

Study on the effectiveness evaluation of medical consortia based on AHP

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Abstract: Objective: To effectively evaluate the timeliness of China's medical union policy, and to help the medical management department provide a reference basis for the implementation of the medical union policy, this paper, by combing the relevant research on the medical union policy at home and abroad, constructs a comprehensive evaluation index system of the timeliness of the medical union in four dimensions: the construction of basic medical services, the sharing of regional information, the two-way referral within the medical union, and the level of medical service. The weights of different indicators are calculated by using the analytic hierarchy process, and the results of different indicators are compared and analyzed. The results show that the level of medical service and regional information sharing are the most important indicators for evaluating the effectiveness of the medical consortium.

Keywords: medical association; Effectiveness evaluation; AHP

1. Introduction

Establishing an integrated medical service system is an important research topic and trend of health reform in the world. China is faced with problems such as the contradiction between the supply and demand of medical resources caused by the irrational allocation of medical resources, the mismatch between the high-quality resources of hospitals and the demands of patients, etc. The state has put forward the hierarchical diagnosis and treatment policy and the medical union policy, hoping to rationally allocate medical resources, and promote the equalization of basic medical and health services and the vertical flow of high-quality medical resources through such a model. Since China put forward the medical union policy in 2017, it has improved the fairness and accessibility of high-quality medical resources in China to some extent. However, at present, there is still a lack of effective evaluation, supervision, and feedback system for the practical effects of various integration policies in China, which makes it difficult for hospitals and health management departments to effectively manage and promote the work of the medical unit.

Through the review, sorting, and summary of the relevant literature on the medical consortium, the analysis of the relevant literature on the evaluation of the medical consortium at home and abroad provides the basis for the study. It can be seen from the literature analysis that most of the research literature on medical consortia in recent years summarized the shortcomings of the existing reform of medical consortia in governance, compensation, operation, and management and gave policy recommendations, but the literature on evaluation of medical consortia through empirical research is less.

1.1. Definition of the medical consortium model

Domestic scholars are similar in their definition of medical consortia, emphasizing that the construction and development trend of medical consortia is mainly based on the vertical integration of medical resources. The main practice models of medical consortia are rough as follows: one is a close-type consortium with assets as the link, the other is a semi-close-type medical consortium with member units entrusted by the core hospital, and the third is a loose medical consortium with technology as the link^[1]. Compared with the concept of "medical union" in China, most foreign studies refer more to the integration of medical services or resources, that is, integrated care. Since the 21st century, integrated medical care has gradually become the focus of the reform of medical and health service systems in various countries. In 2008, WHO defined integrated medical care as the organization and management of various resources in the medical and health system, from which systematic and integrated medical and

health services can be obtained when patients need them, resulting in ideal health effects and corresponding economic value [2]. In practice, due to the differences in the scope and methods of implementing integrated medical care in different countries, different words and concepts have been derived, For example, the transmural care in the Netherlands, the shared care and integrated care networks (ICN) in the United Kingdom, the integrated delivery network(IDN) and integrated delivery system(IDS) in the United States, etc^[3,4]. Among them, the concept and mode of IDS in the United States are similar to that of the medical union in China. It refers to an organizational network composed of medical service providers and medical institutions to provide or arrange integrated and continuous medical services to specific populations^[5].

1.2. Research related to the evaluation of medical consortia

The integration of the medical service system is a key issue in the health system, and the integration of medical evaluation has become a trend. Through the analysis of the relevant literature on the evaluation of medical consortia at home and abroad, it is found that although scholars at home and abroad have done a lot of evaluation research on medical consortia, there has been no systematic theoretical system in the world, and the theoretical model and evaluation method of medical consortia are at the exploration stage. Domestic research is mostly conducted from a single perspective of economics and management, Wang Wenjuan and others^[6], based on the theory of new structural economics, constructed a framework model to guide the situation to evaluate the cooperation mode of the medical consortium; With the help of alliance stability theory, Sun Tao and others^[7] constructed the framework of alliance stability evaluation index system for regional medical consortiums. The theoretical models of foreign research are more systematic and dynamic. For example, Busetto and others^[8] have built a COMIC model to comprehensively evaluate the intervention measures of integrated medical care. From the perspective of evaluation content, due to the differences between different national conditions and research objectives, the evaluation dimensions and indicators set are mostly based on different research needs and research purposes^[9]. The construction and development of medical consortia in China aim to promote the construction of a hierarchical diagnosis and treatment system. The evaluation indicators of medical consortia are complex, including medical service quality, medical service efficiency, two-way referral, discipline construction, talent training, etc^[10]. However, most of the foreign studies are patient-centered, focusing on the evaluation of medical utilization, medical quality, and medical cost^[11-12].

1.3. Evaluation method of medical consortium

Table 1: Evaluation methods of domestic medical association literature

Classification	Evaluation method	Example
Qualitative evaluation method	Case analysis	Evaluate the governance structure and operation mode of hospital collectivization mode ^[13]
	Delphi method	Build the feasibility analysis and evaluation index system of the Corps regional hospital group ^[14] Construction of the evaluation index system for the sustainable development of the medical association -- based on the Delphi method ^[15]
Quantitative evaluation method	Analytic hierarchy process	Use AHP to determine the relative weight of indicators ^[16]
	Artificial Neural Network	Propose that the ANN method can be used for the performance evaluation of medical consortia ^[17]
Objective model evaluation method	TOPSIS method	The linkage mode of medical union and its comprehensive effect before and after the reform of core hospitals Benefit analysis ^[18]
		Comprehensive evaluation of medical quality, efficiency, and benefit of cooperative hospitals ^[19] A comprehensive evaluation of the effect of hospital trusteeship reform ^[16]
	Data Envelopment Analysis	Evaluation on the effect of a community health service center joining the medical union Price ^[20]
Multi-method fusion evaluation	Fuzzy combination of TOPSIS method and RSR method	Analyzing the actual operation effect of each hospital in a medical association in Chengdu ^[21]
		A comprehensive evaluation of the implementation effect of Shanghai Medical Consortium ^[22]
		Implementation status and comprehensive evaluation of urban medical consortia in China Price ^[23]
		Research on performance evaluation of medical consortiums in cities and counties in China Research ^[24]

From the perspective of evaluation methods, both qualitative and quantitative research methods have been adopted at home and abroad. Most medical institutions are evaluation units in China. The literature evaluation methods of the domestic medical association include qualitative and quantitative evaluation, target model evaluation, and multi-method fusion evaluation (see Table 1). Among them, the TOPSIS method is mainly used to evaluate the implementation effect of the hospital before and after joining the medical association.

To sum up, there are relatively few studies on the implementation effect of the medical consortium. Therefore, based on the AHP method, this paper constructs the effectiveness evaluation index system of the medical consortium model under the hierarchical diagnosis and treatment system, calculates the index weight through expert scoring, analyzes the evaluation results, and puts forward policy recommendations.

2. Construction of the effectiveness evaluation model of medical consortia based on AHP

2.1. Concept of the effectiveness of medical consortium

The definition of the effectiveness evaluation of the medical consortium refers to the feasibility and purpose of the implementation of the medical consortium through the relevant indicators of the medical consortium system. Since the implementation of the new round of medical and health system reform, the evaluation of the fairness and accessibility of medical and health services has changed from the evaluation of a single medical institution to the overall evaluation of the leading unit and member units of the medical consortium.

2.2. Data and methods

2.2.1. Research object

The effectiveness evaluation of medical consortia mainly focuses on the urban medical group and the county medical community. At the same time, the technical radiation role of the leading unit and the improvement of residents' health are mainly evaluated for the cross-regional professional alliance and the telemedicine cooperation network.

2.2.2. Method

The evaluation of the effectiveness of the medical unit under the hierarchical diagnosis and treatment system belongs to the evaluation of multiple factors. Among the many influencing factors, some have a large impact on the performance of the medical consortium, and some have a small impact. This requires a certain method to analyze the impact of these factors on the effectiveness of the medical consortium. Saaty, T.L.^[25] believed that the analytic hierarchy process was divided into three steps: hierarchical multi-parameter method, comparing paired attributes to determine weights, and comparing paired alternatives to determine preferences. That is, determine the weight of each indicator, use the analytic hierarchy process to structure the effectiveness indicators, assign scores to relevant documents, compare each evaluation indicator in pairs, qualitatively describe its relative importance, and construct a judgment matrix, which can more accurately calculate the weight of each indicator.

2.2.3. Effectiveness evaluation index system of medical consortium

According to the relevant principles of indicator selection, refer to the Guiding Opinions of the National Health and Family Planning Commission on Carrying out the Pilot Work of the Construction of Medical Consortiums (Guo Wei Yi Fa [2016] No. 75) issued in 2016 and the Guiding Opinions on Promoting the Construction and Development of Medical Consortiums (Guo Ban Fa [2017] No. 32) issued by the General Office of the State Council in 2017 and other relevant documents, Select relevant indicators to reasonably evaluate the effectiveness of the medical unit. Relevant first-level indicators include the construction of basic medical services, regional information sharing, and two-way referral within the medical union, and medical service level. According to relevant theoretical analysis, relevant expertise, and reliability, the most representative indicators can be selected through discussion by the application, and 11 indicators from the following four aspects are selected to evaluate the effectiveness of the medical consortium:

- Construction of primary medical services:

The member units of the medical consortium are responsible for the daily average number of diagnoses and treatments X_1 ; the hospital bed utilization rate of the member units of the medical

consortium is X2; The number of hospital bed turnover in the member units of the medical consortium is X3.

■ Regional information sharing:

Whether the information sharing platform X4 is established; Whether to establish resident health records and electronic medical records sharing X5; Whether the inspection results of the medical consortium mutually recognize X6.

■ Two-way referral in the medical union:

The upward transfer ratio of medical consortium member units is X7; The downward transfer ratio of the core hospital of the medical consortium is X8.

■ Medical service level:

The proportion of diagnosis and treatment of common diseases in medical consortium member units is X9; The characteristic specialty construction level of medical consortium member units is X10; The proportion of patients with acute and critical diseases in the core hospital of the medical union is X11.

The construction results are shown in Figure 1.

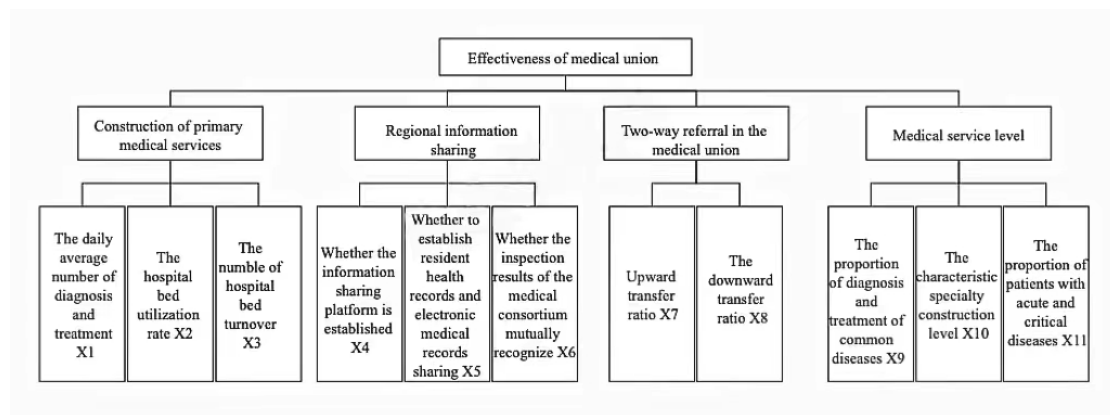


Figure 1: Effectiveness evaluation index system of medical consortia

3. Results and analysis

3.1. The Calculation process of AHP index weight under the model

The importance of indicators is scored according to the indicator system, and then the scoring results are discussed and summarized internally. The pairwise judgment matrix is shown in Table 2:

Table 2 First-level index judgment matrix

	Basic medical service construction	Regional information sharing	Two-way referral in the medical union	Medical service level
Basic medical service construction	1	1/2	2	1/2
Regional information sharing	2	1	3	1
Two-way referral in the medical union	1/2	1/3	1	1/4
Medical service level	2	1	4	1

Calculate the maximum characteristic root of the judgment matrix S to get $\lambda_{max} = 4.0104$. The calculated consistency index $CI=0.0035$, the average random consistency index $RI=0.89$, and the random consistency ratio $CR=0.0039<0.10$. Therefore, it is considered that the results of the AHP have satisfactory consistency. The weights of the calculated indicators are shown in Table 3.

Table 3: Weights of primary indicators

Indicator layer	Weight
Basic medical service construction	0.1850
Regional information sharing	0.3451
Two-way referral in the medical union	0.0999
Medical service level	0.3701

The judgment matrix of the construction of primary medical services is constructed as shown in Table 4:

Table 4: Judgment matrix of primary medical service construction of secondary indicators

	The average daily burden of diagnosis and treatment of members X1	The bed utilization rate of member units X2	Number of hospital bed turnover in member units X3
X1	1	1/5	1/2
X2	5	1	2
X3	2	1/2	1

Calculate the maximum characteristic root of the judgment matrix S for the construction of primary medical services and get $\lambda_{max} = 3.0055$. The calculated consistency index $CI=0.0028$, the average random consistency index $RI=0.52$, and the random consistency ratio $CR=0.0053 < 0.10$. Therefore, it is considered that the results of AHP have satisfactory consistency. The weights of the calculated indicators are shown in Table 5.

Table 5: Weights of primary medical service construction of secondary indicators

Indicator layer	Weight
X1	0.1285
X2	0.5949
X3	0.2766

The judgment matrix of regional information sharing is constructed as shown in Table 6:

Table 6: Judgment matrix of regional information sharing of secondary indicators

	Whether to establish an information-sharing platform X4	Whether to establish resident health records and electronic case sharing X5	Whether the results of the internal examination of the medical association are mutually recognized X6
X4	1	2	6
X5	1/2	1	2
X6	1/6	1/2	1

Calculate the maximum characteristic root of the judgment matrix S for regional information sharing and get $\lambda_{max} = 3.0183$. The calculated consistency index $CI=0.0091$, the average random consistency index $RI=0.52$, and the random consistency ratio $CR=0.0176 < 0.10$. Therefore, it is considered that the results of AHP have satisfactory consistency. The weights of the calculated indicators are shown in Table 7:

Table 7: Weights of regional information sharing of secondary indicators

Indicator layer	Weight
X4	0.6127
X5	0.2693
X6	0.1180

The judgment matrix of two-way referral in the medical association is constructed as shown in Table 8:

Table 8 Judgment matrix of two-way referral of secondary indicators in the medical union

	The upward transfer ratio of medical consortium member units X7	The downward transfer ratio of the core hospital of medical consortium X8
X7	1	1/2
X8	2	1

Calculate the maximum characteristic root of the two-way referral judgment matrix S in the medical association and get $\lambda_{\max} = 2$. The consistency index $CI=0$ and the random consistency ratio $CR=0$ are calculated, so it is considered that the results of AHP have satisfactory consistency. The weights of the calculated indicators are shown in Table 9:

Table 9 Weights of two-way referral within the medical union of secondary indicators

Indicator layer	Weight
X7	0.3333
X8	0.6667

The matrix of medical service level is constructed as shown in Table 10:

Table 10 Judgment matrix of medical service level of secondary indicators

	The proportion of diagnosis and treatment of common diseases in medical consortium member units X9	Characteristic specialty construction level of medical consortium member units X10	The proportion of patients with acute and critical diseases in the core hospital of the medical union X11
X9	1	7	4
X10	1/7	1	1/3
X11	1/4	3	1

Calculate the maximum characteristic root of the medical service level judgment matrix S to get $\lambda_{\max} = 3.0326$. The calculated consistency index $CI=0.0163$, the average random consistency index $RI=0.52$, and the random consistency ratio $CR=0.0313 < 0.10$. Therefore, the results of the AHP are considered to have satisfactory consistency. The weight of the calculated indicators is shown in Table 11:

Table 11 Weight of medical service level of secondary indicators

Indicator layer	Weight
X9	0.7014
X10	0.0853
X11	0.2132

The comprehensive weight is calculated by using the weight of the primary index and the weight of the secondary index, as shown in Table 12:

Table 12 Comprehensive Weight

Indicator layer	Weight	Indicator layer	Weight	Comprehensive weight
Basic medical service construction	0.185	X1	0.1285	0.0238
		X2	0.5949	0.1101
		X3	0.2766	0.0512
Regional information sharing	0.3451	X4	0.6127	0.2114
		X5	0.2693	0.0929
		X6	0.118	0.0407
Two-way referral in the medical union	0.0999	X7	0.3333	0.0333
		X8	0.6667	0.0666
Medical service level	0.3701	X9	0.7014	0.2596
		X10	0.0853	0.0316
		X11	0.2132	0.0789

3.2. Analysis of index weight calculation results

According to the above data, the weight coefficient and comprehensive weight distribution of the first-level and second-level indicators on the effectiveness of the medical consortium can be drawn as shown in Figure 2, Figure 3, and Figure 4.

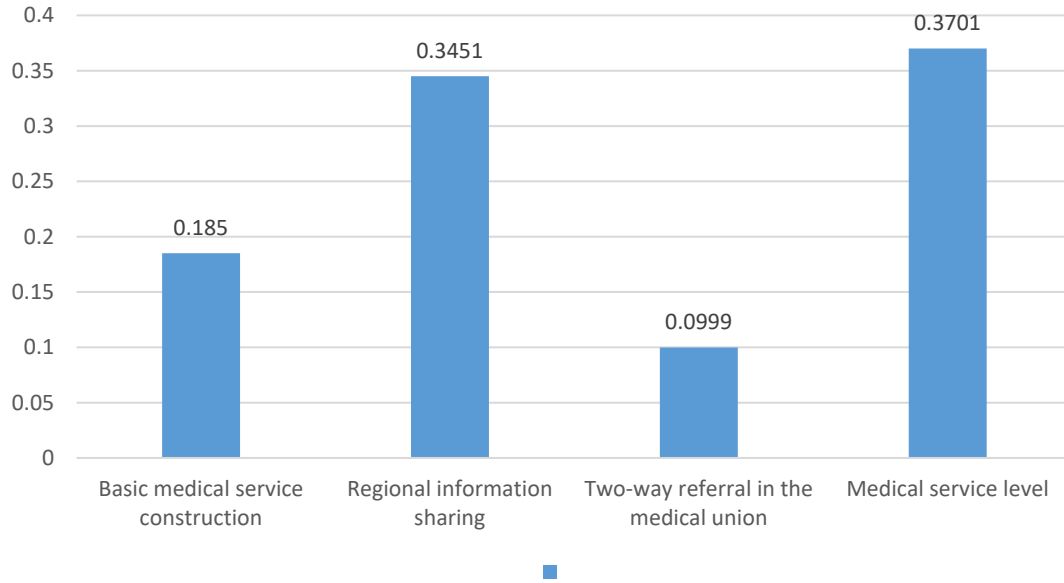


Figure 2 Weight coefficient of the effectiveness of the first-level indicator system on the medical union

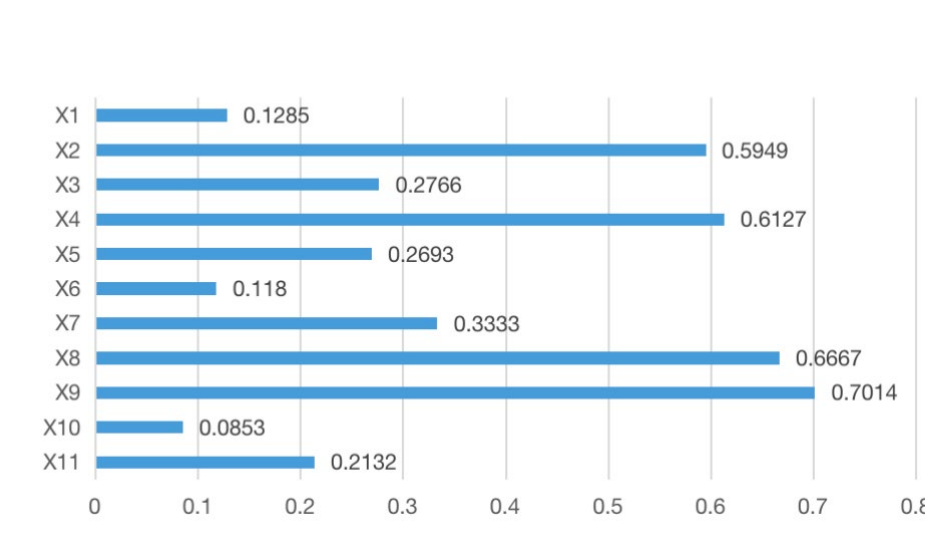


Figure 3 Weight coefficient of the effectiveness of the second indicator system on the medical union

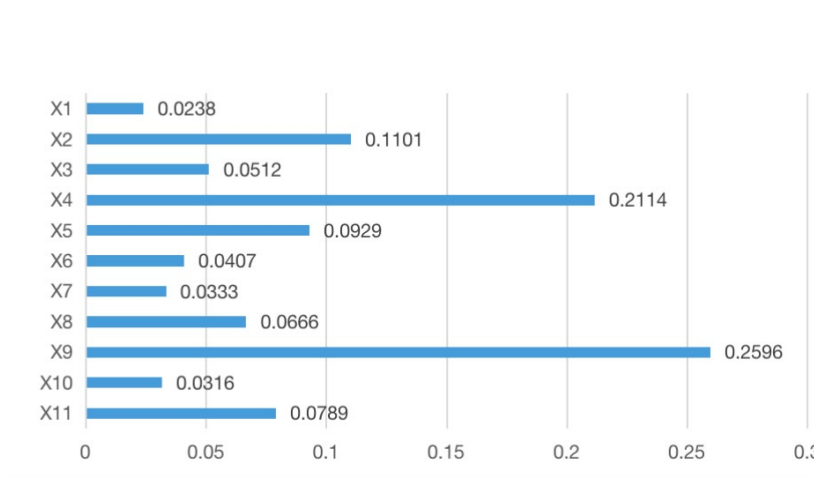


Figure 4 Comprehensive weight coefficient

The ranking of weights in the first-level indicator system is: two-way referral within the medical

union<construction of primary medical services<regional information sharing<medical service level. Therefore, the level of medical service and regional information sharing are the most important indicators for evaluating the effectiveness of the medical consortium. In the comprehensive indicator system, the proportion of common disease diagnosis and treatment in the member units of the medical consortium X9 has a relatively large impact on the effectiveness of the medical consortium, followed by whether to establish an information sharing platform X4, the utilization rate of sickbeds in the member units of the medical consortium X2, whether to establish residents' health records and electronic medical records sharing X5, and the proportion of critical and critical patients in the core hospitals of the medical consortium X11.

3.3. Suggestions

According to the research data and the experience of the evaluation literature of medical consortia, the conclusions of the effectiveness evaluation study of medical consortia based on AHP under the hierarchical diagnosis and treatment system can be summarized as follows:

3.3.1. Strengthen the theoretical research on the evaluation of medical consortia

At present, domestic theoretical research on the evaluation of medical consortia is still insufficient, which can be summarized as follows:

(1) The integration concept suitable for the development of the Chinese Medical Association has not yet been explored. The theoretical analysis of the implementation framework, motivation, and resistance related to integrated medical care is mostly in general terms, and the integration experience based on the characteristics of different regions and different target groups lacks systematic analysis, evaluation, and summary;

(2) Most of the studies are based on the theoretical experience of the medical consortium or the current situation and path of integration in various regions. Few kinds of literature analyze the specific effects of the integration of the medical consortium. Based on research at home and abroad, we should draw on the basic theories and models of relevant disciplines to build a theoretical framework and evaluation model suitable for the evaluation of China's medical consortia, and make up for the deficiencies in the theoretical research field one by one.

3.3.2. Establish a comprehensive and unified evaluation index system for medical consortia

At present, most of the evaluation indicators built in the study are self-designed or refer to similar research documents and the implementation rules of comprehensive hospital evaluation standards, and lack of a scientific, reasonable, systematic, and comprehensive theoretical systems to build evaluation indicators. Because integrated medical care is a dynamic process, and the current evaluation indicators are mostly static, lacking dynamics and consistency. Therefore, these local evaluation systems lead to the cooperation of local medical consortia often only from one side or one angle, which is not conducive to the systematic assessment of the efficiency of regional medical consortia cooperation by relevant government departments.

3.3.3. Actively carry out long-term follow-up and evaluation research of medical consortia

At present, medical institutions at all levels in the country have actively carried out the construction of medical consortia, but due to the late start, there are few studies on the evaluation of the implementation effect, especially the long-term effect. Therefore, it is necessary to learn from the existing domestic theoretical research results, sort out the current main medical consortium models, actively carry out follow-up investigation and analysis of the implementation effect, correctly evaluate the policy effect of the reform of the medical consortium, dynamically summarize the key factors that restrict and promote the implementation effect in the construction of the medical consortium, and provide reference models and experience for China to further improve the construction of the medical consortium.

4. Summary

In this paper, the effectiveness evaluation index system of the multi-level medical association is constructed by dividing the two-way referral situation in the medical association, the construction of basic medical service, the regional information sharing situation, and the medical service level into 11 indicators. The AHP method is used to calculate the index weight of each level first, and then calculate the index layer to obtain the comprehensive weight of the target layer. The factors affecting the

effectiveness of the medical units are arranged to study the feasibility of the medical unit and provide a solution direction for solving the current problems of the medical unit.

Conflicts of Interest

The authors report no conflict of interest concerning the materials or methods used in this study or the findings presented in this paper.

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