System Design of Multiple Network Platform Outpatient Appointment Registration System for Large General Hospitals

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Abstract. This paper analyzed the current registration situation of outpatient patients in hospitals, scientifically allocated and shared medical resources, standardized doctor scheduling, classified and integrated disease source, and established a multi-platform appointment and triage process system; arranged the reception work in advance, optimized the treatment process, and provided multi-channel unified patient appointment; increased the interaction between patients and doctors, and reduced the medical costs of ordinary and minor patients. A new mode of humanized medical service was constructed.

1. Introduction
In recent years, hospital registration has become the focus of attention of hospitals and patients. How to make an appointment in advance, plan to see a doctor, simplify the process, optimize medical resources and improve work efficiency has become the top priority of hospital medical management. Especially, solving the problems of crowded outpatient registration, disordered waiting, multiple queuing, cumbersome process, and emergency treatment of serious illness is the biggest voice of the majority of patients.

Under the condition of the existing medical resources, it is necessary to reform the hospital information system, expand the application of information support platform, establish the appointment triage process system, standardize the management of hospital scheduling, arrange the reception work in advance, optimize the outpatient consultation process, provide patients with multi-channel unified appointment convenience and reduce hanging-up. Manual treatment of window No. 1 can improve the ability of medical service and medical skills. Thus, we should construct a humanized service model, improve the efficiency of patients, enhance the competitiveness of medical treatment, create greater economic benefits and make greater contributions to society.

2. Objectives
Establish a unified appointment registration platform, and integrate the doctor's scheduling and source through the connection with the hospital's HIS system, such as portals, palm hospitals, hospital guides, doctors' appointments, and self-service terminals. The multi-channel is released to meet the needs of all kinds of patients to make appointments, thus alleviating the sharp problem of patients' "one hard to find". The design of the integrated management system software should be designed to be safe, practical, advanced, easy to maintain, and scalable. The system should have a clear role definition and corresponding authority allocation for the personnel involved in the appointment of the integrated management system software construction, and have standardized business processes and functional
module support for the service projects to ensure the realization of the participants in the emergency department process. Information symmetry and barrier-free communication to achieve satisfactory application results.

3. System Requirements
The unified appointment registration platform construction appointment registration channel covers the network appointment registration, the consultation desk appointment registration, the clinic appointment registration, etc. Through the construction of the system, the patient consultation system is realized, thereby optimizing the patient treatment order and eliminating the patient for a long time waiting at the window.

3.1. Appointment Registration System Baseline
Construction appointment registration basic maintenance system: unified management of the appointment number source, according to the characteristics of the department to arrange the consultation plan, according to the characteristics of different departments of the hospital unified allocation and management of the scheduling plan (diagnosis diagnosis), appointment channel authority management, management of each channel reservation number Limitation of source period and quantity. The patient can carry out targeted appointment registration according to the requirements, classify and manage each channel in a unified manner, unify the external call interface, realize the sharing of the source resources, configure the channel source ratio, and monitor the reservation utilization rate of each channel. Therefore, the preliminary design of the appointment registration is as shown in the following figure:

![Figure 1. the preliminary design of the appointment registration](image)

3.1.1. Resource Management. The appointment number source management needs to maintain the doctor's number of consultations and the number of the number of the appointments, and automatically generate the appointment schedule within seven days, as shown in Figure 2, corresponding to 1-7 days per week, and strictly eliminate the repeated appointment registration. The specific construction requirements are as follows:

1) Determine the number and number of each doctor's morning and afternoon based on the attendance of the previous department and doctor, and the doctor's title;

2) Generate the source within seven days from the day, each number specifies the doctor and waiting time, and the system automatically generates the source data of the eighth day in the evening or in the early morning;

3) All the reservation source sources include the common number and the expert number unified in the hospital's source system, and are open to various appointment channels. After each number is successfully hanged, there is one less number on the number list, and there will be no duplication.
3.1.2. Shift of Doctors. According to the situation and regularity of the previous departments, the number of doctors in the workdays and holidays will be arranged reasonably. In the process of scheduling, it is subdivided into specialist diseases, famous experts, directors and deputy directors, and attending physicians. Enable patients to make targeted appointment registrations on demand. If you encounter special circumstances, such as a doctor going out to study or going to the countryside, you can stop the current doctor's consultation plan alone; if you have a holiday, most of the doctors in the hospital can use the holiday stop plan when they are on holiday; one plan, keep updating, long-term recovery If you only need to start the appointment plan, after the plan is scheduled, the subsequent plan can be automatically copied according to the cycle; the current temporary status of the medical resources, call number, visit and other dynamic status can be viewed in the appointment plan management. The concrete structure is shown in Figure 3:

Figure 3. Sitting information design

3.1.3. Real name management. 1) The reservation platform adopts the real-name appointment mode. Patients need to make real-name appointments with information such as social security card, resident health card, ID card, phone number and name.

2) Establish a patient management module to manage the patient's appointment registration, including the following: first visits, return visits, cool appointments, blacklist system.
3.2 Network Appointment Registration

In the various channels of the network (Android APP, Apple, WeChat, official website, etc.), user self-registration, multi-dimensional inquiry reservation source, completion of appointment, and support of registration fee payment.

User information registration and modification: You can modify your own information, such as: name, password prompt question and answer, gender, date of birth, ID number, address, email address and other information.

Medical institutions and experts inquiries: Through this function, you can browse the introductions and departments of each medical institution and experts, and then select experts to make specific appointments.

Appointment registration: including outpatient appointments. This feature summarizes the user's appointment information, including: clinic number, expert, clinic date, appointment date, and can also cancel the appointment.

Source query: Query the doctor's appointment information. The query is divided into the following four modes: query according to the expert name code, query according to the department, perform fuzzy query according to the doctor's expertise, and query according to the time of the visit.

Confirmation of appointment: After the user queries the expert number to be reserved, the user makes an appointment as required; after the reservation is successful, the system will send a notification message of successful appointment to the user's mobile phone to complete the entire appointment submission process. You can also pay the registration fee via your mobile phone.

An overall design structure diagram and a web page appointment registration page example (Figures 4 and 5):

![Figure 4. Flow chart of network reservation registration](image-url)
3.2.1. Change of Appointment Status. The construction of the appointment registration meets the patients with and without card, the card patients support direct deduction, the card-free patient registration reservation, and the hospital payment on the day of the visit. The construction of the appointment change satisfies the patients with and without the card. The card patient directly retrieves the patient information based on the card number, telephone number, and name. The card-free patient can only call up the valid appointment by name and telephone, and finally complete the adjustment.

1) Patient with Card: After verifying the patient card number, name, and phone number and matching, the system displays the patient and basic information. The operator records the patient appointment date, time, appointment department, and appointment doctor. The system regenerates the reservation information by recalling the effective appointment made by the patient, adjusting the appointment time of the patient, making an appointment for the department, making an appointment with the doctor, and the like;

2) Patients without card: Enter your name, phone number, and make a reservation according to the system prompts. The system regenerates the reservation information by recalling the effective appointment made by the patient, adjusting the patient's appointment time, making an appointment to the department, making an appointment with the doctor, and the like.

The specific design is shown in the figure6:

3.2.2. Reservation Inquiry. The construction of the reservation inquiry satisfies all the reservation records on the day of the investigation, and provides the selection of the inquiry conditions: 1
reservation method 2 department 3 doctor 4 reservation 5 appointment date and time, providing printing and exporting excel form; the function module needs to embed the reservation change. It is convenient for the operator to blur the inquiry and change the reservation information.

3.2.3. **SMS reminder.** All the operations of the reservation are built to push the reservation reminder information to the user through the mobile phone number provided by the user, including the appointment time reminder, the reservation change reminder, the appointment cancellation reminder, and the like.

3.3. **Guide Desk Appointment Registration**
Embedded in the nurse triage system, the triage nurse selects the time of the visit according to the patient's needs, the doctor, the visiting department, and enters the above information including the patient's basic information into the appointment registration platform. The system starts according to the time period of the visit. Arrange the time, insert the patient queuing information into the queuing queue, and make an appointment for appointment. Immediately after the appointment is made, an SMS will be sent to remind the appointment information, and the patient will be reminded of the time of the appointment.

3.4. **Appointment Registration**
Embedded in the outpatient doctor module, the doctor directly pops up the referral appointment interface at the time of diagnosis, and can make an appointment for the next visit of the patient. The module can reserve the next appointment time for the patient under the doctor, and cannot make an appointment. After the entry, the information enters the appointment registration form, and waits for the appointment time to enter the queue. If the patient fails to see the doctor as scheduled, the doctor can wait for the patient to go to the clinic and then go to the clinic to call the list again. Specific design as shown in Figure 7:

![Figure 7. Flow chart of appointment registration for triage desk](image)

4. **System Design**

4.1. **Design Principles**

4.1.1. **Confidentiality and Security Principles.** WeChat reservations, mobile reservations, etc. belong to the Internet + applications are outside the LAN, but the system operating under the network environment with the LAN, must pay attention to the security and confidentiality of hospital data, all communication data needs to be strictly encrypted to prevent any Data leaks.

4.1.2. **Practical Principle.** Fully meet the hospital's integration needs for patient information, and serve the patient experience as the main line. Focusing on the three major groups of doctors, nurses and patients, fully utilize the hospital's current hospital information systems to establish a unified comprehensive management platform for appointments. All kinds of appointment channels provide
unified appointment resource management, provide complete arrangement management for the doctor's consultation plan in the hospital, and provide necessary technical support.

4.1.3. Advanced Principle. Adopting the industry's advanced system architecture concept and mature and open technologies (including computer technology, network technology and storage technology), the system is internationally advanced and conforms to international standards such as DICOM 3.0, HL7 and IHE. Maximize the sharing and application of existing information system resources, build a system that can interact in business functions, and build an avant-garde medical information system for all hospital services.

4.1.4. Scientific and Standard Principles. The reservation comprehensive management system and its application follow international standards such as HL7 and IHE, conform to the “Hospital Information System Functional Specification” of the Ministry of Health, and adopt mature, advanced and internationally compliant system structures, computer technology, communication technology, database technology, and storage. Technology and network technology. Query and access speed: The system response speed is fast, and there is no pause in data entry and query.

4.1.5. Extensibility and Flexibility. Open and flexible, through the in-hospital data sharing platform, the reservation integrated management system should open up enough room for future expansion into the in-house business system. It is necessary to maintain interconnection and information sharing with various business systems in the hospital, and also need to be compatible with other government information systems. (such as health card, resident health file, family planning, public security, etc.) interconnection and two-way interaction, so the system should be designed with full consideration of its openness and applicability to meet the changing requirements of business needs.

4.2. Overall Structure
Taking patient management as the core, serving the pre-diagnosis business of patients is the main line, focusing on the three major groups of doctors, nurses and patients, making full use of the data exchange platform and various hospital information systems that have been built in the hospital to establish a unified appointment. The integrated management platform realizes the unified entry, storage and management of the emergency department's sitting resources according to the standard, and provides necessary technical support for the subsequent big data analysis and mining. The platform will be constructed in accordance with the HL7 Health Information Exchange Standard and the IHE Technical Framework Specification to achieve seamless integration with the current in-hospital data exchange platform, support data exchange interfaces and protocols for the in-hospital data exchange platform, and obtain from the platform including but not limited to patient integrity. Basic data, support Oracle, SQL Server, DB2 and other common relational enterprise-level databases to facilitate data management and system maintenance; support flexible deployment on multiple server operating systems such as Windows and Linux; support centralized/distributed hybrid storage. Set file storage pointers in the platform to uniformly manage different files distributed in different business systems to improve file sharing efficiency.

The main functions are as follows:

1) Unified outpatient scheduling management. Outpatient management center unified door emergency scheduling is arranged by each department and the infirmary to submit the specific diagnosis ability of each clinical department combined with the evaluation of historical experience, and arrange the current medical care resources in the hospital. If you encounter special circumstances or holidays, you can enable the holiday stop plan; one plan, continuous update, long-term reuse, that is, only when you start the appointment plan, after the plan is scheduled, the subsequent plan can be automatically copied by cycle.

2) Appointment rule management. It is used by hospital administrators to maintain relevant business rules in the hospital, management rules for canceling appointments, condition rules for blacklisting, and system management rules.
(3) Appointment channel management. Provide maintenance of the major reservation channels of the hospital and the allocation of reserved resources.

(4) Statistical analysis. Detailed data reports for channel appointments, refresh rates, workloads, etc.

(5) Official website reservation. The appointment registration of the PC-side webpage is connected with the existing official website of the hospital. After the patient has made an appointment, the appointment can be cancelled and the reserved record can be viewed on the official website.

(6) Mobile micro platform reservation. The mobile reservation mode includes the Android terminal and the IOS terminal; after the patient makes an appointment, the reservation can be cancelled and the reserved record can be viewed in the mobile micro platform.

(7) WeChat public account appointment. The WeChat public number is reserved for registration, and the patient can cancel the appointment and view the reserved records in the WeChat public account.

(8) Appointment between clinics. The doctor in the hospital will help the patient to complete the appointment and plus function at the clinic. The doctor can also cancel the appointment and check the records of the appointment.

(9) Consultation appointment. The in-hospital consultation will help the patient to complete the appointment and plus function in the waiting room, and the referral nurse can also cancel the appointment and check the records of the appointment.

(10) Patient identity registration. The patient's first identity information is registered, and the registration information is bound to the hospital information system to confirm the identity.

(11) Authority management. The hospital administrator manages all logged in users, categorized roles, and assigned permissions.

The appointment comprehensive management system supports multi-channel appointments for patients, and the unified source arrangement and management allocation in the hospital. And share patient information registration through the HIE platform. Various types of data generated by appointments through multiple types of rules in the hospital. The specific architecture diagram is shown in Figure 8:

**Figure 8. Design of reservation registration system**
4.3 System Network Topology

The reservation system adopts a hybrid network topology structure, which greatly satisfies the expansion of the network, and through the reservation end to the firewall to the server, and then to the intranet environment, the patient's reservation information and payment information, the hospital's scheduling information and management information are reached. Interactive transmission. The specific design is as follows:

![Network Extension Graph of Reservation System](image)

**Figure 9.** Network Extension Graph of Reservation System

4.4 Appointment Channel Management

Appointment channel management refers to the appointment of medical resources for appointments according to the medical treatment scheduling plan of the outpatient management center through different channels, and provides appointment services for patients. The hospital's official website reservation, mobile APP appointment, WeChat public number reservation, telephone reservation, appointment between clinics, and on-site window reservations are planned. Appointment channel management is the allocation and limitation of reserved resources for each channel. The actual business process is shown in Figure 10:

![Business Flow Chart of Reservation Channel](image)

**Figure 10.** Business Flow Chart of Reservation Channel

The appointment channel management mainly adopts the python development language, and uses http (get/post) to call the platform interface.

4.5 Official Website Reservation

The official website of the hospital is reserved through the official website of the hospital. Patients can log in to the official website of the hospital to complete the appointment registration on any computer that can connect to the Internet. If you have not registered, register an account and you can make an appointment. When registering, the patient is required to fill in the personal name, ID number, gender and other information. This part of the information will be stored in a complete encrypted form and cannot be leaked. When making an appointment, you only need to select the department you are visiting, the type of doctor, the name of the doctor, the time of the visit, etc., and find out the appointment resources and patient confirmation information that meet the patient's designation. Business process as shown in Figure 11:
4.6. **WeChat public account and mobile APP appointment**

Patients can register in the hospital's official WeChat public account or mobile app program, and get a 7-day hospital outpatient scheduling doctor information form at any time. The patient can complete the appointment in the hospital's official WeChat public account or in the APP program, the visit plan is changed, the appointment is cancelled, and the current appointment is reviewed.

4.7. **Registered Reservation System Database**

Database design or data model is a very important step in building an information system. For the reservation system, regardless of the appointment success or failure, the appointment record will be left in the system, and the reservation information will include information such as the patient, doctor, department, appointment time, visit time, etc., as well as some derived Related Information. Through the existing database of the hospital and some related information systems, we can obtain and use the data structure in the corresponding subsystem to establish the following relationship diagram (Figure 12.)

**Figure 11.** Official Network Business Process

Implemented in B/S mode, using Python combined with HTML page elements, CSS layout elements and other technologies.

**Figure 12.** Database Design

For each data structure, by extracting the information in the existing database, the following information table is obtained:
Table 1. Section Information Table dbo.zd_unit_code

| Field name   | Field description | key   | type  | Null value |
|--------------|-------------------|-------|-------|------------|
| unit_sn      | Primary key       | PK    | char  | Not        |
| name         | Name of Department|       | varchar| Not        |
| class_code   | Classification of departments | | char |            |

Table 2. Doctor Information Table dbo.a_employee_mi

| Field name   | Field description | key   | type  | Null value |
|--------------|-------------------|-------|-------|------------|
| emp_sn       | Primary key       | PK    | char  | Not null   |
| name         | Name of doctor    |       | varchar| Not        |
| prof_type    | Classification of doctors | | varchar| Null      |
| D_code       | Doctor's code     |       | varchar| Null       |
| emp_tit_code | Doctor's title    |       | varchar| Null       |

Table 3. Patient information table dbo.mz_patient_mi

| Field name   | Field description | key   | type  | Null value |
|--------------|-------------------|-------|-------|------------|
| patient_id   | Patient ID        | PK    | varchar| Not null   |
| Name         | Name of patient   |       | varchar| Null       |
| P_bar_code   | Visiting card     |       | varchar| Null       |
| social_no    | ID number         |       | varchar| Null       |
| home_tel     | Contact number    |       | varchar| Null       |

Table 4. Reservation Information Table dbo.app_appointment_register

| Field name   | Field description | key   | type  | Null value |
|--------------|-------------------|-------|-------|------------|
| register_sn  | Appointment number| PK    | int   | Not null   |
| patient_id   | Patient ID        |       | char  | Not null   |
| doctor_sn    | make an appointment|    | varchar| Not null   |
| unit_sn      | Booking office    |       | varchar| Not null   |
| input_date   | Time of appointment|     | datetime| Not null |

Table 5. Attendance schedule dbo.gh_request

| Field name   | Field description | key   | type  | Null value |
|--------------|-------------------|-------|-------|------------|
| record_sn    | Scheduling number | PK    | int   | Not null   |
| request_date | Visiting time     |       | datetime| Not null |
| unit_sn      | Visiting Department|     | char  | Not null   |
| doctor_sn    | visiting physician|       | char  | Not null   |
| clinic_type  | Signal number     |       | char  | Not null   |

5. Conclusion

Through the multi-platform registration reservation system, patients can choose the appropriate registration platform to express their symptoms purposefully, purposefully and clearly, increase the interaction between patients and doctors, reduce the medical costs of ordinary and minor patients, and improve patients' satisfaction with hospitals; at the same time, it can make the allocation and sharing of medical resources more scientific, and the hospital shunt patients. Others aim at controlling
outpatient flow, timely and effective treatment of serious diseases, more time for diagnosis and treatment of difficult diseases, and better development of key disciplines in hospitals.

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