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# An Analysis of the Efficacy of the Health Butler Application and Intelligent Accompaniment Systems in Smart Outpatient Services Based on Patient Feedback

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**Objective:** This study aims to explore the efficacy of a smart outpatient service system incorporating the Health Butler application and Intelligent Accompaniment based on patients' feedback.

**Methods:** A total of 1000 outpatients from Shenzhen Third People's Hospital were randomly selected in May 2023 and November 2023 to provide feedback before and after implementing the smart outpatient service system consisting of the Health Butler app and Intelligent Accompaniment. The changes in the patient's awareness of the medical treatment process, average waiting time, satisfaction with the experience of seeking medical treatment, and trust in medical services offered based on patient feedback were compared pre- and post-implementation.

**Results:** There were significant differences in outpatients' awareness of the process of medical treatment, average waiting time, satisfaction with the experience of seeking medical care, and trust in medical services before and after the implementation of the smart outpatient service system ($P < 0.05$).

**Conclusion:** The smart outpatient service system, which incorporated the Health Butler app and Intelligent accompaniment based on patient feedback, was effective in improving awareness of the process of medical treatment among outpatients, shortening their average waiting time, improving patient satisfaction with the experience of seeking medical care, and also enhancing their trust in medical services.

**Keywords:** Health butler, intelligent accompaniment, patient feedback, satisfaction with medical service experience, smart outpatient system, trust in medical services

## Introduction

In 2019, the National Health Commission issued the "Notice on Issuing the Key Work Program for the In-depth Implementation of the Action Plan for Further Improving Medical Services", which emphasized the need to enhance the public's sense of access to medical care and to conduct real-time monitoring of patients' experiences with medical care and the work feelings of medical and nursing staff.[1] The "Program for Improving the Feeling of Access to Medical Care and Enhancing the Patient's Experience Theme Activity", released in May 2023 for the period 2023–2025, clearly pointed out that with the goal of effectively improving the public's experience with medical treatment, it is necessary to comprehensively sort out the medical service process, fully utilize new means, new technologies, and new models, and to clear the blockage points in people's access to medical treatment and the difficulties at the blockage points.[2] It is evident that the state places great importance on improving medical experiences and services. With the development of global technology and public health awareness, the demand for healthcare is increasing, and intelligent service systems have

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been introduced into healthcare,[3] which is based on automating a variety of processes to correctly support current medical decision-making. The key to achieving this goal is through the development of a wide range of reliable and intelligent healthcare and healthcare delivery systems for various purposes.[4] Currently, patient voice listening activities in Europe and the United States are more mature. To comprehensively listen to patients' voices and obtain patient information, the US Food and Drug Administration (FDA) and the European Medicines Agency (EMA) have jointly established a platform for sharing patients' voices.[5,6] To fully understand the expectations and needs of patients, this study introduces a patient voice listening mechanism, listens to patients' voices comprehensively, uses different communication methods for different patient populations with different characteristics, pays in-depth attention to the concerns that different categories of patients may have during the diagnosis and treatment process, and provides timely feedback. At the same time, with the application of QC circles in Chinese healthcare organizations, certain achievements have been made in the field of medical and healthcare.[7]

To improve the quality of this study, we applied the management concepts and tools of QC circles, carried out the PDCA cycle throughout the process, and took the voice of the patient as the entry point. We also introduced the "Health Butler" and the "Intelligent Accompanying Procedure" based on the application of the Internet and information technology. With the "Intelligent Accompanying Program", we fully optimized the outpatient environment process, booking diagnosis and treatment, convenient services, quality care, and humanistic care, aiming to build a smart outpatient service system. The initiatives to improve the satisfaction of outpatients' medical experience in 2022 include: the construction of outpatient performance appraisal system, the formulation of the "Assessment Measures for Outpatient Clinics of Various Departments" in combination with the characteristics of outpatient clinics of the hospital, and the conduct of quantitative evaluations, including punctual attendance of outpatient physicians, scheduling, booking of appointment numbers, management of stop and change consultations, pre-hospital appointment rate, and outpatient workload. Quantitative evaluation: including on-time attendance, scheduling, appointment source management, stopping and changing appointments, pre-hospital appointment rate, and outpatient workload. Qualitative evaluation includes: quality of outpatient medical records, order of treatment (one doctor, one patient, protection of patient's privacy), volunteerism, image of service, and humanistic care. Good economic and social benefits were achieved, and satisfaction gradually increased from 88.4% in 2021 to 91.8% in 2022. The main initiatives in 2021 are: to increase the pre-hospital booking rate of outpatients, booking appointments through various ways: online booking such as 160 booking platform and public number, on-site booking, kiosk booking, clinic booking, and telephone booking, and through constant PDCA, the pre-hospital booking rate of outpatients will be increased from 81.9% in 2020 to 91% in 2021, 92% in 2022, and in 2023, the rate will be increased to 94%, and currently maintained at 97% in 2024; the effect is significant, patients can predict the time of patient consultation, do not have to come to the hospital too early to wait, reduce the waiting time of patients, and improve the patient experience. This approach has then enhanced patient satisfaction with the medical treatment experience and achieved good results. The details are reported in the following sections.

## Study Participants

A total of 1000 outpatients from the Shenzhen Third People's Hospital, a modern large-scale general hospital and the Shenzhen National Clinical Research Center for Infectious Diseases, were randomly selected in May 2023 and November 2023, as shown in Table 1. This hospital was specifically chosen due to its extensive outpatient volume, diverse patient population, and robust infrastructure, which facilitated efficient data collection and ensured sample representativeness. The inclusion criteria were as follows: (1) patients registered for outpatient services only; (2) aged ≥ 18 years; (3) able to communicate effectively with investigators; and (4) those voluntarily participating in the study. The exclusion criteria were: (1) patients with a history of mental illnesses such as anxiety and depression; and (2) patients who were unable to complete the entire intervention process.

The questionnaire used in this study included 34 entries. Conventionally, the sample size for such surveys should be at least three times the number of entries (ie, at least 102 respondents). However, after considering factors such as the high volume of outpatients, the distribution of staff across various clinic areas, the complexity of administering and processing the questionnaires, and the need to cover key waiting areas on all floors (including internal medicine, surgery,

**Table 1** Comparison of Basic Information of Patients in the Two Groups (n=1000)

| | | Observation Group (n) | Control Group (n) | $\chi^2$ | P |
|---|---|---|---|---|---|
| Gender | Male | 538 | 529 | 0.163 | 0.720 |
| | Female | 462 | 471 | | |
| Age | 30–45 | 525 | 542 | 0.950 | 0.917 |
| | Under 30 | 224 | 213 | | |
| | 46–55 | 192 | 184 | | |
| | 56–65 | 40 | 39 | | |
| | Over 65 | 19 | 22 | | |
| Address | Outside the province | 11 | 16 | 2.522 | 0.471 |
| | Other districts in the city | 280 | 256 | | |
| | Outside the city | 124 | 135 | | |
| | Around the hospital | 585 | 593 | | |
| Medical insurance? | No | 343 | 366 | 1.156 | 0.304 |
| | Yes | 657 | 634 | | |
| First visit? | No | 684 | 698 | 0.459 | 0.529 |
| | Yes | 316 | 302 | | |

obstetrics and gynecology, otorhinolaryngology, and hepatology), the sample size was expanded to 1000. This expansion was based on team discussions to optimize the reliability and comprehensiveness of the data. Ethical approval for the study was obtained from the Ethics Committee of The Third People's Hospital of Shenzhen on May 8, 2022, all participants have provided informed consent.

# Methods

## Intervention in the Control Group

In May 2023, 1000 outpatients who fulfilled enrollment criteria were randomly selected to be in the control group, and they received the following inputs as per the conventional traditional outpatient service model: (1) Appointment scheduling could be done in various ways, including online appointments through the 160 appointment platform and the official account, on-site appointments, self-service appointments, intermittent appointments, and fixing appointments via the telephone; (2) On the day of visit, they could retrieve their appointment tokens either using a self-service machine or at a manual charge window; (3) Patients waited in the waiting area until they were called for the consultation; (4) A doctor provided the medical treatment and issued forms for the required tests and examinations; (5) Options for payment of fees were online payment, self-service payment, and payment at a service window; (6) For undergoing the tests, patients had to wait in a queue as per their token number and underwent the test/examination in the medical laboratory; (7) For re-visits, patients collected their re-visit number at the triage table and waited for their turn; (8) patients received their medicine, treatment, or hospitalization as necessary; (9) Patients were discharged from the hospital; (10) Regular follow-up was conducted through telephone or information services.

An Outpatient Experience Satisfaction Scale was developed according to the outpatient medical treatment flow chart (Figure 1). In May 2023, a total of 1000 questionnaires were distributed to outpatients and collected, and the data were subsequently compiled and analyzed. This scale was designed based on the Outpatient Experience Questionnaire (OPEQ)[8] for general public hospitals in China. The OPEQ was first proposed by Norwegian scholar Dr. Garratt et al.[9] This is the only tool available for measuring outpatient experience in China.

A total of 7 outpatient triage nurses from various specialties who had been trained by the project team instructed patients to fill out the paper version of the questionnaire on site. There were 4 floors outpatient building: 1 person in the outpatient convenience center on the 1st floor, 1 person at the triage desk for liver disease outpatient specialties on the 2nd floor, 1 person at the Internal Medicine Specialty Triage Desk and 2 persons at the Department of Ophthalmology and Otorhinolaryngology

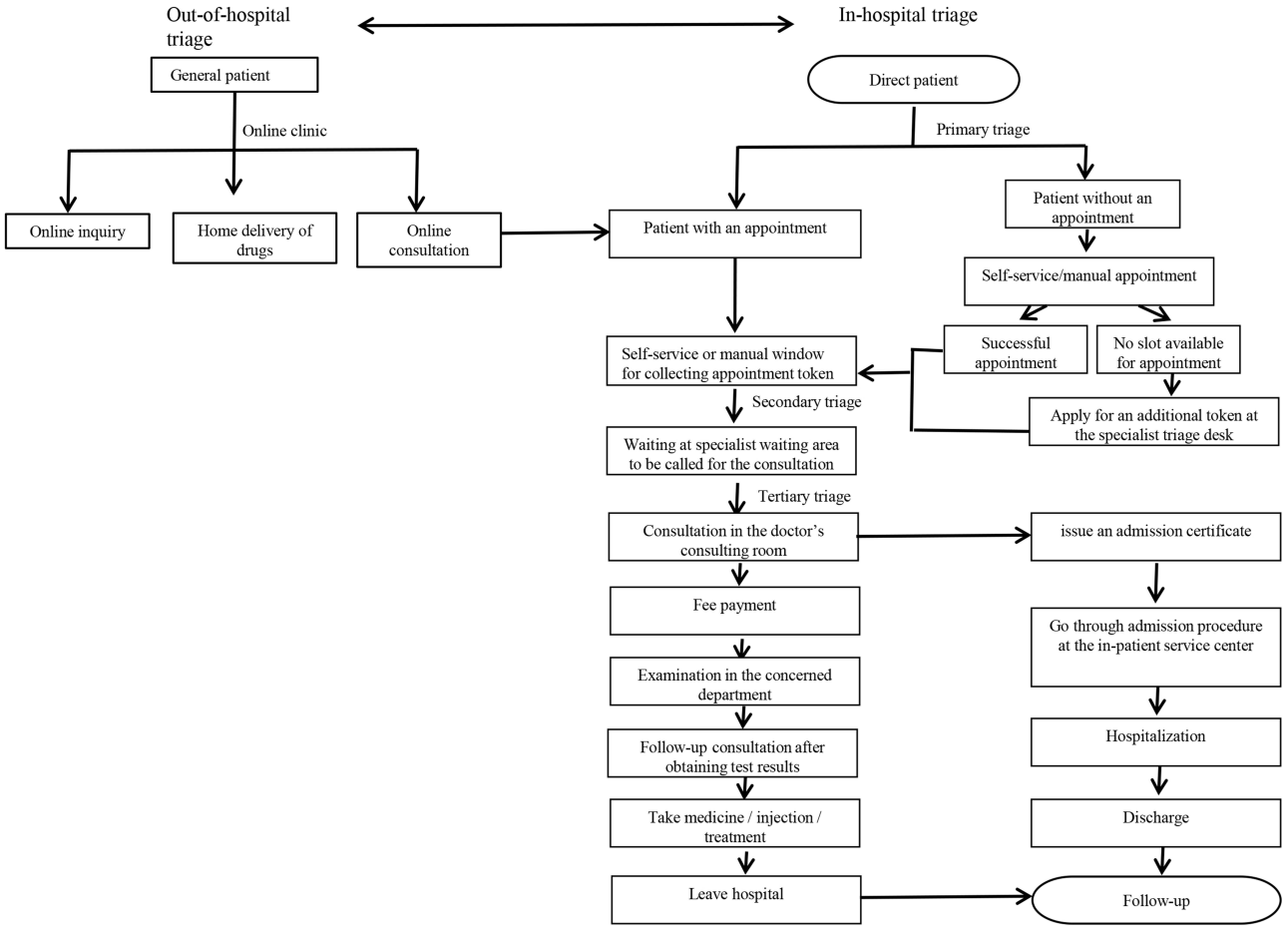


**Figure 1** Outpatient service flow chart.

Triage Desk on the 3rd floor, 1 person at the triage desk for surgical specialties and 1 person at the triage desk for obstetrics and gynecology specialties on the 4th floor. Patients who meet the exclusion criteria were consent informed first. The paper version of the questionnaire was filled out by the patients, and the patients were instructed to fill out the questionnaire to ensure the quality of the questionnaire data. Members of the project team, Bing Xiao and Min Zou were responsible for data entry and analysis. 1 person entered the data, 1 person proofreading, and entered the data for a unified number. Two data entry staff members from the project team were responsible for completing the data entry: one person entered the data, and another person proofread it. Data entry was standardized with a unified numbering system to protect patient privacy, and any questionnaires that did not meet the requirements were excluded in a timely manner.

Five dimensions of the OPEQ scale were adopted in this study, namely, physical environment and convenience, doctor-patient communication, medical information, medical expenses, and short-term diagnosis and treatment results, as well as an overall evaluation. A total of 34 specific items that were tailored to the hospital situation and refined through expert discussions and modifications were included. A 5-point Likert scale was used for examining the key to problems.[10,11] The five response categories were as follows: 5 indicated "very satisfied", 4 denoted "satisfied", 3 denoted "average", 2 indicated "dissatisfied", and 1 was "very dissatisfied".

## Intervention in the Observation Group

In November 2023, 1000 outpatients who fulfilled the enrollment criteria were randomly selected as part of the observation group. They received the smart outpatient service model that incorporated the Health Butler app and intelligent accompaniment systems based on the feedback of patients. Details are described below:

## Establishment of an Activity Group

The activity group was established through the collaboration of multiple departments, including the outpatient office, office of the Party Committee, evaluation office, outpatient convenience service center, chronic disease follow-up department, information department, clinical medical technology department, and outpatient departments. First, homogenization training for group personnel was completed. This included the use of management tools, data collection, and statistical analysis methods, and the formulation and implementation of countermeasures to ensure accurate data collection. Subsequently, a Gantt chart was developed based on the specialty and job position of employees to guide smooth project development. The Gantt chart, also known as a bar chart, is a visual tool to manage the project schedule with bar charts, named after its creator, Henry Gantt.[12] It allows for a visual comparison of time, aiding in managing the progress of the project and timely identification and correction of gaps in the planned schedule and the actual progress (Figure 2). Additionally, Plan-Do-Check-Act (PDCA) and Quality Control Circle (QCC) management tools were used to enhance project outcomes: 1. Led by the outpatient office, the project involves multi-departmental collaboration including the hospital's party committee office, evaluation office, outpatient convenience service center, chronic disease follow-up department, information technology department, clinical medical technology departments, and various positions in the outpatient department, in total of 17 people. Such multi-departmental collaboration can enhance the ability to solve problems and the capabilities of the circle. 2. This QCC was completed strictly following the steps of QCC, with the PDCA cycle running throughout, and each step is interlinked with the previous one. 3. Management tools of the quality control circle were utilized, such as Gantt charts (for activity planning and scheduling), to guide the steady progress of the project; during the current situation grasping phase, which is the distribution and collection of satisfaction questionnaires, the "three realities" principle was applied. In the analysis phase, which is the part of identifying the causes, the Pareto chart was used; from the implementation of countermeasures to the review and improvement phase, it is a continuous PDCA process, where effective countermeasures are continued, and ineffective ones are revisited with PDCA, leading to a continuous upward spiral and continuous quality improvement.

## Extensive Feedback Collection from Patients

A variety of deep listening methods, such as on-site interviews, questionnaires, regular follow-ups, volunteer forums, medical service experience officers, appeal acceptances, and hospital staff feedback, among other channels, were used to collect feedback from patients. The focus was highlighting the importance of patients' experiences of seeking medical care throughout the entire process, identifying potential underlying issues, and identifying critical areas for improvement.

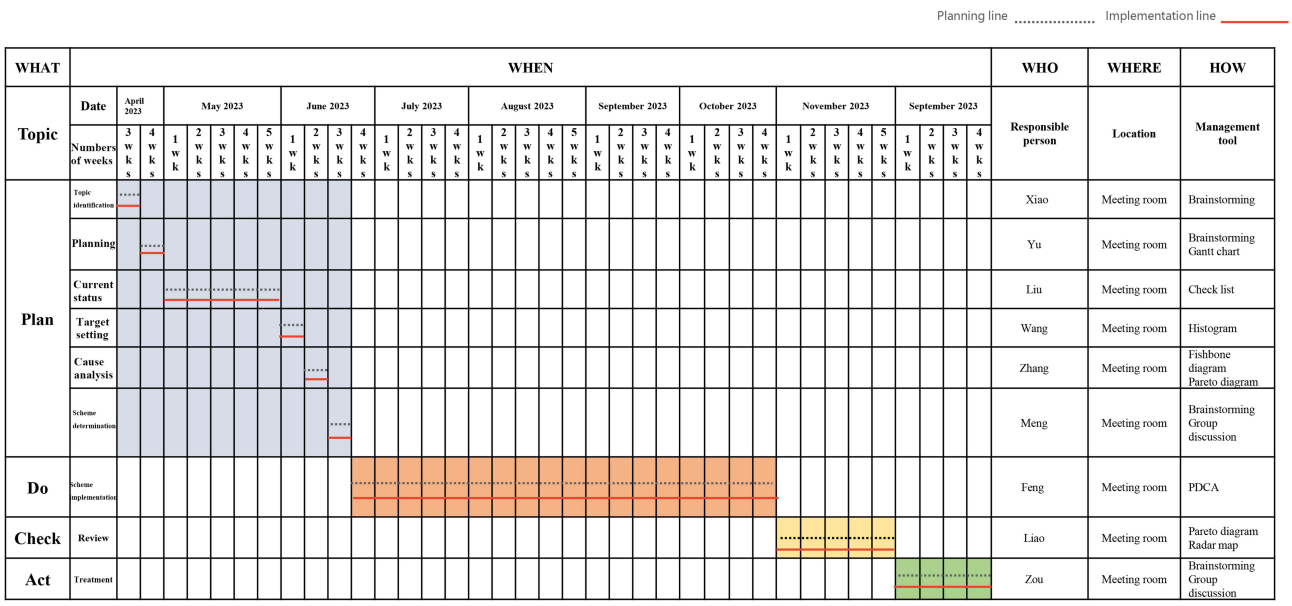


**Figure 2** Gantt chart for project schedule management.

Feedback was collected by Outpatient Department Office through Outpatient Service Center, Medical-Patient Relations Office, Staff Feedback within the Hospital, Inpatient Service Center, Regular Follow-up, Questionnaire Survey, U-Station Volunteer Symposium, and On-site Interview.

## Brainstorming Exercise for Creating a Fishbone Diagram

The fishbone diagram, also called the Ishikawa diagram, was invented by the Japanese management expert Kaoru Ishikawa. This diagram is a method used to identify the root causes of problems, characterized by its simplicity, practicality, in-depth, and intuitive nature[13] with applicability across various industries.[14]

In this study, a group session was organized to brainstorm and discuss the causes that affected outpatient experience satisfaction from four perspectives: personnel, equipment, process, and environment. A fishbone diagram was created to visually represent these factors. All 17 members of the circle contributed their ideas and participated in a brainstorming meeting, which was synchronized online and offline, including one moderator and one recorder. Due to the large number of group members, the moderator generally divides the members into groups for discussion. Representatives then summarize and present the opinions. Of course, the meeting actually reflects a sense of freedom, and members can also speak by raising their hands. The meeting encourages free and open expression, and the moderator will not arbitrarily criticize the opinions expressed by members. The analysis revealed that the existing information system not being intelligent enough, lack of awareness about active services, poor communication, insufficient training, flawed outpatient service procedures, insufficient publicity, inadequate convenience services, long waiting times, and a lack of familiarity with medical care procedures were the main issues affecting the outpatient experience. The fishbone diagram is shown in Figure 3.

## Pareto Analysis

The Pareto analysis method, introduced by the renowned economist Vilfredo Pareto, is used to identify potential risks within complicated problems and rank them. These are then presented intuitively in the form of charts so that managers

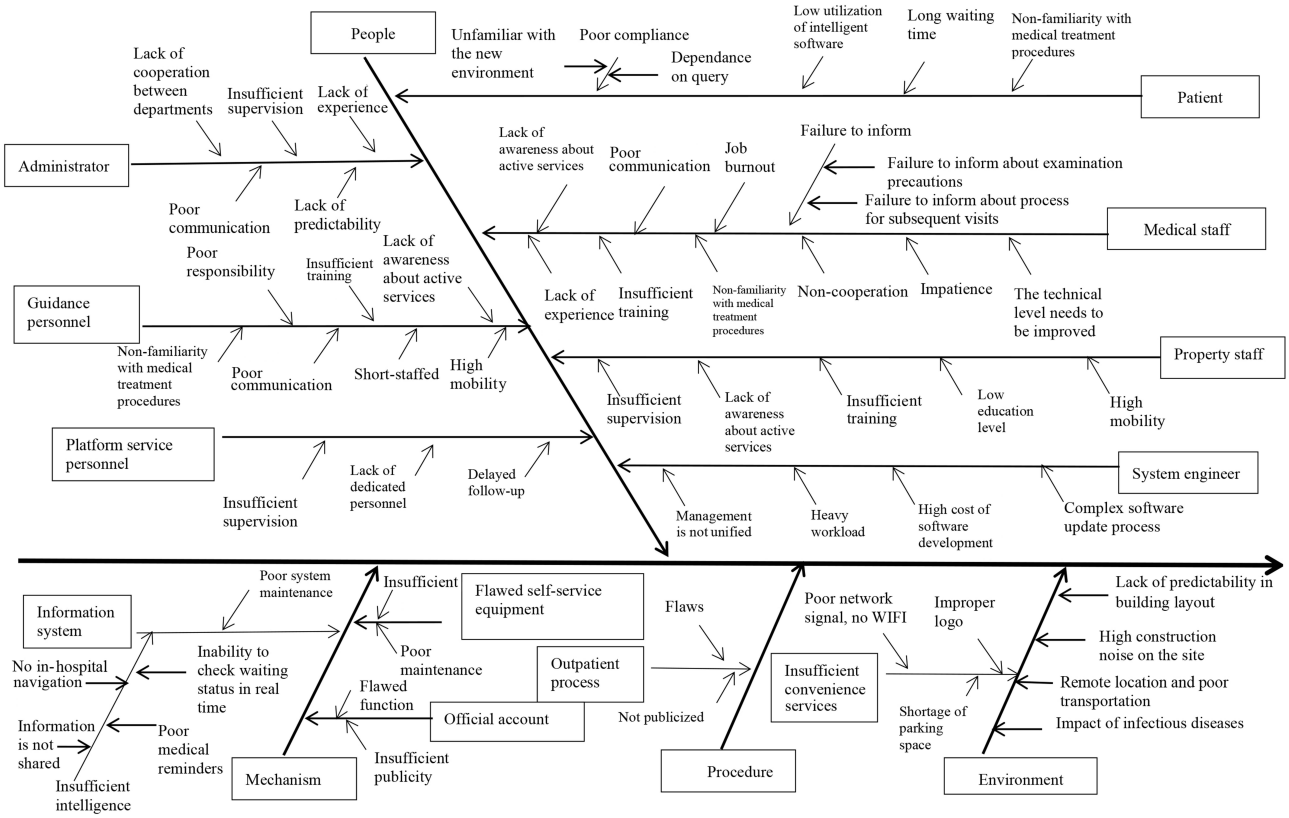


**Figure 3** Fishbone diagram of factors contributing to low satisfaction in first-visit patients' medical treatment experience.

can directly ascertain the key influencing factors. This decision-making tool is premised on the idea that 80% of the problems can be traced to 20% of causes, and consequently, maximal improvement outcomes can be obtained with minimal effort if 20% of the relevant causes are addressed. The advantage of the Pareto analysis method is being able to isolate key factors from a multitude of variables, allowing managers to move beyond experience-based management methods effectively. Additionally, this can also be used to dynamically monitor the effectiveness of measures to provide a basis for their adjustment.[15,16]

A Pareto diagram was drawn after summarizing the findings from the fishbone diagram analysis and the data from the Outpatient Experience Satisfaction Scale collected in May 2023. According to the Pareto 80–20 principle, 77.1% of the project's components were identified as the focus of improvement. The following primary causes were identified: (1) the information system was not intelligent enough; (2) long waiting time; (3) non-familiarity with medical treatment procedures; and (4) inadequate convenience services, as shown in Figure 4.

## Formulation of Countermeasures to Address the Above Causes and Creation of a Smart Outpatient Service System Involving the Health Butler App and Intelligent Accompaniment

In August 2023, the "Health Butler" application service was launched, branded as "Enterprise WeChat Official Manual Customer Service." The Health Butler app can interact with patients, including the elderly, through one-to-one WeChat service to address the various needs of patients via text, video, voice, picture, and other formats. This service functions as an assistant to the physician and can attend to several needs of patients before and after hospitalization. These include registration of pre-admission appointments, medical guidance, information about transport routes, medical insurance reimbursement, as well as scheduling follow-up visits, wound care advice, and rehabilitation guidance post-discharge. Additionally, the Health Butler

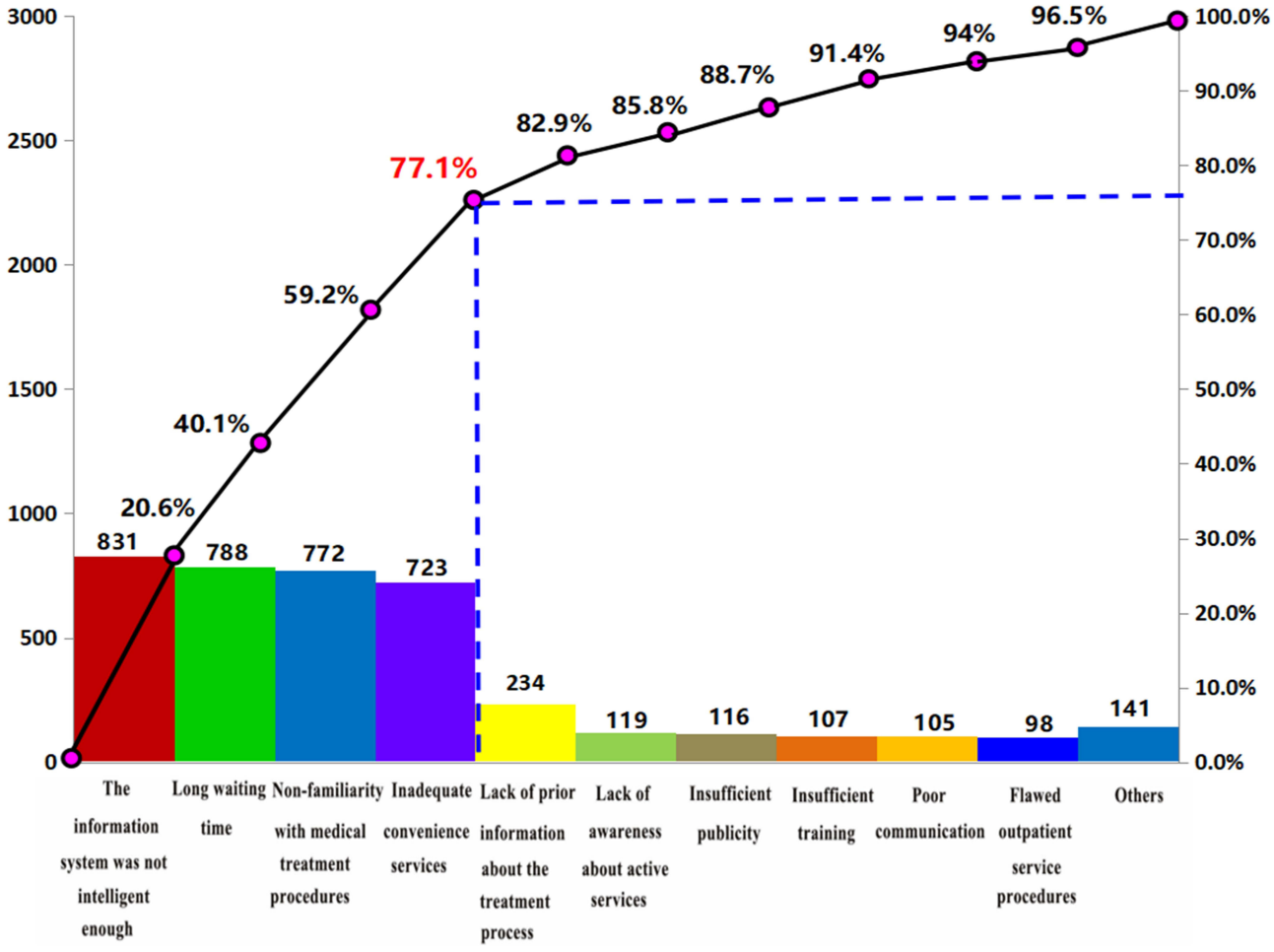


**Figure 4** Pareto diagram before implementation of the smart system.

app assists doctors in guiding patients, analyzing their behavioral characteristics, tracking their illness progress, follow-up care, patient comfort, disseminating scientific information, and data analysis, among other uses.

The visualization of medical services was achieved by leveraging artificial intelligence (AI) accompaniment. The continuous developments and evolution of technology have made it increasingly robust in image recognition, data analysis, and decision-making assistance. Utilizing technology has simplified the outpatient process and shortened the waiting time of patients.[17]

Intelligent accompaniment was introduced in this study, allowing patients to access the AI-intelligent accompanying app via the "Smart Hospital" feature in the WeChat official account. The app offers a range of services, including intelligent consultation, intelligent guidance, navigation to and within the hospital, navigation to the consulting room, an online view of the number of patients waiting, navigation to reach the pharmacy, voice broadcasts, accessing medical reports online, scheduling of subsequent visits, and so on, as shown in Figure 5.

A guiding rule table was created to streamline routine medical processes and services such as registration, waiting for medical treatment, consultation, payment, examination, report of test results, prescription, and obtaining medicines. The rule table also mapped common orders from the physician for laboratory tests, B-ultrasound, CT scans, and medication dispensing with the corresponding receiving department. By analyzing the patient's current medical treatment process, the number of waiting patients, and the doctor's advice in the hospital information system (HIS), the app dynamically and automatically arranges the best treatment process and route for the patients. This approach solves the common difficulties faced by patients and reduces congestion within the outpatient building.

## Establishment of a Mechanism to Guarantee and Ensure Continuity of Care When Patients Return with Test and Examination Results

The protocol for the first visit to a physician includes the consultation with the doctor, the patient undergoing the prescribed physical tests and examinations, and the patient reporting to the same department upon receipt of the test and examination results. If the patient makes a follow-up visit to the same physician within 14 days of the report issue (including the date of report), the patient is exempted from the consultation fee for this visit.

In addition, the functioning of self-service machines was enhanced throughout the entire hospital. This increased availability of machines improved the utilization rate and optimized the functions to streamline routine processes. The inclusion of a feature for automated number collection that replaced the earlier manual process of collecting the token number from the triage table not only saved manpower but also alleviated the congestion of patients at the triage table.

With a better understanding of the expectations and needs of patients, the design of how medical services were being offered was significantly altered to translate these expectations and needs into reality. The medical process was optimized

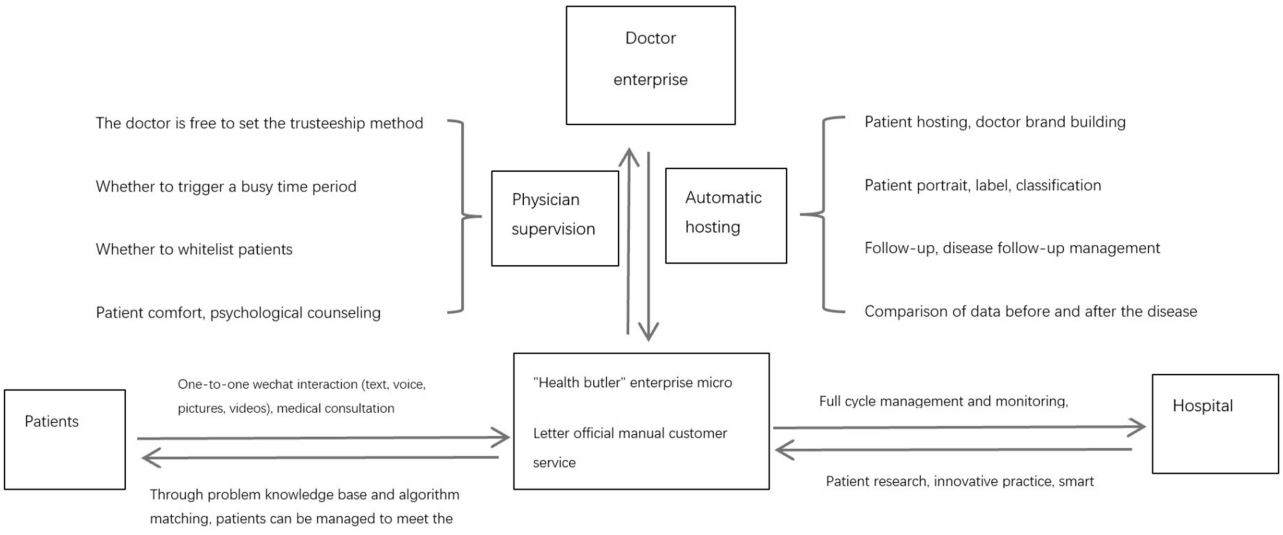


**Figure 5** APP functioning flow chart of "Health Butler" online to meet the needs of patients before and after the hospital schematic.

in various ways to create a clean and comfortable healthcare environment. It has been proven that enhancing the care environment and facilities can further improve the outpatient experience.[18]

Instances of some changes that were implemented to optimize the medical environment included increasing parking spaces, improving the process of accessing WiFi within the facility, providing more shared wheelchairs for patient use, introducing self-service machines for retrieving bags, and having in-hospital navigators for assisting patients in finding their way within the hospital. To complement these facility improvements, personnel were trained in improving humanistic services. These included regular training sessions and drills in professional etiquette and business skills, strict monitoring of rates of punctuality and regularity of attendance as well as grooming, and creating dedicated positions focused on assisting elderly patients. These measures helped to shape the facility's image externally while simultaneously strengthening the internal quality internally by offering thoughtful, patient-centric services that were informed by patients' perspectives. The overall purpose was to ensure that patients are well-informed and understand their medical processes to reduce confusion or unnecessary revisits to the hospital, making their experience of seeking medical care more comfortable, and creating a positive image of the outpatient service window.

## Observation Indicators

The indicators that were tracked in the study included patients' awareness of the process of the medical treatment, average waiting time, satisfaction with their experience of seeking medical care, and trust in the medical service. Once a week, the person in charge of each implemented measure follows up to check whether the measure is effective.

## Statistical Method

The data were entered independently by two individuals. SPSS 25.0 software was used for data processing. Measurement data were expressed using the mean ± standard deviation **eqn**. The data were tested for normality and homogeneity of variance, and the *t*-test was used for comparing the data in a normal distribution, while the $\chi^2$ test was used for comparison between groups. A $P$ value of $< 0.05$ indicated a statistically significant difference.

# Results

## Outpatient Evaluation of Service Links

From Table 2, it can be observed that there is no significant difference ($P>0.05$) between the pre-improvement and post-improvement stages of the outpatient environment in the dimension of physical environmental convenience; all other conditions show significant differences. In terms of medical-patient communication, no significant difference ($P>0.05$) exists between the two groups in terms of explanation and listening; all other options exhibit significant differences ($P<0.05$) between the two groups. Regarding medical information, there is no significant difference ($P>0.05$) in medication guidance between the two groups; all other options show significant differences ($P<0.05$). There is no significant difference ($P>0.05$) in medical costs between the two groups. The lack of significant differences in the aforementioned items is related to the sustained effects of the previous QCC cycle improvement projects. The outpatient department has consistently utilized QCC as a quality management tool, integrating the PDCA philosophy to continuously enhance patient satisfaction with the medical experience. In 2022, measures such as improving the environment, increasing the punctuality of doctors, enhancing service image and communication skills, humanistic care, medical order, one doctor per patient, protecting patient privacy, and price transparency were related to these improvements. There is a significant difference in short-term therapeutic effects between the two groups; in the overall evaluation, all options show significant differences ($P<0.05$).

3.2 Among all evaluation indicators, the control group had relatively lower satisfaction with the medical experience in terms of transportation convenience (3.33 points), waiting time (3.97 points), self-service equipment (3.81 points), medical-patient interaction time (4.06 points), outpatient signage (4.27 points), logistics services (4.36 points), convenience measures (4.40 points), and follow-up appointment notifications (4.42 points). After improvements, the

**Table 2** Comparison of Responses Pertaining to the Medical Service Experience of Patients in the Two Groups (n = 1000)

| Item | | Grouping (Mean ± Standard Deviation) | | t | p |
|---|---|---|---|---|---|
| | | Control Group (n = 1000) | Observation Group (n = 1000) | | |
| Physical environment and convenience | Transportation convenience | 3.33±1.13 | 4.40±0.78 | −24.58 | 0.000** |
| | Waiting time | 3.97±1.15 | 4.52±0.70 | −13.093 | 0.000** |
| | Appointment for registration | 4.76±0.45 | 4.81±0.46 | −2.662 | 0.008** |
| | Fee payment | 4.74±0.48 | 4.88±0.33 | −7.688 | 0.000** |
| | Clinic logo | 4.27±0.66 | 4.74±0.53 | −17.699 | 0.000** |
| | Outpatient layout | 4.42±0.68 | 4.58±0.61 | −5.51 | 0.000** |
| | Medical process guide | 4.46±0.65 | 4.81±0.41 | −14.489 | 0.000** |
| | Outpatient setting | 4.63±0.63 | 4.67±0.54 | −1.534 | 0.125 |
| | Order of medical treatment | 4.52±0.63 | 4.82±0.46 | −11.942 | 0.000** |
| | Convenience facilities | 4.40±0.60 | 4.83±0.43 | −18.494 | 0.000** |
| | Self-service equipment | 3.81±0.96 | 4.77±0.54 | −27.75 | 0.000** |
| Doctor-patient communication | Explaining and listening | 4.75±0.50 | 4.78±0.58 | −1.405 | 0.16 |
| | Time spent in communicating with the patient | 4.06±0.64 | 4.68±0.63 | −21.828 | 0.000** |
| | Respect towards patients | 4.71±0.50 | 4.81±0.48 | −4.404 | 0.000** |
| | Focus on patient's emotions | 4.77±0.42 | 4.83±0.52 | −2.824 | 0.005** |
| | Participation in decision making | 4.63±0.60 | 4.70±0.67 | −2.422 | 0.016* |
| | Protection of privacy | 4.69±0.49 | 4.74±0.51 | −2.108 | 0.035* |
| | Medical and patient services | 4.58±0.58 | 4.75±0.53 | −6.864 | 0.000** |
| | Nursing services | 4.63±0.61 | 4.72±0.60 | −3.568 | 0.000** |
| | Guide services | 4.64±0.63 | 4.71±0.63 | −2.176 | 0.030* |
| | Logistics services | 4.36±0.81 | 4.62±0.72 | −7.507 | 0.000** |
| Medical information | Notification of examination and treatment | 4.65±0.54 | 4.81±0.46 | −7.092 | 0.000** |
| | Notification of test results | 4.68±0.54 | 4.83±0.43 | −6.6 | 0.000** |
| | Notification of the diagnosis | 4.69±0.54 | 4.81±0.50 | −5.102 | 0.000** |
| | Guidance with respect to medication | 4.68±0.56 | 4.72±0.54 | −1.787 | 0.074 |
| | Health education and information | 4.64±0.61 | 4.81±0.49 | −6.81 | 0.000** |
| | Information about follow-up visits | 4.42±0.79 | 4.79±0.47 | −12.615 | 0.000** |
| | Medical technology | 4.70±0.57 | 4.80±0.49 | −4.297 | 0.000** |
| Medical costs | Medical costs | 4.52±0.71 | 4.48±0.79 | 1.201 | 0.23 |
| Short-term efficacy | Short-term efficacy | 4.63±0.58 | 4.75±0.52 | −4.958 | 0.000** |
| Overall evaluation | Awareness of the process of medical treatment | 2.98±1.24 | 4.15±0.84 | −24.693 | 0.000** |
| | Trust in the medical services | 4.43±0.65 | 4.67±0.68 | −8.065 | 0.000** |
| | Willingness to return | 4.60±1.73 | 4.75±0.57 | −2.519 | 0.012* |
| | Willingness to recommend the service to others | 4.59±0.71 | 4.68±0.65 | −3.042 | 0.002** |
| | Overall satisfaction | 4.45±0.14 | 4.71±0.12 | −45.428 | 0.000** |

**Note**: * p<0.05 ** p<0.01.

observation group showed a noticeable increase in these indicators. Regarding transportation convenience, both the questionnaire collection process and various feedback channels reported that the shortage of parking spaces at our hospital significantly affected.

## Discussion

Drawing insights from healthcare management experiences across the world, it is crucial to prioritize the voice of patients for fostering improvements in medical care. The practice of incorporating measures for patient feedback about medical treatments as well as collating and interpreting information about the needs of patients can aid in the establishment of effective mechanisms and processes of care. In this study, we developed a system for collecting patient feedback in an in-depth manner from a diverse range of patients that can be applicable in healthcare setups in China.

The smart outpatient service system incorporating the Health Butler app and intelligent accompaniment based on patient feedback significantly enhanced the outpatient experience. The use of these technologies helped patients overcome the limitations of time and space for accessing medical care, transforming the traditional medical treatment process. With the continuous development of intelligent outpatient services in the Internet era, hospitals can better leverage technological support to understand the needs of patients before, during, and after diagnosis. This approach enables addressing the needs of patients dynamically while accurately guiding patients throughout the care process and improving the efficiency of medical treatment delivery so that the patients benefit from a new and comfortable experience, both visually and sensorily.

Since its launch in August 2023, there were approximately 80,000 questions that were compiled in the Q&A library of the Health Butler app by the end of November 2023. The contents in the library were mainly from the common questions summarized by the hospital's medical staff based on the clinical experience and the inquiries put forward by participating patients in the early stage of the study. The answers in the Q&A library of the manual customer service are limited, and there will be some questions that cannot be answered, necessitating the continuous expansion of the Q&A library based on real-world patient interactions. In cases where questions cannot be answered immediately, the manual customer service team will update the knowledge library and provide dynamic follow-ups to improve the patient's experience. In addition, the intelligent accompaniment can alter patients from passive recipients of care to active and engaged individuals by transitioning them from patients waiting to seek out services to proactively pushing for various services for patients based on their medical treatment process. This approach can increase transparency in the medical process while also helping patients visualize the process and guiding patients through a "point-and-find" experience step by step.

The implementation of a smart service system needs a robust and guaranteed information system. The establishment of an intelligent service system can improve patients' experiences of seeking medical care, but it needs the cooperation of multiple departments, including the lead department, information department, demand department, executive department, logistics support department, and so on. Each department must have clearly defined responsibilities, plans, schemes, measures, division of tasks and cooperation strategies, appropriate incentives, integration of interdisciplinary research, and active industry participation.[19]

Given the complexities of inter-departmental cooperation, this study integrated management tools such as the Gantt chart, fishbone diagrams, and Pareto charts with PDCA and QCC methodologies. By applying a structured PDCA cycle and adhering to QCC principles, each project phase was seamlessly linked, ensuring steady progress. Multi-departmental participation enhanced problem-solving capabilities and team cohesion. Brainstorming sessions further encouraged team members to express ideas, promoting proactive solutions and boosting confidence, enthusiasm, and harmony.[20] The results of this study demonstrate that a smart service system can be developed in an organized and scientific manner.

The promotion and integration of humanistic services are crucial in the process of building a smart service system. In medical practice, technology and the humanities together constitute the entirety of medicine, with the medical humanities playing a key role in enhancing doctor-patient communication, which forms the foundation of generating trust.[21] Several initiatives were undertaken in this study to create the atmosphere of a responsive medical treatment service and cater to the needs of patients of all ages. A Party member volunteer service post based on existing social volunteer services was created, and their hospital-wide participation in outpatient volunteer services was actively encouraged. Preferential treatment windows for special groups such as the elderly were set up in various specialist triage tables, charge offices, pharmacies, and clinical medical technology departments. The information system was optimized to ensure priority for these patients during treatment and for tests or examinations. In addition to improving the emotional experience of

patients, the existence of an optimized information support system also helps to establish a relationship of trust between doctors and patients.[22] This system ensures continuity of care while also providing patients with easy-to-understand and relevant health information and education, facilitating effective communication between medical personnel, patients, and their families, as well as offering convenient access to information required for the rehabilitation and other needs of patients. Such measures ensure that patients feel cared for and respected, further enhancing their satisfaction with their experience of seeking medical care.

## Conclusion

In conclusion, the smart outpatient service system incorporating the Health Butler app and intelligent accompaniment based on patient feedback was effective in significantly improving awareness about the outpatient visit process among patients, shortening their average waiting time, enhancing their satisfaction with the experience of seeking medical care, and increasing their trust in the medical service. Its positive impact underscores the substantial potential for adopting this system extensively.

## Data Sharing Statement

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

## Ethics Approval and Consent to Participate

This study was conducted with approval from the Ethics Committee of Shenzhen Third People's Hospital. This study was conducted in accordance with the declaration of Helsinki. Informed consent was obtained from all participants.

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## Disclosure

The authors declare that they have no conflict of interest.

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