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Designing a Financial Resource Allocation Model Using Goal Programming Approach: A Case Study of a hospital in Iran

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ABSTRACT

Background: Prioritization and resource allocation are the most important processes in managing and developing each organization. Given the high turnover and cost of hospitals in health system, this study aimed to provide a model for financial resource allocation with the Goal Programming (GP) in Afzalipour teaching medical center in Kerman.

Methods: This mixed method and case-study study was conducted in Afzalipour teaching medical center located in Kerman, south-eastern of Iran. Participating key informants and operation research experts, twelve focus group discussions (FGDs) were developed to extract a goal programming model. Then, the hospital accounting data were collected from 2010- 2013 according to the extracted model. The WinQSB software was used for running the model.

Results: The findings of this study showed that the share of personnel costs of this hospital was 72% which 28% was devoted to fee-for-service (FFS) and contractual services, current and other costs were 6%, 2%, and 12%, respectively. However, the findings of goal programming model showed that the optimum and satisfactory amount of personnel costs must be 66%, 14% of which were allocated to the FFS cost. The share of contractual services, current and other costs must be 15%, 2%, and 17%, respectively.

Conclusion: The results showed that resource allocation in the hospital follow merely the accounting perspective rather than optimum and satisfactory ones. It is suggested in order to achieve the optimum values, the board of trustees should be institutionalized in practice; moreover, the outsourcing services should be addressed more. Therefore, personal costs which include a large part of costs can be reduced.

Keywords: Resource Allocation, Financial Resources, Goal Programming, Hospital, Iran

Citation

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Introduction

One of the most important functions of the Iranian government is to provide healthcare for the public which is declared as a right for every Iranian in Article 29 of the constitutional law (1). Nowadays, the health sector is one of the most important service sectors and its progress is one of the key elements of social welfare and development (2). Nowadays, technological advancements at different levels including medical technologies and people's high expectations of health systems have increased health expenditures at all levels, especially hospital, para-clinical, and diagnostic services (3).

Hospitals, as a key element of the health system, have an effective role in treating people. Furthermore, increasing health service expenditures have changed hospitals to costly organizations; since a significant part of the health sector resources is allocated to hospitals (4).

The main financial resources of the health sector are allocated to hospitals. This proportion is estimated to be about two third of health government budget in many developing countries (5).

Accordingly, in order to reduce the financial burden imposed on governments, some measures have been taken in the last three decades such as converting public hospitals to autonomous units and organizations with the board of trustees and privatizing them to improve the management process and allocation of resources of these units (6,7).

The contradiction between limited resources and diverse and unpredictable needs leads to prioritization and allocation of resources in the health and treatment sector (8). Since the aim of the study was to prioritize and reduce health inequalities and to increase productivity (9), traditional methods were not efficient, and it was necessary to use approaches and mechanisms of resource allocation according to new conditions (10). Therefore, it was conducted to make informed decisions about the appropriate allocation, to ensure equity in access to services, and to improve health system performance (11, 12).

Previous resources (i.e. budgeting) were different in a way that the organization was considered as a peaceful and stable environment, and the budget was merely used as a mean of control. Therefore, budgeting and resource allocation were not complicated, and subjective and qualitative methods such as conventional budget methods were often used (13). By applying operations research techniques in resource allocation in the 1960s, the goal programming was mainly used as a strong and efficient operations research technique for planning and allocation of resources (14). The goal programming is a multi-criteria decision making model in the field of linear algebra. This model encompasses several objectives and is adjusted based on minimizing the deviation from the targets (15). The main advantage of the goal programming is to consider constraints and ideals along with decision variables while planning and making decisions. This art gets special effects when several factors are optimized simultaneously (13).

In the study entitled "allocation of strategic resources in acute care hospitals using the goal programming approach", Black and Carter examined the status of resource allocation in the Mount Sinai Hospital in Toronto. To this end, they presented a model based on the combination of the provided services and the cost of every service. They stated that this model could be used to make decisions on the number, type and, price of services offered by the hospital and could improve the economic incentive of hospitals and hospital medical staff (16).

Abedi et al. (17), argued that the current allocation of resources was based on traditional methods, manpower experiences and mental reasoning. They also stated that use of these methods caused dissatisfaction and were not generalizable. Therefore, the goal programming was suitable to close the gap between quantity and quality of human reasoning. Moreover, goal programming is one of the most common

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operations research techniques which provide a way to move simultaneously towards several goals (15, 18, 19).

Concerning limited resources, unlimited needs and necessity of optimal allocation of resources in the Ministry of Health and Medical Education, the researchers examined the status of resource allocation in Afzalipour teaching hospital which was a hospital with a board of trustees and examined the efficiency of the allocation. They also designed and presented a resource allocation model for this hospital so as to consider the allocation of resources in the health sector and to present an optimal way to allocate resources in the hospital.

Afzalipour Teaching Medical Center

Afzalipour Hospital opened in 2002 and is one of the largest and best-equipped hospitals in Iran located in south-eastern of Iran. It is designed in 2 phases with the capacity of 540 beds. Currently, the first phase provides health services with 462 approved beds and the bed occupancy rate of 80%. It has 1123 employees, and 300 students are trained in this center every year. In 2013, 250461 people had outpatient visits and 33831 had inpatient stays. The center has a turnover of $ 190 million.

Financial resources of hospitals in Iran are mainly provided by governments, insurance companies, and people's direct payments. The annual budget for employees' salaries and other benefits is also provided by the Ministry of Health in the form of an increased budget; Afzalipour hospital also follows the same rule. Overall, more than 70% of the financial resource of this hospital is provided through operational revenues (revenues from the provision of services); public revenues provide 25 to 28% of its funding and non-operational revenues provide a very small share of the resources.

This center has become a hospital with the board of trustees since 2009. The board of trustees is responsible for leading and managing the hospital as well as setting goals and determining macro-policies of the hospital. Members of the board of trustees include chief of Kerman University of Medical Sciences (chairman of the board of trustees), chairman of the board of trustees (secretary), director of the hospital, planning or development deputy governor, the representative of chiefs of hospital clinical sections (chosen by the chiefs), mayor of the city, the representative of health donors assembly, director of social security organization, director general of health insurance system, a representative of Islamic Consultative Assembly (as an observer in meetings of the board of trustees), an expert on management issues and one person on behalf of the center deputy assembly.

Materials and Methods

This mixed method and case study was conducted in Afzalipour teaching medical center located in Kerman, eastern-south of Iran. This study reviewed the regulations, bylaws, ministerial guidelines, and all administrative documents related to board of trustees' hospitals. It was examined financial resources allocation and budgeting mechanisms in these hospitals such as FFS payments disciplines. Then, the key participants were identified. Twelve focus group discussions (FGDs) were held in the presence of the head, manager of the revenue unit, manager of the accounting section and one of the members of the board of trustees, and the operation research experts. Every meeting lasted for about two hours. The goals for the model were extracted from FGDs. Using system analysis and holding the FGDs, the model of resource allocation was calculated. This model was estimated for the year 2013 so as to have some plans for the coming years.

The goal programming model is one of the most applicable operations research techniques first introduced by Charnes, Cooper & Ferguson in 1955. The goal programming tries to combine and mix the optimization logic in mathematical programming with the decision-maker's desire to satisfy several objectives (19).

The goal programming has three "decision, goal and systemic constraints and objective function" variables; its general model is as follows:

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Minimize $Z = \sum_{k=1}^{\wedge} P_m^+ d_k^+ + P_m^- d_k^-$

Subject to

$\sum_{j=1}^{n} C_{jk} x_j - d_k^+ + d_k^- = g_k, \quad k = 1,2,\dots,k$

$d_k^+ \geq 0, d_k^- \geq 0, x_j \geq 0 \ (j = 1,2,\dots,n)$

The decision variables: $X_1, X_2, \dots, X_n$

The number of targets: k

Goals assigned to the K target: g_k

Priority of targets: $P_1 > P_2 >, \dots, P_m$ $(m = 1,2,\dots,n)$

This study was approved by ethics committee at Kerman University of Medical Sciences (KUMS) with the code of ethics 1135.1393.

Results

Using the FGDs, the decision variables and goals were extracted from this center. Table 1 shows the decision variables and their definitions.

In this study, the model was designed and implemented according to the costs. The costs included total salary costs, fee-for-service (FFS) health care, current costs, outsourced services and other costs.

Table 3 shows the costs and incomes of Afzalipour hospital from 2010-2013. This information was extracted from the accrual system and accounting reports like balance sheet and profit and loss statement.

According to Table 3, the level of personnel costs increased from 54% in 2010 to 80% in 2013; it could be due to recruiting contract personnel and retracting outsourced services. Costs of outsourced services decreased from 41% in 2010 to 6% in 2013; it could be due to the recruitment of manpower and lack of outsourcing such services from private companies. Since most of these services were provided through recruitment (e.g. pharmacy).

Non-operational revenues of this center such as incomes resulted from rent decreased from 1.69% in 2010 to 0.38% in 2013. After retracting some outsourced services, these revenues decreased; for example, after transferring the pharmacy from the private center to this center, revenues resulted from renting the pharmacy were deducted from the non-operational revenues. Performance revenues of this center increased during the study years due to increased annual tariffs in diagnostic and medical services. General revenue (i.e. budget allocated by government to public hospitals) also increased over these years; since credits related to offsetting the cost of staff salaries and wages formed part of these incomes. Recruiting contractual manpower by the center and retracting some services from the private sector, the budget allocated to personnel increased as the number of staff increased.

The goal programming was designed in 2013. The results showed that the level of total salary of personnel including base payment, overtime and bonuses was far from the optimal and satisfying level. Moreover, according to the optimal values, costs of the outsourced and contractual services decreased significantly in 2013 due to reclaiming some services from the private sector. As a result, it could be concluded that the amount of total personnel costs (i.e. sum of total salary and FFS costs) could decrease by outsourcing some services. Employees' incentives and efficiencies could increase and get closer to the optimal and satisfactory levels through bonuses.

Concerning the revenues of this center, it could be stated that these revenues were in good conditions compared to the optimal amount. Operational revenues of the center were close to the optimal status and were in good conditions; it could be due to annual tariff changes which increased without the control of the hospital. However, non-operational revenues of the center decreased in 2012 and 2013 due to the reclamation of services given to the private sector. As a result, incomes from renting part of physical space of the hospital decreased.

The general revenue allocated by the university to the hospital, increased during the study years; since some parts of these credits was related to employees' salaries which increased by reclaiming the allocated services and recruitment of manpower.

According to the optimal levels obtained from the goal programming model, generally, it could be said that when outsourcing some sections of the hospital such as pharmacy, real values were closer to the values obtained from the goal programming.

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Table 1. Decision variables used in goal programming model for financial resource allocation in Afzalipour teaching medical center

Decision variable	Parameter label	Definition
Base payment	X_1	These costs are items such as job and employee payment, hardship payment, child and wife allowance.
Overtime	X_2	A charge which is monthly paid based on extra hours of service provision
Bonuses	X_3	The amount added to wage as a reward for good performance
FFS* for physicians	X_4	It is amount of operational revenues paid to physicians performance
FFS for non-physician personnel	X_5	It is amount of operational revenues paid to personnel performance
Outsourced services	X_6	The costs that are paid to the private sector for contractual services
Current costs	X_7	These costs include items such as gasoline, water, electricity, gas and etc.
Other costs	X_8	These costs include such as banking charge, training costs and etc.
Non-operational revenues	X_9	Revenues which are indirectly attained from rent of some facilities such as restaurant, coffee shop, bookstore and etc.
Operational revenues	X_{10}	Revenues which are directly attained from health care services provided to patients
General revenue	X_{11}	The budget allocated by government to public hospitals

Table 2. Goals and deviation of the model

Goals		Goal constraints	Deviation from goals d^+	Deviation from goals d^-
G.1	Total personnel costs should not exceed 65% of total costs.	$X_1 + X_2 + X_3 + X_4 + X_5 + d_1^- - d_1^+ = 0.65 (X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7 + X_8)$	d_1^+	-
G.2	Total personnel costs should not be less than 50% of total costs.	$X_1 + X_2 + X_3 + X_4 + X_5 + d_2^- - d_2^+ = 0.50 (X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7 + X_8)$	-	d_2^-
G.3	The share of FFS* should not exceed 35% of total personnel costs.	$X_4 + X_5 + d_3^- - d_3^+ = 0.35 (X_1 + X_2 + X_3 + X_4 + X_5)$	d_3^+	-
G.4	The share of FFS should not be less than 20% of total personnel costs.	$X_4 + X_5 + d_4^- - d_4^+ = 0.20 (X_1 + X_2 + X_3 + X_4 + X_5)$	-	d_4^-
G.5	The share of base payment should not exceed 85% of total salary.	$X_1 + d_5^- - d_5^+ = 0.85 (X_1 + X_2 + X_3)$	d_5^+	-
G.6	The share of overtime should not exceed 15% of total salary.	$X_2 + d_6^- - d_6^+ = 0.15 (X_1 + X_2 + X_3)$	d_6^+	-
G.7	The share of FFS of physicians should not exceed 65% of total of FFS costs.	$X_4 + d_7^- - d_7^+ = 0.65 (X_4 + X_5)$	-	d_7^-
G.8	The share of FFS of physicians should not be less than 50% of total of FFS costs.	$X_4 + d_8^- - d_8^+ = 0.50 (X_4 + X_5)$	-	d_8^-
G.9	The share of fee for services of non-physician personnel should not 45% of total of FFS costs.	$X_5 + d_9^- - d_9^+ = 0.40 (X_4 + X_5)$	d_9^+	-
G.10	The share of FFS of non-physician personnel should not be less than 20% of total of FFS costs.	$X_5 + d_{10}^- - d_{10}^+ = 0.20 (X_4 + X_5)$	-	d_{10}^-
G.11	Outsourced services costs should not be less than 20% of total costs.	$X_6 + d_{11}^- - d_{11}^+ \leq 0.15 (X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7 + X_8)$	-	d_{11}^-

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G.12	The share of current costs should not exceed 2.5% of total costs	$X_7 + d_{12}^- - d_{12}^+ = 0.025 (X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7 + X_8)$	d_{12}^+	-
G.13	The share of other costs should not exceed 12% of total costs	$X_8 + d_{13}^- - d_{13}^+ = 0.12 (X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7 + X_8)$	d_{13}^+	-
G.14	The share of public income should not exceed 25% of total incomes.	$X_{12} + d_{14}^- - d_{14}^+ = 0.25 (X_9 + X_{10} + X_{11})$	d_{14}^+	-
G.15	The share of performance revenue should not be less than 70% of total incomes.	$X_9 + X_{10} + X_{11} + d_{15}^- - d_{15}^+ = 0.70 (X_9 + X_{10} + X_{11})$	-	d_{15}^-
G.16	The hospital does not have any loss.	$(X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7 + X_8) + d_{16}^- - d_{16}^+ = (X_9 + X_{10} + X_{11})$	-	d_{16}^-
G.17	The hospital work independently from general revenue.	$(X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7 + X_8) + d_{17}^- - d_{17}^+ = (X_9 + X_{10} + X_{11})$	-	d_{17}^-
G.18	If possible at least 5% of the hospitals saving should be spent on infrastructure and development	$(X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7 + X_8) + d_{18}^- - d_{18}^+ = 0.95 (X_9 + X_{10} + X_{11})$	-	d_{18}^-

System constraints of the model are as follows.

$X_1 + , \ldots, + X_8 = 1$

$X_j, d_k^-, d_k^+ \geq 0$

$L \leq Xi \leq U, L = 0, U = 1$

The objective function of this model is as follows.

$$MIN\ Z = P_1 (d_{16}^-) + P_2 (d_{14}^+ + d_{15}^-) + P_3 (d_1^+ + d_2^- + d_3^+ + d_4^- + d_5^+ + d_6^+ + d_7^- + d_8^- + d_9^+ + d_{10}^- + d_{11}^- + d_{12}^+ + d_{13}^+) + P_4 (d_{17}^-) + P_5 (d_{18}^-)$$

Table 3. Cost and revenue items and their relative index in Afzalipour teaching medical center for 2010-2013 (Numbers in billion rials)

Items	2010		2011		2012		2013		Optimum results of GPM [b]
	Amount	% [a]	Amount	%	Amount	%	Amount	%	
Total costs	172.14	100	215.12	100	248.90	100	276.45	100	100
Total personnel costs	93.63	54.39	116.32	54.07	176.73	71.00	221.40	80.09	66.00
Total salary	67.87	39.43	80.17	37.27	129.01	51.83	158.57	57.36	52.00
Base payment	60.40	35.09	67.47	31.36	126.72	50.91	140.71	50.90	37.00
Overtime	7.47	4.34	12.68	5.89	2.27	0.91	17.83	6.45	8.00
Bonuses	0.00	0.00	0.01	0.00	0.01	0.00	0.03	0.01	7.00
FFS [c]	25.76	14.96	36.15	16.80	47.73	19.18	62.84	22.73	14.00
Physicians	20.23	11.75	25.01	11.63	29.09	11.69	38.14	13.80	10.00
Non-physician Personnel	5.53	3.21	11.14	5.18	18.63	7.48	24.70	8.93	4.00
Other costs	78.51	45.61	98.81	45.93	72.17	29.00	55.05	19.91	34.00
Outsourced services	70.60	41.01	76.36	35.50	40.03	16.08	15.27	5.52	15.00
Current costs [d]	1.04	0.60	4.11	1.91	5.70	2.29	6.83	2.47	2.00
Other costs	6.87	3.99	18.33	8.52	26.45	10.63	32.96	11.92	17.00
Total revenues	186.99	100	250.64	100	331.97	100	323.66	100.00	100.00
Performance based revenues	132.41	70.81	185.16	73.87	243.30	73.29	230.84	71.32	75.00
Non-operational	3.21	1.72	4.94	1.97	2.55	0.77	1.22	0.38	2.00
Operational [e]	129.19	69.09	180.22	71.90	240.75	72.52	229.62	70.94	73.00
General revenue	54.58	29.19	65.48	26.13	88.67	26.71	92.82	28.68	25.00

[a] Relative index for each item in costs and revenues is calculated by dividing the item by the total costs or total revenues [b] GPM: Goal programming model [c] FFS: Fee-for-service [d] Current costs consists of gasoline, water, electricity and gas [e] Operational revenues consists of inpatient and out-patient services revenues.

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Discussion

Improving the economic performance of these organizations plays a crucial role in the proper allocation of financial resources as the most important capital of the health system. Therefore, designing an efficient and effective system with proper and systematic management improves hospital performance.

The results showed that there was a significant difference between current distribution of resources and their optimal distribution. It represented economic inefficiency of Afzalipour Hospital. The World Health Organization also stated that more than 50% of health resources in the health sector were not efficient (4).

One of the most important reasons of economic inefficiency in this center was high expenses including manpower costs and the operational costs due to changes in the payment system, especially the FFS payment system that requires fundamental changes based on performance.

Personnel costs are one of the most important costs of educational-treatment centers. In this study, a large amount of resources was allocated to these costs. Therefore, optimal allocation of resources plays a significant role in economic efficiency of these centers because humans have a crucial role in the hospitals. Inadequacy of wages and unfair and inefficient payment system cause problems such as employees' dissatisfaction, absenteeism, turnover and strike. Moulavi stated that manpower was considered the most important resource in any organization and plays an important role in success and effectiveness of the organization. To use this factor optimally in the long run, the first to be considered will be the salary paid to the personnel ().

Among the operational costs of a hospital, costs related to the human resources are the most important ones. In the present study, these costs consisted of 50% to 80% of the costs of the center in the study years. In a study conducted by Khatami et al. (21), in public hospitals, the share of staff operational costs was 58% of total costs of the hospitals. Furthermore, according to the international standards, staff costs are 55% to 60% of total hospital operational costs. It should be noted that this does not mean that increasing in the personnel share of total costs in hospital can necessarily be led to the performance and efficiency improvement. It is required that further research to be conducted considering the performance data such as bed turnover, bed occupancy rate, etc.

Goudarzi et al. (22), stated that more than half of health care staff worked in hospitals. In other words, a significant portion of fixed healthcare costs were allocated to personnel costs. Pourmojib (23) also pointed out in his study that the medical and paramedical personnel formed more than 70% of hospital manpower, and 65 to 70% of current costs of hospitals were allocated to them.

Generally, it reflected undeniable importance of human resources in the hospitals and their significant role in hospital costs and showed that the hospital management could reduce hospital costs significantly and could improve efficiency and effectiveness of hospital care by reviewing manpower arrangement and identifying unnecessary costs.

During the study years, outsourced and contractual services costs decreased dramatically due to repeal purchasing some services from the private sector. The volume of hospital operational costs and inefficiency in the health system caused hospitals to outsource services to the non-governmental sections to reduce costs and improve the efficiency. The present study showed that outsourcing some services to the private section had a positive effect on the costs of the manpower. The WHO (24) stated that outsourcing means using resources out of the organization and mentioned that outsourcing provides the opportunity to present non-vital services such as laundry, information technology and transportation to the specialized providers through purchasing the services from private sector. Hesiao et al. (25) pointed out that outsourcing for hospitals, especially public hospitals could result in some benefits such as removing human resources shortages, improving productivity and reducing the financial burden of hospitals. Recently, the

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Ministry of Health (MOE), considered outsourcing in order to downsize the government and strengthen the accountability and efficiency of the health care and to implement Clause 5 of Article 2 of the Administrative Regulations in 2003 and the Third Development Plan (26). Martin et al. (27), regarded liberalization of financial and human resources with the aim of allocating these resources to the organization goals as the main achievements of outsourcing. Results of a study conducted by Ferdowsi et al. (28), revealed that consumable and manpower costs could decrease by outsourcing some services.

Conclusion

The contradiction between limited resources and unlimited needs of the health sector has made the allocation of resources inevitable. Concerning the effective role of hospitals in treating people and their high portion in current government expenditure, examining the status of allocation of financial resources of hospitals is of great importance. Thus, the status of allocation of financial resources in Afzalipour teaching medical center was examined based on the programming; because the theory of the new government might increase productivity. Moreover, making use of the goal programming model could increase productivity and satisfaction. As a result, it could be a good model for hospitals with the board of trustees. According to the accounting governance, lack of transparency in the prioritizing process and resource allocation in this center, the programming goal was presented based on the same presumption. In order to improve this model, priority setting and resource allocation of this center must be reformed and presented clearly and systematically. Resource allocation in this center was based on the organizational structure; however, it was not based on objectives and results. This viewpoint did not provide justice and productivity.

In general, resource allocation was not desirable in this center. According to the results of the research environment, expenses of human resources embraced a huge portion of resources and these expenses increased by reclamation of outsourced and contractual services. Thus, hospital incomes from public revenues increased and non-operational incomes decreased.

In order to optimize the resource allocation in this center, to reform the payment system especially the free service system, and to reform employment of human resources, it is recommended that non-main and non-operational services be outsourced to the private section which can decrease human resource expenses and free service expenses. Moreover, bonuses and rewards can increase employees' motivation and performance and can be effective steps in achieving optimal and satisfying levels.

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Conflicts of Interest

The authors declare that they have no conflicts of interests.

Authors' contributions

Lashkari M and Mehrolhassani HM designed research; Lashkari M conducted research and Saberi H helped and facilitated the data gathering particularly the FGD sessions. Mehrolhassani HM, Mohammadi M and Yazdi-Feyzabadi V analyzed data and verified the final analysis; Lashkari M and Yazdi-Feyzabadi V wrote the drafting of this manuscript. All authors read and approved the final manuscript.

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