

Comparison of the Ministry of Health's tariffs with the cost of radiology services using the activity-based costing methodRohollah Kalhor¹, Saeed Amini², Majid Emami³, Keivan Kakasoltani⁴, Nasim Rhamani⁵, Leila Kalhor⁶

¹ Ph.D. of Health Services Management, Assistant Professor, Social Determinants of Health Research Center, Qazvin University of Medical Sciences, Qazvin, Iran

² Ph.D. Student of Health Services Management, Markazi Provincial Health Center, Arak University of Medical Sciences, Arak, Iran

³ M.Sc. of Accounting, Researcher, Health Services Management Research Center, Institute for Futures Studies in Health, Kerman University of Medical Sciences, Kerman, Iran

⁴ M.Sc. Student of Financial Management, Researcher, Health Management and Economics Research Center, Iran University of Medical Sciences, Tehran, Iran

⁵ M.Sc. Student of Business Management, Teacher of Educational Organization, Qazvin, Iran

⁶ B.Sc. of Statistics, Students Research Committee, Hormozgan University of Medical Sciences, Bandar Abbas, Iran

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Introduction: Efficient use of resources in organizations is one of the most important duties of managers. Appropriate allocation of resources can help managers to do this well. The aim of this study was to determine the cost of radiology services and to compare it with governmental tariffs (introduced by the Ministry of Health in Iran).

Methods: This was a descriptive and applied study that was conducted using the retrospective approach. First, activity centers were identified on the basis of five main groups of hospital activities. Then, resources and resource drivers, activities, and hospital activity drivers were identified. At the next step, the activities related to the delivery of radiology process were identified. Last, through allocation of activities cost to the cost objects, the cost price of 66 services that were delivered in the radiology department were calculated. The data were collected by making checklists, using the hospital's information system, observations, and interviews. Finally, the data were analyzed using the non-parametric Wilcoxon test, Microsoft Excel, and SPSS software, version 18.

Results: The findings showed that from the total cost of wages, materials, and overhead obtained, the unit cost of the 66 cost objects (delivered services) in the Radiology Department were calculated using the ABC method (Price of each unit of Nephrostogram obtained \$15.8 and Cystogram obtained \$18.4). The Kolmogorov-Smirnov test indicated that the distribution of data of cost price using the ABC method was not normal ($p = 0.000$). The Wilcoxon test showed that there was a significant difference between the cost of services and the tariff of radiology services ($p = 0.000$).

Conclusions: The cost of delivered services in radiology departments was significantly higher than approved tariffs of the Ministry of Health, which can have a negative impact on the quality of services.

Keywords: activity based costing (ABC), radiology services, public sector, governmental tariffs, Iran

1. Introduction

The situation of global markets of health care services is changing dynamically. So, managers continuously search for new methods and procedures to manage costs (1). Hospitals are one of the most important organizations in each health care system because they deliver health services to all of the people using existing resources and facilities. Efficient use of resources is a common policy in all of health care systems (2). Cost analysis can help managers use

Corresponding author:

Leila Kalhor, Students Research Committee, Hormozgan University of Medical Sciences, Bandar Abbas, Iran.

Tel: +98.763337192, Fax: +98.763337192, Email: l.kalhor69@gmail.com

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limited resources in a better way, so that, health care managers should use cost analysis and cost-effectiveness analysis to get better recognition about resource flow (3). Costing and cost analysis can show how much and how hospital organizations meet public needs (4). It can be said that cost analysis is an economical technique in decision making that helps managers conduct better planning (5). In recent years, many improvements have been made in costing methods. The newest method is Activity Based Costing (ABC) (6).

The main assumption of ABC is that the activities are spent on products (or services) and resources are spent on activities (7). The ABC approach created a method for costing that is useful for cost accounting, and its cost information in the decision-making process increases the effectiveness of decisions. It also creates two new approaches in performance management and financial management, i.e., activity based management and activity based budgeting, respectively (8). Using the ABC information system, we can identify the costs of inefficient methods of industries and programs and also measure the amount of savings caused by the improvement of those methods (9-10). Numerous studies have calculated the cost of hospital services using different methods. Namazi stated a significant difference between using ABC or fuzzy activity based costing (FABC) to calculate the cost of hospitals' diagnostic departments (11). Arab Mohammad calculated the cost of bed-day for an orthopedic department to be about \$10.9, while the approved Ministry of Health (public sector) tariff was \$7.20. Thus, the cost of a bed-day was \$3.70 higher than the approved tariffs (12). Also, in another study, there was a significant difference between the average cost of medical services and their tariffs that caused losses in the departments that were studied (13). Muto concluded in his study that film-less systems were more effective than film-based systems in delivering services to patients in radiology departments (14). Nisenbaum et al. calculated the cost of C.T. Scan procedures in radiology departments using the ABC method. They estimated the total costs of head, breast, and abdominal C.T Scans to be \$189, \$274, and \$343, respectively (15). Other researchers have calculated the cost of other hospital departments, for example surgery and laboratory departments, using the ABC method (16-18). By now, usual methods of cost allocation in order to calculate the cost of hospital services have been on the basis of the traditional method of cost allocation, but the ABC method includes the identification of cost centers and then allocates the costs of the supporting centers to the operational centers. In the present study, we calculated the price of services delivered in radiology departments using the ABC method and compare it with the approved governmental tariffs of the Ministry of Health.

2. Material and Methods

2.1. Setting and general methods

The studied hospital was a single-specialization hospital with 160 active beds and an 85% occupancy rate in 2014. This is a descriptive and applied study that was done using the retrospective approach on an annual basis. Data were extracted from the Health Information System (HIS) and the Management Information System (MIS). Also, some of the data that weren't registered in the above systems were collected through observations and interviews. These data included resources, resource drivers, activities, and some activity drivers. Excel and SPSS software were used to perform the calculations. Note that, to calculate the cost of a product, three main types of costs were included, i.e., wages (manpower cost), materials, and overhead costs. By considering the structure of teaching hospitals, the activity centers were classified into five main groups, i.e., clinical, para clinical, supporting, educational, and other.

2.2. Calculation of the cost of services

After classification of these departments, the following nine steps were administered to determine the cost of services in the hospital:

2.2.1. Identification of activity centers

By assessing the nature of activities, the departments were identified and assigned to one of the determined groups. Table 1 indicates a sample of activity centers based on the nature of their activities. It should be noted that all of the activity centers were assigned to one of five groups, i.e., clinical, para clinical, supporting, educational, and others.

2.2.2. Identification of resources drivers and allocating resources to activity centers

Table 2 provides a sample of resources and related drivers. Resources are the same with economical elements that are the origin of costs. The resources in organizations include labor and direct consumable materials, indirect activities, and facilities (6). The nature of the activity-based method is direct identification of costs into activity centers. As far as possible, the costs should be directly linked to the activity centers unless there were inherent limitations in direct identification of costs.

Table 1. Activity centers and the nature of related activities

Main group of activity	Name of activity center	Nature of activity
Clinical	Surgery	Delivering clinical services directly to the surgery patients
	Internal	Delivering clinical services to patients
	ICU	Delivering clinical services to the patients that need special care
Para clinical	Laboratory	Performing diagnostic tests to inpatient and outpatient
	Imaging	radiography performed for inpatients and outpatients
	Physiotherapy	Delivering rehabilitation services to inpatients and outpatients
Supporting	Kitchen	Cook and distribute food to patients and staff
	Laundry	Washing dirty cloths of patients
	Reception	Reception of patients that need treatment in the inpatient departments
Educational	Library	Delivering educational books to the students
	Educational classes	Educational classes for students
	Head of educational department office	Delivering educational services to the students
Other	Office of insurance agents	Review patient records for insurance organizations
	Bank	Delivering financial services to the employees and patients
	Prayer house	Holding prayer ceremonies

Table 2. Identification of resources and related drivers for allocating resources to the activity centers

Resources	Resource driver
The cost of water consumption	The number of patients and employees in each department
The cost of gas consumption	The number of blades of radiators, the number of fan coils
The cost of power consumption (Electricity)	The amount of voltage consumed in each department
The cost of transportation service	The number of employees in each department that use transportation service
The cost of supporting HIS service	The number of computers in each department

2.3. Identification, gathering, and separation of costs of activity centers

In this stage, all of the costs of activity centers in the hospitals were identified, gathered, and then separated into activity centers

2.4. Identification of activities and activity drivers in activity centers

For each activity center, at least one activity was defined and its driver was specified (Table 3). Also, in each of the main departments, the personnel and their activities were categorized into primary and secondary activities.

Table 3. Activities and activity drivers on the basis of activity centers

Name of activity center	Activity	Activity driver
Kitchen	Cook and distribute food to patients and staff	The number of cooked and distributed food to patients and staff
Reception	Reception of patients that need treatment in the inpatient departments	The number of admitted patients
Laundry	Washing cloths	The amount of washed cloths (kg)
Radiology	Perform radiography for patients, review of performed radiographies	The number of performed radiographies, the number of written radiographies

2.5. Allocating costs

By identifying the activities and activity drivers in the previous step, the costs of supporting activity centers were shared into the centers of clinical and para clinical activities. In this study, to allocate the costs, we used the step-down method (one-way method).

2.6. Separation of activities and costs of main activity centers (clinical and para clinical)

This step was done by considering the nature of personnel activities in the related departments. Note that, in each department, personnel and activities focused on delivering services to patients were divided into primary and secondary activities. For example, in the Radiology Department, activities were divided into four areas, i.e., physician, department supervisor, experts, and reception. Then, the sub-activities were specified, as presented in Table 4.

Table 4. Identified activities in the process of delivering services in the radiology department

Working area of radiology department	Physician	Department supervisor	Experts	Reception
Sample of activities	Study of prescriptions	Management of radiology department	Preparing patient for radiography	Reception of radiography
	Writing radiography report	Control of radiographies qualitative and quantitative	Description of imaging	Timing patients
	-----	-----	Preparing drug	Entering inpatient and outpatient reports
	-----	-----	Taking vessel or catheterization	Setting received prescriptions from patients
	-----	-----	Drug injection	Typing department letters when necessary

2.7. Allocating the costs of secondary activities of each department to primary activities of the same department

By considering the related drivers in the Radiology Department, activities of expert and physician groups were categorized as primary activities, and activities of the department responsible and reception groups were categorized as secondary activities.

2.8. Identification of cost object (services delivered in the Radiology Department) and its relation with primary activities of each department

After specifying the costs of primary activities, it was necessary to allocate the costs to the cost objects. Before the allocation, it was necessary to know to which cost object the activity was related (services delivered to patient) and then activities should be allocated to the services. Table 5 shows a sample of the mentioned allocation. Note that there is a difference between activities and delivered services. Activities consisted of work that was done to deliver services (6).

Table 5. Allocation cost of activities to the cost objects (USD)

Service	Activity							
	Preparing patient for radiography	Imaging description	Preparing drug	Taking patient vessel or catheterization	Drug injection	Study of prescriptions	Writing radiography report	Sum of cost object
Radiographies of the skull, face and profile	151	0	0	0	0	111	222.6	485
Nephrostogram	7.6	1.9	3.8	0	3.8	5.6	11.223	34
Cystogram	2.86	0	0	0	0	2.1	4.2	9.1

2.9. Determination of the cost of services delivered to the patients and its comparison with the approved governmental tariffs

Table 6 provides samples of the cost of services. Last, the cost of each service was compared with the approved tariffs of the Ministry of Health in Table 7. The non-parametric Wilcoxon test was used to study the mean difference between cost of the ABC method and the approved governmental tariffs of the Ministry of Health. We used the constant charge method to calculate the depreciation of machines (as part of overhead costs) in this study.

Table 6. Cost price of radiography services (USD)

Cost object	Man power cost (wage)	Materials cost	Overhead cost	Total	Number of delivered services	Price of each unit	Approved governmental tariffs	Difference
Radiographies of the skull, face and profile	628.6	78.5	817.2	1564.4	238	6.57	2.49	4.08
Nephrostogram	94.6	2.64	29.5	126.8	8	15.8	10.9	4.9
Cystogram	29.3	0.6	6.86	36.84	2	18.4	6.63	11.8

Table 7. Wilcoxon test to determine the relation between mean cost price of radiology services using ABC method and the approved governmental tariffs of health ministry (USD)

Item	Number of services	Minimum	Maximum	Mean	p-value
ABC	66	5.6	170.8	22.9	0.000
Tariff	66	1.4	16.4	3.3	

3. Results

Because of the large volume of information and the variety of services delivered in the Radiology Department, we have reported only the most important findings of the study. The findings showed that 29,653 radiographic examinations were done in this hospital in 2014. Table 1 indicates a sample of activity centers and the nature of related activities on the basis of five main groups of hospital activities. This division was done because the hospital was a teaching hospital. Table 2 indicates some of the identified resources and resource drivers for allocating resources to their activity centers. For example, for allocating the cost of supporting HIS service, we used the number of computers in each department as the resource driver. Table 3 indicates some of the activities and related activity drivers by considering the identified activity centers. This information was used in the next step for allocating costs, i.e., wages, materials, and overhead (direct and indirect) to the activities. Table 4 indicates the identified activities in the process of delivering services in the Radiology Department on the basis of four work areas. To identify the activities in each field, we used the views of personnel working in the field. Table 5 indicates the way we allocated activity costs to cost objects in the Radiology Department (as one of the departments that presents final services in the hospital). For example, cystogram as a final service (cost object) in the above table included preparing the patient for radiography, study of prescriptions, and writing the radiography report. The cost of these services were included in the cost of the cystogram. The cost of other activities, e.g., imaging description, preparing drugs, taking patient vessel or catheterization, and drug injection, was not used in the calculation of the cost of this service. From the total cost that was obtained for wages, materials, and overhead (direct and indirect), the unit cost of 66 cost objects (delivered services) in the Radiology Department was calculated using the ABC method (Table 6). Out of these 66 studied services, only in 1 service (antegrade nephrostogram-one way), was the cost lower than the approved governmental tariffs. The Kolmogorov-Smirnov test indicated that the distribution of the cost data using the ABC method was not normal. Therefore, non-parametric tests must be used to study the difference between the mean of these two methods ($p < 0.05$). The non-parametric Wilcoxon test was used to study the mean difference between the costs of the ABC method and approved governmental tariffs of the Ministry of Health. The results showed that there was significant difference between the cost using the ABC method and the approved governmental tariffs ($p = 0.000$).

4. Discussion

Out of the total calculated cost price of radiology services, 57% belonged to the cost of manpower (wages), 37% overhead costs, and 4% material costs. These findings are similar to the findings of other studies. To decrease costs, hospital managers should focus on manpower cost and overhead costs to get better results. These findings were in accordance with Saber's and Ebrahimi's studies (19, 20). Ideally, the cost of manpower should be 60% of total hospital costs (4). In the present study, the cost of consuming material was 4%, which was lower than in the Saber study (7.57%) in the Radiology Department and Ebrahimi study (23%) in the intensive care unit (19, 20). However, difference in the percentage of overhead costs can be for difference in the performance kind of the studied departments. Gupta stated that traditional accounting methods that allocate overhead costs on the basis of a driver are incorrect and misleading. In order to solve this problem, activity-based costing was created to identify real costs

of activities that Leads to service (21). Performance-based costing establishes operational budgeting and also performance-based management in hospitals. Through establishment of operational budgeting, resources are allocated to the main and essential activities of the hospital, thereby preventing unrelated costs that do not provide added value for the organization (6, 26). The findings of this study indicated that there was a significant difference between the mean cost for radiology services using the ABC method and the approved governmental tariffs of the Ministry of Health. The mean cost of 65 services was higher and only in one service was the cost lower than the tariffs. The results of this study were similar to Saber's study, so that, in her study, the total costs of the Radiology Department was about 53.5% more than total specific revenues of the Department. This indicates that the Ministry of Health's tariffs were lower than the cost of services in this Department (19). Also, Namazi's study showed that there was a significant difference between the cost of services using ABC, fuzzy ABC, and the approved governmental tariffs in the Diagnostic Department (11). The studies of other researchers, including Rajabi and Rezapour, support these findings. So, it can be concluded that the approved tariffs of the Ministry of Health cannot meet the costs of radiology services and have a negative impact on the quality of services in the long term. The gap between the approved tariffs and the cost of selected services in the studied hospitals was significant and indicated that the real costs of services were not considered in the Radiology Department. Using ABC data in the comparison with tariff method is very applicable and suitable (25). The tariff method results in managers making incorrect decisions (26). Recently, hospital managers have emphasized the knowledge of the cost of imaging. Real estimation of the cost of imaging using traditional costing is difficult because imaging includes many indirect costs. The ABC method manages the cost process, and, by calculating the costs of activities, improves the personnel's knowledge about the costs. To decrease imaging costs, it is recommended that hospitals run a film-less system in their radiology departments. This allows better identification of costs and the reduction of the cost of services in this department (14). Some of the study's limitations were diversity of radiology services, poor cooperation of personnel in delivering information about their activities in the departments, and also collecting and agreement on activity drivers.

5. Conclusions

After calculating the cost of radiology services and comparing the results with the tariffs of the Ministry of Health, we found that there is a significant difference between the approved tariffs of the Ministry of Health and the actual cost of the service. The difference in the long run can adversely affect the performance and quality of radiology services.

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Conflict of Interest:

There is no conflict of interest to be declared.

Authors' contributions:

All authors contributed to this project and article equally. All authors read and approved the final manuscript.

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