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Original Article

How is the Cost Structure of Hospital in Developing Countries? A Case of Public University Hospitals in Iran

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Abstract
Introduction: The health systems around the world are facing significant pressure to control the costs and improve the health services delivered. A method to address this challenge is to express the potential savings and inefficiencies of hospitals. The hospitals should provide health care services with the acceptable quality and minimum cost. For this purpose, managers should have accurate information about the cost of the services they provide.
Methods: This is a cross-sectional retrospective study carried out based on the data of financial year of 2017-2018. In this study, the cost structure of Shafa Hospital was analyzed and its unit cost of the final activity centers was calculated using top-down approach.
Results: The total cost of the hospital in the studied period was US$ 265034418.4. The highest and lowest cost share was related to human resources and energy consumption (59.95% and 0.54%, respectively). The human resources, medicines, and consumables account for over 84% of the cost of the final clinical activity centers. The unit cost of the final activity centers varies so that among admission wards the unit cost of ICU is the highest (US$372.45) and the daily bed cost in the neurology ward is the lowest (US$118.9).
Conclusion: Clarification of the hospital cost structure can provide a comprehensive analysis of hospital costs for decision making and policy making. The unit cost of the final activity centers also provides insights into the hospital cost management planning.
Keywords: Costing, Unit cost, Cost analysis, Public hospital, Cost structure.

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Background

Health systems around the world are facing significant pressure to control the costs and improve the health services delivered. A method to address this challenge is to express the potential savings and inefficiencies of hospitals (1). Hospitals are important in the health system because they provide both health services and training of medical professionals. In addition, many of the health system resources are used to provide human resources, medicines, consumables, and equipment (2). Recently, regarding resource constraints and the shift towards more efficient allocation of resources, it seems that the selection of appropriate cost data for economic health evaluations is necessary (3). Occupied beds per day and the costs of para-clinical services in many countries are important components of cost data. Hence, in any hospital setting, the cost of bed day has been reported as the total cost of treatment of a disease (4).

In most hospitals, cost control has become a priority for managers, as various factors that increase the cost of health care services are forcing the authorities to control the costs. (5). The hospitals should provide the community with health care services with acceptable quality and minimum cost. For this purpose, managers need accurate information about the cost of services they provide (6). In this regard, calculating the cost of the occupied bed day in terms of specialty and unit cost can guide decisions of managers and policymakers in this field.

Many studies have been conducted on the cost unit of a hospital ward, but only a few published studies have estimated the cost structure and unit cost of hospitals. Olukoga has addressed the unit cost of admission to five regional hospitals in South Africa (7), Stey investigated the cost of 202 hospitals with abdominal surgery in the United States (8), Bai studied the direct cost of readmission to Medicare and Medicaid discharged patients (9), Aboagye has addressed the cost of care provision at three hospitals in southern Ghana (10), Smet examined the characteristics of hospital cost function (11), Murru has studied hospital costing at Lacor Uganda Hospital (12), and Swierkowski identified hospital cost drivers at mid-sized Australian hospital (13).

The hospitals use buildings, equipment, medicines, and medical resources to provide health care services. The total cost of a medical service includes all hospital costs, including capital and operational costs (14). Given that the share of different types of costs such as direct or indirect, fixed and variable costs varies among different hospitals, it is necessary to analyze and understand hospital costs for controlling and reducing costs (9, 13 ,15). Therefore, the present study was conducted to answer the following questions: What is the hospital cost structure? What cost items are the most expensive to decide? And how much is the unit cost for the final activity centers?

Unit cost could be analyzed by two main techniques of standard costing and activity-based costing (16). Most of the costing studies in Iran were conducted using activity-based costing model and mainly in one ward or unit. Therefore, the purpose of conducting this study is to determine the share of cost items from total hospital cost, identify cost centers, identify direct and indirect costs of the cost centers' output units, calculate the actual cost of a unit out of final activity centers, and finally help the managers make decisions to manage the hospital costs.

Methods

Study Design

This is a cross-sectional retrospective study which was carried out at Shafa Hospital in Kerman based on the data of financial year of 2017-2018. The data of this study was obtained from financial and accounting records. Top down approach was used, so how much the patients or their families have spent (out of pocket) is not considered. This study aimed to identify the cost structure of the hospital and activity centers; we also calculated the unit cost of final activity centers, and finally sensitivity analysis was performed on some cost items.

Study Setting

Shafa hospital is a general teaching hospital in Kerman Province which is affiliated with Kerman University of Medical Sciences. Shafa Hospital is one of the oldest and largest hospitals in the south-east of Iran which was established in 1965 and some wards have been added overtime. The hospital currently operates with a capacity of 381 beds, including 30 ICU beds, 24 CCU beds, 29 emergency beds and 298 general beds. The hospital has 15 inpatient wards, 4 operating rooms, Cath lab, dialysis, nuclear medicine, outpatient clinics, laboratory and pathology, radiology and CT scan, physiotherapy, and radiation therapy. There are 1229 people working at hospital, of whom 869 work in clinical activity centers, 98 in para-clinical activity, and 262 in support activity centers.

Costing Method

The unit cost of the activity centers was calculated using the standard costing method. The top-down approach was used for cost allocation in this study. At the first stage, organizational structure was analyzed, and the activity centers were grouped into three categories of clinical endpoints, para-clinical activity, and administrative-logistic activity centers. In the next stage, direct and common costs including human resource, medicine, medical and non-medical consumables, depreciation, energy, food, and public services (vehicle, waste, green space, health, waste, computer services, repair and maintenance) were calculated for each of the above mentioned activity centers.

The human resource costs include salaries and other benefits such as per case payments and end-of-year bonuses. The bonuses and salaries for each person is constant throughout the year, but per case is calculated based on the person's performance and hospital income during the year, using financial subset of HIS. For the personnel who worked at multiple cost centers, the costs were determined based on the amount of time spent at each activity center. In order to calculate the cost of human resource for each ward, the hospital payroll was extracted from the financial system, and then the cost of each ward was determined based on the personnel involved and the amount they received. The physicians' salaries are also fixed throughout the year, but per case depends on their performance, calculated through financial subset of HIS.

Pharmaceutical and medical and non-medical consumables costs are also recorded in each ward of the Hospital Information System (HIS). For this purpose, in order to calculate the cost of medicines and medical supplies for each ward, the hospital cost information system was extracted for the study period, and for non-medical consumables the costs recorded by the warehouse were calculated and collected for each ward during the same period. Food, energy, and general services costs were also collected using the hospital's financial software system, which included the costs that were largely outsourced.

In order to calculate the capital costs, we estimated the land opportunity cost, equipment, vehicles, and building depreciation cost. The straight-line depreciation approach was used. Finally, to calculate the unit costs, overhead costs (para-clinical and logistic) were allocated to the final activity centers by direct allocation method (Table 1). Then, the unit cost was obtained by dividing the cost of each activity center by the number of service provided during one year.

Data Collection and Analysis

Data collection consisted of four stages: 1) Clinical cost centers (final activity centers) and para-clinical and overhead cost centers were identified (Table 2), 2) Cost data (contracts, properties, personnel payments, etc.) were collected from the Hospital Information System (HIS), 3) A meeting was held to validate the data with the authorities in charge, and 4) If the data for a cost item were not reliable, the relevant ward or other authorities who had the necessary information helped to solve the problem. For example, if the data for a cost item were unclear and/or less than expected, the person in charge of producing the data was contacted for problem solving. A form including cost items and cost centers was used for data extraction, and then the collected data were entered into Excel for analysis.

Sensitivity Analysis

Because of some uncertainties in cost parameters, sensitivity analysis was performed for the salaries (Scenario 1) and costs of medicines (Scenario 2). The salary increases according to the inflation rate, and the price of the medicine depends on the inflation and exchange rate set by the government. For this purpose, regarding the current conditions, we increased the cost of human resource and medicine items by 20% and examined its effect on the unit cost of the final activity centers.

Results

The cost data for financial year are from October 2017

Table 1: Overhead cost centers, allocation basis, and calculation method

No.	Cost centers / items	Details of costs	Allocation basis	Calculation method
1	Energy	Cost of utilities, gas and telephone	Area(m^2)	$\text{hospital total energy cost} \times \frac{\text{each ward area}}{\text{area of hospital}}$
2	Repair and maintenance	Includes human resource costs, depreciation of buildings and equipment, energy, consumables	Area(m^2)	$\text{Total cost of hospital facility} \times \frac{\text{area of each ward}}{\text{area of hospital}}$
3	Admission	Includes human resource costs, depreciation of buildings and equipment, energy, consumables	Number of admissions of each ward	$\text{Total cost of hospital admissions} \times \frac{\text{admissions of each ward}}{\text{total admissions of hospital}}$
4	Food	Contract cost, energy and power supply unit cost	Bed day	$\text{Total cost of hospital food} \times \frac{\text{day bed of each ward}}{\text{total day bed of hospital}}$
5	Depreciation	Cost of depreciation of building and capital equipment	Area(m^2)	$\text{Total cost of hospital depreciation} \times \frac{\text{area of each ward}}{\text{area of hospital}}$
6	security	Includes human resource costs, depreciation of buildings and equipment, energy, consumables	Area(m^2)	$\text{Total cost of hospital energy} \times \frac{\text{area of each ward}}{\text{area of hospital}}$
7	Laundry	Contract cost	Number of admissions of each ward	$\text{Total cost of hospital lange} \times \frac{\text{admissions of each ward}}{\text{total admissions of hospital}}$
8	Para-clinic	Costs of human resource, depreciation, energy, medical and non-medical consumables	Number of admissions	$\text{Total para} - \text{clinic cost of hospital} \times \frac{\text{admissions of each ward}}{\text{total admissions of hospital}}$

Table 2: Cost centers identified at Shafa Hospital

No.	Clinical cost centers	Overhead cost centers	
		Para-clinical cost center	Administrative and logistic cost centers
1	CCU 1	Pathology	General administration
2	CCU 2	Laboratory	Repair and maintenance
3	Stroke ICU	Ct scan	Admission and discharge
4	Heart ICU	Physiotherapy	Medical Equipment
5	General ICU	Radiotherapy	Kitchen and nutrition
6	Orthopedic	Radiology	Repair and maintenance
7	Emergency		Security
8	Reconstructive surgery		Public services
9	Eye surgery		Laundry
10	Heart surgery		
11	ENT		
12	Heart internal		
13	Neurology1		
14	Neurology2		
15	Rheumatology		
16	Burn		
17	Angiography		
18	General Operation Room		
19	Eye Operation Room		
20	Burn Operation Room		
21	Health Operation Room		
22	Outpatient clinics		
23	Dialysis		
24	Nuclear medicine		

Table 3: Percentage of the cost item of hospital activity centers (Cost in USD)

	Final clinical activity centers		Para-clinical activity centers		Administrative& supportive activity centers		Total of activity centers	
	Cost	Percent	Cost	Percent	Cost	Percent	Cost	Percent
Human resource	118940883.8	62.47	259706189.4	259706189.4	445148907	43.79	158898656	59.95
Drug and medical consumable	63773316.67	33.50	23416251.6	23416251.6	11079087.6	1.09	65728835	24.80
Medical Depreciation	4094244.048	2.15	10112004	10112004	25820020.8	2.54	6131206.905	2.31
Building Depreciation	190791.9048	0.10	471219	471219	1203211.8	0.12	285714.2857	0.11
Non- medical consumable	2442783.81	1.28	4109775.6	4109775.6	27701079	2.73	4246120.238	1.60
Energy	954184.0476	0.50	2356653.6	2356653.6	6017482.8	0.59	1428908.333	0.54
Outsourcing	0	0	0	0.00	183002227.8	49.19	10374275.95	10.69
Total	190396204.3	100.00	300172093.2	100.00	15190803.6	100.00	861156.6667	100

to October 2018. The total cost of the hospital during the studied period was US$ 265034418.4 (42,000 Rls. per dollar). Cost structure by cost items and activity centers is presented in Table 3. Inpatient costs and operating rooms contributed to about 90.5% of all costs, whereas outpatient services contributed the remaining to 9.5% of total costs. The average cost per visit was US$39.5 for outpatient department. The highest costs were related to human resources with 59.95% of total hospital costs and the lowest costs belonged to energy with 0.54%. Among the cost items, human resources accounted for the highest share among the three categories of final activity centers. Also, human resources, medicines and medical consumables accounted for more than 84.75% of the cost of the final clinical activity centers (Table 4). Figure 1 also shows the share of hospital costs by clinical, para-clinical, administrative, and logistic cost centers. 71.84% of the total hospital costs were related to final activity centers, 6.42% to para-clinical centers, and 21.74% to administrative, support and overhead centers.

The unit cost of final activity centers varied so that among the wards the unit cost of ICU was the highest (US$372.45) and the cost of a bed day in the neurology ward was the lowest (US$118.9). Among

Table 4: The unit cost of different wards of Shafa hospital (Cost in USD)

Final activity centers	Services unit	Active bed	Inpatient day/ admission	Direct cost	Shared cost	Total cost	Percent of total cost	Unit cost
CCU 1	Bed day	12	4113	680189.18	299835.42	980024.6	3.29	22.72
CCU 2	Bed day	12	4303	608511.48	317888.31	926399.79	3.11	21.52
Stroke ICU	Bed day	7	2206	389898.54	257218.52	647117.06	2.17	293.34
Heart ICU	Bed day	13	3602	899283.28	442270.79	1341554.07	4.51	372.44
General ICU	Bed day	10	3493	742761.95	405679.93	1148441.88	3.86	328.78
Orthopedic	Bed day	23	3363	629015.58	251768.97	880784.55	2.96	261.9
Emergency	Admission	29	6493	1699557.78	1265629.1	2965186.88	9.97	82.56
Reconstructive	Bed day	22	2003	427670.32	298335.34	726005.66	2.44	154.66
Eye surgery	Bed day	36	4097	546038.42	366818.28	912856.7	3.07	179.9
Heart surgery	Bed day	20	3189	875850.71	246309.17	1122159.88	3.77	351.88
ENT	Bed day	37	4694	447468.31	339897.83	787366.13	2.65	146.48
Heart internal	Bed day	52	5074	1665569.41	567172.09	2232741.5	7.50	229.23
Neurology1	Bed day	37	3189	771229.97	548627.64	1319857.61	4.44	118.89
Neurology2	Bed day	30	5375	681557.18	458983.73	1140540.91	3.83	138.19
Rheumatology	Bed day	33	9740	709012.40	485515.55	1194527.94	4.01	284.54
Burn	Bed day	8	11101	206889.74	153038.72	359928.46	1.21	226.37
Angiography	Admission	No applicable	8253	1201294.55	254380.28	1455674.83	4.89	381.26
General Operation Room	Surgery	No applicable	4198	1233102.26	451387.94	1684490.2	5.66	1473.74
Eye Operation Room	Surgery	No applicable	1590	491797.70	264811.1	756608.8	2.54	220.2
Burn Operation Room	Surgery	No applicable	3818	313103.25	158327.03	471430.28	1.58	258.31
Heart Operation Room	Surgery	No applicable	1143	1325690.15	351546.12	1677236.27	5.64	1533.12
Outpatient clinics	Visit	No applicable	3436	1224130.62	1606511.21	2830641.83	9.51	39.5
Dialysis	Admission	No applicable	1825	951535.38	438689.79	1390225.16	4.67	89.63
Nuclear medicine	Admission	No applicable	1095	480478.78	320259.31	800738.09	2.69	108.13
Total	No applicable	381	92804	19201636.94	10550902.17	29752539.08	100	No ap-plicable

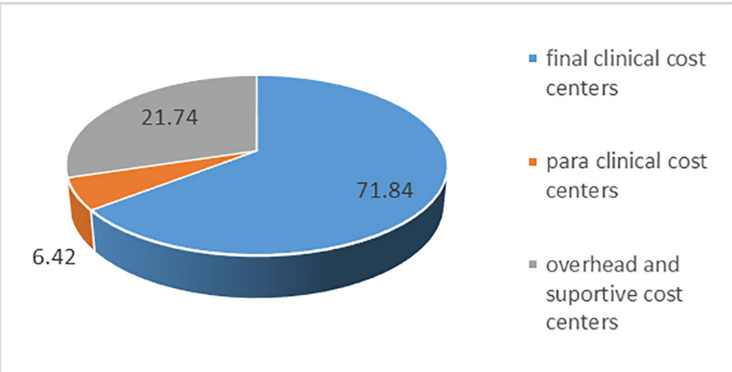

Figure 1: Cost percentage of final activity centers of total hospital cost

the operating rooms, the cost of heart operating room was the highest (US$1533.12) and that of the eye operating room was the lowest (US$ 220.2). The cost of an outpatient visit was US$39.5 and that of admission for each hemodialysis and nuclear medicine patient was 89.63 and US$108.13, respectively.

Sensitivity Analysis

Sensitivity analysis (as explained earlier) indicated that a twenty percent increase in salaries caused the unit cost of General Operating Room and Heart Operating Room to increase mostly, with 10046310 and U$ 8673460, respectively; also, a twenty percent increase in the cost of medicine led to the highest increase in the unit cost of general ICU and the burn ward with their unit cost reacheing 335209 and US$ 201996, respectively (Figure 2).

Discussion

This study was conducted to explore the hospital cost structure and determine the unit cost of the final activity centers. In this study, the cost of human

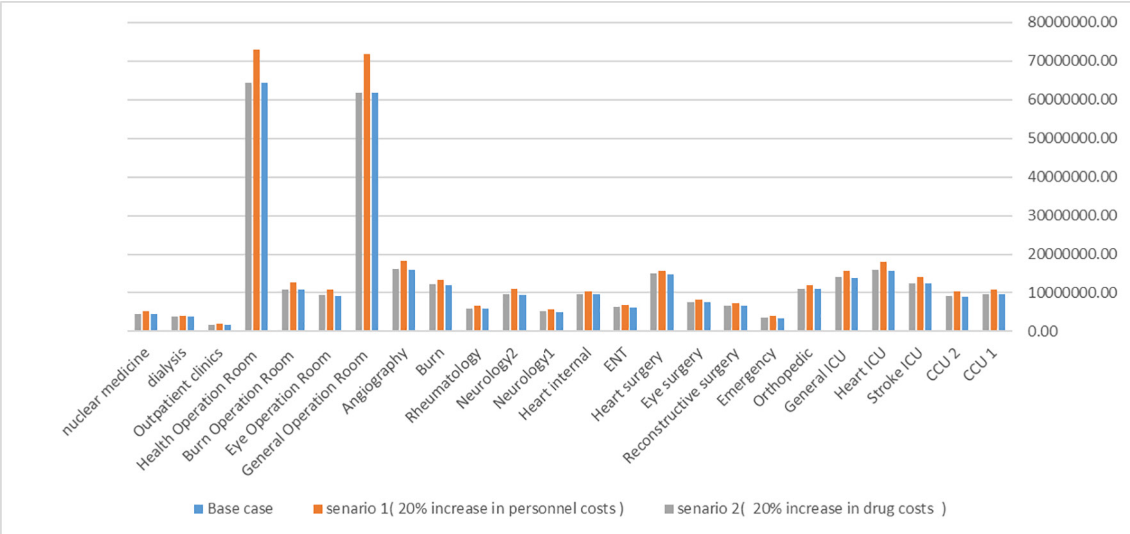

Figure 2: Sensitivity analysis of uncertain parameters of the model

resources, medicine, and medical consumables had the highest share in the hospital costs. The results of the present study are consistent with Noori et al.'s (2013) study at a military hospital in Tehran (17) and Younis et al.'s study in Palestine in 2008 (18), indicating that human resource and medicine and supplies accounted for the highest share of the hospital costs.

The study results are almost consistent with this Pareto's theory (19), as 86% of the studied hospital costs comprised of human resources, medicines, and medical consumables. The managers and policymakers, by identifying the cost items and classifying them according to Pareto's theory, can efficiently use the resources which impose the highest cost on the organization.

Similarly, Chatterjee et al. concluded that human resource cost was the highest in regional and tertiary hospitals and medical consumables accounted for the largest share of the total hospital costs in private and charitable hospitals (20). This is probably because more human resources are employed in public hospitals, and the provision of medicines is largely subsidized. It also costs less in the private sector due to closer monitoring of human resource and higher productivity. Difference in the nature of services, applying clinical guidelines and cost-effectiveness of medications could be the other reasons.

In some other studies, such as that carried out by Than et al. who studied the unit costs of the two public hospitals, the most costly contributions in one hospital were medicine and human resources, respectively, and in another hospital the equipment, medicine and consumables had the highest share of the cost of components of the whole hospital. The reason for this difference is in the cost structure, the differentiated specialist services, and the level of hospital specialization despite the equal number of beds (2). In a study by Noori et al., the cost of medicine and human resources accounted for the largest share of the total hospital costs (20). Therefore, identifying the structure of cost items that imposes the most costs on the hospital can help the managers pay more attention to the item cost management plans. It also helps the policymakers to find new and appropriate strategies to improve the financing system, control costs, and finally increase the efficiency.

In the present study, the unit cost was calculated for inpatient, operating rooms, outpatient, and dialysis clinics. Among the wards, cardiac surgery ICU had the highest bed day costs and the lowest bed day costs belonged to the neurology ward. Among the operating rooms, the heart operating room had the highest unit cost and the lowest cost belonged to the ophthalmology operating room. The highest bed day costs were related to ophthalmology ward and the lowest costs belonged to the dental ward (2). In a study by McPake, the highest unit cost was for the general operating room, which is consistent with the results of the present study (21). However, depending on the technology and human resource involved, the cost structure may vary from one country to another and even from hospital to hospital. However, studying and analyzing the costs for policymakers in the field of efficient and effective supply and use of resources seems necessary.

Of human resource costs, 63.84% were related to non-medical personnel and 36.16% to medical personnel. Among the final activity centers, emergency with US$1270813 (10.5%) followed by general operating room with US$1015999.9 (8.4%) accounted for the largest share of human resource costs. Among the diagnostic centers, laboratory and radiology accounted for the largest share of human resource costs, with US$405936.27 (27.4%) and US$378426.08 (25.5%) respectively.

Neurology ward had the most expensive medicines, with U$234109.36 (16.88 percent). Cardiac surgery ward had the highest cost of medical consumables with US$ 1004776.42 (19.37%) and the highest non-medical costs with US$234109.36 (26.26%).

The hospital depreciation accounted for a small part of the total hospital costs (2.16%). It seems that the main reason for the low cost of depreciation of the total cost of the hospital is its old building and the use of some medical equipment whose shelf life is longer and their depreciation is not calculated by the software system.

Conclusion

This study provides information about the total cost of the hospital and cost items that can assist the policymakers and managers of health system in budget allocation decisions. The cost of human resources items, medicines, and consumables accounted for the largest share of the costs, so the hospital authorities can prioritize these cost items in the planning and cost management programs to control the hospital costs. The calculated unit cost provides guidance for outsourcing of the wards and units of the hospital. Also, identifying the cost structure and calculating the unit cost of the final activity centers provide insight for the hospital cost management planning, so this paves the way for hospital authorities to get involved in interventions for reducing hospital costs. Finally, the results of this study were made available to the hospital authorities for decision-making, planning, and reviewing the efficiency of the wards and the hospital.

Strengths and Limitations

To the best of our knowledge, this is the first study which has collected and analyzed the details and identified public university hospital cost structure in Iran. Another strength of this study is using up-down costing approach according to the hospital spending.

On the other hand, this study faced some limitations. The first was the difficulty of access to the physician's salary and benefits due to the confidentiality issues. To overcome this limitation, we calculated the amount received by each specialty and allocated them based on the income of each specialty as its cost. Second, we were unable to select several hospitals for two reasons: A) This study was the result of a student dissertation and should be completed at a specified time, and B) The hospitals differ in terms of the number of wards and nature of health services they provide. Therefore, we did a comprehensive analysis of the hospital cost structure. And the last, few studies have been conducted on the unit cost of hospitals and there is few sources for discussion and comparison of the study results, so we discussed the comparison of the results with precaution.

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