Development of Ward Visitor Management System in the COVID-19 Epidemic

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Abstract. The purpose of this study was to design, develop, and deploy a visitor management system (VMS) to effectively manage visitors during COVID-19. The VMS was designed using the User-Centered Design (UCD) methodology. The iterative process of UCD includes 3 interviews and 5 usability tests and cognitive walkthrough cycles. This system comprised six parts: the WEB server provides visit scheduling service; the database server stores visit data and provides visit data services; the mobile application server provides security checks and scanning services; the electronic medical record (EMR) server provides ward data service; the Internet application gateway provides health code data service and exchanges health code data with the Sichuan Tianfu Health Code platform, and the service bus enables the centralized exchange and integration of visit data. The visit management system optimizes the workflow of ward visitors, improves staff productivity, and reduces the risk of infection transmission.

Keywords. COVID-19, ward visitor, management system

1. Introduction

COVID-19 is a highly infectious disease that has caused a global pandemic. Rapid identification of individuals at risk for COVID-19 and the management of patients with COVID-19 are critical to slowing down the global spread of COVID-19 [1,2]. People visiting the inpatients during the epidemic may themselves be carriers and are therefore likely to spread COVID-19 on the ward. Infection control measures for hospital visitors are needed to prevent cluster outbreaks [3]. To control the spread of COVID-19, almost all healthcare facilities have strict visitor restriction policies [4].

Although measures have been taken to restrict visitors, traditional paper registration is not sufficient to control and monitor a large number of visitors to major hospitals [4]. It does not facilitate the timely processing of information, and it is difficult to realize the management and monitoring of visitors in the whole hospital [5]. Studies have indicated that a hospital visitor management system (VMS) can effectively manage visitors and help prevent the spread of COVID-19 [6]. In this paper, we have described the design,

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development, implementation, and early use of the VMS during the COVID-19 pandemic. This system is likely to be important for hospitals around the world facing similar crises.

2. Methods

2.1. Study site

West China Hospital is one of the largest comprehensive public medical centers in China. As of November 2020, the hospital has 4300 beds served by more than 10,000 staff. After the National Health Commission of the People's Republic of China announced the supervision policy for ward visits, the hospital restricted the visiting time to a period from 16:00 to 18:00 every day, with no more than one visitor for the same patient at the same time. The ward visitation management system was implemented within one month and has been in use at the hospital since November 10, 2020.

2.2. Design process

The visit management system was designed using user-centered design (UCD) methods to ensure that the opinions and requirements of the end users of the system (patients' families, nurses, nursing management, and hospital security personnel) were considered in the design process. The UCD iteration process included three interviews and five usability tests and a cognitive walk-through method.

2.3. Technology application

In the process of system architecture, we have used the following techniques: hypertext markup language 5 (HTML5); enterprise service bus (ESB); 4G-5G network; cloud computing.

2.4. Data security

To ensure data security, the data interacting with the Sichuan Tianfu Health Code platform is digitally signed using HMACSHA256. HMACSHA256 is a type of keyed hash algorithm that is constructed from the SHA-256 hash function and used as a Hash-Based Message Authentication Code (HMAC). It protects the integrity and non-repudiation of the data being exchanged. In addition, the data is encrypted before transmission to protect the integrity, non-repudiation, and confidentiality of the interacting data.

2.5. Ethics

This research was observational, based on user responses to interface design, and did not involve medical intervention. The research did not require ethical approval under the regulations of the author's country.

3. Results

3.1. The system architecture

This system consists of six main components and is connected to the Sichuan Tianfu Health Code platform. The ward visit system is shown in Figure 1: (1) WEB server provides visit appointment service. (2) The database server stores visit data and provides visit data services. (3) The mobile application server provides security checks and scanning services. (4) The EMR server provides the ward data service. (5) The internet application gateway provides the health code data service and exchanges health code data with the Sichuan Tianfu Health Code platform via a virtual private network. (6) The service bus enables the centralized exchange and integration of visit data. The Health Code is an electronic certificate for individuals entering and leaving any city in China to confirm their health status. All data can only be transmitted over the internet after being signed and encrypted.
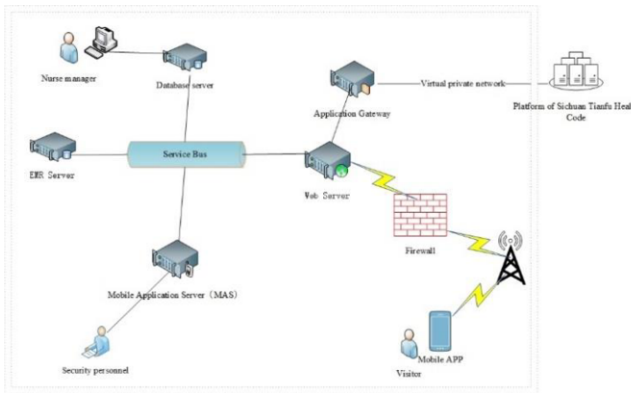

Figure 1. The architecture of the visit management system.

3.2. Application process

Requests can be made via APP or WeChat. According to the visiting policy, the ward nurse manager reviews the visit request in the visit management system (Figure 2). Once the request has been reviewed and approved by the nurse manager, the electronic visit card is generated. Once a request is approved, the requester is notified via an alert message (Figure 3). The requestor can manually cancel the appointment in the appointment record booking interface, and the appointment information is automatically cancelled when the patient is transferred to the ward, department, or discharged. When visitors enter the hospital, they must be scanned by security staff to confirm their visit code before entering the ward, and the code expires immediately after scanning. By interfacing with the Sichuan Tianfu Health Code platform, the system dynamically monitors the visitor's health status in the background. In the event of an abnormality, an SMS (short message service) alert is sent to relevant management personnel. Managers can also view monitoring reports and monitor the health status of visitors at any time. The system will automatically perform statistical analysis of the number of visits, department distribution, ward distribution, time distribution, abnormality analysis, workload analysis, visit time analysis, etc.

Figure 2. Application process.

Figure 3. Approval process.

3.3. Functionality of the system

Each of these functions is designed to facilitate user and effective visitor management, as described below.

Alerting: The system can alert visitors, patients, managers, security staff, etc. as required.

Monitoring and tracking: By using the Sichuan Tianfu Health Code platform, we can continuously monitor the health of visitors. If there are any issues, managers will be notified immediately via SMS. Managers can also access monitoring reports to stay updated on the health status of visitors.

Analysis: The system will automatically statistically analyze the number of visitors, department distribution, ward distribution, time distribution, abnormality value analysis, workload analysis, visiting time analysis, etc.

3.4. Preliminary application

The system recorded 292 visits between November 10, 2020, and November 18, 2020. 90 visits were authorized, 90 secure visits were carried out and 584 dynamic monitoring and early warnings were issued, creating a dynamic, three-dimensional, and secure VMS.

4. Discussion

The system is linked to the "health code" system, which is used by the Chinese government to monitor personal health and control the spread of COVID-19. By

exchanging visitors' health information through the existing telecommunications infrastructure, the system can identify high-risk visitors and reject applications from those with abnormal health codes. It can also track visitors who have contracted COVID-19 through the "health code" system. The control code is updated in real-time and personalized for each visitor, ensuring a tailored intervention. Visitors are notified of changes to their health code through the app dashboard.

The nurse manager checked the visitors' application via the online platform. This prevents high-risk visitors from coming into direct contact with our hospital staff, reducing the spread of COVID-19. The platform also records visitor-patient interactions, which is crucial during a hospital outbreak. These records help identify high-risk visitors and allow us to analyze the risk level of each ward. With this information, policymakers can create tailored visitor policies, improve visitor management, and enhance patient and visitor satisfaction.

The privacy protection strategy of permission before use is followed in the design. Visitors are required to confirm permission to authorize the use of their data (name, ID number, health status, health description) in the Tianfu Health Code system when applying for visits. During the subsequent code scanning process, their authorized data can be retrieved for use in the visit management system. When requesting an appointment, hospitalization data must be obtained from the medical system. To protect the patient's privacy, the requester must provide the inpatient's hospitalization number (which is a unique ID within the system and is held by the patient) and name, and only if the two-match will the hospitalization data be returned. This process uses the username/password security policy.

5. Conclusions

The VMS optimizes the ward visitor process, improved the staff's productivity, and reduced the risk of infection transmission, supervision and other issues. The system enabled dynamic monitoring and effective management of visitors by assessing ward control, real-time access conditions, and health code status.

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