

Research of China's general hospital informationization construction situation.

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Abstract

Objective: In order to understand the current situation and problems of hospital information system construction in China, this article analyses the main problems and development tendency to provide the scientific basis of formulation.

Methods: Develop stratified sampling network questionnaire survey of the different levels general hospitals in countrywide 31 provinces, cities, municipalities and Sinkiang production construction legions, sampling from one general hospital in province, city and county which includes tertiary hospital, secondary hospital, primary hospital and unclassed hospital.

Results: The directors of hospital manage informationization in almost 90% general hospitals. From 2009 to 2012, the average growth rate of general hospital informationization construction funding was 57.59%; informationization planning and making situations had significant differences in informationization fulltime staff, funding and other criterions; from 2009 to 2012, the self-financing occupied 82.65% of total construction funds in general hospitals, financial capital investment's sustainability did not get good development; the average employees of China's general hospital informationization was 2.76; about 90% of hospital did not develop information security level protection classification.

Conclusions: China need to research and promulgate the relevant instruction for hierarchical guidance of the general hospital informationization, include different levels of hospital informationization human resources' arrangement standard, exploration of the operation and maintenance of the matched funds enhancing the systematization and continuity of financial inputs, encourage the social capital join the hospital informationization construction, expedite the cooperation of network information security department to formulate medical institution information security management, and promote hospital system connection and information sharing.

Keywords: General hospital, Informationization, Situation, Comparison research.

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Introduction

The hospital informationization construction is the useful way to enhance medical service quality and efficiency, and it is also the significant symbol of modern hospital construction [1]. In the end of 2013, the national health and family planning commission promulgated "About Accelerate Advance Population Health Informationization Construction Instruction", it ranked medical service informationization as one of six business applications, emphasized the vital function of medical service informationization construction in total national population health informationization construction [2].

The general hospitals are the principal part of China's medical service institution (until 2013, the number of general hospitals occupied 64.8% of all hospitals, the outpatient visits occupied 73.7% of the medical services in all hospitals, the number of inpatients occupied 77.9% of all inpatients in hospitals) [3], the

general hospitals are also "Bellwether" of medical services and provide demonstration effect of the informationization construction [4]. So the general hospital level can be looked as the significant measurement criteria of Chinese health informationization. Through many years of efforts to exploration and practice, China's hospital information construction has a certain size, but there are still many problems. Lacking of information talents and investment, information isolated island phenomenon caused by non-uniform standards and the complexity of the internal operation of the hospital have become the important reason to hinder the construction of hospital information [5]. To solve these problems will not only further speed up the construction of hospital information, but also make the hospital management in our country gradually moving towards modernization [6]. Talent, capital, organization and management, system design, infrastructure, etc. are important factors affecting the hospital

information construction [7]. According to various regions' general hospitals' informationization construction situation survey, compare and analyse different levels of general hospitals' informationizational level differences, contribute to discover the main rules, existing problems and developing requirements of the current medical institution informationization development, provide basis to the next specific developing strategy formulation.

Methods

According to the files from the national health and family planning commission's planning and information department, use network questionnaire survey to collect data. The design of questionnaire was mainly based on hospital informationization input, product and effect, and passed two times of expert consultation and one time of preliminary investigation to guarantee the representativeness and veracity of questionnaire questions. The objects of survey included all levels of general hospitals in nationwide provincial administration, cities, municipalities, sampling from one general hospital in province, city and county. There are 31 provincial administrations, 333 prefecture-level cities, 2852 county-level administrative regions, so the total sample is 3216 (data source from China statistics annual abstract in 2013) in Chinese Mainland, and in accordance with the above number, questionnaires were issued. Recovered questionnaires, totally number was 1938, the recovery rate was 60%. In 1938 questionnaires, the number of

useful questionnaires was 1898, and the effective rate of questionnaires was 97.94%. The total number of general hospitals is 15021, according to the level the hospital was classified each level hospital's effective samples were shown in the Table 1 as below.

Table 1. Each level hospitals effective sample.

| | Total samples* | Effective samples | Coverage rate |
|--------------------|----------------|-------------------|---------------|
| Tertiary hospital | 995 | 328 | 32.96% |
| Secondary hospital | 4,172 | 1,354 | 32.45% |
| Primary hospital | 4,635 | 146 | 3.15% |
| Unclassed hospital | 5,219 | 70 | 1.34% |
| Totally | 15,021 | 1,898 | 12.64% |

Note:*Data come from Chinese health statistics annual abstract in 2013.

Survey subjects included informationization organization and management, financial input, information system construction and application, informationization performance, existing problems and other situations [8]. Each subject included several specific indexes (Table 2).

Table 2. Survey subjects and analysis indexes.

| Subject | Index |
|--|--|
| Informationization organization and management | Major leader |
| | Informationization worker |
| Informationization development plan | Formulation situation |
| Investment input | Accumulative input |
| | Average input |
| | Input rate |
| | Input constitution |
| Information system | System construction and application |
| | System connection situation |
| Information assurance | Information system emergency plan |
| | Information assurance level protection |
| Informationization performance | Subjective performance change |
| Informationization problem | Obstructive factor |

The original data of survey was saved in the Oracle database of investigation system. Research group filtrated the original data through call-back, cross check and various ways, eliminated unreasonable data, amended several parts of errors, based on these foundations and used SPSS19.0 to complete relevant statistics analysis. According to one-way Analysis of Variance

(ANOVA), analysed different levels of general hospital informationization input and product differences; according to non-parametric test, analysed the relevance between funding and other effect elements of informationization. The scale, function and technical force had big differences under diverse levels hospitals, so the whole development pattern exhibition

of general hospital informationization was based on classification. On the foundation of all levels investigations, in terms of all levels hospitals' (include undetermined level hospitals) actual constitution's proportion to revise, and got the average value of the countrywide general hospitals [9].

Results and Analysis

Informationization organization and management

The principal leader situation of informationization works: Informationization acts as "The top one" project, can effectively enhance informationization works' promote coordination efforts and attentional extent in different organizations [10]. The survey data reported that the current proportion of general hospitals' "The top one" manager informationization was 29.50%, vice directors were mainly in charge of 58.6% institutions' informationization works. The lower level the hospital, the higher proportion the "The top one" manager supervised informationization works. In secondary hospitals, the number of "The top one" manager informationization and non "The top one" manager informationization had huge difference, as well as the informationization total funding input in latest 4 years. In other levels hospitals, the number of informationization staff, the number of informational staff and the number of medical workers at informationization leader level didn't have significant difference to the total funding input and other indexes in latest 4 years.

Informationization fulltime staff situation: Informationizational fulltime staff arranged situation can present the ability and level of institution developing informationization to some extents. Data showed that the current average informationizational fulltime staffs were 2.76 in China's general hospitals, the average informationizational fulltime staffs in primary hospitals were less than 1 person, and almost 80% of primary hospitals did not have fulltime informationizational workers. The number proportion of tertiary to primary general hospitals' informationizational fulltime staffs was 29:10:1, hospital informationizational fulltime staffs in each level had relative centralized distribution (Figure 1). Based on the number of every 1000 medical workers' informationization fulltime staffs to count, the number of informationization workers in second and third level was close, was about 9; the number of informationizational fulltime workers in first hospital was relative lower, was 5.28. Based on the number of each informationization worker's responsible beds which measured hospital informationization staffs' collocation, each levels hospitals' informationizational fulltime staffs' collocation had apparent differences, the number of tertiary hospitals' informationization workers' collocation situation was best, was 105.36; the number of first level hospitals was 166.78, the hospitals' informationization workers' collocation was lowest. The countrywide average enrolled rate of informationizational fulltime workers was 60.93%; there was no big difference on each level. Each level's specific situation was shown in Table 3 as below.

Table 3. Each level hospital informationization fulltime workers distribution.

| | National average | Tertiary hospital | Secondary hospital | Primary hospital |
|---|------------------|-------------------|--------------------|------------------|
| Average of informationization fulltime workers | 2.76 | 10.9 | 3.68 | 0.38 |
| Proportion of no informationization fulltime workers' institution | 19.10% | 1.80% | 15.00% | 78.87% |
| Fitted informationization fulltime workers of each 1000 medical workers | 9.17 | 8.73 | 9.61 | 5.28 |
| Proportion between beds and informationization fulltime workers | 135.29 | 105.36 | 132.17 | 166.78 |
| Enrolment proportion of informationization fulltime workers | 60.93% | 61.82% | 60.34% | 70.30% |

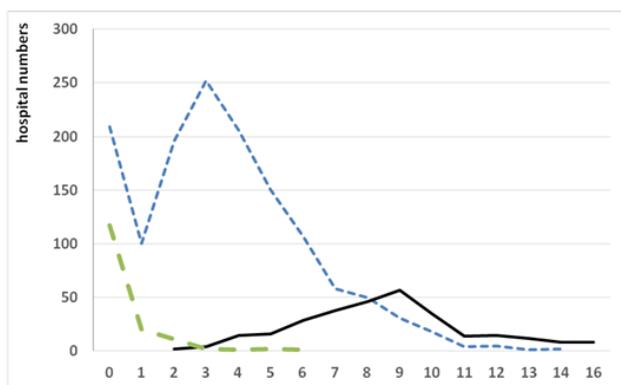


Figure 1. Primary, secondary, tertiary hospital informationizational fulltime staffs distribution.

Informationization development program

The establishment condition of informationization development program reflected informationization developing normalization and sustainability [11]. Currently, 71.6% of tertiary general hospitals declare that institutions have formulated comprehensive informationization development planning, while the corresponding 70.5% of primary general hospitals have no development planning. The specific situations of each level were shown in Table 4 as below. Informationization development planning formulation situation has differences among informationizational fulltime staff quantity, quantitative proportion between informationization workers and medical workers, latest 4 years' total informationizational financial input, total hospital service incomes and other indexes, and whether planning is over all

between informationization workers' and medical workers' proportion does not have obvious difference.

Table 4. Year 2012 hospital informationization investment input and several indexes spearman relevant indexes.

| | Service income | Medical workers | Informationization people | Outpatient capacity | Beds |
|--------------------------------------|----------------|-----------------|---------------------------|---------------------|---------|
| National average investment inputs | 0.550** | 0.605** | 0.550** | 0.562** | 0.597** |
| Tertiary hospital investment inputs | 0.465** | 0.422** | 0.362** | 0.377** | 0.396** |
| Secondary hospital investment inputs | 0.420** | 0.448** | 0.358** | 0.405** | 0.426** |
| Primary hospital investment inputs | 0.289** | 0.289** | 0.190** | 0.207** | 0.266** |
| Unclassed hospital investment inputs | 0.654** | 0.694** | 0.766** | 0.669** | 0.694** |

Note: **When confidence coefficient (double testing) is 0.01, relevance is apparent

Informationization construction capital source and funding formation

China's health informationization construction had two obvious watersheds, one was that after "SARS" epidemic situation in 2003, infectious disease data-report system promoted a part of hospital informationization construction [12]; the other was that after the declaration of new medical reform in 2009, health informationization was promoted to the main technical support altitude, accelerated hospital informationization construction [13]. Hence, in this survey, year 2003 was served as the start point of financial input situation survey, considered the long interval times, before year 2009, merged and reported funds accumulation in six years from 2003 to 2008, was called "before year 2008", started reporting year by year science year 2009.

The general hospital informationization construction input situation before year 2008: Before year 2008, the average informationization accumulated inputs of general hospitals were ¥ 974.4 thousand, 6.5% general hospitals had no informationization construction inputs in the latest 6 y. Different levels general hospitals' inputs had big difference, the average inputs of tertiary hospital were ¥ 6,628.8 thousand; secondary hospitals' average inputs were ¥ 1,058.2 thousand; primary hospitals' average inputs were ¥ 254.1 thousand, the proportion of funding was 26.09:4.16:1.

The average input changes trend of general hospital informationization construction funds from 2009 to 2012: From 2009 to 2012, the funding of general hospital informationization construction generally presented continuous increasing trend, the average inputs increased from ¥ 326.7 thousand to ¥ 1,278.6 thousand, annual average growth rate

was 57.59%, and growth rate of secondary hospital got obvious increasing in all levels hospitals, was 53.96%. In 2012, the funding rate of tertiary to primary hospitals was 22.6:5.6:1. Secondary and tertiary hospitals' funding intervals were gradually decreasing. The average inputs of tertiary hospitals were 6.7 times to average inputs of secondary hospitals in 2009, and it decreased to 4 times in 2012 (Figure 2).

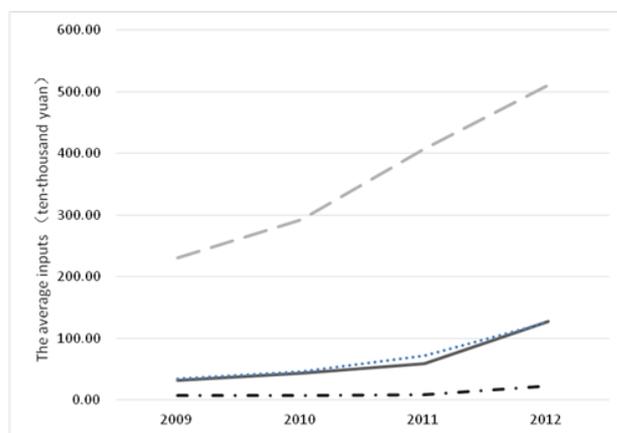


Figure 2. 2009-2012, the funding of general hospital informationization trend.

Discovered through analyzing the relevance of hospital informationization funding and relevant influencing informationization elements in 2012, the indexes such as funding and total service inputs, medical workers, outpatient capacity and fulltime informationization workers' quantity presented moderate correlation, these indexes and primary hospital informationization inputs were weak correlative (Table 5).

Table 5. 2009-2012 informationization investment input situation.

| | National average | Tertiary hospital | Secondary hospital | Primary hospital |
|---|------------------|-------------------|--------------------|------------------|
| Informationization input situation over the years (¥ thousand) | | | | |
| 2009 | 326.7 | 2,302.6 | 345.5 | 81.8 |

| | | | | |
|--|---------|---------|---------|--------|
| 2010 | 440.1 | 2,931.2 | 460.1 | 74.0 |
| 2011 | 594.5 | 4,081.5 | 720.8 | 92.9 |
| 2012 | 1,278.6 | 5,104.3 | 1,260.8 | 225.9 |
| Proportion of investment source constitute | | | | |
| 2009-2012 finance | 13.49% | 6.93% | 21.34% | 16.73% |
| 2009-2012 self-raised | 82.65% | 91.1% | 72.42% | 81.34% |
| 2009-2012 others | 3.86% | 1.97% | 6.24% | 1.93% |
| 2012 finance | 16.95% | 5.62% | 28.00% | 13.77% |
| 2012 self-raised | 78.37% | 92.15% | 64.89% | 84.44% |
| 2012 others | 4.68% | 2.23% | 7.11% | 1.80% |
| 2012self-raised investment's proportion of service incomes | 2.08% | 1.17% | 0.89% | 4.03% |
| Distribution proportion of cost | | | | |
| 2009-2012 software | 35.42% | 33.42% | 38.20% | 29.77% |
| 2009-2012 hardware | 52.73% | 54.17% | 50.93% | 43.77% |
| 2009-2012 operating and maintenance | 7.36% | 8.12% | 6.51% | 8.11% |
| 2009-2012 others | 4.49% | 4.29% | 4.36% | 18.35% |
| 2012 software | 39.59% | 38.05% | 41.82% | 36.01% |
| 2012 hardware | 49.80% | 50.12% | 48.92% | 45.90% |
| 2012 operating and maintenance | 6.20% | 7.57% | 5.10% | 5.67% |
| 2012 others | 4.42% | 4.26% | 4.16% | 12.42% |

The source and constitution of general hospital informationization construction funds: The survey data presented that self-raised funds was the main source of general hospital informationization construction funding. From 2009 to 2012, general hospital self-raised funds occupied 82.65% of total construction funding. Accompany with new medical reform policy implements, financial inputs increased from ¥ 20.5 thousand of each institution in 2009 to ¥ 216.7 thousand of each institution in 2012, annual growth rate was 119%, and it was well over the 57.58% growth rate of total informationization construction funding. The proportion of financial inputs in total construction funding increased from 6.26% in 2009 to 16.95% in 2012, and self-raised funds gained from ¥ 297.7 thousand in 2009 to ¥ 1,002 thousand in 2012, growth rate was 49.86%, constituent ratio decreased form 91.13% to 78.37% (Table 3).

In 2012, tertiary hospitals' self-raised funds occupied 92.15% of informationization funding of all levels hospitals, was the highest, and the proportion of secondary hospitals' self-raised funds was lowest, was 64.89%. Observed from the self-raised funds' proportion of total institution services incomes, tertiary hospitals' proportion was 1.17%, the pressures of self-raised funds were lower than the average proportion 2.08%; primary

hospitals' proportion occupied 4.03% of services incomes (Table 6).

Table 6. General hospital informationization investment source and cost constitution.

| | 2009 | 2010 | 2011 | 2012 |
|---------------------------|--------|--------|--------|--------|
| Software | 30.11% | 32.56% | 33.94% | 39.59% |
| Hardware | 56.28% | 53.62% | 54.62% | 49.80% |
| Operating and maintenance | 9.35% | 8.86% | 7.03% | 6.20% |
| Others | 4.26% | 4.96% | 4.41% | 4.42% |
| Finance | 6.26% | 8.93% | 15.28% | 16.95% |
| Self-raised | 91.13% | 86.33% | 82.02% | 78.37% |
| Others | 2.60% | 4.74% | 2.70% | 4.68% |

The financial inputs of each level hospital these several years generally presented increasing trend, but the fluctuation of each year was larger. Tertiary hospitals' financial inputs got substantial growth in 2011, while it had slight decline in 2012. Secondary hospitals' financial inputs were continuously increasing in latest 4 years, and annual growth rate was the highest, was 87%. Primary hospitals' financial inputs got decline to some extents in 2011 (Figure 3).

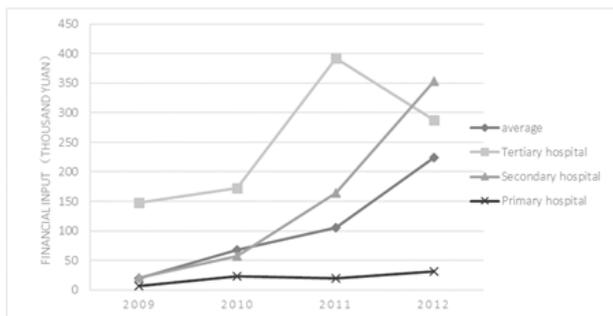


Figure 3. 2009-2012 general hospital informationization construction financial input change trend.

The general hospital informationization construction input cost constitution: The general hospital informationization

Table 7. Top 10 general hospital information system construction rates.

| Rank | Management information system name | Construct-ion rate (%) | Clinic information system name | Construct-ion rate (%) |
|------|--|------------------------|---|------------------------|
| 1 | Drug storage management system | 88.64 | Nurse work station | 81.70 |
| 2 | Outpatient pricing and charging system | 87.92 | Inpatient doctor work station | 71.78 |
| 3 | Outpatient pharmacy management system | 86.17 | Outpatient doctor work station | 64.54 |
| 4 | Inpatient pharmacy management system | 85.86 | Electronic medical record(EMR) system | 62.74 |
| 5 | Entering, leaving and transferring management system | 78.16 | Laboratory information system | 57.65 |
| 6 | Outpatient register system | 75.74 | Medical image store and transfer system | 52.05 |
| 7 | Medical record management system | 73.68 | Ultrasonic image information system | 49.02 |
| 8 | Supplies materials management system | 67.78 | Radiology department information system | 47.84 |
| 9 | Accounting record system | 64.02 | Endoscope information system | 35.30 |
| 10 | Fixed assets management system | 58.01 | Long-distance medical system | 33.91 |

Discovered from the main cost components of different sources comparison, most of financial funds were used on hardware devotion while most of self-raised funds were used on operation and maintenance, communication services, system use training and other costs. In each level hospital, beyond 20% self-raised funds were used on others and 9% of self-raised funds were used on hardware and software operating and maintenance in primary hospitals, they had obvious difference with other levels hospitals (Table 8).

Table 8. 2009-2012 each level hospitals total different source funds' cost constitution.

| Financial funds | Software | Hardware | Operating and maintenance | Others |
|-------------------|----------|----------|---------------------------|--------|
| Tertiary hospital | 37.84% | 59.21% | 1.78% | 1.17% |

construction's hardware costs were the highest. From 2009 to 2012, hardware devotion was always the import costs of general hospital informationization construction (52.73%), software devotion was a little bit lower than hardware (35.42%). Software devotion increased from ¥ 98.4 thousand of each institution in 2009 to ¥ 506.3 thousand of each institution in 2012, component ratio was growing year by year. Operating and maintenance fees increased from ¥ 30.5 thousand to ¥ 79.3 thousand, but component ratio was reducing year by year, from 9.35% to 6.20%. The component ratios of all kinds of costs in different levels hospitals did not have obvious difference, just primary hospitals' other devotion proportion was higher, up to 18.35% (Table 7).

| | | | | |
|--------------------|--------|--------|-------|--------|
| Secondary hospital | 51.02% | 44.36% | 1.09% | 3.53% |
| Primary hospital | 26.78% | 64.48% | 5.24% | 3.50% |
| Self-raised funds | | | | |
| Tertiary hospital | 32.93% | 53.73% | 8.73% | 4.60% |
| Secondary hospital | 33.68% | 53.77% | 7.96% | 4.59% |
| Primary hospital | 30.21% | 39.90% | 9.04% | 20.85% |

Information system construction and application

The general hospital information system construction situation: The general hospitals with higher construction rate were shown on Table 9. Generally, Management Information System' (MIS) construction rate was higher than Clinical Information System (CIS), the construction rates of top 10 management information systems were beyond 55%; in business information system, the clinical front line systems, such as the construction rates of nurse station and doctor

station were higher than the construction rate of medical and technical system, Laboratory Information System (LIS) and Picture Achieving and Communication System (PACS).

Table 9. Top 10 general hospital information system construction rate.

| Rank | Management information system name | Construct-ion rate (%) | Clinic information system name | Construct-ion rate (%) |
|------|--|------------------------|---|------------------------|
| 1 | Drug storage management system | 88.64 | Nurse work station | 81.70 |
| 2 | Outpatient pricing and charging system | 87.92 | Inpatient doctor work station | 71.78 |
| 3 | Outpatient pharmacy management system | 86.17 | Outpatient doctor work station | 64.54 |
| 4 | Inpatient pharmacy management system | 85.86 | Electronic Medical Record (EMR) system | 62.74 |
| 5 | Entering, leaving and transferring management system | 78.16 | Laboratory information system | 57.65 |
| 6 | Outpatient register system | 75.74 | Medical image store and transfer system | 52.05 |
| 7 | Medical record management system | 73.68 | Ultrasonic image information system | 49.02 |
| 8 | Supplies materials management system | 67.78 | Radiology department information system | 47.84 |
| 9 | Accounting record system | 64.02 | Endoscope information system | 35.30 |
| 10 | Fixed assets management system | 58.01 | Long-distance medical system | 33.91 |

The connection situation among general hospitals, regional platform and external system: Data reported that 22.81% general hospitals had connections with regional health information platform, and the proportions of this platform in tertiary, secondary and primary hospitals were 23.80%, 20.95%, 37.66%. The proportions of general hospitals which connected with new rural cooperative medical information system, medical insurance information system, public health information system were 76.14%, 77.42%, 25.55%. Accompany with the decreasing of hospital level, the connecting rates of New Rural Cooperative Medical System (NCMS) and medical insurance information system were decreasing, but the connecting rates of primary hospitals and public health information system were higher than secondary and tertiary hospitals.

Information assurance

34.4% of general hospitals formulated perfect information system contingency plan, and the proportions of this plan in tertiary and secondary general hospital were 64.46% and 31.75%. 10.9% of general hospitals completed information assurance protection grading works, 36.97% and 59.72% hospitals were ranked as third protection level and second protection level. 33.9% of the tertiary class-A hospitals finished grading works, and 49.5% of the tertiary class-A

hospitals were grading or reforming. 16.4% of tertiary class-B hospitals and 8.2% of secondary hospitals completed the grading works.

Informationization brings performance changes to general hospital

Survey selected bad accounts increasing and decreasing, accounts settlement time, out-patient waiting time, average hospital stays, drug stocks, average hospitalization expenses and malpractice occurrence totally 8 indexes to evaluate the subjective feelings that informationization performance changes brought to hospitals. Overall, informationization effects to hospitals were positive: 73.35% of general hospitals considered that bad accounts had reduction; 69.39% of general hospitals showed that accounts settlement times were decreasing; 80.94% of general hospitals presented that out-patient waiting times had reduction; 83.76% of general hospitals' daily outpatient capacity had increases; 55.69% of general hospitals' average hospital stays were decreasing, 46.86% of general hospitals' drug stocks were reducing, 46.48% of general hospitals' average hospitalization expenses were lower than before; 81.47% of general hospitals considered that the use of information technology decreased the occurrence of malpraxis (Table 10).

Table 10. Informationization brings general hospital performance change.

| Performance index | Substantial increase | Slight increase | No change | Slight decrease | Substantial decrease |
|-------------------|----------------------|-----------------|-----------|-----------------|----------------------|
|-------------------|----------------------|-----------------|-----------|-----------------|----------------------|

| | | | | | |
|---|--------|--------|--------|--------|--------|
| Bad account increase and decrease situation | 2.73% | 6.21% | 17.70% | 37.70% | 35.65% |
| Financial settlement time | 10.86% | 7.44% | 12.30% | 21.31% | 48.08% |
| Waiting time | 5.51% | 5.57% | 7.97% | 33.55% | 47.39% |
| Daily outpatient quantity | 43.28% | 40.48% | 12.30% | 2.15% | 1.79% |
| Average in hospital days | 4.66% | 15.31% | 24.33% | 46.67% | 9.02% |
| Drug storage change situation | 6.16% | 15.64% | 31.34% | 33.19% | 13.67% |
| Average in hospital fees | 3.33% | 26.61% | 23.58% | 38.36% | 8.12% |
| Medical mistake occurrence | 1.82% | 2.79% | 13.91% | 42.77% | 38.70% |

The obstructive factors of informationization construction

38.66% of general hospitals considered that the current informationization level would not satisfy business requirements, only 3.03% of general hospitals thought that information level was able to satisfy business requirements and the last 58.30% of general hospitals deemed that informationization level would basic satisfy business requirements. These proportions illustrated that informationization level would has big advancements. Less of enough financial support, talents scarcity and insufficient informationization construction were the top 3 obstructive factors of general hospitals' informationization construction, and the proportions were 82.51%, 65.03% and 59.89%.

Discussion

The organization and inputs of informationization construction attract universal attentions in general hospitals

Analysed from all above results, almost 90% hospitals' top leaders was in charge of informationization, more than 80% hospitals had worker team supports. In terms of inputs, the investment level in 2012 was close to the summations from 2003 to 2008, and financial inputs had obvious increase. Hospital information system had high level of dissemination. Informationization construction also brought positive impacts to the performance of hospital management operating and medical quality.

Attentions of informationization planning and arrangement will directly enhance hospitals' informationization works development

Data survey presented that currently the top leaders managed informationization, did not have obvious impacts to informationization inputs, planning and effect, while planning relevant informationizational development project was related to informationization works' launch and implementation. The inferred result was that the top leaders managed hospital informationization works was just the necessary condition of better informationization development, and the top leaders' insight, leadership and coordinate efforts was acting as more

important roles. On the other hand, it reflected that parts of hospitals just realized the formalistic top leader management, but informationization did not have high priority of all the top leaders' works, relevant works' development and implementation still needed reinforcement. Besides whether the top leader should supervise informationization works, paying more attentions to informationization planning and implementation would have more direct effects to informationization development.

Policies have big influence on financial fund inputs, sustainability still need enhancement

From 2009 to 2012, each level hospital's informationization financial inputs had big fluctuation ranges. Tertiary hospitals' financial inputs increased from ¥ 172.5 thousand in 2010 to ¥ 392.7 thousand in 2011, but the financial inputs decreased 27% in 2012. In contrast, primary hospitals' financial inputs decreased 17% based on year 2010, and it increased almost 64% in 2012. What's more, secondary hospitals' financial inputs got continuous rapid growth in recent years, in 2010, the financial inputs of secondary hospitals exceeded 18.7% to tertiary hospitals. The fluctuations of each level hospital were direct affected by relevant policies recent years. In 2010, the central government invested about ¥ 1.9 billion to support basic medical and health institutions' pilot works and village clinic informationization construction, primary hospitals acquired relevant funds for enhancing informationizational infrastructure and business system construction; from 2010 to 2012, secondary hospitals acquired relevant informationization construction financial support through Midwest county hospital capacity building (central finance ¥ 1 billion) and country public hospital comprehensive revolution pilot (central finance ¥ 0.9 billion) special projects. From 2010 to 2011, several tertiary hospitals acquired relevant financial support through remote consultation system pilot. Now the ways of informationization financial inputs focus on developing defect, use pilot and direct investment to implement. This investment way is useful to centralize power to rapidly promote the construction level of one aspect, but it also exists some limitations. First, it is hard to plus relevant special project and pilot to planning in time when hospitals get relevant building tasks, funds matching lacks of budget, adverse to the integrating development of hospital holistic informationization

construction; moreover, financial inputs' period is short, lack of continuity, planning and maintenance fees collection lacks matching ways and mechanism.

Primary hospitals have big pressures on informationization self-raised funds

Primary hospitals' self-raised funds occupied the highest proportion of all service incomes, and fund requirements presented rapid increasing trend. Survey data showed that the average self-raised funds of primary hospital informationization were ¥ 190 thousand, occupied 4.03% of total hospital service incomes, the proportion were the highest of all levels hospitals. Primary hospitals were the basic medical health service institutions, and they undertook most precaution, health care and other social public welfare functions, market profitability was weak [14]. Through primary hospitals' self-raised funds to develop informationization construction, would aggravate infrastructure operating pressures and reduce enthusiasm of institution construction and information system usage. After new medical innovation implantation, the basic medical health service institution informationization construction got unprecedented attention. A mount of financial funds were input into the basic medical health information system's software and hardware facilities construction, but the fees of operating and maintenance, communication services and system use training mainly came from self-raised funds. With the increases of primary hospitals' informationization software and hardware, and the expenses of relevant self-raised funds would also increase. Under the invariable informationization funds input mode situation, the funds raising pressures of basic medical health service institution would have further increase.

Secondary and tertiary hospitals' planning and maintenance fees are increasing

Research indicated, with constantly mature informationization development, operating and maintenance fees expenses would gradually increase, until kept balance with software and hardware expenses [15]. Survey data presented that currently the domestic hospitals' software, hardware and operating maintenance input proportions were about 2.8:7.2:1, operating maintenance fees still had big growing space. In addition, software and hardware operating maintenance was becoming the main source of providers' profits. Now, secondary and tertiary hospitals had many construction systems, the average operating maintenance fees of charge standards in each kind of system were commonly 10%-20% of total construction fees. Because operating maintenance fees were included in software and hardware construction fees in former years after system completed, did not have obvious presentation, but 3-5 years after system completed, operating maintenance investment requirements would increase obviously.

The phenomenon of informationization workers shortage is obvious

Survey presented more than 65% of hospitals considered that the lack of informationization professionals was one of the top 3 elements to hinder informationization development. Relative to the 26:4:1 proportion of funding in each level hospitals, the quantity gaps of informationization workers in each level hospitals were more obvious, the proportion was 29:10:1. The main reason of talents shortage was the contradiction between position technologies had high requirements and payment, attentions were not enough. On one hand, hospital informationization construction professionals' training still required enhancement on the number and practical abilities of domestic degree education; on the other hand, hospital information management staffs lacked dedicated job title evaluation series and career development path, and staffs went away frequently.

Hospital information security situation is austere

Medical industry data involved national security and personal privacy. In 2011, ministry of health promulgated "Health care industry information security levels protecting works instruction" (ministry of health promulgate (2011) No. 85), required each level medical institutions to proceed information security level protection works. It indicated, the core business information systems in tertiary class-A hospitals were not lower than tertiary hospitals in principle [16]. Survey showed that almost 90% hospitals did not develop information security level protection grading, just one third of tertiary hospitals completed grading works. When system had problems, hospital management information system emergency plan formulation, which guided hospital each department to maintain medical order, keep each medical service's continuity, and reduce medical accident and medical mistakes, was the effective measure to protect hospital information security. What's more, survey data presented that currently almost two third of general hospitals did not have information system emergency plan, and information security supporting measures still requested further reinforcement.

System connection and information sharing levels were mainly affected by hospital requirements

Inside each kind of system connections, the medical protection system which involved hospital fees compensation had the highest connection, was beyond 75%; but public health and comprehensive management system mainly worked for data report and cooperation with regulatory, most of them were supported by administrative power, connection rate was about 25%. Therefore, hospital development requirements were the main driving force to promote system construction and connection rate. Moreover, system connection rate was related to system main preparation. Survey data showed that the connection rate between primary hospitals and regional platform was 37%, was a little higher than other levels hospitals, mainly because parts of primary hospitals used systems were planned, designed and deployed by counties, so

most of functions were involved in data sharing and system connection of comprehensive management.

Suggestion

Guide hospitals to formulate feasible informationization development plan

The local government enhance guidance and training of local medical institutions through technology providing and investment supporting. Build the bridge among scientific research institution, association, hospital and government, promulgate relevant guidance to hierarchically direct general hospital informationization works development, help hospitals to develop top-level design and overall planning of informationization construction works, design to hospital actual, strong operational and high cost-effective construction plan, escape repeating low level construction.

Encourage many raising ways to protect hospital informationization construction investment input

On one hand, hospital is still the input subject, coordinate self-developing requirements, scientific formulate input project, ensure that system can orderly building, operating and maintaining. On the other hand, government should appropriately transfer funds, support hospital informationization infrastructure and resource sharing construction [17]. Especially increase the supports to primary and secondary hospitals, help sharing hospital's financial burden. Meanwhile, enhance systematic and continuity of financial inputs, change current input mode which is main of special items, explore definite appropriation and performance based appropriation forms. Encourage social investment to participate hospital informationization construction through financing, lease, cooperating established joint-stock company and other ways, form effective cost-sharing system. Explore and research operating maintenance model and matched fees' calculating and devoted model, prevent happening of "operating and maintenance black hole".

Improve hospital informationization talents standards, enhance talent resources construction

First, country level should enhance health informationization talents' degree education and further education, from the source to guarantee the quantity and quality of informationization construction human resources. Second, relative institutions should research and formulate the informationization talents outfit standards and proportions in different levels hospitals, and guarantee the enrolments. Specific to primary hospitals which were less required informationization service institutions, explore that setting specialized health informationization professional institutions and departments in certain areas (like city, county level), provide daily required IT service protection to basic health institutions in administrative areas. What's more, general hospitals were main powers to enforce country population

health informationization construction, should lead to build stable informationization talents development mechanism, provide in-job training and study opportunity, broaden promotion ways, and stabilize talent teams.

Highly pay attention to hospital information assurance

China's hospital informationization construction is in rapid developing period, new information system and application are popularizing currently, and information assurance is not the first consideration; second is that China still lacks of the dedicated law of information assurance and privacy protection, illegal act edge is relatively blurry, do not have detailed legal basis to fix duty, especially do not have definition of hospital's entity responsibility. Therefore, suggesting health management department accelerate to formulate medical institution information assurance regulation with network information assurance department, stipulate medical service institution's information assurance entity responsibility, have explicit request to information system emergency plan and information assurance level protection grading [18].

Manage and promote hospital system connection and information sharing through IT

Many elements affect system connection, such as hospital excessive transparent concern, strict supervision, subjective unwilling sharing, existence of information security and privacy disclose risk, data affiliation and management authority involve power and benefit, disunity standards, responsibility of interface development is ambiguous, less of powerful coordinate overall planning department, so hospitals should use IT governance ideas as the guidance when design system connection and information sharing policies, construct connection running, power and limitation mechanism [19]. Based on the relevant interest analysis of data production using department, clear each kind of institutions' data production, management duties and rights. Meantime, develop population health data opening research, clear and standard the type, level, object, ways, and extent of data opening [20].

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Declaration of Conflict of Interest

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