

Development and Utilization of a Patient-Oriented Outpatient Guidance System

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Objectives: To develop a tool which can easily access the hospital information system (HIS) to facilitate outpatient care and maximize patient satisfaction on his or her hospital visit. **Methods:** Our Center for Informatics developed an outpatient guidance system (OGS) after careful analysis of the list of daily tasks undergone by patients and related work processes. Bluetooth beacons were installed to assist patients, to inform them of points of interest, and to guide them along the proper routes to and within the hospital. **Results:** The OGS conveniently provided patients' clinic schedules, routes to the hospital, and direct costs; all of this information was embedded in the HIS accessed from patients' personal mobile devices or kiosks. Patients were also able to identify their locations within the hospital, receiving proper directions to subsequent task. Since its launch in October 2014, the number of mobile accesses increased from 4,011 to 8,242 per month within a year. **Conclusions:** The substantial growth of interest in and use of our OGS in such a short period indicate that this system has been successfully incorporated into patients' daily activities. We believe that this system will continue to help improve health services and the well-being of those visiting the hospital.

Keywords: Hospital Information System, Patient Care, Smartphone, Health Services

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I. Introduction

Hospital information systems (HISs) have been adopted for all activities in many hospitals, helping both patients and medical personnel, leading to increased demands of users. Alongside such changes in information technology within the hospital environment, the robust use of smartphones or personal devices has enabled medical information to be more accessible [1]. On the other hand, tasks for patients to complete in the hospital have become more complicated; a patient often needs to meet more than one specialist in various departments for further evaluation and treatment. Securing medical appointments, preparing proper medical documents, paying bills, and taking the required tests or exams are routine yet often burdensome tasks for patients. This sometimes leads to unwanted, excessive time spent in

hospitals, thus highlighting the need for a fast, convenient, and accurate guide to help patients efficiently utilize medical resources.

There has been an increasing demand for mobile devices to facilitate access to HIS. They could be used to directly provide quality service related to the pertinent personal medical and non-medical information embedded in the HIS. For this end, the Center for Informatics in Seoul Metropolitan Government–Seoul National University Boramae Medical Center has developed an outpatient guidance system (OGS), an information system for patients through which a patient can check his/her schedule of appointments, information about laboratory/imaging tests, and daily tasks the patient should complete.

II. Methods

1. Work of Scope for the Development of the Patient-Oriented OGS

A mobile (smartphone) application was first developed to (1) check the patient's schedule at home, (2) direct a road path to the hospital, and (3) provide a to-do list upon arrival with guidance to the appointed doctor's office on time. The application also included a brief survey after payment as reference for future service improvements in the hospital. For those patients without smartphones, information kiosks were utilized to check the schedule and projected patient's path on site. Daily (Table 1) as well as the total forthcoming tasks (Table 2) were defined by analyzing the footprints of outpatients visiting the hospital.

Table 1. Outpatient service processes on the day of appointment

Process	Tasks
Registration	Payment of appointment fee Submission of referral letter in case of patients on Medicaid (for first visits to respective clinics) Obtaining signatures approving specialist service Uploading outside radiology films or files Confirmation of tests to undergo prior to appointment through the integrated kiosk or mobile outpatient guidance system (OGS) Performance of tests prior to appointment Hospital guide through the integrated kiosk or mobile OGS
Appointment	Confirmation of patient arrival at reception kiosk (inform patient of unpaid fees, unperformed tests, guide on anthropometric measures including blood pressure, etc.) Notification of 'Registration - Stand-by - Completion' status of appointment on the mobile OGS Meeting the physician on schedule
After appointment	Making the appointment for the following visit Reservation of proper exams or tests through nurses' office or corresponding departments Guide on schedule of remaining tests Payment of fee if on-the-day tests are conducted Confirmation of payment displayed on the integrated kiosk, mobile OGS Signing at the register if classified as a patient with rare or severe disease Printing the prescription at the integrated kiosk Medicine pick-up at the hospital pharmacy in case of inpatient prescription (stand-by numbers are posted on OGS) Receiving medical treatment including injection, blood transfusion, etc., upon necessity Guide to admissions office if directed to be hospitalized Document pick-up at the counter where medical certificates are issued, if order is placed
Medical records	Payment of fee for copies of medical documents at the counter for medical records and print-out at medical record copy issuing kiosk Patients are also able to fill out an application form directly at the counter for medical record
Education	Patient education via on- or off-line, if there is a doctor's order

Table 2. Work processes included in the overall schedule section

Schedule	Tasks
Appointment schedule	Inquiry of full list of forthcoming outpatient reservations
Examination schedule (reserved)	Inquiry of schedules by reservation dates Guide on 'precautions, general information' when selecting examination Confirmation of examination room location
Examination schedule (others)	Guide on remaining examination list prescribed from previous appointment Guide on precautions, confirmation of examination room location
Visit to the registration desk	Notification of unpaid items and amount among forthcoming schedules Confirmation of payment schedules at subsequent visits Guide on incomplete signatures approving medical service Guide on unclaimed medical certificates at counter

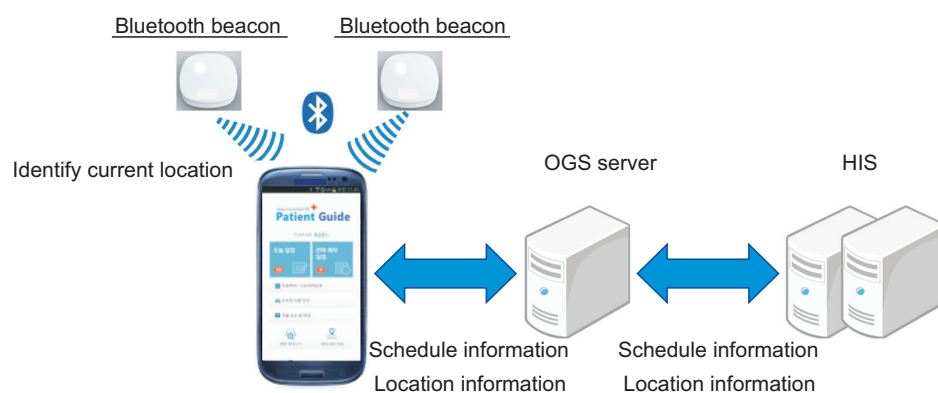


Figure 1. Communication between mobile device, outpatient guidance system (OGS) server, and health information system (HIS).

2. Synchronization of the OGS Application and HIS

The smartphone connects to the server for the OGS to download the patient's schedule information and finds its location inside or outside the hospital. The server is located securely in the hospital, and the connection between the smartphone and the OGS server is made through the secure socket layer (SSL) to protect privacy. For those who do not have smartphones, kiosks are available to provide the above information on site. The OGS server retrieves the patient's personal information from the HIS, where it is relayed by an HIS-interface server to prevent possible security risks upon direct communication between the HIS and the OGS server (Figure 1).

3. Location Guide

To provide a location-guide service, 3D modeling of the hospital was done, which was then converted to a simplified 3D map. The 'outpatient traffic' was assessed to acquire the path topology on the 3D map, where commonly accessed locations were registered as points of interest (POIs). The 3D map could be browsed by a viewer in both mobile and kiosk versions, and updated in sync with the 3D map information

in the server. Bluetooth beacons were installed in the hospital for the real-time path guide of the mobile version. The beacons were installed 10 meters apart; signal was received by smartphones to locate the patient's current position by a fingerprint algorithm to find the optimal path towards the destination.

4. Statistics

The usage statistics were acquired from the number of downloads and the number of active users during a year after the launch of the OGS service. The 'number of active users' was defined as the number of those who logged in at least once to the OGS mobile application. SPSS ver. 20.0 (IBM, Armonk, NY, USA) was used for statistical analysis.

III. Results

1. Functions of the OGS Mobile Application

The connection between smartphones and the OGS server is made through SSL to secure privacy, and interface between the OGS server and the HIS server was established to protect sensitive information of registered users. The mobile appli-

cation provides features to allow detailed information of appointment schedules, directions to and within the hospital, bill preview, and customer feedback (Figure 2). Receiving a Bluetooth beacon signal upon arrival at the hospital, a welcome message pops up, and guidance begins. For those who do not have smartphones, dedicated kiosks provide schedule information and directions, all of which are available to print out.

2. Schedule Information on Medical Service

An intuitive user interface was developed to enable patients use the application with ease. Schedules for the day of visit

and subsequent visits are highlighted to be easily recognized and displayed. On starting the OGS application, patients are introduced to a menu to select from either the present day or the entire schedule (Figure 3A). Figure 3B and 3C show to-do lists for the present day, and the entire schedule, respectively, as defined in Tables 1 and 2. Schedules for the remaining appointments are grouped separately (Figure 3B and 3C). This list is regularly updated to include tests or evaluations ordered by doctors saved in the HIS server.

3. Location Guide

The 3D map can be presented at various angles with pan-

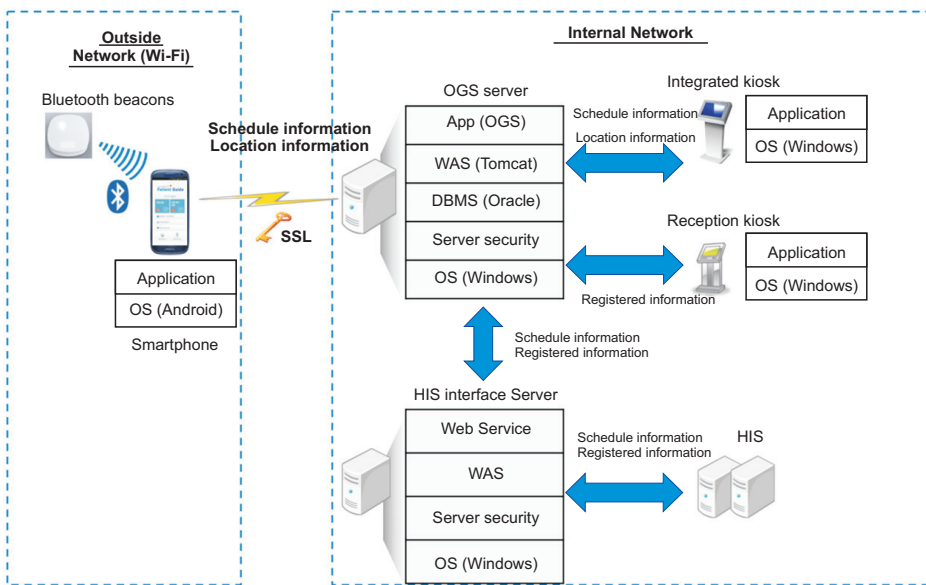


Figure 2. System configuration. OGS: outpatient guidance system, SSL: secure socket layer, WAS: Web application server, DBMS: database management system, HIS: health information system.



Figure 3. In-hospital direction guide (mobile). (A) startup page, (B) today's schedule, (C) full list of schedules, (D) 3D map, and (E) direction guide. OGS: outpatient guidance system.

ning and zooming (Figure 3D and 3F). POIs are differently colored by categories of medical, administrative and convenience facilities; the application was designed for patients to easily search POIs. When a POI is selected, the optimal path from the current location is displayed taking buildings and floors into account. First, an overview is displayed showing the path to the destination. Then, it changes to a 3D map view that highlights the path after the start icon is pressed. When the patient moves, the smartphone communicates with the Bluetooth beacons, updates the current location, and re-searches a path if needed.

4. Patient Usage of the OGS

To estimate usage of the OGS by outpatients, user statistics of the mobile application and kiosk were analyzed between October 2014 and September 2015. The number of downloads of the OGS mobile application was 14,447 from June 1, 2014, the date of release, until October 3, 2015; roughly a monthly average of 900 downloads. The number of active users was 7,311 by October 2015 (Figure 4). The number of monthly log-ins to the OGS mobile service increased by 105% from 4,011 in October 2014 to 8,242 in September 2015. More than 90% of the usage was to access appointment schedules (Figure 5). In terms of total usage by age, the highest was for patients in their 50s; the percentages per total patients were 11%, 15%, 14%, 9.7%, and 7.0% for patients in their 20s, 30s, 40s, 50s and 60s, respectively (Figure 6). With the opening of the OGS kiosk, the workload and staff numbers in the information desk and kiosk reduced substantially; 50% less (8 to 4) kiosk staff members than a month before the OGS was launched.

IV. Discussion

Our OGS was developed to provide appointment information, direction guidance to and within the hospital, detailed schedule of the day of visit, and medical bill preview, and to

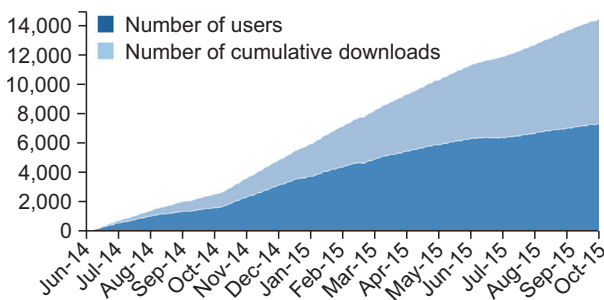


Figure 4. Increasing number of patients using the mobile outpatient guidance system.

obtain user feedback. The number of users has increased significantly since its introduction at our institution. The OGS provides easier access to a patient's list of daily or future appointments, resulting in better user experience of medical service. Furthermore, this enabled our medical personnel and staff members to focus on delivering a higher quality of service in our community hospital.

Nowadays medical service is not only judged by medical skills but a range of other factors, including medical expertise, accessibility, and patient service in and out of the hospital [2]. In other words, excellence in cordiality, convenience, and efficiency are recognized as key factors of medical service we now seek. We believe that our OGS meet these requirements for patient care.

Smartphones have been used in diverse applications in medical service. First, they relay medical information for health professionals. Recent studies have reported that 30%–

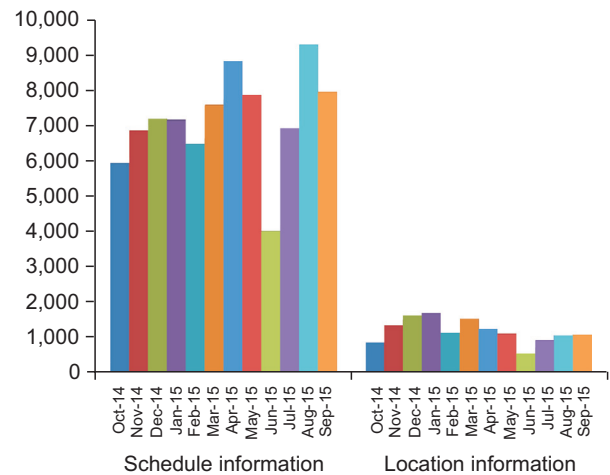


Figure 5. Number of outpatient guidance system kiosk users according to tasks.

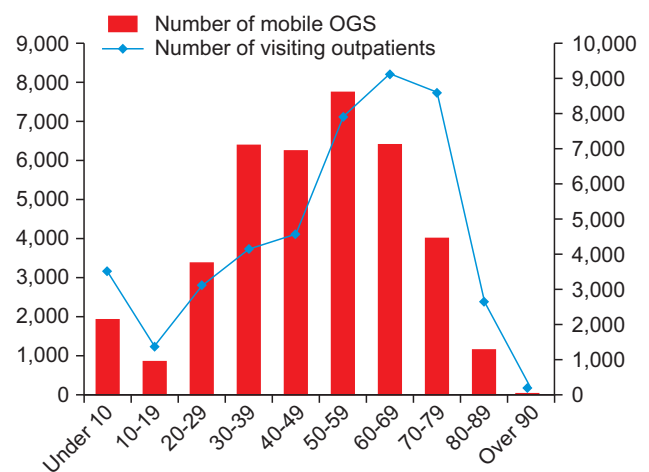


Figure 6. Number of mobile outpatient guidance system (OGS) users according to age groups.

50% of health professionals use medical apps in clinical care [3,4]. From the patients' perspective, smartphones can help increase compliance to medication [5], deliver medical advice from healthcare providers [6-8], support efforts to quit smoking [9], and reinforce diet and exercise [6,7,10]. A mobile application for inpatients has also been applied in hospitals [11]. A bedside station apparatus developed by our co-authors provides bedside check-in and -out, bedside room service, bedside scheduling, schedule of medical rounds, medical chart, healthcare contents, which all improve the quality of patient care and patient satisfaction while enhancing communication between patients and medical providers [11].

Although access to information often results in privacy issues, our OGS successfully avoids this problem through the adoption of an SSL and the installation of the web-service-based HIS interface server. The OGS ultimately enhances efficiency in managing human resources as well. More studies are needed to bypass concerns regarding the usefulness of medical applications for patients; i.e., its validation, quality assurance, and cost-effectiveness [12]. As for future works, the addition of payment and registration/scheduling features to the OGS mobile application will benefit patients and reduce administrative workloads. Furthermore, the addition of personal health records obtained by the application, followed by two-way system syncing with our HIS is a goal not only for this project, but it may soon be an essential platform for every HIS.

In summary, the successful development and utilization of our OGS has improved the quality of medical service in our hospital by providing accessible, customized information for patients.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

Acknowledgments

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