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Measuring the net profit of laboratory services: A case study in Iran

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Abstract

Background: Clinical laboratories need to manage resources properly and scientifically to survive in today's highly competitive environment. In this context, scientific-economic principles should be considered to determine the profitability or loss of laboratories. Thus, in this study, the net profit of laboratory services was measured based on scientific-economic principles.

Methods: This was an applied research with descriptive-retrospective approach. A laboratory was selected from 61 laboratories of Kerman, Iran, which performed the highest number of tests among the laboratories of this city. In addition, due to easy access, it was the most visited laboratory by patients. The present study had 2 main phases: (1) measuring the price of services and (2) calculating the net profit of the studied laboratory. Data analysis was performed using activity- based costing (ABC) as an econometric model and Excel software.

Results: The highest charges were related to direct costs (78.28%); consumable goods (47.26%) and professional and logistic human resources (46.31%) had the highest share of these costs. In the test groups, the most expensive tests belonged to the hormones (23.03%) and clinical chemistry (20.84%). Total cost, revenue, and the net profit of the studied laboratory were 641 645, 1 390 942, and 749 297 USD, respectively. After doing sensitivity analysis (50% increase in the frequency of tests), the following values were obtained: 987 071, 2 086 413, and 1 099 342, respectively.

Conclusion: Some test groups in the studied laboratory were not profitable, and this was due to the high cost of these tests and illogical tariffs. One way to overcome this problem is to increase the frequency of laboratory tests.

Keywords: Cost price, Direct and indirect costs, Net profit, Clinical laboratories, Tariffs

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Introduction

Clinical laboratories are vital departments that assist health care providers in diagnosis, treatment, and prevention of diseases, especially in modern medicine (1-3) because two thirds of important medical decisions are made through the laboratory tests results (4,5). Nowadays, the number of laboratory tests and their requests have increased. The reasons are development of new laboratory equipment and the opportunity provided to physicians in making an appropriate diagnosis (3,6). These factors have led to an increase in laboratory costs (1).

About 10% of total health care costs are spent on laboratory services (1). Nowadays, due to regulations set for the health systems, many countries face financial restrictions (7,8), and thus, it is essential that funds be used efficiently

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↑What is "already known" in this topic:
Laboratories face scarcity of resources due to cost of their services. Direct and indirect costs of laboratories and their profitability should be managed using scientific methods. Activity-based costing is a good method to measure cost areas and profit and loss rates.

→What this article adds:
To avoid bankruptcy, laboratories tend to conduct more profitable tests, which can decrease the quality of services. Increasing the capacity to perform more tests can be one of the solutions for profitability because it decreases costs. Increasing this capacity may result in the integration of laboratories and formation of mega-labs, which can be a suitable solution for providing high quality, accessible, and profitable laboratory services.

to manage clinical laboratories (9, 10). Also, the managers of these sectors should improve productivity and control the costs of the health system scientifically to maintain their position in today's competitive world (1, 3). Controlling costs requires information about resources and costs by different laboratory units. This can be obtained through the use of scientific methods of costing and its analysis (7, 11).

Costs that are directly or indirectly spent on laboratory services can be identified using scientific methods. Costly domains, and on the other hand, the benefits of these domains can also be determined (12, 13). This could reflect the overall profitability of the laboratory and that of each test (14). Net profit is the calculation of the income after deducting costs (15). Jafari Sirizi et al., by calculating the profitability of laboratory and radiology departments in public and private sectors in Kerman (Iran), found that costs of selected tests in laboratories were higher than the tariffs. This situation was less severe in the private sector (11). Buljanovic et al. simulated an economic model to improve the performance of laboratories. They created a model based on SWOT analysis. In reality, laboratories' profit increases with the use of detected strengths and opportunities. Conversely, with the occurrence of threats, the amount of profit will reduce (16).

Kerman is the most developed and important city in the southeast of Iran, with a population of 740 000 and an area of about 45 401 square kilometers. There are 61 laboratories in this city, which imposed over 12 535 000 USD to the health system in 2015. According to Mouseli's study, there were 16 laboratories that performed less than 60 000 tests a year (17). Thus, given the fixed and variable costs, these laboratories are not economic in scale. Thus, calculating their profits and losses using a scientific method is necessary for the survival in the competitive market of laboratories. Therefore, the present study was conducted to examine the cost and net profit of a clinical laboratory in Kerman, Iran, to provide a guidance for better management of clinical laboratories.

Methods

This was an applied research with descriptive-retrospective approach. One laboratory was selected from 61 laboratories in Kerman, Iran. Because the present study aimed at calculating the gained profit from laboratory tests, we selected a laboratory with the largest number of tests, based on the laboratories tariff book. The selected laboratory was able to perform 188 tests of 629 tests in the tariff book, which was the highest number of tests performed among the laboratories in Kerman. Also, due to easy access, it was the most visited laboratory by patients.

This study had 2 main phases: (1) measuring the cost of services and (2) calculating the net profit of the studied laboratory. In the first phase, the cost was calculated using activity- based costing (ABC) and by following formula: Total = Σpersonnel cost + consumable goods cost + depreciation cost + building opportunity cost + energy cost + other costs

Fixed parameters for calculating the above formula were as follow:

- Laboratory area (153 square meters)
- Number of personnel and monthly salary per person
- Pathologist in charge (1 person, 1979 USD)
- Technical (3 people, 990 USD)
- Logistical (4 people, 330 USD)
- Service (2 people, 264 USD)
- Depreciation cost: Dividing the depreciation cost of fix assets by their expected useful life (useful life: 10 to 15 years)
- US Dollar: 30 315 Iranian Rials (According to the Central Bank of the Islamic Republic of Iran at the time of the study)

The cost of laboratory services was calculated based on the steps outlined in Fig. 1. In the first stage of this process, using observation and interview, activity centers (the points where works are done) were identified and the followings were considered: laboratory area (m^2), managerial, technical, and logistical personnel (number of people), depreciation of specialized and other equipment (year), consumable goods (number), energy (m^3), and quality control (USD).

According to activity centers, cost centers (the points where costs are made) were identified and categorized as direct and indirect costs. The outputs were identified by type of costs. Then, costing was done by analyzing the related (fixed and variable) parameters in the incurred costs. In the next step, to determine the cost price, the cost sharing of each activity center was calculated and determined (18, 19).

In the second phase, the revenue of tests was calculated by the following formula:

Total laboratory revenue = Test tariff * Test frequency

Based on the above formula, all 188 tests that were performed in the laboratory were calculated. These tests were in 12 laboratory groups as follow: 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).

After obtaining the costs and revenues of the tests, net profit was calculated using this formula: Net profit = total laboratory revenue - total laboratory cost. Also, with calculating the costing and net profit and implementation of the economic model, sensitivity analysis was done on uncertain

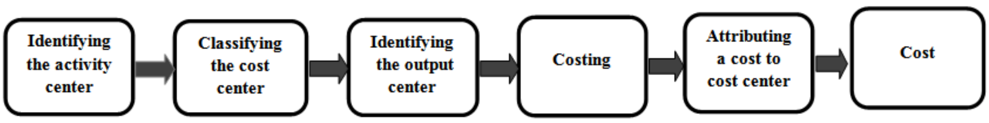

Fig. 1. Cost pricing steps based on activity- based costing (ABC)

parameters, such as frequency of different tests in the form of 50% decrease or 50% increase compared to the existing situation.

Results

Table 1 presents the cost amount and sharing based on direct and indirect cost centers. Based on this table, direct costs accounted for 78.28% and indirect costs for 21.72% of the total costs. In direct cost centers, consumable goods (47.26%) were more costly, and in indirect cost centers, the higher cost belonged to rent (49.55%).

In the laboratory, the most direct costs were related to hormones tests (120 178 USD) and the least costs to other tests (3 248 USD). The highest indirect costs were related to the clinical chemistry tests (38 560 USD) and the least costs to other tests (363 USD). In general, the most cost belonged to consumable goods, with 37%, and the lowest cost to energy, with 0.53% (Table 2).

In addition to calculating the cost of the test groups, the cost of individual test in each group was also calculated and compared with the tariffs. In the coagulation test group, the smallest difference in the cost of tests and tariffs was observed in blood clot test (0.2 USD), and the biggest difference was observed in the anti-platelet antibody test by IVF procedure (36 USD). In the blood bank test group, the smallest difference in the cost of tests and tariffs was detected in indirect coombs test (1 USD), and the biggest difference was seen in direct coombs test (7 USD). In the admission and sampling test group, the smallest difference in the cost of tests and tariffs was detected in virginal, prostate, or urinary tract biopsy (0.5 USD), and the biggest difference was seen in blood sample collection in children under the age of 5 (5 USD).

In the urine analysis test group, the smallest difference in the cost of tests and tariffs was observed in the test of measuring protein in the urine collected during the set time (0.04 USD), and the biggest difference was observed in Bens-Jones urine test through a chemical procedure (53 USD). In

Table 1. Cost amount and sharing based on direct and indirect cost centers in the studied Lab - 2015

Cost Amount and sharing	Direct cost centers				Total	Indirect cost centers					Total
	Consumable goods	Depreciation of specialized equipment	Professional human resources	Logistical human resources		Energy	Quality control	Rent	Depreciation of other equipment	Other	
Cost Amount	$237382	$32327	$160098	$72529	$502336	$3394	$39987	$69024	$20954	$5950	$139309
Cost Sharing	%47.26	%6.43	%31.87	%14.44	%78.28	%2.44	%28.70	%49.55	%15.04	%4.27	%21.72

Table 2. Direct and indirect costs based on laboratory tests group - 2015

Group of laboratory tests	Direct cost centers				Indirect cost centers					Total cost (percent)
	Consumable goods	Depreciation of specialized equipment	Professional human resources	Logistical human resources	Energy	Quality control	Rent	Depreciation of Other Equipment	Other	
Admission and sampling	$ 1006 0.42%	$ 000 0.00%	$ 4312 2.63%	$ 1935 2.67%	$ 530 15.62%	$ 0 0.00%	$ 8700 12.60%	$ 3963 10.58%	$ 619 10.58%	3.27
Urine analysis	$ 4415 1.86%	$ 0 0.00%	$ 5056 3.16%	$ 2322 3.20%	$582 17.14%	$ 1601 4.00%	$ 9413 13.64%	$ 3239 8.64%	$ 506 8.64%	4.23
Clinical chemistry	$ 39308 16.55%	$ 23455 72.54%	$ 22871 14.29%	$ 9508 13.11%	$ 1378 40.61%	$ 10183 25.47%	$ 22299 32.31%	$ 1835 48.97%	$ 2865 48.97%	20.84
Specialized clinical chemistry	$ 33302 14.03%	$ 1445 4.47%	$ 23473 14.66%	$ 10780 14.86%	$ 80 2.36%	$ 3981 9.96%	$ 1298 1.88%	$ 10.68 2.85%	$ 167 2.85%	11.78
Hormones	$ 78281 32.98%	$ 1672 5.18%	$ 27566 17.22%	$ 12659 17.45%	$ 318 9.38%	$ 11745 29.37%	$ 10302 14.93%	$ 4496 12.00%	$ 702 12.00%	23.03
Tumor markers	$ 4411 1.86%	$ 186 0.58%	$ 5658 3.53%	$ 2598 3.58%	$ 35 1.05%	$ 783 1.96%	$ 1148 1.66%	$ 501 1.34%	$ 78 1.34%	2.40
Hematology	$ 26971 11.36%	$ 2705 8.37%	$ 7704 4.81%	$ 3538 4.88%	$ 120 3.54%	$ 3250 8.13%	$ 3888 5.63%	$ 2378 6.35%	$ 371 6.35%	7.94
Coagulation	$ 923 0.39%	$ 1758 5.44%	$ 5176 3.23%	$ 2377 3.28%	$ 78 2.30%	$ 618 1.55%	$ 5150 7.64%	$ 1545 4.12%	$ 241 4.12%	2.78
Blood Bank	$ 525 0.22%	$ 80 0.25%	$ 5417 3.38%	$ 2488 3.43%	$ 4 0.10%	$ 159 0.40%	$ 115 0.17%	$ 70 0.19%	$ 110 1.88%	1.40
Serology and immunology	$ 27294 11.50%	$ 1026 3.18%	$ 45020 28.12%	$ 20675 28.51%	$ 147 4.32%	$ 4643 11.61%	$ 4742 6.87%	$ 1178 3.14%	$ 184 3.14%	16.35
Microbiology	$ 20157 8.49%	0 $ 0.00%	$ 6259 3.91%	$ 2875 3.96%	$ 112 3.30%	$ 2884 7.21%	$ 1813 2.63%	$ 632 1.96%	$ 99 1.69%	5.43
Other	$ 789 0.33%	0 $ 0.00%	$ 1685 1.05%	$ 774 1.07%	$ 10 0.28%	$ 140 0.35%	$ 156 0.23%	$ 49 0.13%	$ 8 0.13%	0.56
SUM	$ 237382 37%	$ 32327 5.04%	$ 160098 24.95%	$ 72529 11.30%	$ 3394 0.53%	$ 39987 6.23%	$ 69024 10.76%	$ 20954 3.27%	$ 5959 0.93%	100

Table 3. Net profit/ loss of the studied laboratory based on test groups before and after sensitivity analysis - 2015

Group of laboratory tests	Before sensitivity analysis			After sensitivity analysis		
	Total cost (USD)	Total revenue (USD)	Net profit / loss (USD)	Total cost (USD)	Total revenue (USD)	Net profit / loss (USD)
Admission and sampling	20966	51983	31017	24700	77975	53275
Urine analysis	27134	42334	15200	36711	63501	26790
Clinical chemistry	133702	406439	272737	233358	609659	376301
Specialized clinical chemistry	75594	115029	39435	111270	172543	61273
Hormones	147741	382198	234457	269292	573297	304006
Tumor markers	15398	84530	69132	17958	126795	108837
Hematology	50925	75423	24498	96238	113135	16898
Coagulation	17866	66519	48653	18109	99778	81669
Blood Bank	8968	2812	(6156)	3645	4218	573
Serology and immunology	104909	129831	24922	106457	194747	88290
Microbiology	34831	31250	(3581)	66123	46875	(19247)
Other	3611	2593	(1018)	3211	3889	678
SUM	641645	1390942	749297	987071	2086413	1099342

Table 4. Amount of changes of the laboratory average costs based on test groups before and after sensitivity analysis – 2015

Group of laboratory tests	Amount of reduced cost (USD)	Net profit / loss (USD)
Admission and sampling	(1)	-%36
Urine analysis	(9)	-%84
Clinical chemistry	(2)	-%36
Specialized clinical chemistry	(3)	-%46
Hormones	(3)	-%57
Tumor markers	(1)	-%61
Hematology	(4)	-%32
Coagulation	(2)	-%30
Blood Bank	(7)	-%33
Serology and immunology	(5)	-%47
Other	(2)	-%73

the tumor marker test group, the smallest difference in the cost of tests and tariffs was observed in the Alpha-fetoprotein (AFP) test (-6 USD), and the biggest difference was seen in Cirsium antigen 15-3 test (-11 USD).

In the hematology test group, the smallest difference in the cost of tests and tariffs was observed in the Total IgE test (-0.2 USD), and the biggest difference was seen in red blood cell fragility test (60 USD). In the serology and immunology test group, the smallest difference in the cost of tests and tariffs was seen in the coombs wright test (-0.1 USD), and the biggest difference was found in Listeria antibody test (IgG, IgM) by ELISA (58 USD). In clinical chemistry test group, the smallest difference in the cost of tests and tariffs was detected in the blood VLDL-C measurement test (0.2 USD), and the biggest difference was seen in the amino acid tests (90 USD).

In the specialized clinical chemistry test group, the smallest difference in the cost of tests and tariffs was found in measuring Vanillyl Mandelic Acid (VMA) test (-1 USD), and the biggest difference was seen in the paper chromatography tests (51 USD). In the microbiology test group, the smallest difference in the cost of tests and tariffs was observed in the direct fungal test (1 USD), and the biggest difference was found in the vaginal culture test (39 USD). And finally, in the hormones test group, the smallest difference in the cost of tests and tariffs was observed in the Aldosterone test (0.2 USD), and the biggest difference was seen in the free beta HCG test (-11 USD).

Also, in the studied laboratory, the net profit was 749 297 USD in 2015, with clinical chemistry tests the most profitable (272 737 USD) and urine analysis tests the least profitable tests (15 200 USD). Other tests, microbiology tests, and blood bank accounted for 1018 USD, 3581 USD, and 6156 USD losses, respectively, in the studied laboratory. With an increase of 50% in uncertain variables, such as frequency of tests in a laboratory, the net profits from 749 297 USD per year will increase to 1 099 342 USD per year (Table 3).

As presented in Table 4, with a 50% increase in uncertain variables, costs of tests reduced from -%30 in coagulation tests to -%84 in urine analysis tests. In hormones test group performed in the laboratory, the smallest difference in test's cost and private tariff was observed in ACE test (0.2 USD), and the biggest difference was observed in Calcitonin test (18 USD). In the other test group, the smallest difference in the test's cost and private tariff was observed in measurement of semen fructose (0.4 USD) and the biggest difference was detected in the measurement of the size, count, motility, and morphology of sperm (0.8 USD).

Discussion

Based on the findings of this study, it was found that direct costs accounted for 78.28% and indirect costs for 21.72% of the total costs. The high costs of consumable goods (47.26%) and human resources (46.31%) increased the direct costs. in the study of Mehrolhassani et al., the share of direct laboratory costs was 94.9%, and compared to the present study, the largest share of these costs was related to human resources (8). Human resources are costly in all parts of a hospital, and this is emphasized by the study of Mouseli et al. that found nurses accounted for 36% of hospital costs (20). In the studied laboratory, the high cost of consumable goods was justifiable due to the large number of clients and excessive use of these goods. However, the exchange rate fluctuations affected the amount of these costs due to the import of many consumable goods.

In addition to determining the total share of direct and indirect costs, the share of each of them was also calculated in different test groups. Based on the findings, group tests of hormones (23.03%), clinical chemistry (20.84%), serology, and immunology (16.35%) had the highest cost as well as other tests (0.56%), and the blood bank (1.40%) had the lowest cost. In the study of Nasiripour, clinical chemistry tests (52.08%) had a high share of the cost of tests. In their study, hematological tests (1.80%) and microbiology (3.31%) had the lowest cost (18). Overall, in laboratories, the cost of different tests depends on the frequency of requests and the cost of a specific test. In the selected laboratory, because it was possible to perform most tests and there were referrals from other laboratories, the frequency of hormones tests was high, and consequently, their costs increased. Also, these tests are inherently costly tests.

Another finding of this study was calculating the cost of individual test in the laboratory tests group and comparing them with the tariff. The biggest cost difference with the tariff in the qualitative measurement of amino acids test was 90 USD per amino acid, and the smallest difference in the measurement of urine in a set duration was 0.04 USD. In the study of Musavi et al., average cost in the laboratory was 0.23 USD, and average variation of the cost was 0.01 USD (13). In the study of Jafari et al., the price of all selected tests was more than tariffs, and the biggest difference was seen in the TSH test (2.80 USD), and the smallest difference was in the ferritin test (0.39 USD). However, vitamin D tests, with the difference of 0.18 USD, and FBS test, with the difference of 0.21 USD, were not profitable. In other tests, the price was lower than the tariff (11). Nasiripour et al., in a study, showed that the most share of the cost belonged to urine analysis tests (21%) and the least share belonged to biochemistry tests (11%) (18). Javanbakht et al. also concluded that the cost of services was higher than the state sector tariff (21). In the present study, the tariffs of some tests were low compared to their cost. This can be offset by increasing the frequency of tests; for example, with an increase of 50% in the frequency of urine analysis test, costs can be reduced from -30% to -84%. Nasiripour et al., in their study, showed that with the increase of test frequency, the difference between calculated cost prices and state sector tariffs were reduced by -63% (18).

In general, in this study, total cost, revenue, and net profit in 2015 were 64,645, 1 390 942, and 749 29 USD, respectively. Clinical chemistry test group with 272 737 USD profit had the most share, and urine analysis test group with a 15 200 USD profit had the least profit. The other, microbiology, and blood bank tests groups accounted for 1018, 3581, and 6156 USD in losses, respectively. In a study of Nouri et al., total hospital costs were 8 062 543 USD (22). Despite the profitability of the studied laboratory, some of the test groups, such as microbiology and blood bank tests, were losses. This requires the adoption of a proper strategy, such as increasing the frequency of these tests by integrating laboratories and establishing mega-labs.

Conclusion

In this study, the cost and the net profit of the studied laboratory services and tariffs of laboratories were considered. The studied laboratory was generally profitable, but it was detrimental to some of the test groups, which was due to the high cost of the tests and illogical tariffs. One of the ways to overcome this problem is to increase the laboratory tests. Taking this approach, the laboratories increase their revenue without inflicting additional costs to the patients. Therefore, if the government does not set appropriate policies and regulations, the quality of the non-profitable tests will decrease. The current situation sends a message to laboratory service providers to concentrate more on profitable services. This may affect the quality of laboratory services that are not profitable (orphan tests). Therefore, policymakers should set appropriate rules to ensure the quality of none- profitable tests in the laboratories.

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Conflict of Interests

The authors declare that they have no competing interests.

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