

Research on Assessment Index System and Comprehensive Evaluation Model of Informatization Level of Chinese Top Three Hospitals

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Abstract

This paper revealed the problems of Chinese top three hospitals' informatization thus provided basis for the government to enact relevant policy measure and for the hospital to adjust their informatization construction and planning. We formulated the comprehensive assessment model of informatization level for Chinese top three hospitals, which constituted by 6 dimensionalities and 57 indexes, through document research, comprehensive scoring method and expert consultation method. We checked and evaluated the reliability and validity of the model with sampling survey. The result showed that the model has good reliability and validity, and was appropriate for the comprehensive assessment of Chinese top three hospitals' informatization level.

Keywords: informatization level, top three hospitals, comprehensive assessment model

1 Introduction

As the application of informatization of hospital gets more and more thorough, information system has become nerve system of hospital administration and business operating. So, at present, the assessment of informatization has become very important in the informatization construction and application for hospitals. But the lack of scientific and effective assessment tools badly restricts the informatization level assessment of hospitals.

Document research shows, American, such as American Healthcare Information and Management System Society (HIMSS), did many researches on the assessment tools of hospital informatization level. American HIMSS did annual questionnaire survey to American medical institutions on informatization construction since 1990. Up to 2007, they have published 18 annual investigation reports [1]. These reports researched the informatization level of American medical institutions from promotive and obstructive factor, the application of information technology, the security of information technology and etc, and formed a assessment index system constitutes with IT prior filed, IT obstructive factor and 11 programs, 22 dimensionalities and 172 indexes.

Eric G Poon [2] and more than 10 specialists evaluated the informatization level of hospitals in Boston and Denver with improved expert consultation method in 2005. The assessment index system included electronic display of the results, electronic medical record of inpatients, doctor's advice (including electronic recipe) of inpatients, chief complaint, electronic communication during patient and

doctor, electronic communication during medical care personnel and etc..

Document retrieval shows [3-7], Chinese relevant research is few. Some of the relevant research is resting on theoretical discussion and only small part has formed thorough assessment index system. Interiorly, the research on the assessment model of hospitals' informatization level is badly deficient.

This research enacted assessment index system of informatization level of top three hospitals employing comprehensive scoring method and expert consultation method, and checked and evaluated the reliability and validity of the assessment index system.

2 Establishment of Comprehensive Assessment Model

A. THE ESTABLISHMENT PROCESS AND RESULTS OF COMPREHENSIVE ASSESSMENT INDEX SYSTEM

Preliminary Design

On the basis of document research, we used relevant foreign research on assessment of hospitals' informatization level for reference and the informatization level assessment of state, informatization level assessment of enterprise and some other relevant research. Combined with the character of Chinese top three hospitals, and meanwhile, to enhance the readability of the index's implication, we worked out an assessment system of the informatization level of Chinese top three hospitals constructed by 6 assessment dimensionalities and discussion draft of data collection table.

Preliminary Investigation

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In December, 2013, we randomly selected 56 top three hospitals on a national scale as the samples to conduct the preliminary investigation. Purpose of preliminary investigation; test the feasibility of the questionnaires; revise the items of the preliminary investigation questionnaire; get the time the test demands; provide experience for formal investigation.

Discussion of Specialists Group

When the preliminary investigation finished, we analyzed the survey result, and discussed fully the preliminary questionnaire and the pre-survey result with the specialists group (constituted by leading group of informatization of ministry of health, specialists of Chinese Academy of Medical Sciences and some other organizations). At last, we worked out the first draft of expert consultation and questionnaire of the assessment dimensionality and index

of hospital informatization level constituted by 6 assessment dimensionalities (6 first grade indexes, 62 second indexes and 107 sub-problems).

Expert Consultation

To further perfect the delimensionality construction and the index system, the research used focal sampling and convenience sampling to consult relevant experts in larger scale with revised assessment dimensionality and index of Chinese top three hospitals' informatization level. These 25 consulting experts were from departments in charge, universities, research institutions and medium and large hospitals. After two rounds of experts consultation, we collected the opinions and suggestions and worked out the final draft of the assessment dimensionality construction of Chinese top three hospitals' informatization level at last. As shown in table 1.

TABLE 1 Table of assessment index dimensionality construction of hospitals' informatization level and allocation of index and weight

First grade index	First grade weight(100)	Second index	Second weight (100)
Recognition degree of hospital	20	The top leader's status of informatization work	4.00
		Whether installed independent informatization department	4.00
		Whether have full-time supervisor	4.00
		Whether formulated specialized informatization budget	3.00
		Whether formulated special informatization planning	3.00
		Stability of informatization investment	2.00
Information infrastructure	17	The proportion of the informatization investment in the annual income	1.53
		The per capita holding quantity of computer and associated equipment	1.02
		The quantity of doctor workstation and nurse workstation of each sickbed	1.36
		Digitization ratio of medical examination and inspection equipment	1.02
		The ratio of online medical examination and inspection equipment	1.02
		The ratio of intelligent cabling system	1.02
		The advancement of cabling system	1.02
		The dielectric of hospital's backbone network	0.85
		Bandwidth of hospital's backbone network	1.02
		The outlet bandwidth of hospital's backbone network	0.68
		How the hospital's network access Internet	0.68
		The quantity of per capita holding network node in hospital	0.68
		The usage rate of network node	0.85
		The proportion of computer accessed to the net of hospital	0.85
		The proportion of computer accessed to the Internet	0.68
		Construction mode of hospital's net	0.68
		Development mode of hospital's information system	1.02
Stage of hospital's information construction	1.02		
Application of information technology	16	Coverage degree of automation application to traditional office functionality	2.08
		Column construction of hospital's website and perfection degree of the function	1.60
		Informationalized level of hospital's decision making	1.44
		Degree of evidence-based medicine used clinically by hospital	1.44
		The rate hospital host or participate in remote consultation(hospital-scale)	1.28
		The rate hospital host or participate in remote consultation(in hospital)	1.44
		Service condition of uniform coding system in the informatization construction	1.76
		The adoption condition of international standard in informatization construction	2.08
		Perfection degree of subsystem of business	2.88
Human resource and information resources	15	The service and ownership condition of electronic information(database and etc.)	2.10
		The proportion of full-time information technology talents	2.25
		Educational background structure of full-time information technology talents	2.25
		Professional background of full-time information technology talents	2.70
		The training and apply of information technology among hospital staff	3.00
		Electronization degree of medical workers' study	2.70
Application of information security technology	15	Input intensity of funding in information safety	2.25
		Service condition of network security measures	1.80
		Service condition of safety measures of information system's architecture	1.80
		Service condition of safety measures of data security	1.95
		Service condition of antivirus program and equipment	1.80
		Formulate contingency plan of information system	1.50
		Formulate system and measures of information security	1.95
		Mean free error time of information system	1.95
Performance	17	The influence of information construction on bad debts	2.04

of information construction	The influence of information construction on average hospitalization costs	1.36
	Influence of information construction on average length of stay	1.36
	Influence of information construction on drug stock	1.36
	Influence of information construction on medical consumable stock	1.36
	Influence of information construction on diagnosis amount	1.36
	Influence of information construction on the ability of financial final accounts	2.04
	The coverage degree of information construction on hospital management	2.04
	The coverage degree of information construction on medical business	2.04
	Transformation degree of information construction on traditional processing mode of business	2.04

3 Reliability and Validity of the Comprehensive Assessment System and the Questionnaire

A. DATA ACQUISITION AND RESEARCH METHODS

On the basis of comprehensive assessment system above, the informatization leading group of ministry of health, using empirical method, organized 20% stratified sampling investigation to all those top three hospitals of counties and cities of 31 provinces (including municipality city and autonomous region) of China, except for Hong Kong, Macao and Taiwan. The samples were 1221 hospitals. We recollected 1136 valid questionnaires with the recovery rate of 93.04%.

Cronbach's alpha coefficient was used to evaluate the internal consistency of these 6 dimensionalities of the assessment index system, which is to measure the internal reliability of these 6 dimensionalities of the questionnaire. The relevant coefficient of spearman was adopted to evaluate the split-half reliability under the condition of no resurvey. Exploratory factor analysis was used to analyse

the construct validity. One-way analysis of variance was used to evaluate the discrimination validity. Use SQL2000 to set up a database, and use SPSS 11.0 to analyse the database. We chose $\alpha = 0.05$ as the inspection level for all the statistic analysis in this research. The probability value we got was all two-sided probability.

B. EVALUATION RESULTS OF RELIABILITY AND VALIDITY

Reliability

Internal consistency reliability. Cronbach' α coefficients of all the dimensionalities were above 0.6680, with 0.8101 as the maximum, as shown in table 2. The Cronbach' α coefficients of dimensionality1, dimensionality2, dimensionality3 and dimensionality5 were above 0.4500, and the Cronbach' α coefficient of dimensionality4 approached 0.70, only Cronbach' α coefficient of dimensionality of dimensionality6 was 0.6680. Divide all the items into two groups according to odd and even of the sequence number and calculate the reliability. Among them, the relevant coefficient of spearman was 0.90; split-half reliability was 0.95.

TABLE 2 Internal consistency reliability of assessment dimensionalities of hospital's informatization level

Dimensionality	Items of index	Quantity of index	Cronbach' α coefficient
Recognition degree of hospital	V1.1-V1.6	6	0.753 6
Infrastructure of informatization	V2.1-V2.18	18	0.810 1
application of information technology	V3.1-V3.9	9	0.797 6
Human resource and information resources	V4.1-V4.6	6	0.698 5
Information safety	V5.1-V5.8	8	0.784 3
Performance of information construction	V6.1-V6.10	10	0.668 0

Validity

Face Validity and Content Validity

According to the feature of hospital infomatization construction, this study put forward a conception by taking relevant research both at home and abroad for reference combining the reality of informatization of Chinese hospitals. We established the assessment system from 6 aspects: recognition degree of hospital, infrastructure of informatization, application of information technology, human resource and information resources, information safety and performance of information construction. Through verification and revise of several rounds expert consultation and pre-investigation, the final assessment dimensionality and index has been accepted by experts and

those we filled in the form. The content validity of the assessment index system was guaranteed to be fine.

Construct Validity

Construct validity is used to investigate the degree of theoretic construction or peculiarity which we can measure. The most common method we used to investigate construct validity is factor analysis. Use factor analysis to test the validity of the survey form, and efficiently extract common factor. If the common factor is very close to the theoretic construction, the survey form has great construct validity. Rotated those factors with Varimax, the result and the structure of different dimensionality of the assessment index are shown in table 3.

TABLE3 Structural table of the assessment index system of hospital's informatization

Dimensionality	Factors (contribution of variance,%)	Index included	Quantity of index
Recognition degree of hospital	Institutional construction (35.0%)	V1.1,V1.4-V1.6	4
	Institution setting (32.5%)	V1.2,V1.3	2
Infrastructure of informatization	Network facility (22.3%)	V2.7-V2.11,V2.14,V2.17-V2.18	8
	Network application (13.4%)	V2.2,V2.6,V2.12,V2.13	4
	Digitization of service (9.3%)	V2.4,V2.5,V2.16	3
	Input intensity (7.4%)	V2.1,V2.3	2
	Internet application (6.9%)	V2.158	1
application of information technology	Technology application (38.2%)	V3.1-V3.4,V3.7-V3.9	7
	Remote consultation (15.6%)	V3.5-V3.67	2
Human resource and information resources	Human resource (36.4%)	V4.2-V4.4	3
	Information resource (29.1%)	V4.1,V4.5,V4.6	3
Information safety	Information safety (45.3%)	V5.1-V5.8	8
Performance of information construction	Financial performance (23.8%)	V6.1-V6.5	5
	Business performance (23.2%)	V6.6-V6.10	5

Discrimination Validity

Compared the scores of different dimensionality of different type of hospital and the results of one-way analysis of variance suggested : the difference of score of

dimensionality 4 (human resource and information resource) was of no statistical significance while the score of those other dimensionalities all had statistical difference, as shown in table 4.

TABLE 4 Scores of different dimensionality of different types of hospital (X±S)

Dimensionality	General hospital	TCM hospital	Hospital of traditional Chinese and Western medicine	Specialized hospital	F value	P value
Dimensionality 1	15.25±4.39	13.89±4.97	12.46±5.62	15.37±4.34	6.035	0.000
Dimensionality 2	7.96±2.21	7.19±2.33	7.34±3.10	8.21±2.28	6.128	0.000
Dimensionality 3	4.95±2.39	4.21±2.43	4.38±2.62	5.21±2.53	5.136	0.000
Dimensionality 4	6.15±2.87	5.93±3.20	6.11±3.42	6.74±2.94	1.897	0.109
Dimensionality 5	6.43±2.88	5.86±2.88	5.80±3.45	6.78±2.95	3.137	0.014
Dimensionality 6	9.28±2.28	8.67±2.42	8.69±2.53	9.27±2.50	3.133	0.014
Total	50.02±13.21	45.73±14.76	44.77±18.03	51.58±13.85	5.853	0.000

Compared the scores of every dimensionality of different types of hospitals and the results of one-way analysis of variance suggested that all those scores of

these 6 dimensionalities had statistical significance, as shown in table 5.

TABLE 5 Score of each dimensionality of different types of hospital(X±S)

Dimensionality	Affiliated hospital of university	Teaching hospital	Non-teaching hospital	F value	P value
Dimensionality 1	17.64±2.39	15.57±4.13	13.79±4.93	45.574	0.000
Dimensionality 2	9.80±1.57	8.12±2.13	7.16±2.26	80.519	0.000
Dimensionality 3	6.83±2.06	5.17±2.31	4.08±2.31	79.007	0.000
Dimensionality 4	7.98±2.39	6.60±2.77	5.58±2.88	49.260	0.000
Dimensionality 5	8.48±2.21	6.67±2.77	5.58±2.88	58.812	0.000
Dimensionality 6	10.66±2.14	9.47±2.26	8.53±2.26	51.905	0.000
Total	61.39±9.11	51.58±12.45	44.52±13.67	98.224	0.000

4 Discussion and Conclusion

The internal consistency reliability of this assessment system was fine. Cronbach's alpha coefficient of these 6 dimensionalities could respectively reach the identification criteria of "preferable (0.6-0.8)" and "superb (>0.8)" The

computation result of split-half reliability was: the relevant coefficient of spearman was 0.90; the split-half reliability was 0.95. This assessment index system could be considered steady and reliable.

Content validity: it suggests if the items of the survey form reflect the content it is about to express. It is a

subjective index, commonly marked and confirmed by experts. This assessment index system assured its content validity from the conception, proposing and filtrating of index to expert's confirmation to the index.

The assessment model of hospitals' informatization level, structured by this research, satisfies the basic requirement of surveying. It is reliable, effective and sensible and it can generally reflect the informatization

construction level of hospitals. The system has the value of popularization and application. It demands further research and perfection to establish the assessment system which applies to all kinds of hospitals nationwide and applies to the informatization construction level of top three hospitals for longtime. The items should be simplified to make the system more operable.

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