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# Cost analysis based on performance indicators during Healthcare Reform Plan in selected educational hospitals

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## Abstract:

**INTRODUCTION:** Hospitals are the main axis of health-care reforms or national health plans; therefore, accurate recognition of hospital costs based on operational indexes to these plans is necessary. The impact of implementing national health plans on the performance of health systems is ambiguous and misleading; therefore, the aim of this study was to assess the impact of Healthcare Reform Plan (HRP) on the micro level (e.g., educational or university hospitals).

**METHODS:** This study was a descriptive retrospective study that research variables are checked in 1 year before and mean of 3 years after implementation of HRP by self-administrated checklist in selected public-educational hospitals covered by the medical universities in Tehran. The final analysis of the data was performed using cost–performance ratio and independent *t*-test for comparing the variables' changes before and after HRP.

**RESULTS:** Unlike adjusted hospitalization costs, most operational indexes were not significant. The per capita cost adjusted of hospitalization in first and mean of 3 years after HRP increased 49.49% and 16.31%, respectively ( $P < 0.001$ ), the adjusted cost per day was increased by 24.48% and 21.46% ( $P < 0.001$ ), and adjusted cost per bed was increased 47.06% and 20.07% compared to before HRP ( $P < 0.001$ ).

**CONCLUSION:** Given the lack of alignment in adjusted cost changes in exchange for functional indicators, certainly, it cannot be argued that HRP had a favorable or undesirable effect on the hospitals.

## Keywords:

Cost, Healthcare Reform Plan, hospital, operational indexes

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## Introduction

Hospitals are the main focus of health system macro plans or programs. In practice, in order to have a better policy-making in the future, being aware of performance-related changes in hospital costs is of particular importance.<sup>[1,2]</sup> Since hospital costs account for the largest share of the costs of health systems, the appropriateness of cost changes with performance indicators seems necessary for hospitals.<sup>[3,4]</sup> Although the nature of the

relationship between costs and hospital indicators is a controversial subject, a reasonable change in costs, especially reduction in hospital costs, makes a reduction in a number of hospital indicators such as patient length of stay (LOS).<sup>[5,6]</sup> Therefore, the success of health system macro plans depends on a more accurate hospital managers' understanding of hospital costs and indicators,<sup>[7,8]</sup> such that if the cost content of macro plans focuses on the performance indicators of health-care providers, it can provide an answer to the question of what is the impacts of health system macro plans at micro level in order to

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remove additional costs rather than reducing health-care costs.<sup>[9,10]</sup>

The Ministry of Health and Medical Education of Iran implemented the Healthcare Reform Plan (HRP) in 2014 with the aim of equity in providing health-care services, reducing out-of-pocket patient payments, improving structure and management of health-care services, and promoting health indicators. The main objective of this plan was to reduce out-of-pocket payments for patients.<sup>[11,12]</sup> The general policies of the plan were determined by the government on April 7, 2014, and implemented by the Ministry of Health in a few weeks later.<sup>[13-15]</sup> This plan has been referred to as Health Sector Evolution Plan, Health Transformation Plan, Health Transformation Plan, and Health System Reform.<sup>[11,16,17]</sup> The Ministry of Health had considered specific funds to finance each of the program packages included in this plan. For example, along with the package of physician retention with huge financial resources being injected into hospitals, there was a package for reducing out-of-pocket patient payments in which urban patients and rural patients (or cities with population under 20,000) hospitalized in the included hospitals should pay only 10% and 5% of hospitalization costs, respectively, and the rest was covered by the funds intended for this package. Hence, HRP is known as a very costly national plan.<sup>[12,18,19]</sup>

Logically, HRP has affected hospital costs and indicators, health-care tariffs, social security, and health insurance industry.<sup>[10,20-24]</sup> Therefore, regarding the importance of this plan's impact, this study was conducted with the aim of cost analysis of performance indicators of selected public-educational hospitals covered by medical sciences universities in Tehran during 2014–2017.

## Methods

This is a descriptive study which carried out a cost analysis of hospitals based on performance indicators. The purpose of this study was to examine the changes and process of changes in the variables studied in the 1<sup>st</sup> year and the average years after the implementation of HRP in selected public-educational hospitals in Tehran. The research population consisted of all educational hospitals, and research sample consisted of three public-educational hospitals covered by medical sciences universities in Tehran which specified under the titles 101, 113, and 168 active beds (H2, H1, and H3 hospitals, respectively) in this study. Not using expensive equipment (imaging and therapeutic equipment with advanced technology) and lack of physical development of hospitals in the studied years are the reasons for choosing these centers because these factors are among the biggest confounding factors in increasing hospital

costs.<sup>[25]</sup> Research variables including cost data and performance indicators of selected hospitals during the years of implementation of the HRP (2014–2017) were as follows: hospitalization cost, drug and consumable cost, indicator of patient LOS, indicator of bed occupancy rate (BOR), bed turnover, hospitalization day, and number of hospitalizations. The year 2014 (the year before the implementation of the plan) was considered as the base year in data analysis, and the following years (i.e., 2015, 2016, and 2017) with the average discount rate of 10.16 to adjust raw costs were considered as the years after the implementation of the plan for each hospital.<sup>[26]</sup> In data analysis, at first, the raw and adjusted values of costs and performance indicators were examined separately for each of the hospitals by the average and percentage change compared to the base year and the previous year, and again, the average of and percentage change in hospitalization costs compared to the base year and the previous year were calculated as raw values and based on each of the performance indicators as well. In this study, hospitalization costs based on performance indicators included: (a) hospitalization cost per day; (b) hospitalization cost per patient or per capita hospitalization cost; and (c) hospitalization cost per active bed, separately for each hospital and the average of all hospitals. Furthermore, analytical and descriptive statistics and independent *t*-test have been used to compare changes in each research variable before and after the implementation of the HRP.

## Abbreviations

Base year: The year before the implementation of the HRP (2014).

Years after the implementation of the plan: The average of the target variable in three consecutive years after the implementation of the HRP (2015, 2016, and 2017).

BOR: bed occupancy rate. LOS: Length of Stay.

## Results

In general, after the implementation of the HRP, indicator of hospitalization day increased by 7.07% in all hospitals (on average, in each hospital, hospitalization days increased from 25,087 in the year before the implementation of the plan to 27,376 in the 3 years after the implementation of the plan). In the 1<sup>st</sup> year of implementation of the plan, the amount of this indicator decreased slightly (–0.85%), but in the 2<sup>nd</sup> and 3<sup>rd</sup> years, it increased by about 9% and 15%, respectively, compared to the base year (on average, in each hospital, hospitalization day in the 2<sup>nd</sup> and 3<sup>rd</sup> years of implementation of the plan was 27,787 and 29,260, respectively). The volume of hospitalizations in all hospitals increased from 5939 to 6332 (i.e., equivalent to 9.45%) (compared to the base

year, the volume of hospitalizations in the 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> years of implementation of the plan increased by +1.76%, +14.65%, and +11.93%, respectively). The average indicator of BOR in each year after the implementation of the plan was somewhat different from 2013, but the average of this indicator in the whole years after the implementation of the plan has not changed much compared to the base year (it increased from 65.48% in the base year to the average of 65.44% in the years after the implementation of the plan; it means that, in general, only a very small increase of one hundredth of a percent of the BOR has taken place in all hospitals). On average, patient LOS in all hospitals decreased by 1.95% (about 2%) in the years after the implementation of the plan compared to the previous year [Table 1].

Comparing the performance indicators of hospitals, it was found that during the years under study, the most statistics on hospitalization day were related to 168-bedded H3 hospital, and 113-bedded H1 and 101-bedded H2 hospitals were in the next ranking, respectively: hospitalization day in H3 hospital was 34,228 in the year before the implantation of the plan, and on average, it was 39,712 in the years after the implantation of the plan. Hospitalization day in H1 and H2 hospitals was reported to be 22,810 and 18,224, respectively, before the implementation of the plan and 23,270 and 19,147, respectively, in the average years after the implementation of the plan.

The BOR of all three hospitals before the implementation of the plan was somewhat at the same level, but after the implementation of the plan, a difference of about 10%

was observed in each hospital, indicating that each of the centers had different outputs: on average, the BOR of 113-bedded H1 center was 56%, 101-bedded H2 center was 65%, and 168-bedded H3 center was 74% during the years after the implementation of the plan; but, in the base year, these values were 67%, 66%, and 63%, respectively, for each of these centers. In terms of bed turnover, hospitals have the same ranking both before and after the implementation of the plan: 101-bedded H2 hospital had the highest bed turnover (7.69 after the implementation of the plan and 7.68 before the implementation of the plan), and 113-bedded H1 hospital had the lowest bed turnover (2.85 after the implementation of the plan and 2.37 before the implementation of the plan) [Table 2].

In terms of the indicator of patient LOS both before and after the implementation of the plan, hospitals had a different ranking contrast to the bed turnover indicator: H1 hospital had the highest patient LOS (6.08 after the implementation of the plan and 7.51 before the implementation of the plan), and H2 hospital had the lowest patient LOS (2.61 after the implementation of the plan and 2.46 before the implementation of the plan). In the years after the implementation of the plan, the highest hospitalization day rate and the highest BOR were associated with 168-bedded H3 hospital, the highest bed turnover rate was associated with 101-bedded H2 hospital, and the maximum patient LOS was associated with 113-bedded H1 hospital [Tables 3 and 4].

Regarding the ranking of hospitals according to the following tables, it is difficult to decide on the performance of the hospitals because, except for the BOR,

**Table 1: Mean of each of the performance indicators in all of the hospitals studied**

Operational indexes	2013 (before HRP)	2014 (1 year after HRP)	2014-2016 (mean of 3 years after HRP)
Admission day index		Change percentage: -0.85 SD: 466 P: 0.29	Change percentage: 7.7 SD: 2074 P: 0.03
	25,087	25,082	273,76
Bed occupancy index		Change percentage: -3.88 SD: 1.86% P: 0.43	Change percentage: -0.01 SD: 1.87% P: 0.84
	65.48	65.48	65.44
Patient length indicator		Change percentage: -1.43 SD: 0.14 P: 0.91	Change percentage: -1.95 SD: 0.18 P: 0.27
	4.84	4.64	4.52
Turnover indicator		Change percentage: 2.49 SD: 0.13 P: 0.55	Change percentage: 8.86 SD: 0.14 P: 0.03
	4.75	4.93	5
Number of admissions		Change percentage: 0.00 SD: 0.707 P: 0.91	Change percentage: 9.45 SD: 341 P: 0.02
	5939	5938	6332

HRP=Healthcare Reform Plan, SD=Standard deviation

**Table 2: Performance indicators for each of the hospitals**

Operational Indexes for each of the hospitals	2013 (before HRP)	2014 (1 year after HRP)	2014-2016 (mean of 3 years after HRP)
<b>Admission day index</b>			
H1		Change percentage: 8.83 SD: 1165 P: 0.02	Change percentage: 24.44 SD: 1765 P: 0.01
	22,810	21,162	23,270
H2		Change percentage: -0.22 SD: 28.99 P: 0.44	Change percentage: 5.06 SD: 867.4 P: 0.37
	18,224	18,183	19,147
H3		Change percentage: 4.88 SD: 1182 P: 0.16	Change percentage: 16.02 SD: 3893 P: 0.59
	34,228	35,900	39,712
<b>Bed occupancy index</b>			
H1		Change percentage: -23.6 SD: 11.21% P: 0.02	Change percentage: -15.72 SD: 6.92% P: 0.03
	67.16	51.31	56.60
H2		Change percentage: 5.97 SD: 2.83% P: 0.38	Change percentage: 4.03 SD: 1.83% P: 0.43
	63%	67%	65.67%
H3		Change percentage: 5.96 SD: 2.81% P: 0.61	Change percentage: 11.71 SD: 4.74% P: 0.04
	62.28%	62.28%	74.04%
<b>Patient length indicator</b>			
H1		Change percentage: -12.78 SD: 0.68 P: 0.71	Change percentage: -19 SD: 0.79 P: 0.07
	7.51	6.55	6.08
H2		Change percentage: 1.22 SD: 0.02 P: 0.49	Change percentage: 6.1 SD: 0.14 P: 0.72
	2.46	2.49	2.61
H3		Change percentage: 7.27 SD: 0.23 P: 0.06	Change percentage: 7.05 SD: 0.18 P: 0.11
	4.54	4.87	4.86
<b>Turnover indicator</b>			
H1		Change percentage: 0.42 SD: 0.01 P: 0.00	Change percentage: 20.25 SD: 0.44 P: 0.01
	2.37	2.38	2.85
H2		Change percentage: 7.29 SD: 0.4 P: 0.09	Change percentage: 0.13 SD: 0.5 P: 0.17
	7.68	8.24	7.69
H3		Change percentage: -0.24 SD: 0.01 P: 0.48	Change percentage: 6.21 SD: 0.23 P: 0.52
	4.19	4.18	4.45
<b>Number of admissions</b>			
H1		Change percentage: 8.83 SD: 185	Change percentage: 24.44 SD: 660

Contd...

**Table 2: Contd...**

Operational Indexes for each of the hospitals	2013 (before HRP)	2014 (1 year after HRP)	2014-2016 (mean of 3 years after HRP)
		<i>P</i> : 0.04	<i>P</i> <0.001
H2	2967	3229	3852
	Change percentage: -0.63		Change percentage: 0.09
	SD: 32.5		SD: 155
		<i>P</i> : 0.64	<i>P</i> : 0.76
H3	7326	7280	7333
	Change percentage: -2.91		Change percentage: 3.81
	SD: 155		SD: 409
		<i>P</i> : 0.67	<i>P</i> : 0.34
	7524	7305	7811

HRP=Healthcare Reform Plan, SD=Standard deviation

**Table 3: Ranking of each of the average performance indicators after Healthcare Reform Plan**

Rank	Patient length indicator		Turnover indicator		Bed occupancy index		Admission day index	
	The amount	Hospital	The amount	Hospital	The amount	Hospital	The amount	Hospital
First	6.08	H1	7.69	H2	74.04	H3	39,712	H3
Second	4.86	H3	4.45	H3	65.67	H2	23,270	H1
Third	2.61	H2	2.85	H1	56.6	H1	19,147	H2

**Table 4: Ranking of each of the average performance indicators before Healthcare Reform Plan**

Rank	Patient length indicator		Turnover indicator		Bed occupancy index		Admission day index	
	The amount	Hospital	The amount	Hospital	The amount	Hospital	The amount	Hospital
First	7.51	H1	7.68	H2	67.16	H1	34,228	H3
Second	4.54	H3	4.19	H3	66.28	H3	22,810	H1
Third	2.46	H2	2.37	H1	63	H2	18,224	H2

the rest of the indicators had similar ratings before and after the implementation of the plan; therefore, output of the hospital can not be described only by performance indicator.

### Costs

The average per capita hospitalization cost of hospitals in the 1<sup>st</sup> year of implementation of the plan and the years after the implementation of the plan increased by 49.49% and 16.31%, respectively, compared to the base year (it increased from \$ 877 in 2013 to \$ 1315 in the 1<sup>st</sup> year and \$ 1204 in the average years after the implementation of the plan): the 101-bedded H2 hospital had the lowest per capita hospitalization cost, and the 113-bedded H2 hospital had the highest per capita hospitalization cost. The cost per hospitalization day of hospitals was approximately equal to per capita hospitalization cost: in the 1<sup>st</sup> year of the implementation of the plan and the subsequent years, the cost per hospitalization day increased by 48.24% and 21.46%, respectively, compared to the condition before the implementation of the plan (it increased from \$ 102 in 2013 to \$ 150 in the 1<sup>st</sup> year and \$ 165 in the average years after the implementation of the plan). In the meantime, the 101-bedded H2 hospital had the lowest increase in hospitalization costs per day of hospitalization, and the 113-bedded H1 hospital had the highest increase in hospitalization costs per day of hospitalization. Changes in the average hospitalization

cost per bed in the studied centers were almost the same as the changes in per capita hospitalization cost and hospitalization cost per day. The hospitalization cost per bed in the 1<sup>st</sup> year of implementation of the plan and the years after the implementation of the plan increased by 47.06% and 20.07%, respectively, compared to the condition before the implementation of the plan (it increased from \$ 20213 to \$ 29726 in the 1<sup>st</sup> year and \$ 31258 in the average years after the implementation of the plan): the 101-bedded H2 hospital had the lowest increase in hospitalization cost per bed, and the 168-bedded H3 hospital had the highest increase in hospitalization cost per bed [Tables 5 and 6].

Furthermore, the share of drug and consumables costs in the hospitals under study reduced by about 3% during the years after the implementation of the plan. Before the implementation of the plan, 13.13% of the total hospitalization costs of the hospitals accounted for drug and consumable costs, but the average of this indicator reached 10.26% during the 3 fiscal years after the implementation of the plan and reached the lowest level (i.e., 9.82%) in the 3<sup>rd</sup> year of implementation of the plan.

### Discussion

The effect of the implementation of a national macro plan on the health system performance is ambiguous

**Table 5: Adjusted hospitalization costs and drug and consumables costs in mean of total hospitals**

Costs	2013 (before HRP)	2014 (1 year after HRP)	2014-2016 (mean of 3 years after HRP)
Total adjusted cost of hospitalization		Change percentage: 45.99 SD: 1,321,579 <i>P</i> <0.001	Change percentage: 69.43 SD: 2,159,428 <i>P</i> <0.001
	2,789,109	4,071,769	4,725,662
The adjusted per capita cost of hospitalization		Change percentage: 49.94 SD: 310 <i>P</i> <0.001	Change percentage: 49.74 SD: 218 <i>P</i> <0.001
	877	1315	1313
The adjusted cost per day of hospitalization		Change percentage: 48.24 SD: 35 <i>P</i> <0.001	Change percentage: 62.45 SD: 33 <i>P</i> <0.001
	102	150	165
The adjusted cost of hospitalization to each bed		Change percentage: 47.06 SD: 6727 <i>P</i> <0.001	Change percentage: 72.86 SD: 8266 <i>P</i> <0.001
	20,213	29,726	34,439
Total adjusted cost of drug-consumables		Change percentage: 20.61 SD: 53,377 <i>P</i> : 0.001	Change percentage: 32.45 SD: 67,229 <i>P</i> <0.001
	366,304	441791	485,158

HRP=Healthcare Reform Plan, SD=Standard deviation

**Table 6: Adjusted hospitalization costs and cost of drug-consumables in each of the hospitals**

Costs for each of the hospitals	2013 (before HRP)	2014 (1 year after HRP)	2014-2016 (mean of 3 years after HRP)
The cost of hospitalization			
H1		Change percentage: 60.01 SD: 1,042,639 <i>P</i> <0.001	Change percentage: 106.64 SD: 1,543,184 <i>P</i> <0.001
	2,457,095	3,931,610	5,077,342
H2		Change percentage: 36.66 SD: 243,837 <i>P</i> <0.001	Change percentage: 54.03 SD: 279,940 <i>P</i> <0.001
	940,733	1,285,570	1,448,968
H3		Change percentage: 40.82 SD: 1,434,457 <i>P</i> : 0.001	Change percentage: 53.95 SD: 1,430,077 <i>P</i> <0.001
	4,969,497	6,998,127	7,650,675
Per capita cost of hospitalization			
H1		Change percentage: 47.03 SD: 275 <i>P</i> <0.001	Change percentage: 58.04 SD: 256 <i>P</i> <0.001
	828	1218	1313
H2		Change percentage: 37.52 SD: 34 <i>P</i> : 0.002	Change percentage: 53.94 SD: 38 <i>P</i> <0.001
	128	177	198
H3		Change percentage: 45.04 SD: 210 <i>P</i> <0.001	Change percentage: 48.3 SD: 165 <i>P</i> <0.001
	660	958	980
The cost per day of hospitalization			
H1		Change percentage: 72.47 SD: 55 <i>P</i> <0.001	Change percentage: 110.18 SD: 66 <i>P</i> <0.001
	108	186	226

Contd...

**Table 6: Contd...**

Costs for each of the hospitals	2013 (before HRP)	2014 (1 year after HRP)	2014-2016 (mean of 3 years after HRP)
H2		Change percentage: 36.96 SD: 13 P: 0.02	Change percentage: 46.36 SD: 12 P<0.001
	52	71	76
H3		Change percentage: 34.26 SD: 35 P<0.001	Change percentage: 32.75 SD: 24 P: 0.01
	145	195	193
The cost of hospitalization to each bed			
H1		Change percentage: 60.01 SD: 9227 P<0.001	Change percentage: 106.64 SD: 13656 P<0.001
	21,744	34,793	44,932
H2		Change percentage: 36.66 SD: 2414 P<0.001	Change percentage: 54.03 SD: 2772 P<0.001
	9314	12,728	14,346
H3		Change percentage: 40.82 SD: 8538 P<0.001	Change percentage: 53.95 SD: 8512 P<0.001
	29,580	41,656	45,540
The cost of drug-consumables			
H1		Change percentage: 21.16 SD: 169,566 P: 0.01	Change percentage: 39.29 SD: 200,045 P<0.001
	916,667	1,156,469	1,276,845
H2		Change percentage: -7.32 SD: 9333 P: 0.2	Change percentage: -1.98 SD: 7472 P: 0.71
	182,245	168,904	178,629
H3		Change percentage: - SD: -	Change percentage: - SD: -

HRP=Healthcare Reform Plan, SD=Standard deviation

and misleading because it is affected by various confounding factors such as political, social, and economic factors.<sup>[27,28]</sup> Therefore, in this study, hospital indicators (such as hospitalization day, BOR, and turnover) and hospitalization costs of hospitals were investigated separately for each of the indicators at the micro level (i.e., the selected hospitals), rather than investigating the general indicators of the health system. However, it should be noted that short-term results after the implementation of a 1-year plan were somewhat distinct from the long-term results after the implementation of a 3-year plan. These results were heterogeneous as well. In addition, the heterogeneity and inconsistency of changes in indicators and costs based on the indicators in the long run were also the reasons for the fact that one cannot definitely state that the changes made after HRP will be desirable or undesirable.

The relationship between hospital costs and performance depends on the nature of the production process of the hospital and that how much it is independently

influenced by inefficiencies and consequences.<sup>[23,24]</sup> The results of Magnussen study showed that most wards of the hospital independently influenced by costs and performance indicators.<sup>[29]</sup> In their study, Hung and Chang acknowledged that after the implementation of the National Health Insurance Plan, insurance coverage and quality of health care increased, and at the same time, health costs in Taipei's urban hospitals increased significantly. The reason was that uninsured people (the elderly) and patients with a variety of complex diseases increased the rate of health-care use (such as increasing the volume of hospitalization in this study after the implementation of HRP [in Iran]), and the freedom of patients to choose hospitals led to the use of therapeutic equipment (new technology) and better quality treatment (longer stay) as well. In our study, the patient LOS during the years after the implementation of HRP decreased significantly in one of the hospitals and increased slightly in the other two hospitals as well. In general, the experimental results of Hung and Chang study were as follows: first, hospital costs significantly

increased after the implementation of the National Health Insurance reform (NHI reform) plan, and second, factors affecting the increase in Taipei's urban hospitals were LOS and various types of diseases, due to the direct impact of the NHI reform plan.<sup>[25]</sup> However, according to the results of Tan *et al.*'s study, longer LOS is not a proper indicator insuring the hospital evaluation.<sup>[30]</sup>

In Fragkiadakis *et al.*, McKay and Deily, and Miller *et al.* studies, several general hospitals were selected as the research sample, like this study.<sup>[1,27,28]</sup> In most studies, hospital performance indicators and hospital costs were examined individually after the implementation of a national plan, while in our study, the mentioned variables were compared to each other. We also used hospitalization costs rather than outpatient costs because the role of hospitalization costs is more pronounced in economic analysis than outpatient costs.<sup>[23,24,28]</sup>

The hospitalization day indicator increased by 7.07% in all hospitals (on average, in each hospital, the hospitalization day increased from 25,087 in the year before the implementation of the plan to 27,376 during the 3 years after the implementation of the plan). However, since our conclusion criterion was the cost per mentioned hospital indicators, hospitalization costs of hospitals were adjusted based on the relevant performance indicator that separately for each hospital and in all hospitals which is one of the strengths of this study.

The most important thing that occurred during the years of implementation of the plan was that, while significant changes have been occurred in per capita hospitalization cost, cost per hospitalization day, and hospitalization cost per hospital bed in both the 1<sup>st</sup> year and the 3-year average after the implementation of the plan, the percentage of changes in the average hospitalization cost of all studied centers per hospitalization day (per capita hospitalization cost) and per hospital bed was largely the same. However, this situation differed from one hospital to another. It means that the percentage of changes in the above-mentioned items in each hospital was different from one another, for which one of the reasons can be the difference in the size of each hospital ward (e.g., intensive care unit) among the studied centers. Therefore, in this study, judgment criterion was based on the average percentage of changes in the variables of all hospitals, not separately for each individual hospital. Therefore, in general, a significant increase has been observed in hospitalization costs, drug and consumables costs, and hospitalization costs per a number of performance indicators in the short and long run.

As commonly stated in many studies, the most important hospital indicator that has a great impact on the increase

in hospitalization costs is the patient LOS, while in this study, after the implementation of the plan, no significant changes have been observed in this indicator in all the studied hospitals and each individual hospital under study, and at the same time, hospitalization costs increased. Furthermore, both in the 1<sup>st</sup> year and in the average years after the implementation of the plan (2014, 2015, and 2016), there was no significant change in the average of other performance indicators of all hospitals, and only significant change has been occurred in hospitalization costs and drug and consumables costs. Therefore, the increased percentage of per capita cost per hospitalization day, hospitalization cost per bed, and per capita hospitalization cost can be due to the increased therapeutic tariffs after the implementation of the HRP or factors outside the hospital domain, such as annual, partial, or nonpartial inflation and economic conditions. It should also be noted that whether all or part of the increase in hospitalization costs is only due to the implementation of the HRP. It requires more research and further investigations. Contrary to our results, in their study, Miller *et al.* stated that the implementation of the HRP has not had a significant effect on the total hospital costs.<sup>[28]</sup>

Foreign (external) studies that were somewhat similar to our study have investigated the implementation of macro plans in health sector, most of which were either insurance or financial plans. It should be noted that regarding the program packages included in these plans, HRP has the most variety of financial and program packages. Therefore, it is better to separately investigate the effect of each program package included in HRP on hospital performance indicators, hospital costs, or hospital performance cost, in future studies.

Internal studies have also examined the changes in hospital costs and performance, separately, within 1 year after the implementation of HRP. Two key distinctions and the innovation of this study compared to other studies are as follows: first, considering short-term (the 1<sup>st</sup> year of the implementation of the plan) and long-term (the average 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> years of the implementation of the plan) changes and performance indicators and hospitalization costs, and second, considering both of these variables. Therefore, it is suggested to investigate both the 1<sup>st</sup> year and the years after the implementation of the plan to prevent the impact of short-term economic shocks because, in this research, a large difference (about 20%) has been observed between the short-term and long-term results of the research variables after the implementation of HRP. Furthermore, the most important limitation from the viewpoint of the researchers of this study is considering cost changes and related indicators separately for each hospital wards and comparing the same wards of each



hospital together along with the consideration of changes in human resources during the years of research. It is, therefore, recommended to consider this point in future research.

## Conclusion

Considering the investigation of both hospital costs and performance indicators and heterogeneity and inconsistency of changes in hospitalization costs per performance indicators, both in the 1<sup>st</sup> year of the implementation of the plan and in the years after that, and even separately for each of the hospitals, one cannot definitely state that after the implementation of the HRP in the hospitals under study, desirable or undesirable changes will have occurred. Therefore, conducting research on the costs and performance of hospitals is still at an early stage, and further studies are needed to determine if these results are consistent with other time periods and other hospitals, such as single-specialized hospitals. In doing so, more hospitals and further studies such as conducting qualitative studies on induced costs should also be considered and its reasons should be investigated as well.<sup>[10,24,27]</sup> Finally, it is recommended that in addition to the variables studied in this research, variables such as energy costs, building spaces, hospital staff size, and even changes in the management staff of the centers during the years of research should be included simultaneously in the analysis, and the number of the studied centers should increase to the possible extent. It is also suggested that preventive cares such as Family Physician Plan (investigating urban and rural health centers), which have lower costs than medical expenses, should be taken into account along with the hospital analysis.<sup>[10,12,19,31]</sup>

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## Conflicts of interest

There are no conflicts of interest.

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