Prime costs of clinical laboratory services in Tehran Valiasr Hospital in 2009

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التكاليف الرئيسية للخدمات المختبرية السريرية في مستشفى طهران فالياسار في عام 2009

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الخلاصة: يمكن لمحددات التكاليف الرئيسية أن تزيد من الفعالية الإدارية في تخصيص الميزانية والتخطيط الاستراتيجي. وقد صممت الدراسة لحساب التكلفة الرئيسية للخدمات المختبرية السريرية في مستشفى طهران ولي عصر باستخدام نموذج تقدير التكاليف على أساس النشاط. وكانت أعلى التكاليف هي للموارد البشرية (44٪) وأقلها للطاقة (5٪). وكانت أكبر نسبة منها مخصصة للأنشطة التي يقوم بها المختصون (97٪) ، مما يعكس أهمية الموارد البشرية في التكاليف الرئيسية. وكانت أعلى تكلفة رئيسية هي لتحليل البول (11٪ من الاختبارات) وأدناها لتحديد الصوديوم (21٪ من الاختبارات)، وهذا يدل على انخفاض التكلفة الرئيسية مع تزايد وتيرة الخدمة. وكان متوسط التكلفة الرئيسية التقديرية أعلى بـ 63٪ من الرسوم التي وضعتها وزارة الصحة والتعليم الطبي. وتظهر النتائج أن مختبر مستشفى طهران ولي عصر يواجه عجزاً في الميزانية. ويمكن تخفيض التكلفة الرئيسية للخدمات من خلال تحسين إدارة الموارد البشرية الضبط المعياري لاستهلاك الموارد.

ABSTRACT Prime cost determinations can increase managerial effectiveness in budget allocation and strategic planning. This study was designed to calculate the prime cost of clinical laboratory services in Tehran Valiasr Hospital using the activity-based costing (ABC) model. The highest costs were for human recourses (44%) and the lowest for energy (5%). The largest proportion of activities (97%) was by specialists, reflecting the importance of human recourses in prime costs. The highest prime cost was for urinalysis (11% of tests) and the lowest for sodium determination (21% of tests), which demonstrates that prime cost decreases as service frequency increases. The average estimated prime cost was 63% higher than the fees established by the Ministry of Health and Medical Education. The results show that the Tehran Valiasr Hospital laboratory faces a budgetary deficit. The prime cost of services can be reduced by improving human recourse management and standardization of resource consumption.

Coût primaire des services de laboratoires cliniques à l'hôpital Valiasr de Téhéran en 2009

RÉSUMÉ L'établissement du coût primaire permet d'améliorer l'efficacité gestionnaire en matière d'affectation budgétaire et de planification stratégique. La présente étude avait pour but de calculer le coût primaire des services de laboratoires cliniques à l'hôpital Valiasr de Téhéran à partir de la méthode des coûts par activité. Les coûts les plus élevés concernaient les ressources humaines (44 %), et les plus faibles l'énergie (5 %). La majorité des activités (97 %) était le fait des spécialistes, ce qui reflète l'importance des ressources humaines dans les coûts primaires. Le coût primaire le plus élevé était celui des analyses d'urine (11 % des tests) et le moins élevé concernait la détermination du sodium (21 % des tests), ce qui prouve que les coûts primaires diminuent quand la fréquence du service augmente. Le coût primaire moyen estimé était supérieur de 63 % aux coûts établis par le ministère de la Santé et de l'Enseignement médical. Les résultats montrent que le laboratoire de l'hôpital Valiasr de Téhéran est en déficit budgétaire. On peut réduire le coût primaire des services en améliorant la gestion des ressources humaines et l'uniformisation de l'utilisation des ressources.

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Introduction

One of the most important concerns of health and medical care centres is the provision of high-quality health and medical services at the lowest possible cost. To achieve this goal, managers and policy-makers should be aware of the cost of health and medical services and know how to allocate available resources. Rapid increases in the costs of health and medical care worldwide have led health professionals to seek new ways to control costs [1]. More than half of all healthcare resources are spent on a small percentage of the population that is hospitalized each year [2]. In Iran, >4.6% of the gross national product is used to cover health expenditure [3]. Hospitals are the largest and most costly healthcare institutions and consume 50%–80% of the total cost of health and medical care [4]. Although hospitals represent the largest investment in the healthcare system in terms of financial and staff resources, few studies have investigated hospital expenditure, particularly before the 1980s. The study of Newbrander et al. revealed extensive waste of resources in the health and medical care sectors in developing countries [4].

Cost analysis plays an important role in health and medical care policies, and helps decision-makers to develop appropriate strategies to achieve their aims. The costs of services are covered by pre-established fees that reflect the economic conditions in society. If the costs are not analysed accurately based on expert evaluation, inefficiencies could have undesirable effects on the continuity of health and medical care services due to the high cost of equipment and consumables [1].

Activity-based costing (ABC) considers the causal relationship between costs and activities, and provides managerial information in the form of financial criteria. ABC clearly reflects manpower, equipment and systems activities, therefore, it is more useful for managers than traditional accounting methods [5–7]. The ABC approach provides appropriate feedback to allow mangers to control the efficiency of different sections of the hospital [8]. Idoate et al. (1998) showed that the best way to determine the costs of tests was to separate activities and operational expenditures based on ABC [9]. Salehi et al. (2010) showed that the ABC model, by providing real, accurate costs, led to increased efficiency, effectiveness and eventually achievement of the strategic objectives of the organization [10].

In this study we used the ABC method to calculate the prime costs of the 30 most frequently performed laboratory tests provided by the clinical laboratory at Tehran Valiasr Hospital in 2009. The aims of this study were to test the ABC model in a working hospital laboratory to determine whether the analysis has the potential to be applied to the entire range of activities performed by the laboratory, and to identify ways to reduce costs at expensive hospital units.

Methods

The present study was carried out at the clinical laboratory of Valiasr Hospital, Tehran, Islamic Republic of Iran. The hospital is affiliated with Tehran University of Medical Sciences and is a central facility for four hospitals that belong to the Imam Khomeini Hospital Complex. As a result, it provides a range of different services including education, research and diagnosis. The laboratory conducts a total of 790 different tests, including haematology, biochemistry, microbiology, serology, immunology and fluximetry. We carried out a retrospective analysis of the 30 most frequently performed tests in 2009.

Eight data collection forms were used: human resource analysis; non-medical materials consumed in each organizational unit; medical materials consumed in each organizational unit; transportation vehicle use; unit expenditure at physical facilities; annual energy consumption costs; activity and income per unit of activity; and observation of activities. The time devoted to each activity was also recorded. Information was collected based on laboratory costs, performance and work processes. The data collection instrument was based on the information forms mentioned above for the laboratory itself, the assets department, the warehouse, the inventory of documents and instruments available at each unit, and the organizational chart of the laboratory and all related units.

After the structure of the laboratory was studied, we modelled the analysis according to work processes at the laboratory with the MyABCM model in three general categories: resources, activities and cost objects. 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 to compute the prime costs.

To calculate allocated space, the total space used for each activity was calculated and divided from the output of activities (the number of tests) [11–13] For example, for microbiology which is a specialized activity, the outcome is number of tests as a driver. Therefore, we have the total space of the microbiology ward/department and divide that by the output (the number of tests) but for each activity the outcome could be something different depending of the driver.

The depreciation cost of buildings and equipment was calculated in each financial period with the straight line depreciation calculator approach. In this method, given the purchase price,

salvage value and useful life, the depreciation cost can be calculated using the following equation [11]:

- Depreciation = [purchase price – salvage value/useful life (years)] × (actual use load per year/standard use load per year).

Standard use load per year = number of outputs/total capacity of the system, and actual use load per year = number of outputs/system use load.

System efficiency per year = actual use load per year/standard use load per year.

The lack of sufficient data for prices and the year of equipment purchase, as well as the end of useful life, led us to modify the formulae as follows [11–13]:

- Depreciation of the used product = estimated salvage value/estimated useful life (as estimated by the equipment expert);
- Depreciation of facilities = purchase price/45; medical equipment depreciation = purchase price/10; and building depreciation = purchase price/70.

An investment return of 21% is considered appropriate according to the Central Bank of the Islamic Republic of Iran. Accordingly, investment return was calculated at the total value of fixed assets × 21%. The investment return for the property in which the laboratory was built was set at 5% by the Central Bank. Accordingly, investment return was calculated as the property value × 5% [11–13].

According to Table 1 all resources were prorated using resource drivers into the specialized tasks. Personnel costs were divided into four groups: specialized activities, support activities, laboratory assistance activities, and managerial activities, which are prorated according to the number of tasks performed (Table 2). Direct resources such as labour, specialized consumables and specialized equipment depreciation were contributed directly without intermediates over the output, considering the number of outputs of 1 year for each type of test.

The prime cost of a service was calculated as follows [14,15]:

- Cost of one service in the laboratory = direct and indirect labour costs + costs of special consumables + shared service costs + specific costs depreciation (specialized equipment) + contribution of energy costs + other costs;
- Prime cost of a service = the cost of one service in the laboratory/total output of 1 year;
- Total costs of each unit = $N_1Uc_1 + N_2 Uc_2 + \ldots = \Sigma NUc$;
- Prime cost of each unit = Σ NUc/ total output of the unit.

We used *MyABCM* software to calculate prime costs, and used Microsoft *Excel* to determine the relationship between the tariffs and prime costs for each type of service.

Opportunity costs and overhead costs charged to the laboratory by the hospital were not accounted. We analysed only the 30 most frequent tests, therefore, economically nonviable tests were also not accounted.

Results

The first stage in ABC analysis is the identification of resources. On the basis of our information about the operation and organization of Valiasr Hospital laboratory, we identified the resource centres as: personnel, cost of common materials (e.g. sanitation, copying and printing, kitchens) and equipment, cost of specialized materials and equipment (e.g. urinalysis, parasitology, serology and immunology), depreciation of common equipment, depreciation of specialized equipment, depreciation of buildings, energy costs, and other costs (e.g. advertising, and workplace social gatherings) (Table 3). The highest cost was for human resources (44% of the total) and the lowest for energy (5% of the total).

Activity centres were identified and categorized into: managerial activities (technical officer and supervisory activities), specialized activities (serology and immunology, microbiology, urinalysis and parasitology, haematology and biochemistry), laboratory assistance activities (sampling activity, transfer of samples, sanitary and service activities) and support activities (specimen reception, warehousing tasks) (Table 4). The highest expenditure was for specialized activities (85% of the total) and the lowest was for support activities (5% of the total).

The cost units were considered outputs of each activity. In the 30 laboratory tests done most frequently, the main cost, unit income, and profit and the loss were calculated. The highest income was produced by the haematology section (65% of the total income), and the lowest by the biochemical testing section (21%) (Table 5).

Discussion

Prime cost calculation is an important tool for laboratory planning, monitoring, control and evaluation, and can lead to reductions in waste and excess or unusual costs. According to our findings, the hospital laboratory tests done most frequently cost less than other less common tests. Higher output implies less overhead and consequently more profitable activities. Mashadsari (2005) showed that biochemical tests were the most frequent at Yahyanejad Hospital, a general 220-bed hospital in Northern Iran, with 44 040 tests per year, whereas hormonal tests were the least frequent at 1623. As a result, the cost of biochemical tests was lower than hormonal tests, and the efficiency was higher [16].

The materials used are another factor affecting the cost of service provision. The cost of common materials in the

Table 1 Assignment of resource drivers to activities

Type	Resource drivers (assignment of resources to activities)	Drivers
Labour costs	Personnel costs	Activity group
Cost of common materials	Sanitary accessories costs	Office space (m^2)
	Stationary material costs	Number of people & degree of activity
	Copy and print costs	Number of trials per task
	Kitchen costs	Number of people
Cost of special materials	Specific materials used for biochemistry	Number of tests
	Specific materials used for haematology	Number of tests
	Specific materials used for urinalysis and parasitology	Number of tests
	Specific materials used for immunology and serology	Number of tests
	Specific materials used for microbiology	Number of tests
	Common materials used in the whole lab	Number of tests
	Cost of materials used for sample collection	Time allocated to the task
Shared service costs	Building depreciation cost	Office space (m^2)
	Facilities depreciation cost	Office space (m^2)
	Common equipment depreciation costs	Number of pieces of equipment
	Specific equipment depreciation cost	Specific task
	Depreciation costs of equipment	Specific task
	Specific to urinalysis and parasitology section	Specific task
	Specific to immunology section	Specific task
	Specific to biochemistry section	Specific task
	Specific to haematology section	Specific task
	Specific to microbiology section	Specific task
	Cost for depreciation of specific equipment in the whole laboratory	Number of tests per task
Energy costs	Water	Number of people
	Electricity	Number of pieces of equipment
	Gas	Office space (m^2)
	Telephone	Number of people
Other costs	Transportation	Number of people

Table 2 Assignment of activity drivers to cost objects

Titles	Activity drivers (assignment of activities to resources)	Drivers
Managerial activities	Technical control	Number of people
	Monitoring and supervision	Number of trials of each task
Specialized activities	Immunology and serology	Number of tests
	Microbiology	Number of tests
	Parasitology and mycology	Number of tests
	Haematology	Number of tests
	Biochemistry	Number of tests
Laboratory assistance activities	Sampling	Number of trials of each task
	Sanitary and services	Number of people
	Transfer of samples	Number of trials of each task
Support activities	Reception task	Number of trials of each task
	Warehousing task	Number of trials of each task

Table 3 Resource centres and their cost at Valiasr Hospital laboratory in 2009

Resource centre	Cost	
	US$	IRR
Personnel	1 213 223	12 145 580 212
Common materials and equipment	629 561	6 302 537 300
Specialized materials and equipment	43 781	438 288 317
Specialized equipment depreciation	482 505	4 830 359 284
Common equipment depreciation (total)	10 261	102 721 100
Building	*6 061*	*60 610 000*
Facilities	*933*	*9 330 000*
Common equipment, reception, sampling, changing room	*3 383*	*33 830 000*
Energy	1 398	13 998 363
Other	20 857	208 800 000

Valiasr Hospital laboratory was 22% of the overall cost; a relatively high figure for a clinical laboratory. This could have been due to wastage caused by incorrect storage or incorrect usage patterns. Mashadsari reported that the cost of commonly used materials in a hospital laboratory similar to the one studied here was 5.2% higher than for radiological materials, and attributed the difference to suboptimal consumption of materials in the laboratory. According to Norouzi, the materials used in Moayeri Hospital constituted just 3% of the total cost, which reflected an appropriate pattern of consumption [17].

The cost of specialized items used in the clinical laboratory of Valiasr Hospital was 15% of the total costs. In the study of Mashadsari, the cost of specialized devices was 12.4% higher in the hospital laboratory than in the radiology department, and this difference was attributed to the higher cost of the equipment and materials used in the laboratory. In Norouzi's comparison of clinical laboratory costs at Valiasr and Moaeri Hospitals in Tehran, the cost of specialized items was relatively high, which was attributed to the short life span of specialized kits and related materials.

The total depreciation rate at Valiasr Hospital clinical laboratory was 17%, which was high, and may reflect the inefficient use of equipment, resources or available space and purchasing unnecessary equipment. This inefficiency could have several explanations: (1) simultaneous use of the laboratory for different activities such as providing health care services for patients and education and research resources for students and academic personnel; (2) difficulties with equipment maintenance because it is all imported from other countries; and (3) low charges levied by this public hospital compared with its private counterparts (30% less). Rajabi showed that the highest hospital laboratory costs in Iran were for maintenance and depreciation of specialized equipment [12]. The cost of technical services and maintenance at Shahid Faghihi Hospital had a large effect on the cost of service provision, but these costs were justified by the high capital cost of the systems and equipment used in the clinical laboratory. In Mashadsari's study, the lowest laboratory cost was for equipment depreciation, which accounted for 4.7% of the total costs. Compared to other hospitals, the depreciation costs at the Moayeri Hospital clinical laboratory were within an appropriate range [17].

Expenditure on personnel accounted for 44% of the cost at the Valiasr Hospital clinical laboratory, which was the highest cost of the laboratory. This is similar to the findings in several other hospital laboratories and departments in Iran [12,16–19].

Our analysis revealed a discrepancy between government tariffs and prime costs at the Valiasr Hospital

Table 4 Activities and their cost in Valiasr Hospital in 2009

Activity	Price	
	US$	IRR
Specialized activities	2 308 996	23 115 360 528
Managerial activities	19 052	190 725 936
Service activities	16 955	169 740 393
Support activities	14 171	141 861 350

Table 5 Analysis of the financial performance of Valiasr Hospital clinical laboratory in 2009

Expenditure unit	Main cost		Income		Profit/loss	
	US$	IRR	US$	IRR	US$	IRR
Haematology	96 458	965 641 088	97 940	980 476 204	1482	14 835 116
Urinalysis and parasitology	1 564 042	15 657 621 258	273 590	2 738 904 841	321 518	3 218 719 417
Immunology and serology	733 747	7 345 536 842	32 347	323 828 200	–701 399	–7 021 707 642
Microbiology	178 401	1 785 975 656	54 881	549 415 100	–123 520	–1 236 560 556
Biochemistry	2 795 613	27 986 882 106	1 257 929	12 593 130 345	–15 376 461	–153 933 752 061

clinical laboratory, which may be due to unrealistic tariffs on the one hand, and lack of adequate financial management of service provision and performance on the other hand. Abbasi Moghadam noted that lower medical care tariffs and budget deficits can eventually impair hospital performance and put pressure on vulnerable members of society [20]. Shaban Khamse (1998) also discussed financial losses at hospitals due to differences between the cost of services and approved public and private tariffs [21]. According to his study, service tariffs have not increased commensurate with the national inflation rate and prime costs. Roivainen et al (2006) showed that costs calculated with the ABC method were higher than the approved tariffs, and noted that lack of consideration of the costs related to unused capacity was the main factor in this difference [22]. Salem Safi [12] and Rajabi [23] also found that public and private tariffs were lower than actual prime costs; a discrepancy that in their view led to reduced hospital effectiveness and efficiency. Mashadsari also concluded that the prime costs of clinical laboratory and radiology services exceeded government tariffs for these services [16]. Nosanchenk (1995) concluded that, in view of the unprofitable nature of services at public hospital laboratories, managers of these centres should devote greater attention to investment methods [24].

Our present analysis and previous studies at different centres provide evidence that what is being neglected in the process of tariff development are the costs borne by activity centres in the form of overhead costs, which are precisely what the ABC method is able to identify, in contrast to other common costing methods. Hospital budgetary deficits caused by the gap between real-world service costs and the tariffs imposed by the government should be covered through government funding.

Our analysis of activities at the Valiasr Hospital clinical laboratory showed that the highest task-related cost was for specialized tasks (97% of the total). This may reflect the fact that Valiasr Hospital is a teaching hospital with academic faculty members among the staff of the clinical laboratory. In this connection, the study by Rajabi showed that the highest costs at hospital laboratories in Iran were for specialist personnel and equipment [12]. The findings of Norouzi were similar [17]: the highest cost for laboratory tasks at Moayeri Hospital was for specialized tasks (64% of the total), and appropriate management of specialized human resources reduced these costs.

The present study shows that the Valiasr Hospital clinical laboratory faces a budgetary deficit. The reasons for this include low laboratory tariffs compared to the prime costs, weaknesses in human resource management, inefficient usage of resources and equipment, inadequate inventory control and cost monitoring, and lack of precision in recording expenditure and calculating prime costs.

It should be noted that our study sample may not be representative of the entire range of tests in this laboratory or any other laboratories in the country, therefore, the findings should be extrapolated with caution.

The results of this study and other research on expenditure problems at hospitals suggest that the most important factors for decreasing prime costs are 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. Recording hospital costs is also one of the most important measures for expenditure management; unfortunately, existing weaknesses in this area at many hospitals limit the information available to managers, which ultimately affects their decision-making and hospital policies. Training in methods to determine prime costs accurately can play a significant role in cost management, increase hospital income, and ultimately enhance decision-making processes.

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