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Research Article

Intelligent Construction of Hospital Management Organization Based on Communication Technology and Information Fusion

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With the mature application of 5G communication and the development of artificial intelligence, the deep integration of modern hospital management and information technology has been fully realized. Therefore, this paper explores the organizational structure and system design of our institute and implements the construction and operation of the information system according to the concept of "management institutionalization, organization informatization, and form computerization." The construction of information management departments was strengthened, the entire 69 information systems with systematic thinking were managed, the dynamic management mechanism of information system operation and maintenance was established, and the fine closed-loop management of hospital processes was realized. The results show that the information system based on institutional management will improve the management efficiency of the hospital and ensure the real-time, accuracy, and security of hospital data information.

1. Introduction

In July 2017, the General Office of the State Council issued the guiding opinions on the establishment of modern hospital management system (GCFA (2017) No. 67) [1], in which the information management system is regarded as one of the eight core systems for the construction of hospital internal governance system.

A smart hospital includes three dimensions: smart medical care, smart service, and smart management [2]—"smart medical care" for medical staff, "smart service" for patients, and "smart management" for management [3]. Smart management is mainly the information application level of hospital comprehensive management (human, financial, material, etc.) [4].

Modern hospital management requires the all-round intervention of information technology and follows the law of the "Michel model" (the Michel model is a classic model for judging the degree of informatization and the development stage of informatization; the structure is shown in Figure 1 [5]). The early stage of single-machine and single-user data processing has developed to the stage of department-level management information systems, and now, based on the stage of hospital-level integrated systems and technologies [6], the information systems of each hospital are gradually covering the entire hospital management process. Provide an effective basis for hospital management and decision-making and guide the refined and high-quality development of the hospital, refer to Figure 1 for further details.

Beijing Tsinghua Changgung Hospital (hereinafter referred to as "the hospital") is a large-scale comprehensive public hospital jointly managed by the Tsinghua University and Beijing Municipal Government. Formosa Plastics and Taiwan Chang Gung Memorial Hospital have donated and assisted in the construction and operation of the hospital. At the beginning of its establishment, Taiwan Changgung Hospital's management philosophy was learned, the deep integration of the management system and information system was explored, information of the hospital in
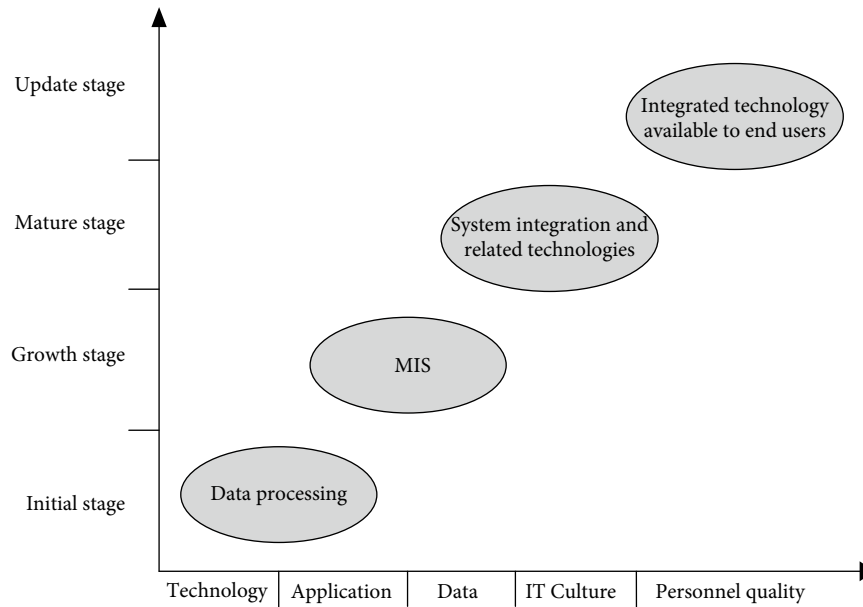
FIGURE 1: The Michel model.

terms of hospital management informatization practice was highly integrated and shared, and certain experience was accumulated.

The rest of the composition is as follows: Section 2 introduces the organizational structure and institutional guarantee, Section 3 shows the information system operation and management practice, Section 4 describes the modification of the information system, Section 5 is the data query business, Section 6 is the closed-loop management mechanism, Section 7 is the discussion, and Section 8 is the conclusion.

2. Organizational Structure and Institutional Guarantee

2.1. Decentralized Audit. The hospital draws on and localizes the management model of the Chang Gung Memorial Hospital in Taiwan, builds a modern hospital management system and operation model, implements the president responsibility system under the leadership of the party committee, and is managed by a professional medical team and a professional administrative team efficiency and effectiveness. The hospital has set up 33 committees, 15 administrative departments, and 19 business departments. The committee and each administrative department, as the professional management and decision-making team of the president, respectively, assist in the review of medical professional affairs and management professional practice and at the same time realize the separation of the management department and on-site execution, promote the participation of professionals in hospital management; promote scientific, democratic, and effective decision-making; and promote the high-quality development of hospitals [7], refer to Figure 2 for further details.

2.2. Hospital Management Philosophy. Based on the management concept of "institutionalized management, form-based system, and computerized form," the hospital fully realizes the deep integration of the management system and information system and forms a high degree of integration and sharing of information throughout the hospital.

2.2.1. Institutionalization of Management. According to the level and scope of use of the system, the hospital is divided into 74 first-level rules (systems, rules, and regulations), 214 second-level rules (measures), and 412 third-level rules (detailed rules and work points), a total of 700 items. Levels of system examination and approval authority are different. For example, the rules and regulations are formulated (revised) by the system management department, and after being reviewed by the corresponding committee, they are reviewed and approved by the president's office; rules and regulations are reviewed and approved by the party committee.

2.2.2. Formalization of the System. The form mainly reflects the process of business processing based on the system, so that the system can be implemented. The elements of the form include business processing links, role permissions, and opinions.

2.2.3. Form Computerization. The elements in the form are presented in an informative form. The use of information technology to build a refined quality control management platform can improve the work efficiency of the management department [8]. The information system is closely integrated with business processes to support and control the entire process of medical activities, ensuring safe and efficient medical services, and at the same time for continuous improvement. Provide decision support for hospital management and medical services.

2.3. Information Management Department Settings. The hospital has a total of 69 information systems, all of which are managed by 14 corresponding system management
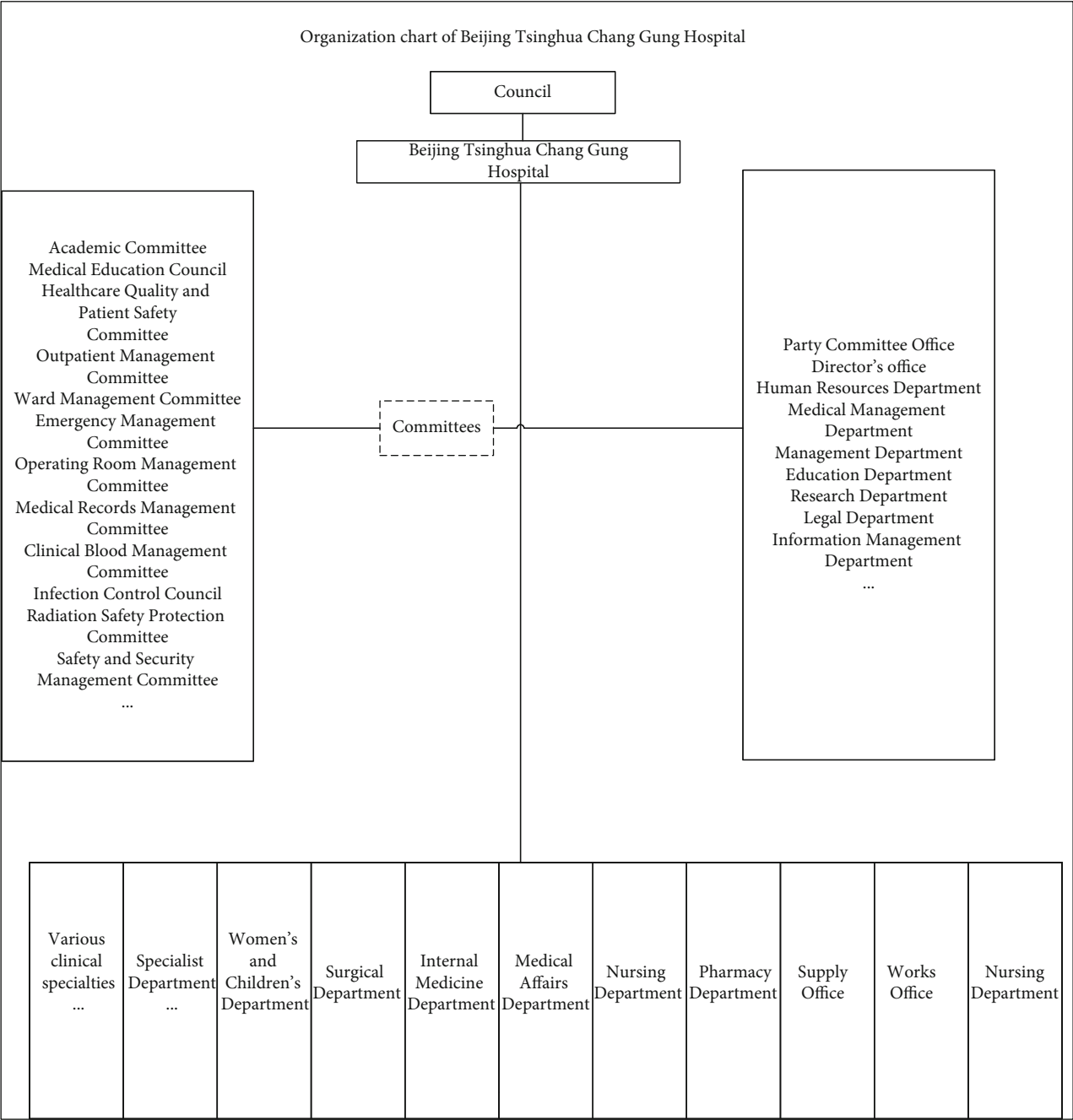
Figure 2: Organizational chart of the Beijing Tsinghua Changgung Hospital.

departments, namely, the functional department, and the software development team is the entrusted executive department. The system management department designates a system administrator for each system module. The administrator's responsibilities include (1) planning and optimization of the system architecture, (2) setting and assigning system permissions, (3) reviewing system modification requirements, and (4) system documentation renewal. For example, the administrator of the registration system is the specialist in charge of the consultation business of the medical management department, the administrator of the inpatient doctor order system is the specialist in charge of the inpatient service of the medical management department, and the administrator of the personnel system is the management specialist of the human resources department.

2.4. Information Support Department Setup. The hospital has its own information management and technical team, independently develops the hospital information system, fully realizes the deep integration of the management system and the information system, and highly integrates and shares the information of the whole hospital [9]. The information team is divided into a software development group and a hardware maintenance group.
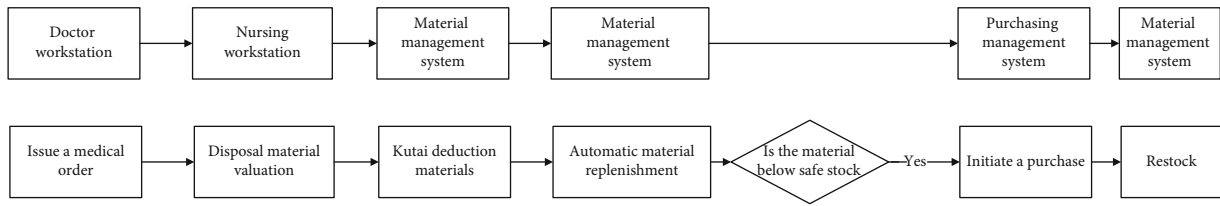
FIGURE 3: Example of data sharing across systems.

The information management department and the information support department cooperate to establish an efficient information system for continuous improvement. From the perspective of overall planning, it is better to ensure that the information system can support the improvement of the overall level of the hospital, ensure the realization of teaching and scientific research goals, and have good scalability.

3. Information System Operation and Management Practices

The hospital currently has 69 information systems covering the whole process, mainly including outpatient registration, inpatient charges, emergency doctor workstation, medical record management, and other systems based on the electronic medical record system, and budget, personnel, materials, finance, equipment based on the logistics management system, scientific research, and other systems can achieve a high degree of data sharing across systems. For example, when a doctor issues a treatment order on the resident doctor's workstation, the nursing workstation automatically charges the treatment materials, the cost warehouse of the patient's nursing station automatically deducts one unit of the priced consumables, and the main hospital library automatically replenishes one unit of the priced consumables to the nursing care station. On the station warehouse platform, when the remaining amount of the consumables in the main warehouse is lower than the safety stock set by the system, the system automatically initiates procurement and replenishes the warehouse to achieve full-process control, refer to Figure 3 for further details.

Each system has a set of system management documents, which are maintained and updated by the administrator. Specifically, these include the following:

3.1. System Association Diagram. Show the relationship between the system and other systems, such as the doctor workstation system and the ward nurse workstation, blood management, medical record management, human resources, inspection, hospitalization, and discharge systems. The associated interfaces between systems have numbers and standard descriptions.

3.2. Job Association Diagram. Show the relationship between different modules of the same system, such as the query of historical medical advice information, view of written medical records, query of inspection and test results report, and query of drug information in the doctor workstation system.

The associated interfaces between modules are numbered and have a standard description, refer to Figure 4 for further details.

3.3. Transaction Flow Chart. The system is to provide support for each specific business process, each business unit has the transaction process, and the flow chart of the transaction of important two dimensions, respectively, corresponds to the movement and the role of each node, and at the same time shows the instructions and may trigger the form, judgment, control, etc., and flow chart of admission to handle affairs, for example, transaction flow diagram contains the content as follows, refer to Figure 5 for further details.

3.4. Operating Instructions. Each operation screen of all systems has instructions for use, including the format requirements and sequence of input in specific fields, especially the control points. For example, in the hospitalization management system, it is specified that physicians should issue medical treatment to patients who are determined by medical diagnosis within the scope of practice and need to be hospitalized. For admission notice, if a resident physician or a physician has not yet obtained a practicing qualification or has not been given the right to exercise the corresponding specialty duties, the system will not grant admission permission, and the physician control cannot issue an admission notice.

The following are the listed tips:

(1) *Form Type.* Hospital admission notice issued

(2) *Function.* Issue admission notice

(3) *Use time.* To issue admission notice

(4) *Department of Use.* Outpatient physicians

(5) Usage

Click the "Appointment Management"—"Opening hospital Notice" button to jump to "Screen 4-2":

(1) Information of the attending physician and department is brought into the system by default, and doctors can click the corresponding field to modify

(2) Patient and diagnosis information is brought into the system by default

(3) The physician selects the date of hospitalization, priority registration, alternative date, scheduled

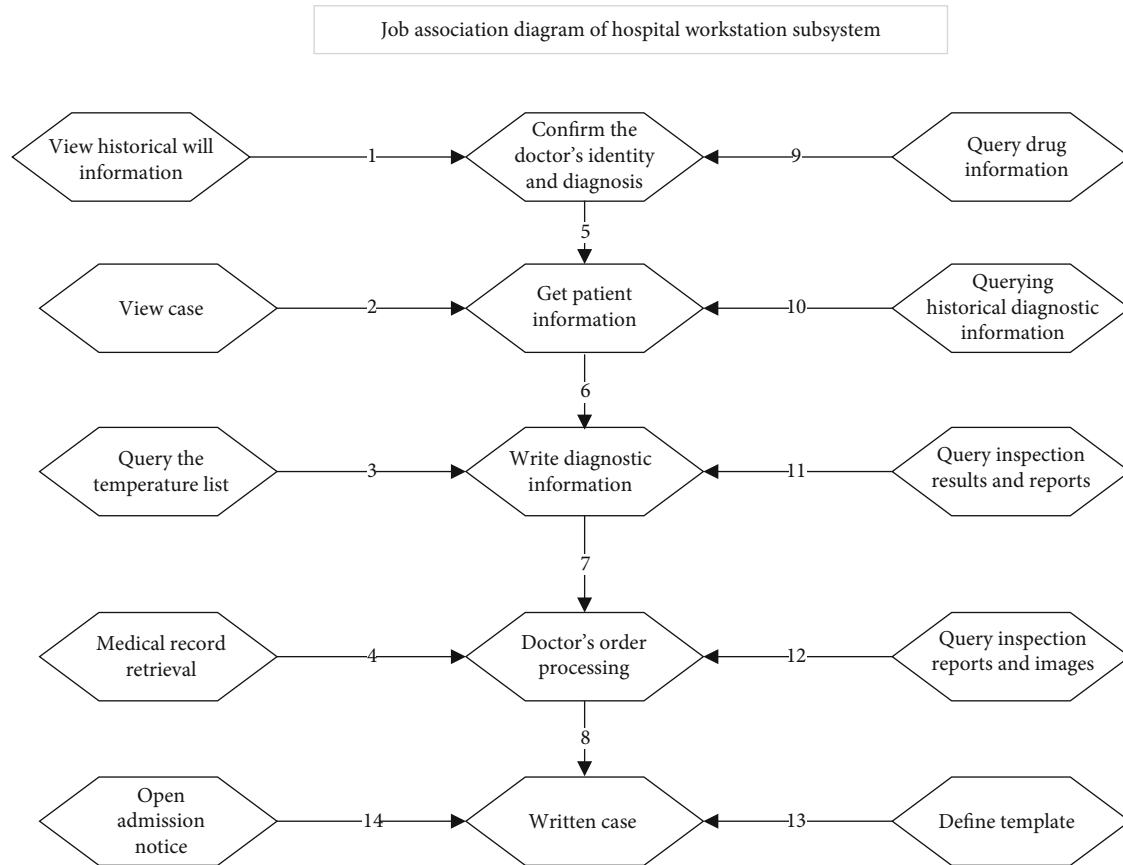Job association diagram of hospital workstation subsystem

FIGURE 4: Example of job association diagram.

operation time, advance payment amount, whether special needs patients, whether daytime chemotherapy, whether trauma patients, and whether 30-day readmission

(4) Click "Apply" to complete the issuance of the hospitalization notice, and the system prints the hospitalization notice by default and delivers it to the patient

(5) Click "Reprint notice" to reprint the notice of hospitalization

(6) Click "Cancel pre-hospitalization" to cancel the notice of hospitalization

4. Modification of the Information System

4.1. Timing of Information System Modification and Change

(1) Changes in government orders and regulations such as medical reform

(2) Revision of the hospital system and the discovery of abnormal loopholes in the business process that need to be improved

(3) The constant operation of on-site business personnel affects work efficiency etc.

4.2. Computer Feedback Form.
System modifications are handled in the form of computer feedback sheets. The specific process is the following: the user department puts forward the demand and the system management department reviews it. The main point of the review is to first judge whether the demand is consistent with the current system. If it is consistent, the review will continue. The business functions involved will be reviewed/countersigned/organized at a meeting by a single functional department, and then, a summary opinion will be given and submitted to the hospital leadership for verification. If you agree to the modification, the computer opinion sheet will be sent to the information department for modification. After the modification is completed, it will be tested by the user department, and finally, the new function will be launched. From this, it can be seen that the information department is the entrusted execution department, and the core of system modification is to clarify the requirements and review the rationality of the requirements, refer to Figure 6 for further details.

5. Data Query Business

In addition to the regular system operation modification through the computer feedback form, another embodiment of the informatization intervention is to provide an effective basis for hospital management and decision-making

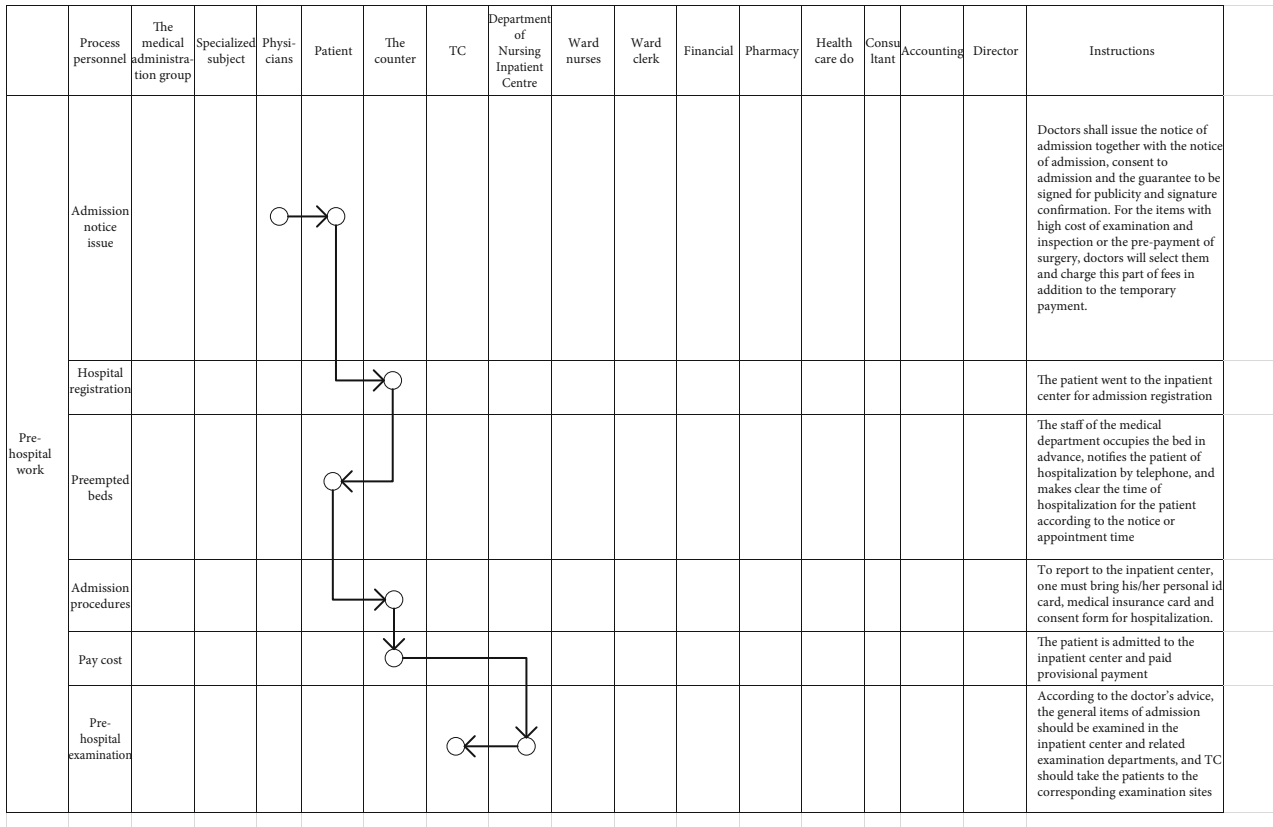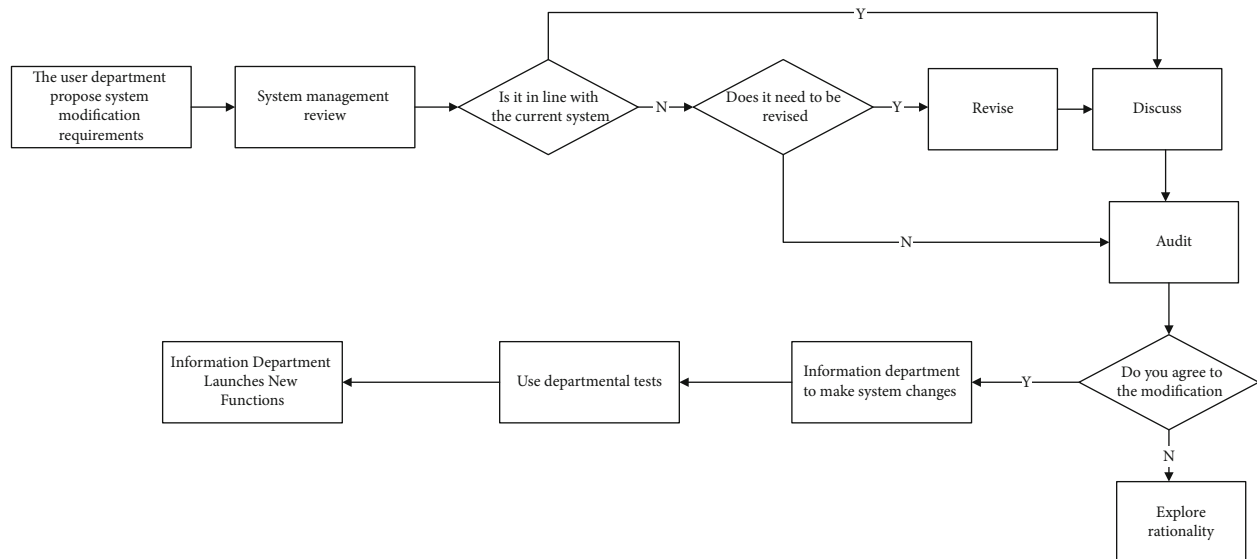| Process personnel	The medical administration group	Specialized subject	Physicians	Patient	The counter	TC	Department of Nursing Inpatient Centre	Ward nurses	Ward clerk	Financial	Pharmacy	Health care do	Consultant	Accounting	Director	Instructions
Pre-hospital work																
Admission notice issue			○→○													Doctors shall issue the notice of admission together with the notice of admission, consent to admission and the guarantee to be signed for publicity and signature confirmation. For the items with high cost of examination and inspection or the pre-payment of surgery, doctors will select them and charge this part of fees in addition to the temporary payment.
Hospital registration					○											The patient went to the inpatient center for admission registration
Preempted beds				○												The staff of the medical department occupies the bed in advance, notifies the patient of hospitalization by telephone, and makes clear the time of hospitalization for the patient according to the notice or appointment time
Admission procedures					○											To report to the inpatient center, one must bring his/her personal id card, medical insurance card and consent form for hospitalization.
Pay cost					○											The patient is admitted to the inpatient center and paid provisional payment
Pre-hospital examination						○	○									According to the doctor's advice, the general items of admission should be examined in the inpatient center and related examination departments, and TC should take the patients to the corresponding examination sites

FIGURE 5: Example of transaction flowchart.

FIGURE 6: Processing flow of computer feedback.

through consistent data information covering the entire process. Data query can be divided into routine data query (such as monthly, quarterly, and yearly) and one-time data query according to different business types.

5.1. The Routine Data Query Business Conducts Business Flow through the Indicator Setting Table. The index data that

can be queried in real-time provides the hospital with real-time monitoring of quality and efficiency and decision-making reference. For the index that continuously exceeds the threshold, the hospital will focus on reviewing the business operation. For example, on the average length of hospital stays, the indicator is defined as the average length of stay of all discharged patients in a certain period, and the

calculation formula is the total bed days occupied by discharged patients/the number of discharged patients in the same period. The numerator is the total number of bed days occupied by discharged patients in each natural month, and the denominator is the total number of discharged patients in each natural month. The threshold is set by the medical management department, and the information department is built into the system. The system can automatically capture the average hospitalization days of the whole hospital and each department within any time range for a specialist and related departments to query and prompt whether the indicator meets the standard according to the threshold in the indicator setting table. The medical management department is based on the data provided monthly by the system. Carry out a subdiscipline review and supervise the improvement.

5.2. The One-Time Data Query Business Conducts Business Flow through the Data Query Application Form. The inquiry department needs to fill in the purpose of data use, data connotation, and statistical time interval, emphasizing that after signing the data use confidentiality commitment, it will be provided by the information department after being reviewed by the system department and the hospital-level supervisor. In the process of system construction, according to the post setting requirements of different departments, from the perspective of information security, the post responsibilities of each department should be clarified, and information security should be ensured to the greatest extent on the basis of strengthening information exchange between departments [10].

6. Closed-Loop Management Mechanism

6.1. Unify the Data Caliber of Each System. The improvement process of the whole information system mentioned above is a self-consistent cycle process of implementing hospital management institutionalization, system form, and form computerized management concepts. The association between them is conducive to monitoring information at each node of the business process, which is easy to find loopholes, and realizes the closed-loop management of institutional processes in the hospital.

6.2. System Revision and System Update Synchronization. When the various systems in the hospital are revised, the relevant information systems should be revised accordingly. When the information system needs to be revised, it should be judged whether it is consistent with the system. After the system is revised, the system management documents should be updated in time to ensure that the system and implementation are always consistent.

6.3. Data Analysis Serves Business Decisions. The process of hospital informatization construction is the reconstruction and transformation of management concepts and models [11]. The information and data of the hospital come from the business, then return to the business, and continuously provide a reference for business decision-making through the comprehensive analysis of the data. Use the information platform to implement intensive and scientific management of each management unit of the hospital, "patient-centered", with limited investment in medical resources to create more medical service value [12].

7. Discuss

7.1. Formation of the Management Mechanism of "Requirements-Review-Execution" of the Information System. The hospital has strengthened the setting of the information management department, which is based on the premise of the decentralization of the administrative function department and the business department. The demand and use of the information system come from and go to the business, and the whole hospital needs to form a consensus on "the business department raises the demand, the functional department reviews and manages, and the information department executes." The construction of a hospital information system is not only a matter of the information department, nor is it only a matter of requirements without review. Only by systematically managing "requirements-review-execution" can the controllability, consistency, and efficiency of information system construction and management be ensured.

7.2. Informatization Construction and Standardization of Data Specifications Are the Basis for Interconnection. Under the wave of the country's vigorous development of smart medical care and the strengthening of Internet hospital construction, the connotation and extension of hospital informatization have undergone great changes. The coding and interfaces used between the existing information system of the hospital and the external system have not yet been unified [13–16]. On the premise of ensuring information security, the hospital needs to strengthen the overall planning of information management, strengthen the ability to communicate with external information, and have certain standardized parameter configuration and good scalability without violating the existing management system (the needs of future hospital development). Through standardization construction, the standard compliance of electronic medical record data and shared documents can be improved, and interconnection and business collaboration can be realized [17, 18].

8. Conclusions and Future Work

A modern hospital must have a modern governance system and management capabilities. The realization of "scientific management, efficient operation, and powerful supervision" mentioned in this goal needs to be built on a powerful hospital information system. When the integration level of the hospital information system is higher, the refined management level of the hospital is also higher. The application of information technology and the effective operation of the smart management system have provided new ideas and new models for public hospitals that are in urgent need of improving efficiency and making breakthroughs and innovations [19]. The information system based on institutional

management will provide strong support for the hospital to improve management efficiency and guide the high-quality development of the hospital. In the future, we will add supervision modules to make the system more efficient.

Data Availability

The experimental data used to support the findings of this study are available from the corresponding authors upon request.

Conflicts of Interest

The authors declared that they have no conflicts of interest regarding this work.

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