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Microeconomic Analysis of Healthcare Services in Bou Ali Sina University Hospital

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Abstract

Background and Objectives: Efficient hospital management requires appropriate cost and price strategies. Informed decision on costs and prices of healthcare services needs estimation of costs of unit services using microeconomic techniques. There is lack of knowledge and skills for such costing methods in the healthcare sector of developing countries such as Iran. This study aims at detail description of a relatively simple microcosting method by cost analysis of unit healthcare services in Bou Ali Sina University Hospital affiliated to Qazvin University of Medical Sciences, Iran.

Methods: A cross-sectional descriptive study was conducted in Bou Ali Sina hospital over the period of October-December 2010. A volume-based top-down microcosting approach was adopted to calculate the average costs of unit services in the facility. Hospital departments were identified and clustered into three categories of general/overhead, intermediate, and final cost centers. The costs were classified into two direct and indirect groups. Data was collected using standard operational budgeting sheets. Costs were prorated using a step-down allocation method. Final units' bed-day indices and the revenue generated from medication services were determined by reviewing hospitalized patient records. The net profit of each medication unit was calculated based on services cost data and occupied bed-day data. Hospital financial performance was analyzed using break-even analysis.

Findings: Over half of the hospital costs were found to incur in intermediate departments (Nutrition, Laboratories, Pharmacy, and Diagnosis Testing departments), and the rest were equally related to general/overhead and final units. Over 75% of the hospital expenditures were direct costs, half of which being related to human resources expenses. An 80% bed-day occupancy rate was identified, with CCUs having the highest, and Ophthalmology Ward having the lowest rate. The hospital turned out to be in net loss with the majority of losses caused by ICU, CCU 2 and Internal Ward 1. The data suggests that the hospital can make significant revenue by activating unoccupied bed-day capacity of Ophthalmology and Heart wards.

Conclusions: Microeconomic analysis of unit services is instrumental to identifying the areas requiring strengths and areas for improvement in hospital financial management. Such an analysis can also provide insight into practical strategies for improving hospital financial performance.

Keywords: Hospital Economics, Hospital Financial Management, Hospital Costs, Hospital Charge, Microcosting, Volume-based Costing, Break-even Analysis, Financial Performance

Background and Objectives

Healthcare is one of the world's largest services sectors absorbing over 8% of global GDP [1] and 5-10 percent of total government budget in most developing countries [2]. In low and middle-income countries (LMICs), the majority of healthcare services are provided by public sector [3, 4] and hospitals are responsible for the major share of healthcare expenditures [5]. Annually 50-80 percent of total health budget, and a great share of qualified and educated work force are dedicated to healthcare facilities [2]. In Iran, despite allocation of 5.5 percent of GDP to the health sector [6], and consumption of 40% of total health budget by healthcare settings [7], there still is a large gap between the volume of available services delivered by hospitals and demands of the society. On the other hand, the increasing trend of population growth and the changing composition of population are expected to ever increase demand for healthcare services in the future, which in turn can lead to significant government budget

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deficits [3]. Overcoming these challenges and balancing the financial burden of healthcare services on the government requires imposing appropriate constraints on the current healthcare expenditures, and adopting effective cost-control and pricing strategies.

In order to balance between quality, availability, and the costs of medical services, managers need information on costs of unit services [8]. While the conventional accounting systems used in healthcare organizations are useful in meeting basic accounting needs, they are not capable of providing these types of information. Indeed, availability of such information mostly relies on detailed economic analysis of healthcare services rather than hospital expenditure accounting. However, the knowledge and awareness of related analysis techniques is limited to healthcare sectors of developing countries, particularly at the organizational level [9]. This calls for enhanced attention and active contribution of universities and research institutes to promoting the knowledge of microeconomic evaluation of healthcare services.

The approaches to cost analysis of unit services are categorized based on three factors, each representing a particular aspect of costing accuracy. They include: (1) the level of cost component aggregation (gross costing versus microcosting); (2) the method of valuating cost components (top-down versus bottom-up costing); and (3) the method of calculating indirect costs (volume-based costing versus activity-based costing) [10]. In gross costing, cost components are defined at a high level of aggregation, while in microcosting the most detailed levels of virtually all components related to costs are considered [11]. On the other hand, in the top-down approach, cost components take values obtained from decomposition of total unit costs, resulting in average unit costs per patient, whereas in the bottom-up approach the resources directly utilized for each patient are identified, and the cost components receive value accordingly [10, 12]. The bottom-up microcosting method allows for the most accurate and reliable cost evaluation. However its application is challenged by the great amount of time required and the absence of adequate hospital information systems [13]. By contrast, the top-down approach, though not capable of tracing costs to the individual patient, enables estimation of virtually all cost components for the average patient [10].

Yet another aspect of cost analysis of healthcare services is the way indirect costs are calculated. Costs of healthcare services are divided into two categories: direct costs and indirect costs [11, 14]. While direct costs are mostly incurred by final services delivered (labor, material, and medication), indirect costs are incurred due to overhead and general services such as support, administration, and coordination. Evidence shows that indirect costs comprise a considerable share of total costs in hospitals [15-17]. Hence, accurate evaluation of them is essential to valid cost analysis of unit healthcare services [10, 17]. In volume-based costing (VBC) method, indirect costs are assigned to each component using a single volume-based cost driver (such as labor time hours or the number of inpatients) [14, 18-20]. Alternatively, in activity-based method (ABC) method, where all cost-incurring events and transactions are considered as “activities”, a specific cost driver is defined for each activity, and the costs of activities are assigned to the services by the corresponding cost drivers [18, 21, 22]. Although the latter approach has proven more accurate, it is complex, expensive, and highly time consuming. Besides, its efficient application requires identification of all activity-based cost drivers, which is not always convenient [18, 23]. However, the VBC method allows for a more feasible and straightforward calculation of costs of unit services.

Given the type and quality of accessible date and accuracy scope of this study and based on the relative advantages of the methods mentioned and the feasibility concerns, herein the methods and results of volume-based top-down microcosting of unit services for the average patient in Bou Ali Sina Hospital of Qazvin University of Medical Sciences (QUMS) is presented. We attempt to show how the results can help elucidate the strengths and weaknesses of the current style of resources allocation, identifying inefficient cost centers and drawing solutions for the health facility efficiency challenges.

Methods

A cross-sectional study was conducted during October-December 2010 in Bou Ali Sina hospital, affiliated to Qazvin University of Medical Sciences (QUMS) based on the accounting information of 2009 fiscal year. Standard data sheets were used for data collection and costing [14]. Variables inside the sheets included human resources statistics for each separated cost center, general and energy expenditures, employee costs for each separated cost center, the cost of consumable materials for each separated cost center, and output variables of services-providing units.

The costing method was adopted from Shepard (1998) [14], which outlines seven steps required for implementing step-down cost accounting. They include: 1) defining the final product; 2) defining cost centers; 3) identifying the costs of each input; 4) assigning the input to cost centers; 5) allocating all costs to final cost centers; 6) calculating total and unit costs for each final cost center; and 7) reporting the results. The details of our adopted procedure are described as follows:

1. *Defining final services:* In this study, we aimed at calculating the unit costs in individual departments to facilitate

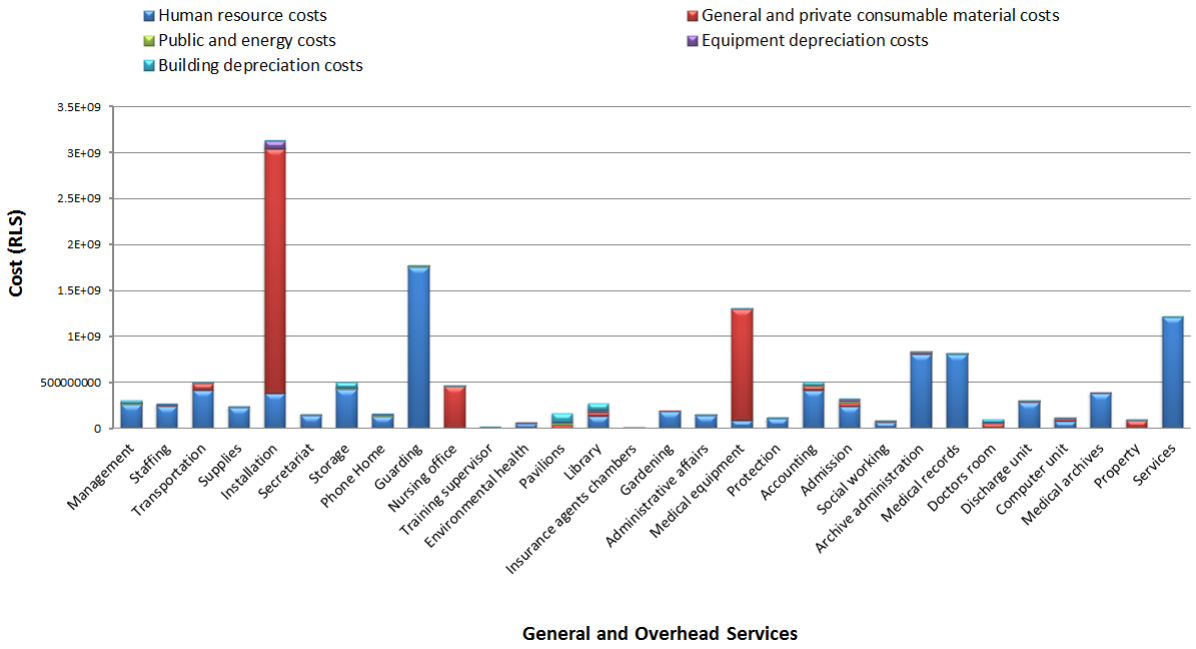


Figure 1 Distribution of human resources and capital costs over general and overhead units

cross-department comparison of costs. Patient care was defined as the final goal of hospital activity for which the unit costs were set to be calculated.

2. *Defining cost centers:* The hospital organizational chart was analyzed and the related departments were identified. Based on their relationship with the organization's final goal, the cost centers were clustered into three hierarchical categories:

2.1. Overhead and general services departments: They include general, administrative and support centers whose activities are only indirectly related to final services. Instances of cost centers in this category are management and administration affairs department, utility unit, transport unit, and warehouses.

2.2. Intermediate units: They include departments that are not creating direct patient outcomes, yet their activities are essential to the proper function of medical units. In our study, the intermediate centers consisted of Pharmacy, Laboratory, Nutrition, Radiology, Endoscopy, Laundry and Tailoring, Optometry, Eco test, and Exercise test.

2.3. Final cost center: They are responsible for direct delivery of healthcare services to patients. The ultimate goal of the hospital (patient care) is realized in these

Table 1 Break-down measures for step-down cost allocation in the hospital [14]

Cost center		Proration measure
Overhead/general services departments	Administrative activities	Direct spending percentage
	Storage	
	Repair and maintenance	Area
	Housekeeping activities	
	Safeguarding	
	Nursing	Nursing personnel
	General services	
	Kitchen	
Intermediate departments	Laundry	Bed-day
	Drug store	Direct spending percentage
	Tailoring activities	Nursing personnel

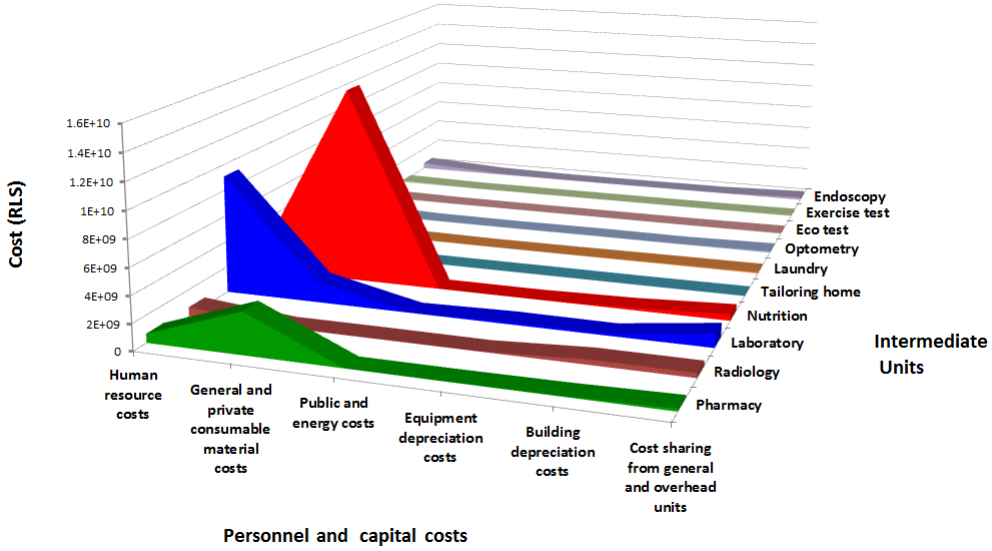


Figure 2 Distribution of human resources and capital costs over intermediate units

departments. In our hospital, the final cost centers included Infection Unit, Neurology, Ophthalmology, Cardiology, Internal wards 'CCU' and ICU.

3. *Identifying costs of each input:* All resource cost items were outlined based on the available accounting documents. The cost of personnel was calculated by summing up staff base salaries and overtime and wages, and taking into account the insurance, tax and deductions. The costs of material and equipment were outlined based on available accounting data. The costs of depreciation was calculated according to the straight-line method as follows:

$$DC = A - B / C \qquad (1)$$

where DC is the depreciation cost; A is current value of asset; B is estimated dismantled value of asset; and C is the useful life of asset.

4. *Grouping and allocating directly relevant costs:* Some costs could be directly assigned to their cost centers [14]. For instance, costs of vehicles and fuel were related to the transport department in the general/overhead services category. Similarly, costs of laboratory material/equipment, drugs and foodstuffs were directly assigned to the corresponding cost units in the intermediate sector. In addition, because distribution of human resources over cost centers was available from the accounting system, the cost of personnel was prorated over these three high-level categories accordingly.

5. *Assigning costs of overhead/general services to intermediate cost centers:* Indirect costs were assigned to intermediate cost centers using a step-down allocation approach. Based on the breakdown measures suggested by Shepard [14] (Table 1), the overhead/general service costs were prorated among the intermediate centers in a

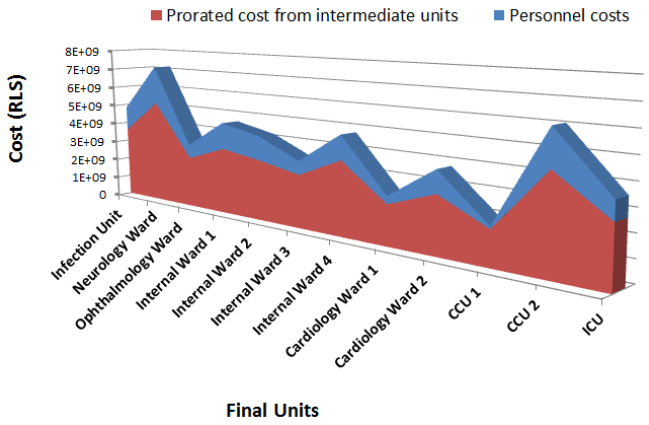


Figure 3 Distribution of direct costs (personnel cost and prorated cost from intermediate departments) over final units

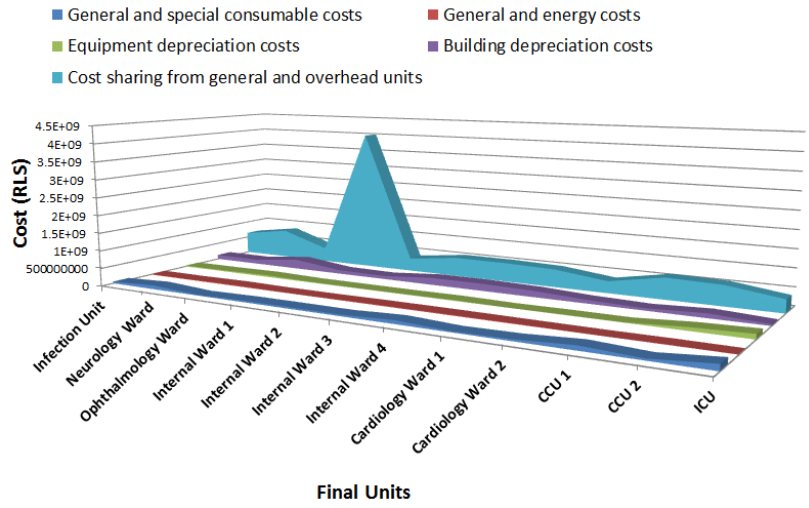


Figure 4 Distribution of indirect costs (general/overhead and capital costs) over final units

stepwise manner. In addition, unidirectional flow of resources through the hierarchy of cost centers was assumed, which implies that the upper-level centers do not receive resources from (impose cost to) lower-level centers.

6. *Assigning costs of general/overhead and intermediate services to final cost centers:* The costs of resources flowing directly from general/overhead cost centers to the final cost centers were assigned to the final units as indirect costs. The portions of direct costs due to the use of intermediate resources/services were also assigned to the final units. Similar to step four, a stepwise unidirectional down-flowing allocation of resources was applied.

7. *Calculating the cost and revenue of service unit:* Based on the active bed data, bed-day capacity and the occupied and empty bed-day of individual medication units were calculated. The bed-day rate of each ward was obtained by dividing the occupied bed-day by total bed-day. The cost of final unit services (bed-day hospitalization cost) in each ward was calculated as the ratio of the total ward's cost to its occupied bed-day. The bed-day revenue of each ward was calculated by multiplying the corresponding occupied bed-day by current bed-day price. The bed-day prices were obtained from the records of the hospital's patient records. The deductibles, insurance, and deductions and discounts provided by Hospital Social Work Union were incorporated into net revenue calculations. Subtracting the bed-day hospitalization revenue from bed-day hospitalization cost gave the bed-day hospitalization variance that indicates the profitability of services delivery in each ward.

8. *Break-even analysis:* To determine the services volume required by each ward to meet its expenditures based on

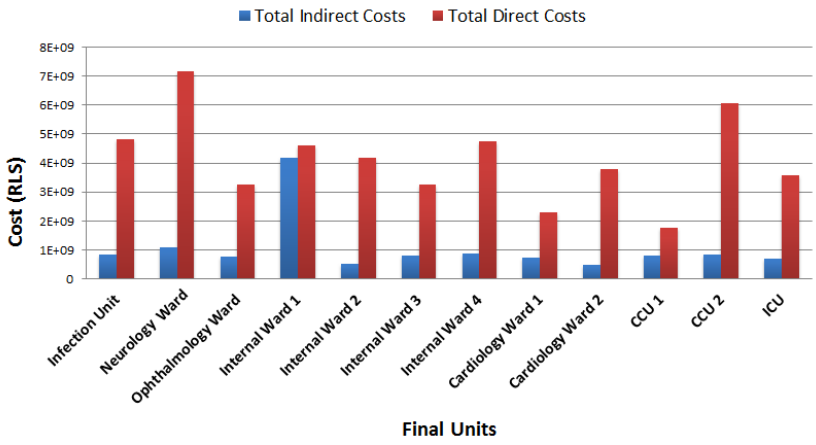


Figure 5 Direct costs vs. indirect costs in final units

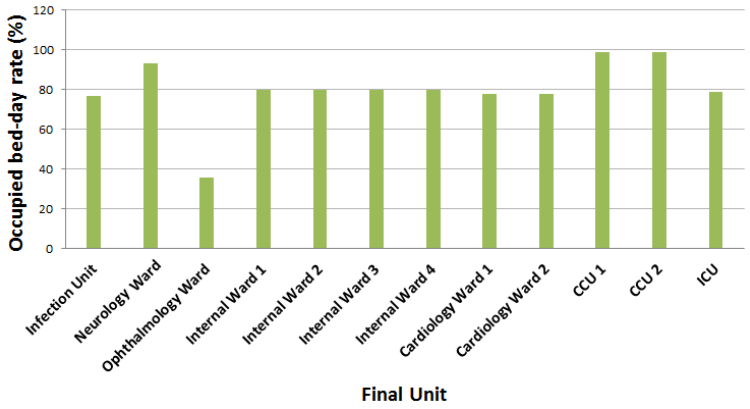


Figure 6 Occupied bed-day rate in each final unit

the current price of unit services, a break-even analysis was carried out. The break-even point is a point at which cost and revenue are equal, thus neither profit nor loss is made. The break-even point was calculated according to the following formula [24]:

$$VC.U = [25\%(BMEC.U + EC.U)] + NGSCM.U \quad (2)$$

$$FC.U = TC.U - VC.U \quad (3)$$

$$BE.U = FC/(SP.U - VC.U) \quad (4)$$

$$BE.V = FC/[1 - (VC.U/FC.U)] \quad (5)$$

with VC.U, the variable cost; BMEC.U, cost of building, maintenance and equipment; EC, energy cost; NGSCM.U, non-general and specified consumable materials; TC.U, total cost (indirect costs + direct costs); FC.U, fixed cost; B-e.U, break-even services volume; SP.U, service price; and B-e.V, break-even revenue of each final unit.

A margin of safety was also calculated for each final unit that measures the extent to which the unit's income can decline before that unit could have a net loss. The margin of safety is calculated by subtracting the break-even income from the actual income. The percentage of margin of safety (margin of safety ratio) was calculated according to the following equations:

$$CR.U = SP.U \times CSV.U \quad (6)$$

$$MS.U = [(CR.U - BE.V)/CR.U] \times 100 \quad (7)$$

where CR.U is the current revenue; CSV.U is the current services volume and MS.U is the margin of safety.

Results

A summary of cost analysis results is presented in figures 1 to 10, and result details are given in Additional File 1. Figure 1 compares the costs incurred in different general/overhead services units. As seen, the highest cost has occurred in Installation Unit followed by Security and Medical Equipment units. Personnel cost is the largest cost component in support and administrative departments. Personnel cost and the cost of consumables together

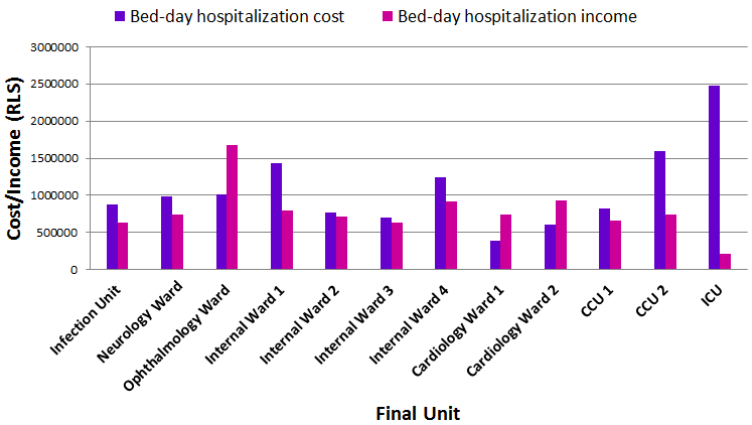
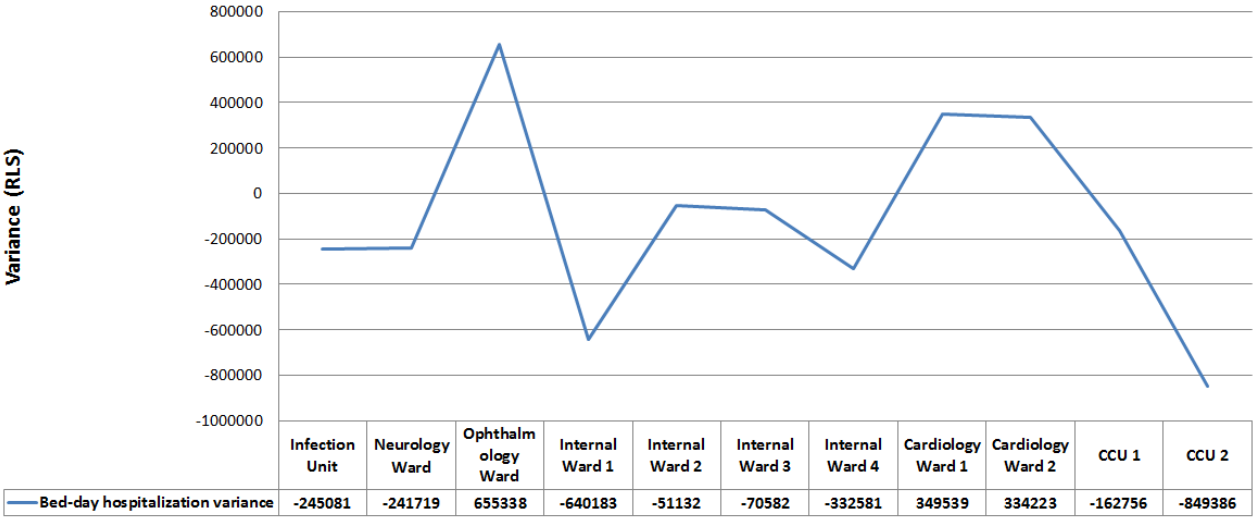


Figure 7 Comparison of bed-day hospitalization cost and bed-day hospitalization income in each final unit



	Infection Unit	Neurology Ward	Ophthalmology Ward	Internal Ward 1	Internal Ward 2	Internal Ward 3	Internal Ward 4	Cardiology Ward 1	Cardiology Ward 2	CCU 1	CCU 2
Bed-day hospitalization variance	-245081	-241719	655338	-640183	-51132	-70582	-332581	349539	334223	-162756	-849386

Figure 8 Bed-day hospitalization variance in each final unit

account for 96.7 % of all general and overhead expenditures (see Additional File 1).

Figure 2 compares distribution of each human resources and capital cost component over intermediate departments. As seen, Nutrition, Laboratory and Pharmacy departments are responsible for the majority of personnel and capital costs in the intermediate cost centers. The largest expenditures in Nutrition and Pharmacy units are due to material consumption while in the Laboratory unit, personnel expenses comprise the greatest cost component.

Our analysis revealed that 80% of total costs of the final units are direct costs. These costs comprised personnel expenditures and the expenses prorated from intermediate units (see Additional File 1). Figure 3 shows distribution of the direct costs over final units. As seen, the highest direct costs are associated with neurology Ward and CCU 2, while CCU 1 holds the lowest direct cost. Figure 4 gives the distribution of indirect costs over final units. As seen, general/overhead services induce the largest indirect costs in the final units, with the Internal Ward 2 being responsible for the major share. Ophthalmology Ward, Internal wards 3 and 4, Cardiology wards 1 and 2, and CCU 2 show considerable cost making due to building depreciation. In addition, in CCU 2 and ICU, some significant costs arose due to depreciation of equipment. Neurology Ward, Internal Ward 1 and CCU 1 account for the three highest material consumption costs.

Figure 5 compares the direct and indirect costs in each final unit. In all units, with the exception of Internal Ward 1, direct costs far exceed the indirect costs. The highest direct cost is incurred by the Neurology Ward followed by CCU 2 and Infection Unit. The highest indirect cost relates to Internal Ward 1, which is virtually as large as the direct costs in this unit.

Our results also elucidated contribution of total costs in each final unit to the total costs of the hospital (see Additional File 1). The costs in Internal Ward 1, Neurology Ward and CCU 2 were found to comprise 38% of total costs. In addition, the internal wards combined were responsible for over 40% of total costs.

Figure 6 compares the occupied bed-day rate among the final units. While the two CCUs show the highest bed-day rate (90%), the lowest bed day-rate (36%) occurs in the Ophthalmology Ward. Moreover, ICU, Internal wards, Cardiology wards and Infection Unit share virtually similar rates of bed-day occupation.

Figure 7 compares the bed-day hospitalization cost and income per unit service in each final department. The highest bed-day hospitalization cost belongs to ICU and the lowest value is related to the Cardiology Ward 1. The highest bed-day hospitalization income is achieved by the Ophthalmology Ward, while the ICU makes the lowest income. Results show that hospitalization is profitable in Ophthalmology and Heart wards, while other departments' incomes do not cover their cost.

The variance of bed-day hospitalization per unit service in each final department is illustrated in Figure 8. The hospital is obviously in loss with the ICU and CCU 2 making the largest contribution.

Figure 9 presents the results of the break-even analysis of services in each final unit. As seen, the Ophthalmology and Cardiology wards are able to make net profit with their current services volume and price of unit services, while this is not the case for other units. The data also shows that the current total revenue of the hospital does not meet the corresponding break-even revenue.

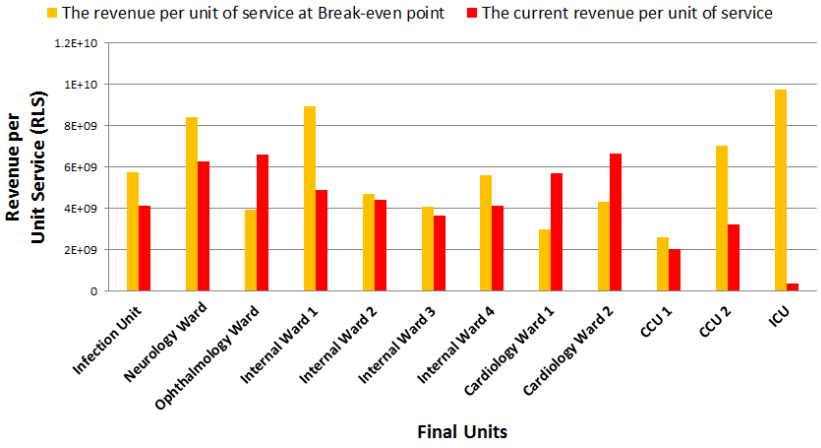


Figure 9 Comparison of the revenue per unit of service at Break-even point and the current revenue per unit of service in each final unit

Discussion

Our microcosting study produced a detailed profile of cost distribution over hospital services. Findings showed that the costs of general/overhead and final services share roughly similar contribution to the total costs (22.6 and 23.8, respectively), leaving over half of the hospital's costs attributed to intermediate services. Although the intermediate services are crucial for the operation of the medical units, their major share of total costs suggests them as high priority targets for cost controlling plans.

Analysis of costs in the intermediate departments identified Nutrition, Laboratory and Pharmacy departments as the main cost incurring units. The Nutrition and Pharmacy units leave little room for cost reduction as their costs directly relate to the costs of food or pharmaceutical material. However, the major costs of the Laboratory department are associated with personnel activities, which can be improved by a more efficient human resources management. The high contribution of human resources expenditures to costs of the Laboratory unit is anticipated, considering the need for an adequate number of personnel with sufficient expertise for Laboratory operation. However, strategies such as using advanced diagnosis technologies or implementing automated testing procedures may help cut personnel expenditures.

Our analysis revealed that 77% of the hospital's costs were associated with direct cost components. This is comparable with the value of 76% in the study of Oostenbrink et al. in Netherlands (2002). However it is higher than the reported 60 to 65 percent values in the study of St-Hilaire et al. in Canada (2000). The relatively high share of direct costs introduces the activities directly relating to patient care as the prime areas of cost improvement.

It was found that 40% of the total costs in final units is incurred by the activities of Internal wards. On the other hand, Neurology Ward and CCU 2 were found responsible for 25% of the total direct costs of final units. In sum, with the direct costs of Internal Ward 1, the level of direct costs in these three units reaches approximately 40% of the total. This finding along with the fact that these departments were not capable of meeting their expenditures through their current services volume/price designates them as the top priority targets for efficiency improvement programs.

The results showed that 53.5% of total hospital costs are the costs of personnel. This is below the mean value of 60% reported by WHO [1], and values reported from LMICs such as Nambia, 69% [25], Pakistan, 54-74% [26] and Iran, 55-65% [27]. This shows that the hospital spends lower amounts on human resources compared to the average international or domestic level. While efficient management of workforce expenses is important for overall hospital efficiency, considering the high impact of human resources on organizational performance, caution should be exercised in extremely conservative allocation of resources to personnel. Several lines of evidence have indicated that organizations that improve the welfare and well-being of their employees, have more productive human resources and higher competitive advantages [28, 29]. Therefore, in efficiency analysis of our study subject, the possible effect of relatively low personnel expense on human resources productivity should not be excluded. Studies have indicated that low human resources productivity has more contribution to hospital's high costs and low performance as compared with the shortage of resources [30].

Calculation of bed-day indices showed that 80% of hospital bed-days are occupied. Rezapour [31] identified a bed-day rate of 64% for hospitals of Iran University of Medical Sciences. A government document reports the average occupied bed rate of Iranian hospitals as high

as 40.7 % [32]. Compared to these statistics, the investigated hospital shows a good rate of bed-day occupation. Nonetheless, the remaining unoccupied capacity especially in profit-making units can still have significant contribution to hospital inefficiency [33]. Our data showed that the fixed costs—that are independent of patient admission—comprise over 97% of total costs in the final units (see Additional File 1). This directly associates unoccupied bed-day capacity to higher costs of unit services.

Cross-unit comparison of hospitalization variance (the different between income and cost) identified Ophthalmology Ward and Cardiology Ward as the only profit making units. In addition, break-even analysis revealed that the current level of income in the mentioned departments is considerably higher than the break-even point. This shows that the combined effects of services volume, and costs and prices in these departments not only allows for profit making, but provides a positive margin of safety for conditions where income may decline. Results of the break-even analysis become more informative when considered with the bed-day occupation data. It is surprisingly observed that the Ophthalmology Ward with the highest profitability potential possesses the lowest level of occupied bed-day rates. Similarly, the two profit-making Cardiology departments do not use their optimal bed-day occupation capacity. Thus, an increase in bed-day occupation rates of these units shows promise for further income, thereby alleviating current hospital losses.

According to WHO, about 50% of hospital resources are not allocated efficiently [1]. It is not 'therefore' un-expectable to find a similar pattern of efficiency in Iran as a developing country. However, detailed cost analysis using microeconomic techniques can shed light on the causes of inefficiency, and identify the key areas of improper resource allocation. Microeconomic analysis can help hospital managers measure health services efficiencies, prioritize programs for improving service performance, predict future trend of costs, analyze the relationship between current and capital costs, find optimal hospital charges, and ultimately improve hospital economy [1, 14].

Conclusions

A top-down microeconomic costing of healthcare unit services in the Bou Ali Sina University Hospital was presented in this article. Using a step-down costing technique, the major cost incurring units and the contribution of each cost component to the costs of final services were identified. Break-even analysis of final services led to the identification of medical units that are able to make profit by their current volume of services and price of unit services and those that cannot cover their costs under present condition. The microeconomic analysis also elucidated the level of activity per unit of services required for the losing departments to fulfill their expenditures. The study described the typical information that microeconomic analyses can generate from hospital accounting data, and their usage in finding solutions to financial efficiency challenges.

Competing Interests

The authors declare that there is no conflict of interests.

Authors' Contributions

FEFA and AR jointly designed the study and determined the settings. AR, JA and HS collected the data. AR, FEFA and MJS and HS contributed to data analysis and interpretation of the results. AR and JA prepared the manuscript. All authors read and approved the final manuscript.

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