($\chi^2(28) = 82,6$ and $p<0,001$); (5): p values represents the statistical significance between distance (in km) and type of vascular access ($\chi^2(6) = 9,6$ and $p <0,142$); (6): p values represents the statistical significance between work status and type of vascular access ($\chi^2(2) = 3,4$ and $p<0,181$); (7): p values represents the statistical significance between smoker status and type of vascular access ($\chi^2(4) = 10,2$ and $p<0,037$); (8): p values represents the statistical significance between type of hemodialysis and type of vascular access ($\chi^2(4) = 75,9$ and $p<0,001$.

Isolated costs per modality and respective treatment procedure of HD

HD	**HDF (both standard and online)**
3 times per week for 4 hours each time	3 times per week for 4 hours each time
catheter = 75 to 225€	

graft = 700€
Installation of catheter = 150€ Installation of graft = 500 to 700€

Discussion

In this study, we analyzed the characteristics of patients undergoing hemodialysis. Our sample represents 27.1% of all dialysis patients in Greece. Of the patients in our sample, 58.27% use a fistula for dialysis. Additionally, 56.6% of patients with a fistula have been undergoing dialysis for 1-5 years. Among those with a catheter, 65.7% have been on dialysis for 1-5 years, while 51.9% of those with a graft fall into the same time range. The total cost of vascular access varies depending on the type of access used. Despite the economic crisis, the costs for hemodialysis patients in public hospitals are fully covered by public insurance, while patients in private clinics are required to pay a portion of the costs. A total of 11,153 patients from nine European countries (UK, Spain, Italy, France, Poland, Portugal, Hungary, Slovenia, and Czech Republic) and Turkey were recorded [5-7,12]. Of these, 1,352 hemodialysis patients were excluded from centers where the baseline data on dialysis parameters were incomplete. Additionally, 838 British patients were excluded due to missing medication information. The remaining 8,963 patients were divided into two groups: 3,396 occasional patients and 5,567 permanent patients. Specifically, 1,707 Spanish patients, 1,600 Turkish patients, and 1,586 Italian patients were recorded. The youngest patients, with an average age of 56 years, were from Turkey [13], while the oldest were from France, with an average age of 69 years. In Greece, the average age of the sample of 2,856 patients was 68.7 years. Another key finding of the research was the incidence of primary diseases. In previous studies, the most common cause of chronic renal failure was glomerulonephritis (16%), followed by tubular interstitial nephritis (14%), diabetes (14%), and hypertension (13%). However, in our study, the leading cause was diabetes (19.7%), followed by glomerulonephritis (10.7%), with a significant percentage of cases classified as "unknown" (33%). Historical data maintained by hospitals for this category of patient's shows that a large proportion suffers from some form of cardiovascular disease, with nearly 73% affected [14]. This incidence varies across countries, ranging from 64% in France [16] to as high as 91% in Slovenia [15]. Additionally, the incidence of diabetes in patients with end-stage renal failure is 25%, with variation across countries—ranging from 15% in Spain to 42% in the Czech Republic. The latest findings of this research indicate that permanent patients had started hemodialysis an average of 5 years before the study began, with most of them using a fistula for vascular access rather than a graft or catheter [17-19]. In Greece, the percentage of patients using a fistula is significantly higher than those using a catheter or graft (58.3% vs. 25.5% vs. 16.2%, respectively).

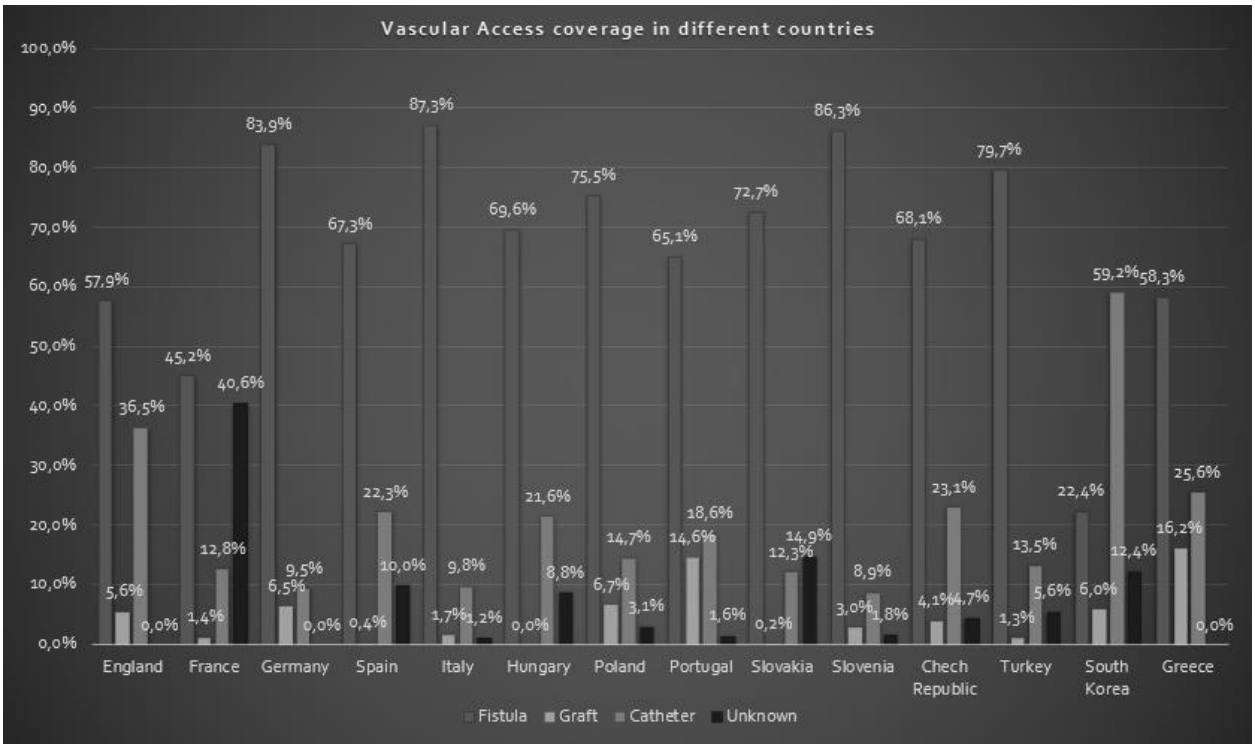
Regarding vascular access, indicative and proportional to the country, a common component is presented which is the preference for using a fistula as a method of vascular access. For a total of 134 clinics, stated at the following 9 European (France, Spain, Italy, Hungary, Poland, Portugal, Slovakia, Slovenia, and Czech Republic) [5-7] as well as Turkey [6], there has been noticed that fistula's usage

has a range from a minimum of 45% to a maximum of almost 88%. In Greece and UK [7], this percentage is at 58%, while in Germany holds an 84%. Finally, for North Korea, the use of fistula appears to be differentiated from the general trend of Europe, with a drop of 22,4% and a preference for the use of catheter (59,2%).We noted that in a local survey conducted in 1998, the initial tendency for vascular access was fistula. Then, in 2016 the catheter emerged, while in our survey for the group of 2.586 patients, fistula precedes again. Contributing to this change is probably the current financial crisis in Greece.

According to a study conducted in 2002 across 101 hemodialysis units in five of the largest EU Member States (United Kingdom, France, Germany, Spain, and Italy) [4,8] and 145 corresponding units in the United States, a significant preference for the use of fistula was observed. In Europe, 80% of the hemodialysis population used a fistula, while in the US, only 24% did. This preference was associated with factors such as sex (more prevalent in men), age (more common at a younger age), lower body mass index, non-diabetic status, and the absence of peripheral vascular disease. Additionally, almost 25% of the European population and 46% of the American population did not have a permanent vascular access before starting regular hemodialysis [9]. In a multinational study, Manns et al. [6] found that primary failure rates are highest for Arteriovenous Fistulas (AVF), ranging from 50% overall to 80% in subgroups of diabetic, elderly, or female patients. However, when successful, the AVF has the highest long-term patency rates and the lowest infection and complication rates [8,9]. While primary failure rates are lower for synthetic grafts, their primary and secondary patency rates are still significantly lower than those of AVF, and infection rates are considerably higher. Central venous catheters offer the advantage of immediate use but are associated with high failure, dysfunction, and infection rates. As a result, current guidelines recommend AVF as the first-line vascular access [6]. Up to 30% of hospital admissions among hemodialysis patients are related to vascular access complications, and substantial outpatient resources, including vascular access monitoring and diagnostic radiology, are required to maintain access patency [10,11]. Therefore, in addition to clinical outcomes, the resources needed to establish and maintain access patency could influence the choice of vascular access type. Currently, only one study has reported the cost of vascular access based on access type, but this study focused only on the cost of maintaining a functioning access in prevalent patients [6]. The cost of access care was high, ranging from CAN $600 to $5,000 per year for various access types, but significantly lower for patients who started the study with a functioning AVF [37-39]. This study did not account for the cost of establishing permanent vascular access, including the cost of "unsuccessful" access creation attempts. Since these costs may be significant, particularly for certain subgroups (e.g., female or elderly patients, or those with diabetes), we conducted a prospective cost analysis among incident hemodialysis patients to determine the cost of vascular access care during the first year of dialysis [6]. In a landmark 1996 JAMA paper, Hirth and colleagues reported that most patients in the United States [34-36] with permanent vascular access were using prosthetic grafts rather than autogenous fistulas, despite known higher rates of infection and thrombosis with grafts. They also found significant regional variation in graft use—from a minimum of 23% in New England to 85% in

the East South Central census region—that could not be explained by patient characteristics [7]. Based on the results of our study (which includes 27.1% of total hemodialysis patients in Greece), we found that the cost of vascular access ranges from €575 to €1,175 for fistulas, €300 to €900 for catheters, and €750 to €1,450 for grafts. The cost varies depending on whether patients are treated in public hospitals or private clinics.

Studies have shown that the European and American hemodialysis populations differ epidemiologically [20-22]. For instance, 55% of the American hemodialysis population has diabetes, while in Europe, this **figure** is 36% [31-33]. Additionally, the use of fistulas among men in the U.S. is 76%, with 69% of women using fistulas, compared to just 41% in Europe, where 22% of women use fistulas [23-25]. From August 2010 to August 2013, the use of Arteriovenous Fistulas (AVF) in the U.S. increased from 63% to 68%, while the use of catheters decreased from 19% to 15% [26-28]. In 2013, AVF use did not differ significantly between age groups, but the use of Arteriovenous Grafts (AVG) was twice as high among people of color in the U.S., with 26% using AVGs compared to 13% among Caucasians [30]. In contrast, in 20 U.S. states, the use of AVF in 2013 ranged from 49% to 92%, while catheter use ranged from 1% to 45%. Preferences for vascular access by gender and race vary in studies, with between 16% and 20% of patients unaware of the benefits or risks of different vascular access types [26-28]. Among new hemodialysis patients in the U.S., whether casual or permanent, the use of AVF remains low, with about 70% of patients using vascular catheters from the onset of treatment [29]. Notably, about 60% of patients continue to use catheters for more than 4 months after beginning hemodialysis.



Looking back to the 1980s, a study conducted in Europe comparing white and colored patients with end-stage renal disease revealed differences in the treatment of diseases associated with this condition **[40]**.

Conclusion

In our large sample of the Greek renal population, there is a clear preference for fistulas over catheters or grafts. The choice of vascular access among Greek patients is strongly influenced by the country's economic crisis. Additionally, patients with end-stage renal insufficiency tend to prefer receiving their vascular access treatment in public hospitals rather than private clinics.

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