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Cost-price estimation of clinical laboratory services based on activity-based costing: A case study from a developing country

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Abstract

Background: It is believed that laboratory tariffs in Iran don't reflect the real costs. This might expose private laboratories at financial hardship. Activity Based Costing is widely used as a cost measurement instrument to more closely approximate the true cost of operations.

Objective: This study aimed to determine the real price of different clinical tests of a selected private clinical laboratory.

Methods: This study was a cross sectional study carried out in 2015. The study setting was the private laboratories in the city of Kerman, Iran. Of 629 tests in the tariff book of the laboratory (relative value), 188 tests were conducted in the laboratory that used Activity Based Costing (ABC) methodology to estimate cost-price. Analyzing and cost-price estimating of laboratory services were performed by MY ABCM software Version 5.0.

Results: In 2015, the total costs were $641,645. Direct and indirect costs were 78.3% and 21.7% respectively. Laboratory consumable costs by 37% and personnel costs by 36.3% had the largest share of the costing. Also, group of hormone tests cost the most $147,741 (23.03%), and other tests group cost the least $3,611 (0.56%). Also after calculating the cost of laboratory services, a comparison was made between the calculated price and the private sector's tariffs in 2015.

Conclusion: This study showed that there was a difference between costs and tariffs in the private laboratory. One way to overcome this problem is to increase the number of laboratory tests with regard to capacity of the laboratories.

Keywords: Cost - Price, Clinical Laboratory, Laboratory Tests, Activity Based Costing, Private Sector

1. Introduction

Financial resources are the engine of the health system in the provision of services, and one of the main concerns of the public and private sectors executives and managers (1-3). But they are limited, and today in most countries, the health systems are faced with a financial crisis (1-3). Thus, the need for efficient use of financial resources is the necessity (4, 5), and managers must be able to provide health services at the lowest possible costs, while

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endeavoring to maintain quality (6, 7). Also, they should be aware of the cost of health services, and know how to allocate available resources (6, 7). But despite this important issue, in many developing countries, health system resources are badly managed, and a lot of them are wasted (8). One of the most widely used parts of the health system is the clinical laboratories department, as they provide diagnostic services through a variety of tests (9, 10). Laboratories play a key role in helping health care providers in clinical decisions for patients, and as a consequence, 60% to 70% of diagnoses are based on the results of laboratory tests (11, 12). In recent years, the demand for laboratory services has dramatically increased due to developments of new diagnostic tests and extensive advances in laboratory technologies (13). This issue along with direct and indirect costs of laboratory services has led to an increase of laboratory costs (3). Today, laboratory services account for around 10% of total costs of health system (11). Thus, laboratories, as an integral part of the hospital environment, should be looking for scientific ways to analyze and control costs (1, 2). Cost analysis plays an important role in policy making, and helps laboratory managers to develop appropriate strategies for real costing (14). This should be done accurately and based on scientific and economic methods (10, 11); otherwise, it could have undesirable effects on the continuity of services delivery due to high costs of equipment and consumable materials (1, 14). Cost control requires knowledge of resources and expenditure by the various sections of the laboratory, which can be achieved through access to systematic information in regard to expenses and activities and by using scientific methods of costing and its analysis. In this regard, Activity Based Costing (ABC), through considering the causal relationship between costs and activities, and providing managerial information in the form of financial criteria, is more useful than traditional accounting methods. ABC clearly reflects manpower, equipment, and activities of the section (15-17), provides real and accurate costs, and leads to increased efficiency, effectiveness and eventually achievement of the strategic objectives of the laboratory (18). Also with this method, direct and indirect costs for providing laboratory services can be determined. Furthermore, laboratory managers should identify the costly areas and estimate their costs against gained profit (1, 2, 19, 20). The city of Kerman, Iran with an area of 45,401 square kilometers and a population of around 750 thousand people, contains 61 laboratories. In 2015, 5,950,000 tests were conducted in the laboratories of the city which cost over $12,535,049 (21). Since the number of laboratories increases every day and requested laboratory tests are also on the rise, it is expected that costs will also increase. Given the test price rise by inflation, some of these laboratories are not cost-effective due to the increased costs (21). This situation is at its worst in private laboratories. Kerman city has 34 private laboratories. The studied laboratory is one of the largest, with comprehensive coverage of most tests. In 2015, of the 84,515 persons referred, a total 591,607 tests were performed. In this year, the cost of performing these tests increased by more than 30 percent, while tariffs rose by only 7 to 8 percent (21). Therefore, the disproportion between increasing costs with determined tariffs will lead the laboratory to be unprofitable in the near future. Accordingly, the present study was conducted to estimate the cost-price of laboratory services in private sector to provide basis for making real tariff.

2. Material and Methods

This cross-sectional study was conducted in 2015. The study setting was the 34 private laboratories in the city of Kerman, Iran. A private laboratory was selected in which, according to data of insurer institutions, most tests are performed, and due to easy access, a large number of patients referred. The most important fixed parameters used in this study included; laboratory area (153 square meters), three technical personnel, 4 support personnel, 2 service personnel and 1 pathologist in charge. Also, the monthly salary of the laboratory technician was $1,979, technical personnel were $330, and service personnel were $990 and Logistical personnel were receiving $264 per month. Of the 629 tests in the Laboratory's tariff book (relative value), 188 in 12 groups were performed in the studies laboratory, including: admission and sampling (4 tests), urine analysis (6 tests), clinical chemistry (38 tests), specialized clinical chemistry (21 tests), hormones (32 tests), tumor markers (6 tests), hematology (8 tests), coagulation (7 tests), blood banks (4 tests), serology and immunology (51 tests), microbiology (8 tests) and other tests (3 tests). In this study, all tests were used to calculate cost-price of the services. Calculating of the cost-price was performed using Activity Based Costing (ABC) methodology. All data and variables recorded in the relevant forms were first entered separately into Microsoft Excel, and after processing, the results were entered into MyABCM software version 5.0 to estimate the cost-price. Total cost was equal to: "Total Cost = Σ Personnel cost + consumable goods cost + Depreciation cost + Building opportunity-cost + Energy cost + other cost".
Total cost was calculated based on ABC through the following steps (Figure 1):

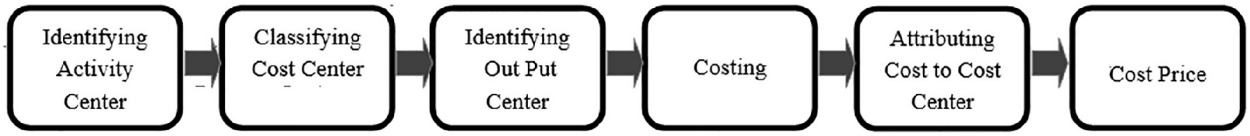

Figure 1. Activity Based Costing (ABC) Steps

Step 1: At this stage, activity centers were defined. An activity is a duty to achieve a set goal through man or machine, or a combination of both (2). Activity centers are places where all the tasks are done. The main factor in defining activities is their costs. Activity centers also have direct and indirect costs (14). Interview and observation methods were used to identify the centers of activity.
Step 2: At this stage, cost centers were classified, based on the type of operation they were undertaking. In this study, the direct cost centers were; human resources, consumable goods and depreciation costs, and indirect cost centers included; overhead costs, including administrative costs, energy, and so on.
Step 3: At this stage, output of each center was identified. In other words, this stage meant to identify output of each center. For instance: the output of hematology laboratory might be different. Since each center has different output with its own price, to do costing, cost centers were classified based on their own output, then costing process was initiated based on outputs (14).
Step 4: At this stage, costing was performed for each cost center. After studying and analyzing available evidence and documents, the costs related to each cost center (including; human resources, materials, equipment, depreciation, food and overhead costs) were determined. Costing basis for each cost center was the number of tests for human resources, consumable goods and depreciation cost and their space (m^3) for energy costs.
Step 5: At this stage, the calculated costs for each activity center was dedicated to the final cost centers.
Step 6: At this stage, the cost price was determined for each output. After identifying the costs related to the final cost centers or centers with output, cost price for each output was calculated by dividing the total allocated costs to each cost center, by a defined output for the center. The result of this calculation was the cost price of each output (22).
Step 7: Finally, at this stage, the costs of each cost center and share of each of the cost centers were compared and determined.
In this study, depreciation cost was calculated by the straight-line method; by dividing the cost of fixed assets' depreciation by assets' expected useful life. The useful life of equipment was calculated as approximately 10 to 15 years. Sharing basis for the cost center included; human resources, consumable goods and depreciation costs for the number of carried out tests and the amount of energy used for space (cubic meters). According to the Central Bank of the Islamic Republic of Iran at the time of the study, each US Dollar was equal to 30,315 Iranian rials. After calculating the cost of laboratory services, a comparison was made between the calculated price and the private sector's tariffs in 2015.

3. Results

In this study, the costs of different tests of the laboratory were calculated using ABC. As is shown in Table (1), in the studied laboratory, direct and indirect cost centers were $502,336 (78.3%) and $139,309 (21.7%) respectively. Also, the depreciation cost of specialized equipment required for all laboratory tests was $32,327, the depreciation costs of other equipment was $20,954, the cost of consumable goods was $237,382, cost of professional human resources was $160,098, cost of logistics was $72,529, energy cost was $3,394, the cost of rent was $69,024, the cost of quality control was $39,987 and other costs were $5,950. Other costs were included; residual, council tax, repair and maintenance, hardware and software setup. In the studied laboratory, consumable goods cost the most $237,382 (37%) and energy cost the least $3,394, (0.5%), (Table 1). The cost of consumable goods and labor in the laboratory had the biggest share with; 37% and 36.3% respectively, (professional manpower 25% and logistical 11.30%). In another part of this study, the calculation of the cost price and the cost of each of the test groups performed in the laboratory are being done. In this study, urine analysis cost $27,134 which accounted for 4.23% of the total costs. Admission and sampling group cost ($20,966) which accounted for (3.27%), specialized clinical chemistry cost $75,594, (11.78%), hormones group cost $147,741, (23.03%), tumor marker group cost $15,398, (2.40%), coagulation group cost $17,866, (2.78%), blood bank group cost $8,968, (1.40%), hematology group cost $50,925, (7.94%), serology and immunology group cost $104,909, (16.35%), microbiology group cost $34,831, (5.43%), and clinical chemistry group cost $133,702, (20.84%) of the total costs. In the studied laboratory, group of Hormones test cost the most at $147,741 (23.03%) and the group of other tests cost the least at $3,611, (0.56%), (Table 2).

Table 1. Direct and Indirect Cost Centers in studied Laboratory (2015).

Cost Centers		Cost Amount (USD)	Cost sharing from total costs (%)
Direct Cost Centers	Consumable Goods	237,382	37.0
	Depreciation of Specialized Equipment	32,327	5.0
	Professional Human Resources	160,098	25.0
	Logistical Human Resources	72,529	11.3
Indirect Cost Centers	Energy	3,394	0.5
	Quality Control	39,987	6.2
	Rent	69,024	10.8
	Depreciation of Other Equipment	20,954	3.3
	Other	5,950	0.9

Table 2. Total Cost of studied laboratory based on separate laboratory tests (2015)

Group of laboratory tests	Cost Amount (USD)	Cost sharing from total costs (%)
Admission and Sampling	20,966	3.27
Urine Analysis	27,134	4.23
Clinical Chemistry	133,702	20.84
Specialized Clinical Chemistry	75,594	11.78
Hormones	147,741	23.03
Tumor Markers	15,398	2.40
Hematology	50,925	7.94
Coagulation	17,866	2.78
Blood Bank	8,968	1.40
Serology and Immunology	104,909	16.35
Microbiology	34,831	5.43
Other	3,611	0.56
SUM	641,645	100

4. Discussion

According to the results of this study, the cost of consumable goods and labor in the laboratory had the greatest share with; 37% and 36.25% respectively, (professional manpower 24.95% and logistical 11.30%). According to a Negrini et al. study in a hospital in Europe (23), Mehrol Hasani et al. in a laboratory of Shafa hospital in Kerman (3), Antonella et al. in the laboratory of Lacor hospital in Uganda (24), Nasirpour et al. in the laboratory of Vali-e-asr hospital in Tehran (14), Zamandi et al. in Tehran Imam Reza Hospital's hematology unit (25) and Hadian et al. in Fatimia hospital in Semnan (26), the cost of consumable goods were; 22%, 21.1%, 21%, 15%, 8.4% and 2% respectively, labor costs were; 49%, 74.2%, 17%, 44%, 33.5% and 48% of the total costs respectively. Also, according to a Torabi et al., study which was conducted in the Golestan Hospital's radiology in Ahvaz, human resources accounted for the most costs (43.3% of all costs) (27). The high cost of consumable goods in the studied laboratory, compared to above mentioned studies, could be due to the high number of client visits that led to an increase in variables costs such as consumable goods. While, in the above mentioned studies, the costs of human resources as a fixed cost, has been accounted for the most costs. According to study results, the energy cost of $3,394 accounted for 0.53% of the total cost of the laboratory. In the studies of Nasirpour et al. (14), Mehrol Hasani et al. (3), Negrini et al. (23), Zamandi et al. (25), Sabermahani et al. (28) and Mohammadi et al. (29) the energy costs accounted for 5%, 0.19%, 3.5%, 0.006%, 0.32% and 15% of the total costs respectively. As energy cost is a fixed cost, and government provides subsidies for the energy, and also as Iran is very rich in energy, the cost in the present study is similar to above mentioned studies. Based on the results, depreciation cost of the specialized and regular equipment accounted for $69,797, which was 10.73% of the total cost of laboratory. In the studies of Hadian et al. (26), Nasirpour et al. (14), Mehrol Hasani et al. (3), Negrini et al. (23), Zamandi et al. (25), Antonella et al. (24) and Mobasheri et al. (30) the costs of depreciation were reported as; 6.7%, 17%, 2.80%, 7.4%, 6.5%, 17% and 13.7% of the total cost of equipments respectively. The high depreciation costs of the laboratory equipment could be due to their functional nature. Since the equipment is an expensive asset and has a relatively high depreciation, the costs of equipment depreciation have been reported high in this study and above mentioned studies. The results of present study showed that, the cost of rent was $69,024 which accounted for 10.76% of the total cost of laboratory. In a Hadian et al. study, the cost of building accounted for 42% of the total costs (26). The high cost of rent in the studied laboratory was due to the location of the laboratory, as it is situated in an expensive part of the city in which

the price of land is very high. Quality control cost in the present study was $39,987 which accounted for 6.23% of the total cost of laboratory. The high cost of quality control is due to the important role it plays in laboratory services, thus, in order to be certain, regarding different aspects of quality in the performed tests, quality of services should be considered, as despite the high costs, in the long term, could significantly increase revenues in the laboratory. Other costs in the study were $5,950 which accounted for 0.93% of the total cost of laboratory. Antonella et al. in their study showed that 45% of the total expenses of Lacor hospital were related to the general expenses (24). Since in the present study, other costs included expenses such as; residual, council tax, maintenance and repairs, and hard and software costs, it should be considered that, laboratory is costly and these expenses are inevitable to ensure quality of services provided in the laboratory. In another part of this study, the calculation of the cost price and the cost of each of the test groups performed in the laboratory, are being discussed. In this study, urine analysis cost $27,134 which accounted for 4.23% of the total costs. In the Nasirpour et al. study, 29.9% of the total cost was related to urine analysis (14). The low cost of urine analysis tests could be due to lower demand for this test by clients. In this study, admission and sampling group cost ($20,966) which accounted for (3.27%), specialized clinical chemistry cost $75,594 (11.78%), hormones group cost $147,741 (23.03%), tumor marker group cost $15,398 (2.40%), coagulation group cost $17,866 (2.78%), blood bank group cost $8,968 (1.40%), hematology group cost $50,925 (7.94%), serology and immunology group cost $104,909, (16.35%), microbiology group cost $34,831, (5.43%), and clinical chemistry group cost $133,702, (20.84%) of the total costs. In the Nasirpour et al. study, hematology group cost $31,854 which accounted for (1.80%) of total costs, serology and immunology group cost $242,307 (13.67%), microbiology group cost $58,914 (3.32%), and clinical chemistry group cost $923,202 (52.08%) of the total costs (14). The amount of costs of each test group in studied laboratory were proportional to the number of client's visits and performed tests, therefore, the amount of cost has a rational figure and shows the amount of client's demand for each test group.

5. Conclusions

In this study, using Activity Based Costing method, it was found that there was a difference between cost-price and tariffs in private sector. In other words, tariffs have not been determined based on scientific and economic methods and they are less than the real costs of laboratory services in private sector. This has led to studied laboratory facing a budgetary deficit. Findings of current study can be used for cost-price estimating of laboratory services based on defined scientific steps, and consideration of all costs (direct and indirect) and developed tariffs actually and reasonably. It is suggested to overcome the budgetary deficit and financial problems of laboratories due to low tariffs, is to utilize maximum capacity of laboratories by increasing the number of laboratory tests as much as possible. Also, it can be done by decreasing cost-price of laboratory services through the use of appropriate human resource management techniques, multitask delegation to specialized personnel, using fully automatic equipment and devices, and implementing efficient inventory control techniques. Finally, it should be noted that this study may not be representative of the entire range of tests in any other laboratories in the country. Therefore, conducting complementary research on cost-price estimation in governmental and nongovernmental laboratories by using other methods, could be appropriate path for future research on this topic.

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Conflict of Interest:

There is no conflict of interest to be declared.

Authors' contributions:

AM conceived the study, participated in data collection and data analysis, as well as preparation of the manuscript. MB contributed to the development of data collection, carried out data analysis, and contributed to the writing and several edits of the manuscript. MA contributed to the writing and several edits of the manuscript, and contributed to the writing of the manuscript. SS participated in the design of study and contributed to the writing and editing of the manuscript. LV participated in study design, contributed to data analysis and writing of the manuscript, and is guarantor. All authors read and approved the final version of paper.

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