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Cost Analysis of Hemodialysis Session: A Comparison Between Activity-Based Costing and Traditional Costing Methods

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ABSTRACT

Objective: This study, aims to determine the cost of hemodialysis sessions by using traditional costing and activity-based costing (ABC) methods, to provide a tool for controlling costs and to contribute to the financial planning studies of health managers.

Methods: The research was carried out in the hemodialysis unit of a university hospital in Türkiye. Medical, administrative, financial, and statistical data of the hospital for 2018 were used for the cost data. Hemodialysis cost per session was calculated by analyzing the obtained data both traditional cost analysis and the ABC method.

Results: As a result of the analysis through traditional cost analysis, the unit cost per hemodialysis session was 49.54 $, while in the ABC analysis, the cost of hemodialysis sessions was calculated as 41.16 $.

Conclusion: As a result of the study detected differences between the hemodialysis costs per session obtained through traditional cost analysis and ABC analysis. The study concludes that the unit cost calculated by the ABC method provides more detailed and more realistic information than the cost calculated with the traditional costing method. Additionally, the cost of a hemodialysis session reached within the scope of the study was determined to be higher than the price of the reimbursement institution. As the cost of a hemodialysis session is higher than the price paid back to the hospital, it is recommended that the hospital develop practices that increase efficiency and that reimbursement prices be increased.

Keywords: Activity-based costing, chronic kidney disease, cost analysis, hemodialysis, traditional cost analysis.

1. INTRODUCTION

Being among the basic health problems in the world, chronic diseases are gradually increasing and placing a big burden on patients, service providers, and the healthcare system. Chronic kidney disease is both an important public health problem and an important financial problem for the healthcare system. Chronic kidney disease (CKD) is often diagnosed with a chronic decrease in renal function and structural renal failure. CKD usually progresses slowly and silently, and renal function becomes already significantly impaired by the time the symptoms appear [1]. The end-stage of CKD is called end-stage renal disease (ESRD) and refers to a drop in renal function below 15% [2].

The national data, regularly gathered by the Turkish Society of Nephrology (TSN), revealed that the prevalence of ESRD in Türkiye was 1,016 per million population and its incidence was 161 per million population, including pediatric patients, in 2022 [3]. Unfortunately, the incidence and prevalence of ESRD have been increasing over the years in Türkiye. The number of patients with ESRD, which was 324 per million population in 2001, reached 1,016 in 2022. Such an increasing trend is expected to be persistent in the coming years, particularly due to the aging of the population and the increase in the prevalence of diabetes, among the most apparent reasons for the emergence of ESRD. Therefore, the increase in the number of ESRD patients over the years may be a robust indicator that relevant treatment options will inevitably be on the agenda of health policymakers soon.

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An ESRD patient has to start one of the treatment options called renal replacement therapy (RRT) to be able to survive. RRT, consisting of dialysis or kidney transplant, is an artificial treatment to eliminate or minimize the problems occurring due to renal failure [4]. Hemodialysis refers to a process of regulating the liquid-solute content of blood with the help of a membrane and a machine outside the body and returning it to the patient [5]. Worldwide, approximately 89% of patients with ESRD receive hemodialysis treatment [5,6]. In-centre HD remains the most common treatment modality for ESRD by a large margin worldwide. In 2021, Montenegro (97.8%), Bangladesh (91.4%), and Romania (86.8%) were the countries with the highest use of in-center hemodialysis for ESRD patients, respectively [7]. Similarly, the most frequently reported treatment option for patients with ESRD is hemodialysis in Türkiye. According to the 2022 data, there were 61,723 (73.21%) hemodialysis patients in Türkiye. It is known that 97.37% of these patients undergo hemodialysis in a relevant center [3]. ESRD, together with the RRT, brings a severely compelling economic burden on national healthcare budgets. Accordingly, the global cost of RRT is estimated at over $1 trillion [8]. The increasing frequency of the disease and the increase in the number of treated patients raise the expenditures for treatment and cause more financial resources to be allocated for health from the budgets of countries. Thus, increasing costs in healthcare institutions and pressure to control the inflation in treatments urge performing a cost analysis for hemodialysis, the most prevalently adopted therapy option in ESRD across the world.

Today, rapidly developing technology leads to substantial transformations in the production and management structures of businesses, which also leads to changes in their production and pricing strategies. As a result, the structure of cost elements (raw materials, labor, and production overhead costs) also changes. Whereas the share of production overhead costs in total costs increases in all technology-intensive organizations, particularly healthcare institutions, it is vice versa for direct labor costs. Therefore, a cost analysis based on traditional costing in a novel production environment has begun to fall short in finding ways to help organizations better understand their processes and costs. It has also elevated the efforts of organizations to “find the right product cost” to ensure that their costing structures are compatible with the changing technology. Moreover, it has become a necessity to utilize different methods in costing products to be able to manage increased overheads and decide which processes verily add value to a product or service [9]. Based on the assumption that there is a causal relationship between the activities and the costs of these activities, the Activity-Based Costing (ABC) method, introduced as an alternative method to traditional costing methods, proposes that costs reflect the actual situation of a business more accurately [10 – 12].

In traditional costing, it is accepted that expenses are incurred for the products produced, and a relationship is established between these expenses and the products. Since this relationship is direct for raw material and labor costs, the related costs are directly charged to the cost of the products to which they belong. In the case of overheads, since the expense-product relationship is indirect, the expenses are charged to the products produced by using the cost driver. In the ABC approach, expenses are incurred for the realization of activities and products benefit from these activities. This is the main point where ABC and traditional costing approaches differ [13].

ABC models the use of business resources according to the activities performed and then relates the cost of these activities to outputs such as products, customers, and services [14]. In its simplest form, ABC is a method that attempts to break down production into its basic activities, identify the costs of these activities, and then allocate these costs to products according to how much of a particular activity is needed to produce products [15]. The ABC method basically uses a two-stage allocation process. In the first stage, the costs of consumed resources are allocated to activities with the help of appropriate resource cost drivers, and in the second stage, the costs allocated to activity pools or activities in the first stage are allocated to cost objects using appropriate cost drivers [16]. ABC is a method that tries to overcome the perceived shortcomings of traditional costing methods by matching activities more closely with products [15].

Increasing costs in healthcare institutions highlight the significance of measuring the costs of services produced in these organizations. The service costs can be calculated using the data of costs emerging in healthcare institutions [17]. Having the proper knowledge of costs brings with it the correct pricing strategies. Nevertheless, one may question the reliability of the costs in complex organizations (e.g., hospitals) calculated through only traditional costing methods. Ultimately, we believe that the ABC method will be helpful in determining costs in healthcare institutions since it reveals cost information closest to the actual situation.

ESRD patients receiving dialysis therapy are considered a unique population. The relevant statistics confirm that the number of ESRD patients and the costs of treatment and follow-up of these patients are on the rise and that such costs are projected to create a tremendous burden on the financial resources allocated for healthcare in the near future. In addition, hemodialysis is among the services demanding high resource allocation in healthcare service delivery. Hemodialysis patients who come to the hospital for an average of 3 sessions per week may require more resource consumption than other outpatients. For this reason, it seems essential to conclude accurate cost information for a robust planning of hemodialysis services and to use scarce and expensive resources effectively and efficiently. Thus, the original findings in the present study may guide managing bodies of hospitals, reimbursement institutions, and further research, contribute to increasing awareness of hemodialysis costs among healthcare managers, policymakers, and researchers, and enrich the relevant literature.

Although the literature hosts research on determining hemodialysis costs, these studies seem to have utilized various costing methods, particularly traditional ones [18-25]. Yet, there are almost no studies, except for a few, resorting to the ABC method to determine the costs of hemodialysis treatment [26, 27]. Although the ABC method was used in these studies, it is noteworthy that costs were determined using a single method. In line with such a gap in the literature, we aimed to utilize both a traditional costing method and the ABC method to acquire more realistic costs for the procedures and applications within hemodialysis treatment, to compare and evaluate the findings, and to make recommendations for further research. We also compared the costs per hemodialysis session calculated using both methods and payment per session set by the reimbursement institution within the relevant period.

2. METHODS

We carried out the present study in the Hemodialysis Center of the Nephrology Department at Ibni Sina Hospital, a university hospital in Türkiye. The scope of the research covers determining the costs incurred in the provision of hemodialysis services in the relevant center from the perspective of the service provider.

This is cross-sectional and descriptive research because the cost analysis is based on the data of a certain period. Medical, administrative, financial, and statistical data of the hospital for 2018 were used for the cost data. The data related to the determination of the activities and activity durations of the hemodialysis process were obtained by the researcher using the time study method. The data obtained within the scope of the study were transferred to the computer environment, and the Microsoft Excel package program was used in the analysis of the collected data. We calculated the costs using traditional costing and ABC methods. Within the traditional costing method, we detected the hospital's expense locations, types, and amounts, calculated the relevant costs, and presented them in three cost allocation tables. On the other hand, within the scope of the research, the determination of the activities and activity durations of the hemodialysis process, which is one of the basic stages in the ABC method, was obtained by the researcher by making actual measurements. To determine the hemodialysis activities in the ABC method, observations were made in the Hemodialysis Unit for the hemodialysis process. As a result of the observations, each activity related to the hemodialysis method and the first materials and materials used during the related activity were determined. In cases where observations were insufficient, expert opinion was sought by interviewing the doctors and nurses in the unit. The 36 activities determined for the hemodialysis session were collected under 8 activity pools by applying expert opinion. Then, we converted the cost per hemodialysis session into dollars based on the average US dollar rate of the Central Bank of the Republic of Türkiye in 2018 to generate a base for further studies and to be able to compare the costs with those calculated in other studies.

3. RESULTS

The results obtained using the traditional costing and ABC methods are presented below:

3.1. Results of the Traditional Costing Method

The findings revealed the total cost of the hospital in 2018 to be $59.854.435,13. Personnel costs constituted 55.64% of the total cost. The shares of raw material costs and production overhead costs in the total cost were 31.50% and 12.86%, respectively.

The total cost incurred in the hemodialysis center as a result of the first allocation was found to be $761.037,16. The second and third allocations yielded it to be $828.478,73 and $835.214,39, respectively. Of the total cost, 44.39% ($370.792,27) corresponded to personnel costs, 26.84% ($224.192,30) was raw material costs, and 28.76% ($240.229,81) corresponded to production overhead costs.

Table 1 presents the conversion coefficients and criteria used to calculate unit costs in the hemodialysis center. Accordingly, the total cost was calculated to be $835.214,39. In addition, we found the total number of converted sessions to be 17,872.98 and the unit price of a converted session to be $46,73. Following the third allocation, the unit cost per hemodialysis session was calculated to be $49,54 for up to 700 sessions and $46,73 for 701 sessions and above (Table 1).

Table 1. *Hemodialysis Session Unit Cost According to Traditional Costing Method*

	NCHI Score	Conversion Coefficient	Actual Production Quantity	Number of Converted Sessions	Actual Unit Cost	NCHI Price
Emergency hemodialysis	334	1,06	1875	1987,5	49,54	41,12
Hemodialysis, up to 700 sessions (including 700 sessions)	334	1,06	9208	9760,48	49,54	41,12
Hemodialysis, 701 sessions and above	315	1	6125	6125	46,73	38,84
Total Cost	835.214,39					
Total Converted Sessions	17872,98					
Converted Session Unit Price	46,73					

NCHI: National Communiqué on Healthcare Implementation

Table 2. *Hemodialysis Session Cost According to ABC Method*

Activity Pool	Total of raw material costs ($)	Total of raw material costs per session ($)*	Total of personnel costs ($)	Total of personnel costs per session ($)*	Total of production overhead costs ($)	Total of production overhead costs per session ($)*	Hemodialysis Session Unit Cost ($)
F1 – Patient Registration	0,00	0,00	347,09	0,02	187,63	0,01	0,04
F2 – Preparation of materials to be used	68.781,05	4,49	3.263,60	0,21	15.047,84	0,98	5,68
F3 – Activities for the initiation of hemodialysis	90.816,46	5,92	24.091,80	1,57	40.825,35	2,66	10,16
F4 – Care activities during hemodialysis	29.378,78	1,92	168.444,07	10,99	59.093,44	3,85	16,76
F5 – Technical Affairs	0,00	0,00	693,73	0,05	15.986,16	1,04	1,09
F6 – Activities to terminate hemodialysis	3.343,52	0,22	20.164,84	1,31	40.825,35	2,66	4,20
F7 – Patient exit procedures	0,00	0,00	4.679,02	0,31	9.934,96	0,65	0,95
F8 – Cleaning activities at the end of the session	0,00	0,00	0,00	0,00	35.139,55	2,29	2,29
Total	**192.319,81**	**12,54**	**221.684,15**	**14,46**	**217.040,29**	**14,16**	**41,16**

**Hemodialysis cost per session was obtained by dividing the total of raw material, personnel and production overhead costs by the number of hemodialysis sessions (15333).*

F1-planning of dialysis sessions and treatment, obtaining dialysis consent, preparation of patient files, etc. activities

F2-Bringing the first materials and supplies used from the warehouse and distributing them to the patient beds (materials used: basic bicarbonate solution, acidic bicarbonate solution)

F3-Activities such as attaching the sets of the hemodialysis device, preparing the patient's current vascular access route, connecting the patient to the hemodialysis device and operating the device, etc. (material used: dialyzer artery/vein set, s-isotonic 09% Nacl 500 ml)

F4-preparation and administration of heparin, checking vital signs 3 to 4 times, checking/examining the patient by the doctor, etc.

F5-the activity of water analyses

F6 – stopping the machine at the end of the session and separating the patient from the hemodialysis device, closing the patient's arm, etc. activities (material used: sterile sponge, plaster 0.2m, gloves)

F7 – The activity of recording the material used for each patient through the system

F8 – Activities such as wiping the surface of the appliance, changing the linen of sofas or beds, etc.

3.2. Results of the ABC Method

We also utilized the ABC method to calculate the cost per hemodialysis session for chronic hemodialysis patients receiving sessions on a weekly basis. Chronic hemodialysis patients were recruited for a total of 15333 hemodialysis sessions in 2018 (9208 for up to 700 sessions and 6125 for 701 sessions and above). Accordingly, we calculated the total cost of the center to be $631.044,25 for chronic hemodialysis patients. The share of raw material costs in the total cost ($192.319,81) was 30.48%. While personnel costs ($221.684,15) corresponded to 35.13% of the total cost, it was 34.39% for production overhead costs ($217.040,29). Overall, we calculated the cost per hemodialysis session of the hospital in 2018 to be $41,16 (Table 2).

4. DISCUSSION

The traditional costing method yielded the unit cost per hemodialysis session to be $49.54, while it was $41.16 according to the ABC analysis. The difference between the costs calculated based on both methods was found to be $8.38. We realized that such a difference in the unit cost originated from the differences in personnel costs ($7.53), raw material costs ($0.75), and production overhead costs ($0.09) (Table 3). It is clear that personnel costs contributed the most to the difference between the unit costs per hemodialysis session. Since the ABC method determines personnel costs considering activity-based labor time, it does not take idle capacity into account. Therefore, the difference is thought to arise from the use of standard labor time determined for activities when calculating personnel costs in the ABC method, that is, the fact that this method does not consider idle capacity in the analysis.

Since the ABC method considers all the procedures for patients, we also determined the use of standard drugs and medical supplies for each procedure while analyzing the activities. On the other hand, we considered all raw materials directly supplied to the hemodialysis center in the traditional costing method. Therefore, the cost of raw materials was found to be $0.75 more in the traditional costing method when compared to the ABC method (Table 3). The difference may be explained by the fact that the ABC method considered only raw materials already used for chronic hemodialysis patients, but the warehouse in the center may have been loaded with materials not yet used for patients.

Table 3. *Comparison of Hemodialysis Session Costs Calculated by ABC with Traditional Costing*

Cost type	Traditional Costing			ABC			Difference
	Amount	Unit Price Per Session	Percentage	Amount	Unit Price Per Session	Percentage	
Raw material costs	224.192,30	13,30	26,85	192.319,81	12,54	30,48	0,75
Personnel costs	370.792,27	21,99	44,39	221.684,15	14,46	35,13	7,53
Production overhead costs	240.229,81	14,25	28,76	217.040,29	14,16	34,39	0,09
Total	**835.214,39**	**49,54**	**100,00**	**631.044,25**	**41,16**	**100**	**8,38**

ABC: activity-based costing

Nevertheless, we realized a negligible difference between both methods in terms of production overhead costs. It may be because the center has only a single output (hemodialysis session). Moreover, we calculated the cost per session only for chronic hemodialysis patients within the ABC method.

Despite the lack of studies utilizing the traditional costing and ABC methods together to calculate the cost per hemodialysis session, some studies are using both methods in different departments (general surgery, obstetrics, radiological imaging) in healthcare institutions. In such studies, the findings of the ABC method generally yielded lower numbers than those of the traditional costing method [28-30]. In this sense, our findings overlap with what was concluded in the literature.

We calculated the cost per hemodialysis session to be $49.54 within the traditional cost method. About 1/4 (26.84%) of the actual cost per session consisted of raw material costs. While 44.39% corresponded to personnel costs, the share of production overhead costs was 28.76%. The previous research concluded the cost per hemodialysis session to be about $74 [20] in Iran and $44.47 [31] in Malaysia. In a prospective study carried out in hemodialysis centers of three public and two private hospitals in Sri Lanka, the scholars calculated the mean cost per hemodialysis session to be $56 [21]. In their study, Vanholder et al. (2012) found significant differences between dialysis reimbursements in 7 countries. In the study, they calculated the cost per hemodialysis session to be $230 in the United States, $248 in the United Kingdom, $248 in Canada, $454 in France, $556 in the Netherlands, $536 in Belgium, and $225-377 in Germany [22]. In another study, the mean cost per hemodialysis session was calculated to be $297. The study also concluded that 12.47% of the total cost consisted of pharmaceutical costs, 13.64% corresponded to material costs, 41.11% was personnel costs, and 18.85% was production overhead costs [19]. Our findings were similar to the study by Al Saran and Sabry (2012), concluding personnel costs to be a category accounting for the largest cost within the total cost.

In general, the previous findings differed by country and institution. Thus, we think that the differences in the calculated costs may have derived from variances in adopted healthcare systems and policies, differences in economic structures, and organizational and time-related differences. Costs are also affected by the quality of service provided, personnel wages, medical equipment and consumables, and reimbursement systems. Ranasinghe et al. (2011) stated that the gaps between the costs reported in the literature are pretty high, which cannot be explained only by annual per capita income between countries [21]. Accordingly, variances in factors, such as inpatient care, local labor costs, management protocols, and import duties, may account for the gaps between the relevant costs. It was also asserted that the reason behind the substantial variance in costs may be that some items are not considered while calculating costs [21].

We calculated the unit cost per hemodialysis session to be $41.16, according to the ABC method. A previous study utilized this method and calculated the total cost of hemodialysis procedures to be IDR1,750,936,588.0 ($119,744.66) and the unit cost per hemodialysis session to be IDR724,725.00 ($49.56)* in 2018 [26]. In a study in Yazd Shahid Sadoughi Hospital in Iran, Mohammadi et al. (2012) calculated the total cost of dialysis services to be IRR1,723,906,772 ($141,652.16)* and the cost per session to be IRR442,028 ($36.32) [27].

The only reimbursement institution in Türkiye is the Social Security Institution (SSI). In Türkiye, SSI adopts the bundle pricing strategy in pricing hemodialysis treatment. The bundled payment per hemodialysis session (up to 700 sessions – 700th session included) to the hospital was $41,12 (TRY198) TL in 2018. In this regard, we discovered that there was a gap between the cost per hemodialysis session ($49,54) that we calculated using the traditional costing method and the payment ($41,12) to the hospital by SSI in 2018. The previous findings of hemodialysis treatment and its costs in Türkiye overlap our results. Moreover, similar to our findings, the previous research concluded that the unit costs per hemodialysis session in healthcare institutions were generally higher than the bundle prices specified in the National Communiqué on Healthcare Implementation (NCHI) by SSI [24, 32, 33].

Moreover, despite the insignificant, we concluded that the payment by SSI to the hospital remained lower than the cost per hemodialysis session we calculated using the ABC method. Accordingly, the amount paid by SSI per session was $0,04 less than the calculated unit cost. Although this finding seems to be in favor of SSI, it is more likely to reach a larger gap between the unit cost and bundle price specified in the NCHI. The drugs used in the treatment of complications developed during sessions and inpatient bed day cost, included in the

bundle price determined in the NCHI, were not considered while calculating the costs of the hemodialysis center using the ABC method.

Even though the literature has no other research using the ABC method to calculate costs in hemodialysis centers in Türkiye, some studies utilized this method in different units in healthcare institutions. Similarly, those studies concluded that the calculated costs with ABC are higher than the bundle prices offered by SSI [34, 35].

5. CONCLUSIONS

We carried out the present study in a hemodialysis center operating at Ibni Sina Hospital of Ankara University and calculated the unit cost per hemodialysis session using traditional costing and ABC methods. Then, we compared both the unit costs per hemodialysis session and the total costs of hemodialysis procedures calculated using both methods with the bundle price offered by the relevant reimbursement institution in 2018.

In healthcare institutions with elevated resource consumption, administrators need to obtain accurate information to ensure efficient and effective use of such resources. Pricing without accurate and sufficient cost information may result in over – or under-pricing the services. Considering this situation from the perspective of SSI, which is the largest and only reimbursement agency for the services offered in healthcare institutions in Türkiye, we believe that research on costing may be guiding for cost-based pricing policies of healthcare services since inappropriate pricing is more likely to result in inefficient allocation of limited public resources.

Hemodialysis service is among those requiring high resource utilization, and a hemodialysis patient visiting the hospital on average three times a week is likely to consume more resources than a regular patient. Therefore, considering the findings of the present study, the institutions should robustly plan their hemodialysis services to utilize scarce and expensive resources efficiently. In addition, since SSI offers bundled payments to hospitals for hemodialysis sessions, it is essential to calculate the cost per hemodialysis session in hemodialysis centers with diversified cost items.

Overall, we concluded that the unit costs in a hemodialysis center calculated using the ABC method became more realistic and detailed than those calculated using the traditional costing method. The detailed and reliable data obtained using the ABC method based on the activities in healthcare service delivery are believed to bring significant contributions to hospital management in different aspects. Additionally, the cost of a hemodialysis session reached within the scope of the study was determined to be higher than the price of the reimbursement institution. Future research may comprehensively address the costs of hemodialysis services by considering the comorbidities and indirect patient costs.

The data obtained in the study and the results of the study are limited to Ankara University Faculty of Medicine, Department of Nephrology, Hemodialysis Unit. Therefore, the fact that the results of this study cannot be generalized to other hemodialysis centers constitutes the limitation of the study. In addition, since the most recent hospital data that could be obtained during the research period belonged to 2018, the data from that year were used in the study.

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Design of the study: MT, İA, GN
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Analysis of data for the study: MT
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