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Relationship between Hospital Case Mix and Costs and Incomes of Tehran Heart Center

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Abstract

Purpose - Clarifying one of the biggest public Hospital Costs and incomes according to patients' case mix. It leads to prepare financial information about pubic medical tariffs and hospital operational costs.

Research design, data, and methodology - This study calculates the costs both, with and without taking into account capital costs. This holds for comparison of hoteling based on case mix in all medical procedures. The checklists were reviewed and filled by reviewing accounting documents of the hospital, warehouse exclusion list, and daily books of laundry and CSR. Data was analyzed descriptively by using Excel.

Results - In both cases, the hospital is losing in terms of hoteling. Because the buildings and equipment are new, this loss is not tangible. However, this will be revealed when costs of reconstruction and replacement of equipment. The loss rate per day of hospitalization was 569318 Rials for Coronary Care Unit (CCU), 528171 Rials for Post Intensive Care Unit (Post ICU), 474570 Rials for ICU, 233183 Rials for Post CCU and 204803 for Surgical ward.

Conclusions - Income of hoteling was lower than its costs. ANOVA showed a strong relationship between case mix and hospital costs as well as case mix and its income. This suggests that optimal case mix can minimize the costs and maximize income.

Keywords: Case Mix, Costs, Income, Hoteling.

JEL Classifications: I15, I18, H51.

1. Introduction

Currently, population growth, increasing prices and poor distribution of resources has led to a special approach and attention to productivity and efficient utilization of existing resources. This is very important for all areas of management, particularly management of health systems in all developing countries (Jalali & Hoseini, 2001). This leads to an increasing supervision on health system expenditure to increase efficiency and provide better, less expensive services. Hospitals are one of the most important components of health systems and the main consumers of resources allocated to medical system, because hospitals:

1) Are the largest and most operational units in health systems;
2) Account for the largest share of healthcare expenditure (Safikhani, 2004).

According to the extensive report of the World Bank on public hospitals, 50-80% of public sector health resources are consumed by hospitals in developing countries (Ensor, 1994). In the health systems, hospitals use expensive equipment and skilled high-wage human resources (Bloom et al., 1986). Obviously, non-optimal utilization of these resources will impose a substantial loss to healthcare system.

Lack of financial transparency challenges health system at a macro level (Zandian et al., 2016). Since a large part of these financial resources is used in hospitals, this problem is more evident in hospitals. This is true for the Tehran Heart Center. The main concern of this study is

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transparency of costs and incomes in the hospitals allocate funds to different wards on a daily basis (through purchase of supplies and requirements, payroll costs, etc.). Although these costs are constant, they have not been addressed analytically. Because the Tehran Heart Center is a single specialty hospital, case mix is limited, allowing study on these cases individually to determine their cost and income for the hospital, on average. This financial information can help managers make optional decisions. Fees must be paid for receiving goods and services; these fees are called cost (Karimi, 2004). Income refers to the money or good received by people, households, institutions or governments in units of time for good or services provided. Total cost of an activity divided by the number of units resulting from that activity is also called average price (Karimi, 2004). Cost center is a unit in hospital to which direct and indirect costs are allocated (Shepard, Hodgkin, Anthony, Shephard, & Staff, 2000). Case mix determines the need for resources in order to estimate necessary medical cares. Case mix is a system by which performance of the hospital and its effectiveness is measured in achievement of objectives. It also provides an instrument to measure complexity and nature of medical services by policy-makers (Smith et al., 2008). By calculating finished cost of beds through prorating, a real finished cost will be obtained; by comparing this real finished cost with income of the hospital and calculating this cost by case mix, a long-term financial plan can be developed for the hospital.

2. Literature Review

Evaluating performance of operation and length of stay, (McDermott & Stock, 2007) claimed that hospital costs are constantly increasing; this indicates the increasing focus on management of this organization. This focus must be directed to cost of services, quality (often measured by death rate) and length of hospitalization. They found a direct relationship between dependent variables (location, capacity and education), while they found a direct relationship between these variables and capital costs, wage costs and staff levels. However, they could find a significant relationship between capital costs and wage and staff levels compared performance of hospitals and physician-owned medical groups (Greene et al., 2002). They compared financial performance and efficiency of hospitals versus private medical groups. Data analysis showed that tangible advantage depends on the difference in the number of patients and treatment procedures addressed economic cost of coronary artery diseases (Fakhrzade et al., 1999). They asserted that coronary artery diseases impose considerable economic costs to the society. They estimated economic costs of these diseases in the patients hospitalized in the Central Hospital of the Oil and Gas Ministry of Iran. In total, 1670 cases were hospitalized in 1999; of them, 1253 cases (75%) were related to coronary artery diseases. Direct costs of the hospitalized cases were 10.94 billion Rials and the per capita cost of each patient was 8.70 million Rials. Direct costs of the patients with coronary artery diseases hospitalized in this hospital (including patients hospitalized in the affiliated clinics) were estimated at 22.77 billion Rials. Total days of absence were estimated at 4 billion Rials. The huge economic loss caused by coronary artery diseases requires an inclusive plan for preventing these diseases in the studied industry.

<Hypotheses>

<H1> There is a relationship between case mix and hospital costs;

<H2> There is a relationship between case mix and hospital income.

This study was an applied research which was conducted by using a descriptive analytical methodology in inpatient wards of Tehran Heart Center Hospital 2007. Data was extracted from documents related to costs of services provided to patients in inpatient wards. For this purpose, this study reviewed financial information of the hospital in 2007 and records of the patients admitted to the hospital from April 21, 2007 to July 22, 2007. The study was conducted in following steps:

2.2. Checklists

Initial checklists were made by reviewing scientific resources and literature on costs of medical services including textbooks and articles related to management, health economy and industrial accounting and by consulting with experts in different parts of the hospital. Then, the checklists were filled by reviewing records of patients and analyzing cost breakdown of each patient.

3. Methodology

The checklists were reviewed and filled by reviewing accounting documents of the hospital, warehouse exclusion list, and daily books of laundry and CSR. The filled checklists were finally analyzed. Data was analyzed descriptively by using Excel.

Calculating the cost of general (non-medical) supplies: general supplies include all non-medical materials and tools which are used commonly to provide services in inpatient wards. The price and cost of items sent from warehouse to inpatient wards was calculated by reviewing available documents. These items included stationery, sanitary ware and other accessories used in wards. These costs were assigned to cost center of each ward.

Calculating medical personnel cost: payroll of medical staff in 2008 was reviewed to determine salaries of personnel.

Physicians working in the Tehran Heart Center were divided into two categories. The first category included physicians hired and paid by the Tehran University of Medical Sciences; for this category, retainer was included in the analysis. The second group included physicians who were employed by the Tehran Heart Center; for this category, both retainer and salary were included in the analysis.

Calculating nursing personnel cost: total salary and benefits of nursing staff, nursing assistants and secretaries working in the wards were studied for calculating nursing personnel cost. For this purpose, the number of personnel in each ward and their payroll in 2008 were calculated by cooperation of the Department of Salary and Wages.

Calculating maintenance personnel cost: the number of maintenance personnel and their payroll in 2008 were calculated to determine maintenance personnel cost. The calculated value was assigned to cost center of the maintenance department and prorated in the cost analysis table in proportion to floor-area of inpatient wards.

Calculating support personnel cost: payroll cost of this personnel was assigned to their cost center (administrative-financial, maintenance, etc.) which was prorated to service providers by different bases.

Calculating food cost: since all catering services were outsourced to private sector, the cost contracted between the hospital and the catering company in 2008 was used for calculating food cost and assigned to food cost center.

Calculating laundry cost: laundry department was considered as a cost center to which all costs of laundry (personnel, supplies, etc.) were assigned. Finished cost of services was calculated by reviewing daily books of the department and assigned to the cost center based on requirements of each inpatient ward.

Calculating CSR cost: because of its direct services to CATH lab and operation room, CSR was analyzed carefully; CSR cost was measured in proportion to sterile equipment used in all wards, based on which CSR cost ratio was prorated between service providers.

Cost of facilities: cost of facilities as one of costs of technical and engineering department was included in this cost center and assigned to service providers based on area in m^2.

General and overhead costs: These costs were calculated annually as a whole due to their variability in months of the year. For example, fuel cost was higher in cold months than in warm months. To consider these fluctuations, these costs were considered as a whole. This study was conducted in 13 support departments and 31 service providing departments in the Tehran Heart Center. Each department was considered as a cost center. Cost proration was used to calculate the finished cost. The hybrid framework of hospital cost analysis noted in Sheppard's textbook and Cost It technique is an analytic instrument developed by WHO for health-care expenditure; both of these techniques are based on proration of hospital costs.

4. Results

This study is concerned with analysis of results to determine actual value of bed day tariff. The comparison was done with considering capital items and without considering capital items for comparing income with finished price of each type of bed.

4.1. Comparison without Capital Costs

As shown in <Table 1>, the difference in income (tariff rate plus differential) was +28268 in surgical beds and +18194 in post CCU; that is, income was higher than the finished price; however, the hospital had lost in other cases (CCU, ICU and post ICU). As shown in <Table 1>, the highest loss was related to post ICU (-141568 Rials), followed by CCU (-135538 Rials) and ICU (-76114 Rials). The reason for which post ICU had the highest loss rate among bed day costs was probably the lack of an approved tariff for post ICU beds which were evaluated as a type of bed by insurance companies individually. Some considered it post CCU and pay the related tariff; some others evaluated it as typical surgical bed. Given the medical equipment and full monitoring system available in post ICU rooms and given that these rooms were single-bed, the finished price was very high and, consequently, the loss was very high.

<Table 1> Profit/Loss for one day staying according to type of beds, without capital costs.

Bed	Finished price	Income (tariff + other)	Tariff – income = profit/loss
Surgical	268732	297000	28268
CCU	617438	481900	-135538
PCCU	360006	378200	18194
ICU	1039914	963800	-76114
PICU	519768	378200	-141568

4.2. Comparison with Capital Costs

As shown in <Table 2>, the finished price of bed day increased and the hospital showed loss in all types of bed day. As shown in the <Table 2>, the finished price increased to 504754106000 which included the cost of land, building and equipment; given the approved number of beds (420 beds), installation cost of each bed was 1201795490 Rials in 2002, which is approximately three times greater than the value declared by the Ministry of Health in that year.

As shown in <Table 2>, the highest loss was related to CCU (-569318 Rials), followed by post ICU (-528171 Rials), ICU (-474570 Rials), post CCU (-233183 Rials) and surgical bed (-204.803 Rials). The reason for which CCU surpassed post ICU in loss is probably due to the higher floor area of CCU compared to post ICU.

<Table 2> Profit/Loss for one day staying according to type of beds, considering capital costs

Bed	Finished price	Income (tariff + other)	Tariff – income = profit/loss
CCU	1051218	481900	-569318
PICU	906371	378200	-528171
ICU	1438370	963800	-474570
PCCU	611383	378200	-233183
Surgical	501803	297000	-204803

4.3. Finished Price of Bed According to Type of Case

4.3.1. Finished Price of Bed according to Type of Case, Considering Capital Costs.

This section determined the mean stay in types of inpatient beds for types of cases. These values were multiplied separately once by the finished cost and once by income per type of bed and the results were compared. For example, the values in <Table 3> which is related to angiography were product of the finished cost of a bed by the mean stay in that type of bed; that is, angiography patients stayed 2.13 days, on average, in the post CCU. The finished price of one-day stay in post CCU was 611383; then, the mean finished price of post CCU would be 2 × 611383 in angiography group. The next column shows income per one-day stay in different inpatient wards. This value was the sum of tariff and other costs (differential) received by the hospital. The next row shows the mean income per bed to the receivable rate, that is, days of stay in a group multiplied by the bed day cost received for that type of bed. For example, the receivable amount per one-day stay in post CCU was 378200 Rials for angiography. The mean stay of angiography patients was 2.13 days in post CCU; thus, the mean income per bed to the receivable rate was 2 × 378200 Rials. Finally, sum of the finished prices was 68122252 Rials for angiography. Thus, total income per one bed was 1345813 Rials for this group. Subtracting income from the finished price, a negative value (1135997 Rials) was obtained; that is, the hospital lost this value per angiography case for hoteling. This value was calculated for other case groups, as shown in <Table 4>. In this table, the highest loss was related to Coronary Artery Bypass Grafting (CABG) of one vessel (-4857797 Rials), followed by (MVR) (-4843011 Rials), CABG of three vessels (4298835 Rials), CABG of four vessels, CABG of two vessels, Percutaneous Transluminal Coronary Angioplasty (PTCA) of one vessel, angiography, PTCA of more than one vessel and finally Percutaneous Trans-Mitral Commissurotomy (PTMC). As shown in the <Table 4>, this loss was very high, which is due to the high construction costs.

<Table 3> Mean Finished Priced of Bed Day to The Receivable Rate in Angiography (with capital costs)

Angiography	Surgery	CCU	PCCU	ICU	PICU	Total
Mean stay	0.00	1.13	2.13	0.00	0.00	
Mean finished price of each bed	501803	1051218	611383	1438370	906371	
Mean finished price of each bed in this group	0	1182621	1299189	0	0	2481810
Receivable rate per bed/day*	297000	481900	378200	963800	378200	
Mean income per bed to receivable rate*	0	542138	803675	0	0	1345813
Finished price cost – received cost = loss/profit	-1135997					

*(Tariff+ Differential)

<Table 4> Profit/Loss Rate for Different Cases by Considering Capital Costs

Procedure	Mean receivable per stay case	Mean finished price per stay case	Finished price cost – received cost = profit/loss
CABG1	7369563	12227359	-4857797
MVR	7883491	12726502	-4843011
CABG3	7497600	11796435	-4298835
CABG4	5792200	9396330	-3604130
CABG2	5328044	8453847	-3125803
PTCA1	1909300	3630895	-1721595
ANJIO	1345813	2481810	-1135998
PTCA>1	1277514	3298492	-1020978
PTMC	1247886	2172824	-924938

<Table 5> Comparison of Mean Finished Price of Bed Day to The Receivable Rate for Angiography (without capital costs)

Angiography	Surgery	CCU	PCCU	ICU	PICU	Total
Mean stay	0	1	2	0	0	
Mean finished price of each bed	263588	614131	358237	916324	515206	
Mean finished price of each bed in this group	0	690898	761253	0	0	1452150
Receivable rate per bed/day*	297000	481900	378200	963800	378200	
Mean income per bed to receivable rate*	0	542138	803675	0	0	1345813
Finished price cost – received cost = loss/profit	-106338					

4.3.2. Finished Price of Bed according to Type of Case, without considering capital costs.

These values were extracted from the table above without considering capital costs. As shown in <Table 5>, hospital loses -106338 Rials per case of angiography. Calculation was exactly similar to calculation by considering capital costs. Since the hospital was public and run autonomously, it was only required to compensate current costs; thus, the finished price without considering capital costs is the focus of planning.

5. Hypothesis Testing

5.1. Hypothesis 1

<H_0> There is no significant difference between type of operation and costs.

<H_1> There is a significant difference between type of operation and costs.

<Table 6> Type of Operation and Cost in ANOVA

ANOVA

COST

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1621476514	8	202684564		
Within Groups	721370339.3	76	9491714.99	21.354	.000
Total	23428468533	84			

As shown in <Table 6>, sig=0.000 is lower than α=0.05; thus, <H_0> is rejected. Therefore, there is a significant difference between type of operation and costs.

<Table 7> Relationship between Operation and Cost in Dancan test

COST

Duncan[a, b]

TYPE OF OPERATION	N	Subset for alpha = .05		
		1	2	3
PTMC	7	2172.824		
PTCA>1	7	2298.491		
ANGIO	16	2481.809		
PTCA1	8	3630.894		
CABG2	9		8453.845	
CABG4	10		9590.023	9590.023
CABG3	9			12022.48
CABG1	8			12227.36
MVR	11			12726.50
Sig.		.371	.439	.052

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 8.899

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

As shown in <Table 7>, there are three groups of operation. There is no significant difference between the first four operations (angiography, PTCA1, PTCA>1 and PTMC), while there is a significant difference between operations of this group and operations of the second and third groups. There is a significant difference between CABG2 and CABG4 (second group). There was no significance in the third group (CABG1, CABG3, MVR). According to above table, there is a significant difference between each operation of the first group and operations of the second and third groups. There is a significant difference between each operation of the second group (except CABG4) and operations of the first and third groups. CABG4 is common in the second and third groups; this means that there is a significant difference only between CABG4 and operations of the first group.

In Duncan table, operations of the third group have higher ordinal mean than other operations; therefore, these operations have the highest effect on costs of the hospital.

5.2. Hypothesis 2

<H_0> There is no significant difference between type of operation and income.

<H_1> There is a significant difference between type of operation and income.

<Table 8> Type of Operation and Income in ANOVA

ANOVA

COST

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7E+008	8	82165665.5		
Within Groups	7E+008	76	3607641.07	22.775	.000
Total	7E+008	84			

As shown in <Table 8>, sig=0.000 is lower than α=0.05; thus, <H_0> is rejected. Therefore, there is a significant difference between type of operation and income.

<Table 9> Relationship Between Operation and Income in Dancan test

COST

Duncan[a, b]

TYPE OF OPERATION	N	Subset for alpha = .05			
		1	2	3	4
PTMC	7	1247.886			
PTCA>1	7	1277.514			
ANGIO	16	1345.813			
PTCA1	8	1909.300			
CABG2	9		5328.044		
CABG4	10		5900.530	5900.530	
CABG3	8			7369.563	7369.563
CABG1	9			7497.600	7497.600
MVR	11				7883.491
Sig.		.511	.527	.097	.595

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 8.899

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

As shown on the <Table 9>, there are four types of operations in terms of income. The first group include angiography, PTCA1, PTCA>1 and PTMC. There is no significant difference between operations of this group, while there is a significant difference between these operations and operations of the second, third and fourth groups. There is a significant difference between operations of the second group (CABG2 and CABG4) and other groups (except CABG4 which is common in the second and third group, that is, CABG4 is not significantly different from operations of the third group). There is a significant difference between operations of the third group (CABG4, CABG1 and CABG3) and the first group; however, CABG4 is not significantly different from operations of the second group, while it is significantly different from other groups. Moreover, there is no significant difference between CABG1 and CABG3 and operations of the fourth group, while they are significantly different from other operations. In Duncan table, operations of the fourth group have higher ordinal mean than other operations; therefore, these operations have the highest effect on costs of the hospital.

6. Discussion and Conclusions

As comparison of two types of costs (with capital costs and without capital costs) shows, this study can be helpful in determining the finished cost in agreement with construction and equipment cost per bed; if the Ministry of Health criteria are considered for construction, there will be a cost between these two. As noted earlier, this study only discussed the hoteling price and its relationship with type of case. All cost factors should be considered to judge about profitability or loss of a type of case, although hoteling cost is one of the major factors. Therefore, hoteling cost is necessary, but not sufficient, for judgment. To obtain a total cost, it is required to consider finished price of treatment procedures, diagnostic services, consulting, and other services such as medicines, equipment etc. in order to calculate expenditure of a hospital per service and receivable rate of services provided. Experience has proven that diagnostic wards are the most profitable wards of a hospital. Profit from any diagnostic services well as income from therapeutic and diagnostic procedures compensates a significant portion of this loss; to determine this, it is required to conduct further studies to determine all cost and income aspects of a particular case. As ANOVA showed, there is a strong relationship between case mix and costs as well as case mix and income of a hospital. This reveals the fact that optimal case mix can minimize costs and maximize income. This was examined by Duncan test for different types of cases separately and their relationship with costs and income. The test showed that CABG1, CABG3, CABG4 and MVR have the highest relationship with costs of the hospital. Costs can be significantly reduced by studying costs of these operations. Moreover, Duncan test showed that CABG1, CABG3 and MVR have the highest effect on income. Therefore, income of a hospital can be increased by studying these types of cases.

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