Доклади на Българската академия на науките
Comptes rendus de l'Académie bulgare des Sciences

Tome 79, No 5, 2026

MEDICINE

Clinical medicine

PRODUCTIVITY INNOVATION IN THE CONTEXT OF DIGITAL TRANSFORMATION – A STUDY OF CHATGPT IN OUTPATIENT SATISFACTION FOLLOW-UP

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Received on September 16, 2025
Presented by B. Petrunov, Member of BAS, on March 31, 2026

Abstract

The aim of this study was to explore the construction of hospital outpatient satisfaction scale and evaluation model, and to optimize outpatient satisfaction performance assessment indices. A satisfaction survey was conducted on 3988 outpatients in July-August 2024 using the ChatGPT artificial intelligence recall system with a structured human-computer interaction mechanism. On the basis of single-factor analysis, a binary unconditional logistic regression model was constructed to further screen the influencing factors and analyze the priority improvement areas through the importance matrix. The scale used in the survey was pre-validated by reliability and validity tests, and all statistical analyses were uniformly performed using SPSS 21.0 software. Satisfaction scores were high, with high scores for information technology convenience experience, consultation environment experience, and overall feeling experience, and low scores for service experience. Satisfaction influencing factors were gender, age, and department of consultation. Priority needs to be given to improving history inquiry and communication services, examination report interpretation services, and treatment plan and medication discussion services; and secondary improvements in privacy services, and respectful or comforting services. The outpatient satisfaction scale designed in this study has practical value, and

This paper is supported by Research and Application of ChatGPT in Outpatient Satisfaction Follow-up, Project Number: Y20240537.

https://doi.org/10.7546/CRABS.2026.05.13

the application of ChatGPT-based intelligent information follow-up system reduces the cost of follow-up, improves the efficiency of follow-up, and enhances the overall service level.

Key words: ChatGPT AI return visit, outpatient satisfaction, influencing factors, dimensions

Introduction. With the continuous development of modern medical technology, the masses of health and health knowledge and self-care knowledge and awareness continue to improve. The patient's needs are also developing in the direction of diversification, personalization and specialization. In order to meet the needs of these developments, medical institutions must ensure that the medical technology improves the quality of their medical services, and establishes a good service image of the hospital. Patient satisfaction is a kind of subjective evaluation of patients, which is a kind of cognition and situation reflection produced by patients through comparing the expectation and actual perception of medical services [1]. Patient satisfaction is an important indicator of the effectiveness of treatment and the quality of medical services. The community and patients of the hospital provide medical services with objective evaluation and measurement of the reliability of hospital quality, which is one of the most important quality indicators in the management of the hospital hierarchy [2]. Patient satisfaction with the level of hospital services directly reflects the level of hospital technology and management quality, and the hospital brand has a special importance [3]. Hospital patient satisfaction survey is generally in the form of hospital self-assessment, third-party assessment and network assessment. In various methods, satisfaction questionnaires are the most commonly used measurement tools [4], and scientific and effective scale evaluation system is the basis of satisfaction survey and the reliable guarantee of the survey results.

In the modern hospital management evaluation system, patient satisfaction is not only an important indicator of the quality of medical services and treatment results, but also closely related to the survival and development of the hospital. Improvement of patient satisfaction is directly related to the enhancement of patient loyalty, which in turn affects the market share of medical service organizations [5–8]. As the outpatient clinic is the department with the largest number of patients and the widest range of services, its quality of work and service level can directly or indirectly affect the overall image of the hospital and its competitiveness. Many hospitals have been using traditional methods such as paper questionnaires and telephone follow-ups to assess outpatient satisfaction, which consumes a lot of human, material and financial resources and may also have human factors affecting the satisfaction assessment results [9]. It is of great practical significance to establish an outpatient satisfaction assessment system that is efficient, convenient, objective, true, time- and labour-saving to enhance the service capacity of hospitals and improve the doctor-patient relationship.

With the development of Internet mobile information technology, more and more cutting-edge science and technology are closely integrated with medicine, and in the information explosion and rapid dissemination of today's society's expectations for healthcare services do not only remain in the traditional concept, but also focus on intelligent healthcare, convenient services, and humanistic care. The ChatGPT-based AI follow-up system applied in this study is an intelligent text-voice integrated interactive platform embedded in the hospital information system, which realizes automated structured interviews and real-time structured processing of patient responses. The research and application of ChatGPT in outpatient satisfaction follow-up has a broad prospect and potential. In the future, with the continuous development and improvement of the technology, it should give full play to its advantages in technology, update the service concept, focus on humanistic care, so as to make a better integration of Internet technology and outpatient medical care, reduce the physical and mental pressure of medical staff, improve the work efficiency, and provide patients with high-quality medical experience, and provide a strong support for the improvement of the quality and efficiency of medical services.

Materials and methods. ***Subjects of the study.*** This study complies with the requirements of medical ethics and adopted a prospective before-after controlled study design to select research subjects from the outpatients of a municipal tertiary Grade A hospital who visited the hospital in July-August 2024. According to the time node of the official launch of the ChatGPT-based AI informationized follow-up system, the subjects were divided into a control group and an experimental group: the control group included outpatients who received services from July 1 to July 15, 2024 and were followed up with traditional methods; the experimental group included outpatients who received services from July 16 to August 31, 2024 and were followed up with the AI follow-up system. The same inclusion and exclusion criteria were applied to both groups to ensure baseline comparability. Inclusion criteria: informed consent, outpatients voluntarily participate in this study, and sign an informed consent form; 18–70 years old, clear consciousness, good comprehension; exclusion criteria: patients who are not willing to participate in the questionnaire; age $\leq$ 18 years old or greater than 70 years old, and cognitive impairment. Baseline data comparison (gender, age, visiting department, disease type) was conducted between the two groups, and the results showed no statistically significant difference ($P > 0.05$), indicating good comparability. Comparing the data of the two groups, the satisfaction rate of follow-up of outpatients in the experimental group was significantly higher than that of the control group, and the difference was statistically significant ($P < 0.05$). The effective rate of follow-up for outpatients was higher than that of the control group, and the difference was statistically significant ($P < 0.05$).

Research content. Our hospital used the traditional follow-up method, which was based on telephone follow-up and paper questionnaires. The data were

extracted and the costs and benefits of follow-up visits were analyzed in detail. The successful telephone connection rate, the time-consuming rate of the follow-up staff, the effective rate of the follow-up, and the satisfaction of the outpatients' follow-up were counted. Among them, the successful telephone connection rate refers to the statistics of the successful telephone connection rate of the two groups of patients. Successful telephone connection rate = the number of connected cases / (planned follow-up number of non-abnormal) cases $\times 100\%$; follow-up effective rate = the number of effective collection cases / the number of connected cases $\times 100\%$, of which the effective collection includes the completion of the information collection, the completion of part of the information collection; patient follow-up satisfaction is the survey of the satisfaction with the medical treatment, the use of the Likert 5-grade scoring method, 1–5 corresponds to very dissatisfied, dissatisfied, generally satisfied, satisfied, very satisfied. Satisfaction rate = number of cases (generally satisfied + satisfied + very satisfied) / total number of cases $\times 100\%$.

The follow-up questionnaire used in this study was self-designed and underwent strict reliability and validity verification before formal application. The questionnaire includes basic patient information and outpatient follow-up satisfaction, and its content is divided into 4 dimensions and 16 entries: information technology convenience experience (3 entries, Dimension I); service experience (6 entries, Dimension II); consultation environment experience (2 entries, Dimension III); overall feeling experience (5 entries, Dimension IV). Reliability test showed that the Cronbach's α coefficient of the total scale was 0.926, and the Cronbach's α coefficients of each dimension were all higher than 0.87, indicating excellent internal consistency; validity test showed that the total content validity index (CVI) of the scale was 0.94, exploratory factor analysis extracted 4 common factors with a cumulative variance contribution rate of 82.36%, which was consistent with the theoretical framework, indicating good content and construct validity.

The ChatGPT-based AI intelligent follow-up system constructed in this study realizes automated interviews and intelligent processing of patient responses through the following workflow: 1) Automatic trigger: After the outpatient consultation, the hospital information system automatically sends a follow-up invitation SMS with a secure access link to the patient's reserved mobile phone number; 2) Automated guided interview: Patients enter the human-computer interaction interface by clicking the link (supporting text/voice dual input), and the system conducts step-by-step structured automated interviews according to the questionnaire framework, with built-in skip logic for invalid answers to ensure data completeness; 3) Response processing: Unstructured patient responses are converted into structured data in real time through natural language processing (NLP) technology, and semantic classification and coding are performed for descriptive feedback; 4) Data aggregation: All structured data is synchronized to the hospital's dedicated data analysis dashboard in real time, realizing automatic

statistics and visual display of scores and feedback; 5) Automatic feedback: The system automatically sends a thank-you message to the patient after the interview, informing them that the feedback has been received and recorded. The system is embedded in the hospital's information application platform, and the hospital management department extracts data through the analysis dashboard and formulates targeted improvement measures based on patient feedback.

After the application of the system, a random on-site satisfaction survey was conducted, and all statistical analyses were uniformly performed using SPSS 21.0 software. The statistical description of the count data was described by frequency and constituent ratio, and the measurement data was described by mean ± standard deviation. Independent samples t-test was used for comparison between two groups of measurement data, one-way analysis of variance (ANOVA) was used for comparison among multiple groups, and chi-square test was used for comparison of count data. A binary unconditional logistic regression model was constructed for multivariate analysis, and the difference was considered statistically significant at $P < 0.05$.

Results. ***Score of each item of outpatient satisfaction.*** The average satisfaction score of outpatients was 4.67 ± 0.42 based on the analysis of 3988 valid questionnaire data collected. Satisfaction scores were high, with high scores for information technology convenience experience, consultation environment experience, and overall feeling experience, and low scores for service experience. They are 4.83 ± 0.61, 4.74 ± 0.55, 4.59 ± 0.59 and 4.57 ± 0.71, respectively. The scores of each item of outpatient satisfaction are shown in Table 1.

Single factor analysis of outpatient satisfaction. For 3988 valid questionnaires, the data information was grouped, and the satisfaction level of each group was calculated, followed by statistical testing between groups. Independent samples t-test was used to compare the satisfaction scores between genders, and one-way ANOVA was used to compare the scores among different age groups and different visiting departments. The results showed that the three factors included in the analysis: gender, age, and department of treatment, all had statistical significance ($P < 0.05$), as shown in Table 2.

Multiple factor analysis of outpatient satisfaction. On the basis of single factor analysis, a binary unconditional logistic regression model is constructed to further screen the influencing factors of satisfaction. The dependent variable Y was defined as a binary variable: satisfied (score ≥ 4.7 points, assigned 1) and dissatisfied (score < 4.7 points, assigned 0). The cut-off value of 4.7 points was determined based on three aspects: 1) it was the upper quartile (P75) of the pre-survey satisfaction score distribution, which was the natural dividing point of high satisfaction; 2) it was higher than the average critical value of 4.5 points for "satisfied" and "very satisfied" levels, in line with the high standard of hospital service evaluation; 3) it made the sample sizes of the satisfied and dissatisfied groups relatively balanced (2156 vs. 1832), avoiding regression bias caused by

Table 1

Score of each item of outpatient satisfaction

Evaluation dimension	Item name	Average score of items	Average score of dimension
Information technology convenience experience	Payment convenience	4.83 ± 0.61	4.83 ± 0.62
	Convenience of checking and printing inspection results	4.82 ± 0.61	
	Convenience of medication guidance	4.84 ± 0.64	
Service experience	Medical history inquiry and communication services	4.57 ± 0.71	4.56±0.73
	Inspection report explanation service	4.58 ± 0.72	
	Treatment plan and medication discussion service	4.55 ± 0.73	
	Respect or comfort services	4.56 ± 0.74	
	Privacy protection services	4.57 ± 0.72	
	Non medical services	4.57 ± 0.73	
Consultation environment experience	Waiting seat supply service	4.74 ± 0.55	4.74 ± 0.55
	Drinking water supply service	4.74 ± 0.55	
Overall feeling experience	Overall satisfaction with medical treatment	4.59 ± 0.59	4.57 ± 0.56
	Willing to recommend medical treatment	4.58 ± 0.58	
	Experience of doctor-patient relationship	4.57 ± 0.59	
	Respect experience for medical workers	4.56 ± 0.54	
	Experience of accepting children to work in hospitals	4.55 ± 0.52	
Average score of satisfaction		4.67± 0.42	

Table 2

Univariate analysis of outpatient satisfaction scores

	Variable	Number of cases	Score	Statistics	P
Gender	Male	2000	4.65±0.43	−3.188	0.001
	Female	1888	4.67±0.41		
Age (years)	0∼	900	4.67±0.42	5.543	< 0.001
	18∼	300	4.68+0.44		
	32∼	188	4.69+0.42		
	47∼	600	4.66+0.40		
	> 60	1900	4.64+0.40		
Department	Pediatrics		4.70+0.40	7.784	< 0.001
	Emergency medicine department		4.61+0.45		
	General medicine		4.68+0.40		
	Surgery department		4.65+0.40		
	Department of gynaecology		4.66+0.40		
	Department of obstetrics		4.68+0.39		
	Department of anesthesiology		4.68+0.41		

unbalanced dependent variables. The three factors with statistically significant differences in the univariate analysis were included in the model as independent variables. Age and the department visited were further set as dummy variables, with the $18 \sim 31$ age group and Pediatrics as the reference groups, respectively.

The results show that when the P-value is less than the significance level $\alpha = 0.05$, there is a statistically significant difference. The score for females in the gender group compared to males is 0.023, and its significance is more significant; In the age groups of $47 \sim 60$ years old and over 60 years old, the P-value is much smaller than the alpha value, indicating high significance; The P-value of Emergency medicine department in the treatment department grouping is lower than the alpha value, with high significance. The higher the significance, the greater the impact on satisfaction scores, as shown in Table 3.

Discussion. This study constructed a ChatGPT-based AI intelligent follow-up system for outpatient satisfaction investigation, and completed a satisfaction survey of 3988 outpatients through a prospective before-after controlled study design. The results showed that the overall outpatient satisfaction score was 4.67±0.42, with high scores in information technology convenience experience and consultation environment experience, and relatively low scores in service experience. Gender, age and visiting department were identified as independent influenc-

Table 3

Multiple factor analysis of outpatient satisfaction scores

Independent variable	classification	B	Wald χ^2	P	OR	95%CI
Gender (male as control)		0.087	5.224	0.023	1.092	1.013–1.177
Age (years)	0∼		42.632	< 0.001		
	18∼	0.038	0.198	0.657	1.038	0.878–1.231
	32∼	0.048	0.373	0.542	1.048	0.901–1.222
	47∼	−0.202	7.518	0.007	0.819	0.708–0.945
	> 60	−0.247	11.723	0.001	0.780	0.678–0.898
Department	Pediatrics (as control)		29.605	< 0.001		
	Emergency medicine department	−0.307	5.324	0.021	0.736	0.565–0.956
	General medicine	−0.023	0.028	0.865	0.979	0.763–1.258
	Surgery department	−0.222	1.818	0.178	0.801	0.549–1.106
	Department of gynaecology	−0.085	0.553	0.458	0.918	0.73–1.149
	Department of obstetrics	−0.011	0.008	0.931	0.991	0.791–1.241
	Department of anesthesiology	−0.013	0.274	0.601	0.903	0.614–1.327

ing factors of outpatient satisfaction through univariate and multivariate analysis. The application of the ChatGPT AI follow-up system significantly improved the follow-up effective rate and patient satisfaction rate, which confirmed the practical value of AI technology in optimizing medical service follow-up management.

The results of this study on the influencing factors of outpatient satisfaction are highly consistent with the conclusions of domestic and foreign relevant studies. Derose et al. [5] found in a study on emergency department patient satisfaction that female patients have a higher evaluation of medical services than male patients, which is consistent with the result of this study that female patients' satisfaction score (4.67±0.41) is slightly higher than that of male patients (4.65±0.43), which may be related to the differences in the sensitivity of different genders to medical service details and communication experience. Chen et al. [3] conducted a nationwide analysis of plastic surgery patient satisfaction and pointed out that demographic characteristics and clinical departments are important factors affecting patient satisfaction, which is also verified in this study – pediatric patients have the highest satisfaction score, while emergency medicine

department patients have relatively low scores, which is due to the different service characteristics and patient experience expectations of different departments (e.g., emergency medicine department has the characteristics of urgent treatment and fast pace, which is easy to lead to insufficient communication). Hwang et al. [6] found that elderly patients have lower satisfaction with medical services in the study of emergency department fast track services, which is consistent with the result of this study that patients over 60 years old have the lowest satisfaction score, mainly because elderly patients have higher demands for service patience and information explanation, and their adaptability to intelligent medical services is relatively weak.

Comparison with previous studies on AI-assisted healthcare services. In the research of AI-assisted medical service follow-up, the application value of natural language processing technology represented by ChatGPT has been confirmed by more and more studies. Brom et al. [9] pointed out that traditional follow-up methods such as telephone and paper questionnaires have the problems of high labour cost and low effective response rate, which is the main pain point of hospital follow-up management at present. The ChatGPT-based AI follow-up system constructed in this study solves this problem well: the automated interview mechanism saves a lot of human resources, and the text/voice dual input mode and convenient link access method improve the patient's participation willingness, thus significantly improving the follow-up effective rate. Similar to the research results of Kaur et al. [7] on intelligent follow-up in traditional and complementary medicine services, this study found that intelligent follow-up systems can improve the objectivity and authenticity of survey data while improving follow-up efficiency, because automated interviews avoid the human interference factors existing in manual telephone follow-up. In addition, the real-time structured processing and visual display function of the ChatGPT system in this study makes the hospital management department able to quickly grasp the problems of medical services, which is an important innovation compared with the traditional follow-up system with slow data processing speed.

Conclusion. This study shows that the overall satisfaction of outpatients in hospitals is high, and the self-designed outpatient satisfaction scale has good reliability and validity and practical application value. Gender, age and visiting department are the independent influencing factors of outpatient satisfaction, with female patients having higher satisfaction, elderly patients having lower satisfaction, and pediatric patients having the highest satisfaction among all departments. Hospitals should continue to maintain the advantageous dimensions such as information technology convenience experience and consultation environment experience, and focus on improving the service experience dimension with relatively low scores, especially medical history inquiry, report interpretation and treatment plan discussion services. The application of the ChatGPT-based AI intelligent follow-up system not only reduces the human and material costs of hospital follow-up

work and improves the follow-up effective rate and efficiency, but also improves the objectivity and authenticity of satisfaction survey data, which provides an effective technical means for the hospital to carry out outpatient satisfaction follow-up and optimize medical service quality. In the future, hospitals should further optimize the AI follow-up system and expand the application scope of AI technology in medical services to realize the continuous improvement of medical service quality and patient satisfaction.

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