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Research Article

Chronic Kidney Disease: Evolution of Healthcare Costs and Resource Consumption from Predialysis to Dialysis in Piedmont Region, Italy

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This study aims at assessing the evolution in healthcare costs for chronic kidney disease (CKD) patients through the analysis of administrative databases of Piedmont region, Italy. This is a retrospective, observational study, for which patients undergoing at least one dialysis for CKD in the period of June 1, 2010–May 31, 2011 were selected. Two subpopulations were evaluated: patients incident-to-dialysis observed for the 12 months preceding dialysis entrance (PreD) and "established" dialysis patients (at least 120 dialyses/year) observed for 12 months (EstD). Overall, 1,059 PreD and 2,018 EstD patients were selected. The average yearly cost per PreD patient accounted for 11,123€ ± 15,095€ (75% hospitalizations, 17% drugs, and 8% diagnostic/therapeutic procedures). The average yearly cost per EstD patient accounted for 53,764€ ± 14,685€ (59% dialysis, 21% diagnostic/therapeutic procedures, 13% hospitalizations, and 6.7% drugs). Among EstD population, hemodialysis patients cost 56,049€ ± 13,473€ per year, whereas peritoneal dialysis patients cost 34,978€ ± 10,847€ per year. The significant difference in expenditure between predialysis and dialysis suggests that prevention, early diagnosis, and the consequent possible delay of dialysis entrance could lead to important savings for healthcare services, as well as a better global health status for patients.

1. Introduction

Chronic kidney disease (CKD) is a common condition characterized by the loss of kidney function over time and is recognized as a major public health concern worldwide.

In its 2014 fact sheet, the National Center for Chronic Disease Prevention and Health Promotion estimated that more than 20 million people in the US may have CKD at different levels and that in 2011 about 113,000 patients entered treatment for end stage renal disease (ESRD) [1].

Information consolidated from 150 countries worldwide showed a number of patients being treated globally for ESRD of 3,010,000 at the end of 2012 and the number of patients is growing faster than the world population (growth rate: 7%). At the end of 2012, haemodialysis (HD) was still the most common treatment modality, with approximately 2,106,000 patients (89% of all dialysis patients) and around 252,000 patients undergoing peritoneal dialysis (PD) (11% of all dialysis patients). At European level, the average growth rate of the dialysis patient population between 2011 and 2012 was about 2% [2].

The last report of the Italian Registry of Dialysis and Transplant (RIDT 2010) revealed a prevalence of HD and PD of 788 patients per million population (PMP) and an incidence of 162/PMP (42,488 patients in haemodialysis, including 8,638 incident patients) [3].

In Piedmont, the prevalence of dialysis is lower than in Italy (715 PMP) and has been stable over the last 9 years. The incidence has varied between 150 and 165 PMP in the last years [4]. CKD is associated with major severe consequences including increased risk of mortality, ESRD, cardiovascular disease (CVD), and mineral and bone disease and increased

risk of acute kidney injury. In CKD subjects, mortality from CVD is estimated to be at least 8- to 10-fold higher compared to non-CKD subjects [5]. Furthermore, in adults with CKD premature death from all causes and from CVD is higher than in adults without CKD. CKD patients, in fact, are 16 to 40 times more likely to die than to reach ESRD [1]. According to the 2010 Global Burden of Disease study, CKD was ranked 18th in the list of causes of the total number of global deaths (annual death rate 16.3 per 100,000) [6].

Estimates on the Global Burden of Disease (GBD) for years 2000–2011, performed by the World Health Organization (WHO), indicated that kidney diseases were responsible for 815,000 deaths (1.5% of the total number of global deaths [7]) and for 28,698,000 disability adjusted life years (DALYs) lost, corresponding to 1% of all global DALYs lost in 2011 [8].

CKD imposes significant economic consequences in terms of direct loss of gross domestic product (as a result of ill health, household financing of care, changes in consumption patterns, and welfare costs) and of expenditure for the management of patients with CKD and ESRD. ESRD treatment expenditure in developed countries accounted for 2-3% of total healthcare expenditure, while ESRD patients represent only 0.02-0.03% of the total population [9]. Total Medicare spending in 2010 reached $522.8 billion (+6.5% versus previous year). The United States Renal Data System reported for 2012 $32.9 billion expenditure for ESRD (+8% versus previous year). 38% of this amount was spent on inpatient services, 34% for outpatient care, 21% for physician/supplier costs, and 7.2% on Part D prescription drugs [10]. In Italy, at the moment of the present analysis, there are few published data on CKD or ESRD expenditure; Pontoriero et al. [11] estimated for 2001 a yearly cost per patient in ESRD of 31,472€ and a yearly cost of 36,234€ per dialysis patient, while Cicchetti et al. [12] founded a yearly cost of 52,830€ for stage-5 dialysis patient in 2010. These data are not comparable because of the differences in methodology, type of costs considered, and perspective of the analysis.

However, direct healthcare costs of predialysis and dialysis have never been studied in an Italian real-world setting.

These data could be useful to estimate the possible economic burden and treatment pathways of CKD patients. Moreover, knowing healthcare costs distribution among different dialysis settings and predialysis periods could help manage healthcare expenditure, underline costs of renal replacement therapies, and highlight possible economic saving of early diagnosis of CKD.

The purpose of this study was therefore to estimate, through the analysis of administrative databases of Piedmont (Italy), resource consumption, and direct healthcare costs for CKD patients in the 12 months before dialysis entrance and for "established" dialysis patients.

2. Subjects and Methods

In Italy, everybody has access to healthcare services as part of the Italian National Health Service (INHS); information on all medical procedures, inpatients, outpatients, and drugs covered by the INHS are collected in local/regional databases.

For the purpose of the present study, CSI-Piemonte (consortium for information Systems of Piedmont) provided a data warehouse containing information on all the Piedmont resident population (about 4,400,000 inhabitants), which was obtained from administrative databases provided by the local health units. The following different databases were analyzed: drugs reimbursed by the INHS and distributed through territorial pharmacies, drugs reimbursed by the INHS and distributed through RHS structures, hospital discharge records, and diagnostic, therapeutic procedures including outpatient visits. Each database also contains the complete demographic characteristics of the resident population, which was linked through the anonymized tax code (a unique number identifying each Italian resident).

This was a retrospective, noninterventional, and observational study, for which all patients undergoing at least one dialysis for CKD in the period of June 1, 2010–May 31, 2011 were selected. For this population, data from June 1, 2009, to May 31, 2012, were extracted from the data warehouse. Two different subpopulations were evaluated for healthcare resource consumption and costs:

(i) patients incident-to-dialysis observed for the 12 months preceding dialysis entrance (PreD),

(ii) "established" dialysis patients observed for 12 months (EstD).

PreD population was identified as those patients who did not undergo any dialysis treatments in the 12 months preceding the selection period.

EstD population was identified as those patients with an interval of at least 365 days between the first and the last recorded dialysis and who had received at least 120 dialyses/year during the period of June 2009–May 2012.

All patients who had undergone dialysis treatment for acute kidney injury were excluded from this study.

For the two populations objects of the analysis, the following data were collected: reimbursed drugs [source: public price reimbursed by the INHS for drugs distributed by territorial pharmacies and real price in charge to the Regional Health Service (RHS) for drugs distributed through RHS structures; reference years 2009–2012], diagnostic and therapeutic procedures and outpatient visits (source: RHS tariffs), hospital admissions, and 1-day hospital stays (source: RHS tariffs for the supplying of hospital care for the years 2009–2012). For expenditure estimation, we examined the real prices and tariffs charged to the RHS and reported in the data warehouse.

As the analysis was performed from the perspective of the Piedmont RHS, private healthcare expenditure was not taken into account. The total cost for a drug was calculated by multiplying the units prescribed by the cost of each fill. The total cost for hospitalizations was calculated by multiplying each hospitalization by the unit cost for each regional DRG's tariff. The total costs for outpatient visits, diagnostic procedures, and laboratory tests were calculated by multiplying each of them by their regional tariff.

Table 1: Healthcare cost composition in PreD and EstD (per patient/year).

	PreD (n = 1,059)	EstD (n = 2,018)	P
Drugs (distributed through RHS structures) € (% on total expenditure)	831 (7.4%)	2,477 (4.6%)	<0.0001
Drugs (distributed through territorial pharmacies) € (% on total expenditure)	1,098 (9.8%)	1,151 (2.1%)	<0.0001
Diagnostic and therapeutic procedures including outpatient (excluding dialysis) € (% on total expenditure)	899 (8.1%)	11,616 (21.6%)	<0.0001
Dialysis € (% on total expenditure)	—	31,661 (58.9%)	—
Hospitalizations € (% on total expenditure)	8,295 (75.7%)	6,859 (12.8%)	0.2255
Total €	11,123	53,764	<0.0001

PreD: patients incident-to-dialysis observed for the 12 months preceding dialysis entrance; EstD: "established" dialysis patients (at least 120 dialyses/year).

As data were extracted from regional administrative databases, the analysis was performed from the Piedmont Regional Health Service (RHS) perspective.

2.1. Statistical Analysis. We used proportion as descriptive statistic for categorical variables and mean, standard deviation for continuous variables. Costs were compared with the Wilcoxon nonparametric test. We used SAS software (version 9.2) to perform data analyses.

3. Results

Overall, 1,059 PreD patients (mean age 66.5, 36.8% females) and 2,018 EstD patients (mean age 66.1, 37.8% females, 84.2% receiving only HD and 9.2% receiving only PD) were selected.

The average yearly cost per patient in the PreD population accounted for 11,123€ ± 15,095€ (mean ± SD), 75% of which for hospitalizations, 17% for drugs (10% territorial distribution and 7% distributed through RHS structures), and 8% for diagnostic/therapeutic procedures and outpatient episodes of care (Table 1).

The average yearly cost per patient in the EstD population accounted for 53,764€ ± 14,685€, 59% of which for dialysis, 21% for other diagnostic/therapeutic procedures and outpatient episodes of care, 13% for hospitalizations, and 6.7% for drugs (2.1% territorial distribution and 4.6% distributed through RHS structures) (Table 1.).

Among EstD population, no significant differences between genders were found in healthcare resource consumption and costs (53,467€/year/patient ± 14,356€ for females and 53,945€/year/patient ± 14,884€ for males, P = 0.92).

Drugs for the treatment of secondary hyperparathyroidism (SHPT), including phosphate binders (ATC codes A011CC04, A012AA04, H05BX01, H05BX02, V03AE02, V03AE03, and V03AE04), were prescribed to 91.7% of EstD population, accounting for an expenditure of 901€/patient/year (1.7% of total yearly cost per patient); about 49% of these costs (440€/patient/year) were for phosphate binders and the remaining for vitamin D and analogues, paricalcitol, and cinacalcet. Considering only patients who were prescribed these drugs at least once, the mean yearly cost per treated patient for SHPT drugs was 983€.

Erythropoietin stimulating agents (ESAs) (ATC codes B03XA01, B03XA02, and B03XA03) were prescribed to 80.5% of EstD population, accounting for an average expenditure of 988€/patient/year corresponding to 1.8% of total yearly cost per patient. Considering only patients who were prescribed these drugs at least once, the mean yearly cost per treated patient for ESAs was 1,227€.

Among EstD population, patients receiving only HD (n = 1,699) had an average yearly cost of 56,049€ ± 13,473€, whereas patients treated only with PD (n = 185) had an average yearly cost of 34,978€ ± 10,847€, $P < 0.0001$. Healthcare cost composition of patients receiving only HD or PD is summarized in Table 2.

Drugs for the treatment of SHPT were prescribed to 91.1% of HD patients and 93.5% of PD patients, while ESAs were prescribed to 81.0% of HD patients and 69.7% of PD patients. Considering only patients who were prescribed SHPT drugs at least once, the mean yearly cost per treated patient in HD was 1,016€ versus 673€ for patient in PD; considering only patients who were prescribed ESAs at least once, instead, the mean yearly cost per treated patient in HD was 1,247€ versus 955€ per patient in PD.

The ten most frequent causes of hospitalizations selected using major diagnosis [identified through the International Classification of Disease, 9th Revision Clinical Modification (ICD-9-CM)] are reported in Table 3 (PreD, HD, and PD populations).

The ten most frequent causes of admissions accounted for 52.5% of the total number of hospitalizations in the PreD

Table 2: Healthcare cost composition in PD and HD (per patient/year).

	PD (n = 185)	HD (n = 1,699)	P
Drugs (distributed through RHS structures) € (% on total expenditure)	1,574 (4.5%)	2,578 (4.6%)	<0.0001
Drugs (distributed through territorial pharmacies) € (% on total expenditure)	1,324 (3.8%)	1,128 (2.0%)	<0.0001
Diagnostic and therapeutic procedures including outpatient (excluding dialysis) € (% on total expenditure)	3,519 (10.1%)	12,753 (22.8%)	<0.0001
Dialysis € (% on total expenditure)	23,070 (65.9%)	32,890 (58.6%)	<0.0001
Hospitalizations € (% on total expenditure)	5,491 (15.7%)	6,700 (12.0%)	0.0005
Total €	34,978	56,049	<0.0001

PD: peritoneal dialysis; HD: haemodialysis.

population, 37.6% in the HD population, and 42.2% in the PD population. In all populations, hospitalizations were mostly associated with the management of kidney disease and with the most relevant comorbidities (cardiovascular, respiratory, and malignancies). Considering the ten most frequent causes of hospitalizations, those strictly related to ESRD and dialysis treatment accounted for 82% of expenditure for PreD patients, 78% for HD patients, and 93% for PD patients.

Considering all hospitalizations, the average length of stay was 17.5 days in the PreD population, 10.2 days in the HD population, and 14.4 days in the PD population.

4. Discussion

The results of the analysis underline the wide difference, in terms of resource utilization and healthcare costs, between predialysis and dialysis patients (11,123€ versus 53,764€, $P < 0.0001$); furthermore, when HD and PD patients were analyzed separately, an important difference in expenditure charged to RHS was found (56,049€ versus 34,978€). These findings are in line with several recent literature reviews [13–15] stating that PD is significantly cost-saving compared to HD therapy in most developed countries and in some developing countries worldwide.

The prevention of damage to kidney and of other chronic pathologies is the most effective solution to obtain better clinical outcomes while optimizing costs. This approach should be applied at all CKD stages, including advanced ones (≥ 3b): an accurate management of the patient, together with the prevention of complications associated with uremic syndrome, could allow a delay in dialysis entrance, a reduction in the number and length of hospitalizations, and the beginning, in presence of clinical indications, of the kidney transplantation pathway. This strategy has been indicated by the National Kidney Foundation [16], the leading organization in the USA dedicated to the awareness, prevention, and treatment of kidney disease, which reported that "*Increasing evidence, accrued in the past decades, indicates that the adverse outcomes of chronic kidney disease, such as kidney failure, cardiovascular disease, and premature death, can be prevented or delayed. Earlier stages of chronic kidney disease can be detected through laboratory testing. Treatment of earlier stages of chronic kidney disease is effective in slowing the progression toward kidney failure. Initiation of treatment for cardiovascular risk factors at earlier stages of chronic kidney disease should be effective in reducing cardiovascular disease events both before and after the onset of kidney failure.*"

Piedmont delivered a regional provision [17] aiming at improving and standardizing the practice of clinical intervention for the most advanced stages of CKD, in order also to promote access to preventive transplantation from a living or cadaveric donor. The data collected in the project "Progetto MaReA" [17] on the optimization of inclusion of patients in the waiting list for transplantation show that an economic saving of €2.8 million could be expected at regional level.

The main limitation of the administrative databases is the lack of detailed clinical data for each patient and the unfeasibility to estimate indirect costs (i.e., loss of productivity) [18]. Moreover, the costs reported in our analysis represent the total direct healthcare costs related to the treatment of HD and PD established patients and to the period preceding dialysis entrance; it was not possible to completely separate costs related to the disease and to its comorbidities. Anyhow, in EstD patients more than 60% of total direct healthcare costs are directly related to ESRD (dialysis, SHPT drugs, and ESA).

On the other hand, the use of administrative databases provides accurate real-world data on large populations; the most important data refer to resource consumption, healthcare costs charged to health services, and treatment pathways. Moreover, the large size of the analyzed sample, the capacity of the administrative data warehouse to contain large quantities of longitudinal data on each patient, and the possibility to link individual records from different datasets (drugs, outpatients, and inpatients) make administrative databases powerful tools for clinical epidemiologic research, especially that on drug/resource utilization and outcomes [19, 20].

Table 3: Main causes of hospitalizations in the different populations.

Major diagnosis	Hospitalizations			
	Total number of admissions (n)	% on total admissions	Total days of stay	Average cost per hospitalization (€)
PreD population				
End stage renal disease	355	20.6	6,669	4,931
Chronic kidney disease, Stage V	234	13.6	2,950	4,412
Chronic kidney disease, Stage IV (severe)	93	5.4	1,692	3,304
Fitting and adjustment of extracorporeal dialysis catheter	81	4.7	172	4,523
Congestive heart failure, unspecified	29	1.7	529	4,160
Left hearth failure	23	1.3	429	6,223
Subendocardial infarction, initial episode of care	20	1.2	304	5,434
Acute respiratory failure	19	1.1	449	18,119
Fitting and adjustment of peritoneal dialysis catheter	17	1.0	132	5,687
Malignant neoplasm of kidney, except pelvis	16	0.9	212	5,364
Chronic kidney disease, Stage III (moderate)	16	0.9	235	2,999
HD population				
End stage renal disease	677	12.6	7,086	7,471
Other complications due to renal dialysis device, implant, and graft	413	7.7	1,726	4,069
Fitting and adjustment of extracorporeal dialysis catheter	239	4.5	601	2,531
Mechanical complication of other vascular device, implant, and graft	194	3.6	653	5,340
Arterial embolism and thrombosis of upper extremity	107	2.0	455	6,224
Subendocardial infarction, initial episode of care	91	1.7	778	6,480
Atherosclerosis of native arteries of the extremities with ulceration	89	1.7	1,077	5,940
Atherosclerosis of native arteries of the extremities with gangrene	75	1.4	1,193	6,980
Senile cataract, unspecified	73	1.4	101	1,069
Fitting and adjustment of vascular catheter	64	1.2	208	806
PD population				
End stage renal disease	86	21.2	1,302	9,237
Peritonitis (acute), generalized	21	5.2	211	1,885
Unspecified peritonitis	19	4.7	176	2,916
Anemia in chronic kidney disease	11	2.7	348	1,345
Other and unspecified angina pectoris	10	2.5	32	2,458
Umbilical hernia without mention of obstruction or gangrene	6	1.5	11	2,720
Infection and inflammatory reaction due to peritoneal dialysis catheter	6	1.5	85	3,280
Other complications due to renal dialysis device, implant, and graft	6	1.5	26	3,495
Encounter for antineoplastic chemotherapy	6	1.5	556	4,240

PreD: patients incident-to-dialysis observed for the 12 months preceding dialysis entrance; HD: haemodialysis; PD: peritoneal dialysis.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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References

[1] National Center for Chronic Disease Prevention and Health Promotion in 2014 fact sheet, 2014, http://www.cdc.gov/diabetes/pubs/pdf/kidney_factsheet.pdf.

[2] ESRD patients in 2012, "A Global Perspective," http://www.vision-fmc.com/files/pdf_2/ESRD_Patients_2012.pdf.

[3] Italian Registry of Dialysis and Transplant (RIDT), 2010, http:///www.sin-ridt.org/web/eventiRIDT/registro_italiano.cfm.

[4] "Italian Registry of Dialysis and Transplant (report registri regionali, RIDT 2009)," http://www.sin-ridt.org/web/procedure/protocollo.cfm?List=WsIdEvento,WsPageNameCaller,WsIdRisposta,WsRelease&c1=RGSRIDTPIE&c2=%2Fweb%2Feventi%2FNEPHROMEET%2Findex%2Ecfm&c3=5&c4=1.

[5] V. Jha, A. Y. Wang, and H. Wang, "The impact of CKD identification in large countries: the burden of illness," *Nephrology Dialysis Transplantation*, vol. 27, supplement 3, pp. iii32–iii38, 2012.

[6] R. Lozano, M. Naghavi, K. Foreman et al., "Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study," *The Lancet*, pp. 2095–2128, 2010.

[7] World Health Organization, *Global Burden of Disease. Regional Estimates for 2000–2011. Disease and Injury Regional Mortality Estimates*, World Health Organization, Geneva, Switzerland, 2014, http://www.who.int/healthinfo/global_burden_disease/estimates/en/index2.html.

[8] World Health Organization, *Global Burden of Disease. Regional Estimates for 2000–2011*, DALY Estimates, 2014, http://www.who.int/healthinfo/global_burden_disease/estimates/en/index2.html.

[9] A. S. Levey, R. Atkins, J. Coresh et al., "Chronic kidney disease as a global public health problem: approaches and initiatives—a position statement from Kidney Disease Improving Global Outcomes," *Kidney International*, vol. 72, no. 3, pp. 247–259, 2007.

[10] "United States Renal Data System 2012 report," http://www.usrds.org/2012/pdf/v2_ch11_12.pdf.

[11] G. Pontoriero, P. Pozzoni, L. D. Vecchio, and F. Locatelli, "International study of health care organization and financing for renal replacement therapy in Italy: an evolving reality," *International Journal of Health Care Finance and Economics*, vol. 7, no. 2-3, pp. 201–215, 2007.

[12] A. Cicchetti, M. Ruggeri, P. Codella et al., "I costi socio-sanitari dell'insufficienza renale cronica," *Farmeconomia e Percorsi Terapeutici*, vol. 12, no. 1, pp. 21–28, 2011.

[13] F. X. Liu, T. P. Quock, J. Burkart et al., "Economic evaluations of peritoneal dialysis and hemodialysis: 2004–2012," *F1000Research*, vol. 2, p. 273, 2013.

[14] P. M. Just, M. C. Riella, E. A. Tschosik, L. L. Noe, S. K. Bhattacharyya, and F. de Charro, "Economic evaluations of dialysis treatment modalities," *Health Policy*, vol. 86, no. 2-3, pp. 163–180, 2008.

[15] A. N. Karopadi, G. Mason, E. Rettore, and C. Ronco, "Cost of peritoneal dialysis and haemodialysis across the world," *Nephrology Dialysis Transplantation*, vol. 28, no. 10, pp. 2553–2569, 2013.

[16] "K/DOQI Clinical practice guidelines for chronic kidney disease: evaluation, classification and stratification," *American Journal of Kidney Diseases*, vol. 39, supplement 1, pp. S1–S266, 2002.

[17] "Consolidamento delle attivita' relative all'ambulatorio per la malattia renale avanzata in applicazione del percorso di diagnosi e terapia sull'avvio del trattamento sostitutivo della funzione renale," Deliberazione della Giunta Regio nale 2 agosto 2013, n. 88–6290, 2014, http://www.regione.piemonte.it/governo/bollettino/abbonati/2013/36/attach/dgr_06290_830_02082013.pdf.

[18] E. R. Haut, P. J. Pronovost, and E. B. Schneider, "Limitations of administrative databases," *JAMA—Journal of the American Medical Association*, vol. 307, no. 24, pp. 2589–2590, 2012.

[19] S. Schneeweiss and J. Avorn, "A review of uses of health care utilization databases for epidemiologic research on therapeutics," *Journal of Clinical Epidemiology*, vol. 58, no. 4, pp. 323–337, 2005.

[20] S. E. Harpe, "Using secondary data sources for pharmacoepidemiology and outcomes research," *Pharmacotherapy*, vol. 29, no. 2, pp. 138–153, 2009.