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Exploring Doctor-Patient Information Interaction Patterns in Online Health Community: Evidence from Chunyu Doctor via Content Analysis

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Abstract: As a new type of doctor-patient information exchange platform in the Internet medical era, online health community integrates abundant health information resources and provides online communication and interaction channels for patients and doctors. This study aims to understand the information interaction patterns in online health community by integrating the dyadic interaction between doctors and patients. Based on 1260 valid interaction information from Chunyu Doctor, a popular OHC in China, this study identified three information interaction patterns, including P-OHC-P (Pattern1), P-OHC-P-H(Pattern2) and H-P-OHC-P-H (Pattern3) via content analysis. Combining the dimensions of information source, information flow, user online and offline diagnosis, medical treatment status, interactive content topic and other dimensions, we summarize the different characteristics of each pattern. The findings of this study have several theoretical implications to the information interaction in online communities, as well as practical implications to managers of OHC. The limitations of this study is also given.

Keywords: information interaction pattern, online health community, doctor-patient, content analysis

1. INTRODUCTION

With the penetration of social media, online health community (OHC) is increasingly popular by communicating health related topics on social media platform. As a new type of information interaction platform and channel in the online medical era, the OHC has integrated rich health information resources and attracted lots attention[1]. Doctors and patients are the two most important user groups in the OHC. Due to the lack of some core information required by the face-to-face clinic, doctors have certain difficulties in grasping the diagnosis in OHC interaction. Therefore, a good online doctor-patient interaction can promote the formation of intimate feelings and relationships between doctors and patients, and bring better results for online diagnosis and treatment, such as higher patient satisfaction, doctor's compliance rate and better disease treatment effects. Thus, understanding the characteristics and patterns of information interaction between doctors and patients has attracted lots attention from academia and practitioners.

The extant research on information interaction in OHC mainly focuses on the process of information interaction, mining of influencing factors. For instance, identifying influence factors of doctor-patient interaction with survey data of patient satisfaction, or quantitative data of patient visits, number of posts, speed of reply, etc[2]. However, there is relatively a lack of in-depth exploration of doctor-patient information interaction patterns in OHC from the level of interactive content. Additionally, taking the methodology of current research into consideration, most extent research on OHC information interaction mainly adopts machine learning technology, structural equation model, semi-structured interview etc., which limits the comprehensive understanding of the interaction content and the interaction pattern recognition.

Some research investigated the user interaction pattern in online communities, but the proposed information interaction mode mainly categorized based on the information type, user type, user relationship. Concentrating on health-related knowledge, OHC has different user information interaction patterns with the conventional online

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communities. The main knowledge contributors for OHC are doctors and patients, and the content of their interaction usually concentrated on the health knowledge based on the patients' needs. Therefore, the currently construction dimension of the information interaction model is difficult to apply to the doctor-patient interaction relationship in the OHC. In addition, in the limited studies on doctor-patient information interaction, the doctor-patient interaction is usually regarded as a whole and the research is carried out from a single perspective or single issue, rather than as a new health communication practice involving both doctors and patients with systematically analyzing the complete interaction process[3].

Based on the discussion mentioned above, this study aimed to explore the doctor-patient interaction patterns from the interaction information in Chunyu Doctor, a popular OHC in China. Content analysis approach was employed to explore the whole process. Based on the real doctor-patient interaction cases and interaction content on Chunyu Doctor, the main research questions for this study are twofold:

RQ1: What are the patterns of doctor-patient information interaction in the OHC?

RQ2: What are the characteristics and differences of these information interaction patterns?

2. RELATED WORK

2.1 Online information interaction

Information interaction is originated from human-computer interaction, which transfer information to users by integrating user, information content and information systems. Its essence is the process of optimizing and integrating users, systems and contents, and evaluating information exchange through information feedback under the premise of fully considering the rational factors of technology and the perceptual factors of human nature[4]. In the process of information interaction in the online environment, users can not only browse, search, retrieve, and obtain the latest information or services, but also create more knowledge and stimulate more information needs. The interaction of these network users is more three-dimensional and nonlinear, realizing the multiplier effect of "information content, information receiver and publisher" [5].

Users' information interaction behaviors various in different scenarios and situations in the network environment, and many new communication patterns have been generated on different platforms. Scholars have explored the internal mechanism of information interaction from different perspectives and constructed diversified information interaction modes under the network environment. In the early stage of research, the method of pattern division by scholars was relatively simple. According to the different interaction subjects, some scholars summarize the information interaction between librarians into four modes: individual, individual and department, department and venues. Some scholars had proposed collaborative interaction mode and Hostile interaction model based on the different representation forms of the interactive information in the online community[6]. With the development of network platforms, the transmission mechanism of information has been revealed more completely. By summarizing and analyzing the mechanism of information sharing and diffusion in microblog, Yuan and Zhao divided its information interaction model into fission mode and aggregation mode from the perspective of information content, and chain mode, circular mode and tree mode from the perspective of topics. In addition to starting from the information itself, users' interactive relationship plays a decisive role in the formation of the information interaction pattern since users are the main body of information interaction. Ding comprehensively applied comparative analysis, inductive deduction and other research methods to analyze the user types and interaction relationships of academic virtual communities, and proposes three interaction models based on links, conversations, and citation relationships.

2.2 Doctor-patient interactions in OHC

The OHC has transformed the face-to-face communication between doctors and patients in offline medical services into online, resulting in a new type of doctor-patient information interaction by using the Internet as a medium. Doctors and patients are content producer and receivers during the online information interaction[7]. This

kind of online doctor-patient interaction specifically refers to medical services mediated by computers or mobile devices with the purpose of health consultation and communication. Doctors provide medical and health knowledge and share disease treatment methods on the network platform. Patients obtain doctors' information and health knowledge through search and browsing. At the same time, they choose appropriate doctors to conduct online consultations and ask questions based on their own conditions, so as to establish a new type of doctor-patient relationship. Existing studies on online doctor-patient interaction mainly concentrated on the interaction process and the factors influencing the dyadic interaction. Some studies divide the online doctor-patient interaction process into multiple dynamic stages to achieve an overall grasp of the doctor-patient interaction in online medical services. On the other hand, many scholars have interpreted the multi-dimensional influencing factors of doctor-patient interaction from the aspects of doctors, patients and online community platforms.

The doctor-patient interaction pattern is to use concise nodes to describe the phenomenon of information flow between doctors and patients to reveal the internal logic of their communication, there are some limited studies have explored it. Wu *et al*. combined the two dimensions of information needs and health information sources to analyzed 1601 cases on the website of HaoDF, and the results showed that there were altogether 15 modes of consumer health information consultation in the OHC[8]. Cao conducted in-depth interviews, concluded the four interaction modes[9]. Li *et al*. obtained doctor-patient interaction sessions on the website of "Chunyu Doctor" by crawler technology[10]. These research results provide certain reference significance and function for the following analysis of this paper.

3. METHODOLOGY

3.1 Data collection

Chunyu Doctor was founded in 2011. The platform is committed to using scientific and technological means to help users master health information, so that patients can obtain professional, high-quality and convenient medical services and suggestions in the process of seeking medical treatment. Chunyu Doctor has a large number of users and mature business, attracted more than 500,000 practicing physicians in public hospitals, and serving more than 200 million patients[11]. Therefore, this article selects the Chunyu Doctor platform as the research object, takes the information content of the interaction between doctors and patients in its online consultation service as the data source, and applies content analysis to analyze the content level. In this paper, the Octopus web scraping tool was used to collect the consultation dialogue data in the "Classic Questions and Answers" section. Patients' personal information, doctors' basic information, the title of consultation questions and the content of consultation conversations between patients and doctors were collected. A total of 1400 consultation conversations were obtained. After eliminating the repeated and incomplete invalid data, a total of 1260 valid conversations were maintained for each department.

3.2 Data analysis

Content analysis was employed in this study to explore the information interaction patterns. Content analysis is defined as a systematic and replicable technique a widely used method to extract the key concept from text. It has been widely used in various disciplines, such as journalism, communication, information science and organizational management[12]. In the OHC, the consultation dialogue is fragmented, varying in the structure, and lack of meta-data such as tag. Thus, it is difficult to obtain potential logical rules from the commonly used text mining methods of network information. Content analysis is a qualitative analysis method based on a quantitative basis. It can not only construct and encode qualitative categories of objective text data, but also conduct quantitative data statistics and in-depth analysis of the encoding results[13]. Therefore, it is an appropriate method to effectively extract the behavior patterns and characteristics of doctor-patient information interaction in OHC.

3.2.1 Open coding

Open coding is the process of extract concepts or categories from original data following the recommended principles[14]. In order to fully understand and conceptualize the content of the original case's content, the coders choose to encode each piece of raw data sentence by sentence. They need to read the original post repeatedly to familiarize themselves with the content, choosing the words from the original case as criteria whenever possible.

The authors coded the collected doctor-patient consultation dialogue word by word, and manually insert conceptual labels for doctor-patient conversations. At the same time, the sequence of appearance of each concept category in the process of consultation has been obtained by the interactive content coding sequence expressed in the initial category. Considering the complexity of initial concepts and related expressions, related similar and cross concepts are categorized. After many times of analysis, sorting, and modification, 20 initial categories were finally obtained. For example, "The child has a runny nose for three days, and the cough was lighter at first, but now the cough is heavier than before and has a low fever" is coded as "Symptom Statement"; "Do you usually smoke and drink? Do you often stay up late? Do you have exercise habits?" is coded as "Daily Life Habits"; "It is recommended that the child go to the hospital for abdominal ultrasound or abdominal CT to exclude some organic diseases" is coded as "Recommend offline medical treatment".

3.2.2 Axial coding

As the second step, the main task of axial coding is to discover and establish various deep connections between conceptual categories from the abovementioned open coding process. Through the cluster analysis of the open coding of the previous stage, the potential logical relations between various categories are explored to form a more conceptual, general and comprehensive abstract coding. On the basis of the initial category, the author analyzed and summarized the relationship between each category. For example, "*symptom statement, symptom confirmation, symptom supplemen*t" was classified as "*symptom presentation*"; "*Personal characteristics and daily habits*" were classified as "*basic information of patients*", etc. Finally, the following six main categories were obtained: *symptoms, basic patient information, diagnosis and treatment history, discussion of the condition, online solution discussion* and *offline medical treatment plan discussion*.

In addition, according to the interaction content coding sequence obtained in the previous stage, the authors analyzed the relationship between the initial categories in the sequence, replaced each sub-category with the corresponding main category. We obtained 21 interaction content sequences expressed in the main category, which described the doctor-patient information interaction process more abstractly from the content perspective. For example, "symptom statement - symptom supplement - disease diagnosis - etiology - drug treatment plan" is further abstracted into "symptom - illness discussion - online solution discussion".

3.2.3 Selective coding

In the selective coding stage, it is necessary to further select the global and dominant core category from the interrelated categories, and cluster the main category from the system level, so as to abstract the attributes and dimensions that can summarize the main category. Further analyze the connection between the core category and other categories, connect the same concept in series to form a system of theoretical framework. Through the above process, the core category of "doctor-patient information interaction in online health community" was finally determined. Combining the doctor-patient information interaction process in the online health community and the content coding sequence, logical sorting was carried out on the six main categories of symptom presentation, basic information of patients, diagnosis and treatment history, discussion of illness, discussion of online solution and discussion of offline medical treatment plan, and the internal relationship and causal relationship among them were analyzed.

3.2.4 Trustworthiness

After encoding the initial 1,150 data, a theoretical saturation test was carried out using 110 cases, which were shelved in the initial stage. The results show that all the conceptual categories obtained have appeared in the previous analysis, no new code was found and no new logical relations or causal relations are generated between

related categories, indicating that the proposed logical framework is reliable and comprehensive.

4. RESULTS

4.1 Identification of the process of doctor-patient information interaction in OHC

Combining the results of three rounds of coding and the coding sequence of interactive content obtained in the coding process, the author further analyzed the potential contextual relationship between them according to the order of appearance of each category, explored the logical and causal connection, and revealed the entire process of doctor-patient information interaction. Finally, the framework diagram of the doctor-patient information interaction process in the OHC is obtained, as shown in Figure 1.
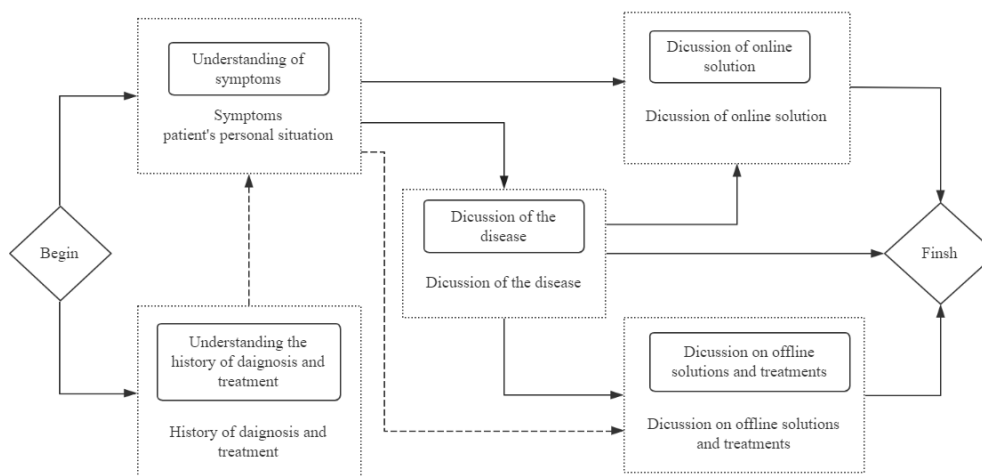

Figure 1.   Framework diagram of doctor-patient information interaction process in OHC

4.2 Analysis of doctor-patient information interaction patterns from different perspectives

Combining the online health community doctor-patient information interaction process framework and the interactive content coding sequence, this article has an in-depth understanding of the OHC doctor-patient information interaction patterns from the perspectives of online and offline transfer, interactive content theme, and the medical status, so as to lay the foundation for the comprehensive and systematic refinement of the final doctor-patient information interaction pattern.

(1) The perspective of online and offline transfer

Combining the interaction sequence of doctor-patient information interaction and content coding, the doctor-patient information interaction in OHC includes two perspectives: online and offline. Online, that is, patients with relevant health directly conduct online consultation through the OHC, the whole process is completed in the online health community. Offline refers to the patients unable to be diagnosed through the online consultation in the OHC, doctors recommends them to go to offline hospitals for further examination and treatment.

(2) The perspective of interactive content theme

From the perspective of the interactive content between doctors and patients, combined with the content encoding sequence obtained in the encoding process, an online health community doctor-patient information interaction pattern including 6 main categories is obtained. The specific pattern is as follows: *Symptom understanding-disease discussion-online solution discussion*; *Symptom Understanding - Online Solution Discussion - Disease Discussion*; *Symptom Understanding - Disease Discussion - Discussion on Offline Medical Treatment Plan*; *Treatment History Understanding - Symptom Understanding - Disease Discussion - Discussion on Online Solution*; *Treatment History Understanding - Symptom Understanding-Discussion on Offline Medical Treatment Plan*.

（3）*The perspective of visit status (initial visit/return visit)*

In this article, the initial consultation is defined as the patient's first visit to the hospital or OHC for related consultation and treatment due to the suffering from a certain disease. The follow-up consultation is defined as the patient seeking disease treatment or health management information for the same disease after the initial consultation. After analyzing the connotation of each model, there is a certain difference in the choice of interaction mode between patients in the initial and follow-up consultation state.

4.3 Extraction of doctor-patient information interaction patterns in OHC

After three rounds of encoding and further analysis, combining with the online and offline transfer, interactive content theme, and medical treatment status of the three analysis perspectives to describe the online health community doctor-patient information interaction model, this section will integrate the information sources and information flow in the process of doctor-patient information interaction. The following three modes of doctor-patient information interaction were finally extracted.

4.3.1 Pattern1: P-OHC-P

The information circulating in this model only involves two sources of information, the patient itself and the online health community. It describes the patients in the state of initial diagnosis, through the online consultation service in the OHC for health information search. The patients actively describe their symptoms and discuss with the doctors, so that the doctors can understand the patient's situation in detail. The manifestation of this pattern is shown in the Figure 2, which includes the following two processes:

(1) *Initial diagnosis-online-understanding of symptoms ➝ Discussion of the disease ➝ Discussion of the solution*.

Doctors diagnose the causes and symptoms of the disease according to the patient's condition, or consults the patient on issues related to his or her own condition. After this interaction, the doctor provides an online solution. In addition, some patients will have a deeper discussion based on the implementation details of the solution provided by the doctor.

(2) *Initial diagnosis-online-Understanding of symptoms ➝ Discussion of the solution ➝ Discussion of the disease*

For some low-risk diseases that are common and easy to solve in daily life, doctors will directly provide solutions online based on the patient's description. After receiving the diagnosis and treatment information, patients will choose to discuss with the doctor whether the plan is in line with their own actual situation, and conduct targeted information exchanges on the cause, severity of the disease, and related pathological knowledge.
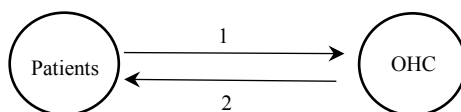

Figure 2.   Doctor-patient information interaction pattern 1

4.3.2 Pattern 2: P-OHC-P-H

The specific form of this pattern is "*Initial diagnosis-online-understanding of symptom➝ Discussion of the disease ➝ re-diagnosis-offline-discussion of medical treatment plan*". Patients in the state of initial diagnosis will first conduct self-screening through the OHC online consultation service, and take the initiative to search for information related to their own health problems. At the same time, conducted online question-and-answer consultation with doctors in the corresponding departments to describe their symptoms in detail so that doctors could make reasonable judgments and provide corresponding diagnosis and treatment plans. For patients whose disease conditions are more complicated and cannot be diagnosed through online channels, doctors will suggest them to offline hospitals for follow-up examination, and provide a meaningful offline medical treatment plan，

some of which will make more inquiries according to specific hospitals, examination contents and other medical-related issues.
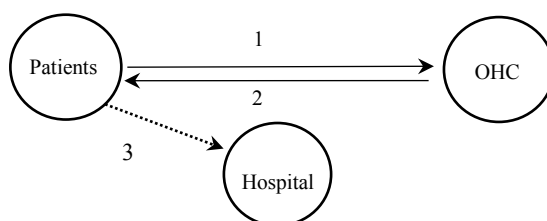

Figure 3.   Doctor-patient information interaction pattern 2

4.3.3 Pattern 3: H-P-OHC-P-H

The specific form of the pattern is "*Initial diagnosis-offline-understanding of treatment history → re-diagnosis-online-understanding of symptom → Discussion of the disease →re-diagnosis-offline-discussion of medical treatment plan*". The patients have been diagnosed and treated in offline hospitals, and have already mastered some disease information related to themselves. Then, through the online consultation service of the OHC, the patient actively informs the previous diagnosis and treatment situation, and interacts with the doctor for more information about this and the subsequent progress of the health condition. Through normal communication links, doctors enable patients to grasp the actual physical condition of the current clearly, and provide patients with more practical diagnosis and treatment suggestions. After the online consultation, due to a conservative attitude or the complexity of the disease, the patient will still go to the offline hospital to seek follow-up treatment.
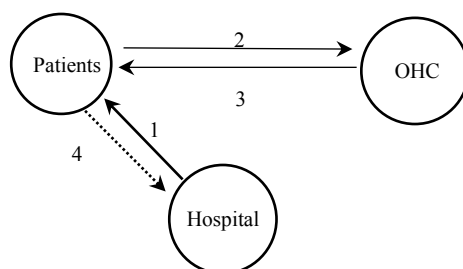

Figure 4.   Doctor-patient information interaction pattern 3

5. DISCUSSION

5.1 Characteristic analysis of different doctor-patient interaction patterns

The patient's need for information is dynamic and will change with the current actual health status. When patients have symptoms of disease or doubt about their own health, they are willing to actively search for relevant health information or seek a doctor's diagnosis, so as to determine whether their health is good. Based on the two dimensions of information source and information flow in the process of doctor-patient information interaction, this study identified three modes of doctor-patient information interaction in OHC, and analyzed the distribution and characteristics of each mode by combining different analysis indicators.

Quantity distribution. Pattern 1 is the most common type of doctor-patient information interaction, accounting for more than half of the 573, indicating that most patients can obtain useful information when using the OHC, so as to reduce the uncertainty at the medical level and solve their own health problems. Pattern 3 was second in number with 382, which shows that due to the complexity of disease, the OHC cannot meet the needs of all patients. The information they obtained online can only be used as a reference for final treatment plan. Influenced by traditional concepts, these patients will eventually go to offline medical institutions for follow-up treatment.

Type of consultation. By analyzing patients' description of problems before online consultation, the patient's consultation type is divided into cause consultation, solution consultation and related problems consultation. As

shown in Table 1, pattern 1 involves all three types of consultations, which means that when patients choose online consultations, they often seek information from doctors with a high frequency of questions about their own confusion on the disease itself and the treatment of the disease. At the same time, actively express their own disease experience and feelings to resolve physical problems and psychological distress. However, there are only two types of cause consultation and solution consultation in Pattern 2 and Pattern 3, indicating that when patients are actually troubled by diseases, they still combine offline medical institutions with the OHC, and compare multiple information channels to increase their control over diseases.

Table 1.   Statistics of consulting types

| Consultation Type	P-OHC-P	P-OHC-P-H	H-P-OHC-P-H	Total
Reason consultation	276	104	85	465
Solution consultation	190	111	247	548
Related questions consultation	107	0	0	107

Treatment options. By analyzing the treatment suggestions provided by doctors in the doctor-patient consultation dialogue, the treatment plan can be divided into online solutions and offline medical treatment plans. The online solution refers to that doctors can directly provide treatment methods and drug treatment plan through online diagnosis; while the offline medical treatment plan refers to that doctors will provide the patient with offline medical advice, and the follow-up should go to the hospital for further examination. The statistical data of treatment plans of each pattern are shown in Table 2. It can be seen that most patients can directly obtain solutions online through the consultation of OHC, indicating that the OHC has played an important role in the current practice.

Table 2.   Statistics of treatment options

Treatment options	P-OHC-P	P-OHC-P-H	H-P-OHC-P-H	Total
Online solutions	573	0	260	833
Offline medical treatment	0	215	72	287

Disease types. The distribution of the consulting departments can reflect the disease types of patients, as shown in Table 3. The most distributed departments in pattern 1 are Andrology, Nutrition, and Dermatology. These three types of diseases are mainly chronic diseases and long-term maintenance. The symptoms are mild, so users usually choose online consultations to conduct self-diagnosis and adjustment after understanding the situation, which is convenient for long-term tracking of their own disease development and avoid frequent trips between medical institutions. The most distributed in pattern 3 is oncology and prevention department, the proportion far exceeds other disease types, which is caused by the particularity of tumor diseases. Tumor diseases are usually incurable and have serious symptoms, which will cause serious harm to patients. Even after consulting through the OHC, they still need to go to medical institutions for physical examination, laboratory examination, imaging examination and other necessary procedures，so as to ensure more effective treatment results.

Table 3.   Distribution of disease types in different patterns
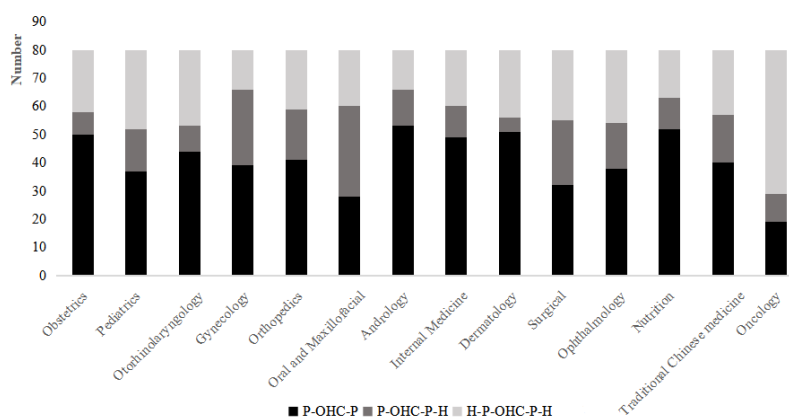
6. CONCLUSIONS

Online consultation in OHC has increasingly become one of the important ways for people to get medical help. Online health communities extend doctor-patient information interaction to the Internet environment, breaking the limitations of time and space, making the interaction between doctors and patients convenient and smooth. Online doctor-patient interaction is not only a supplementary mode, it also has some unique advantages. Therefore, this study is based on the doctor-patient interaction text in the online consultation section of Chunyu Doctor, and uses content analysis to extract the patterns from the dimensions of the information source, information flow, user online and offline diagnosis, the status of the initial visit and the interactive content theme. In the end, three information interaction modes in the process of doctor-patient interaction are drawn.

The results of this study have several important theoretical implications for researchers aiming at analyzing information interaction behavior in social network environments. First, this research interprets the doctor-patient interaction from the perspective of process, enriching the research on information interaction in the Internet medical context. Secondly, this study can provide some guidance for refining the influencing factors of users' behaviors in OHC. The three patterns constructed in this study indicate that patients with different diagnosis and treatment history, disease types, consultation goals and other background information will present different characteristics of their participation behaviors. On the basis of distinguishing different behavioral patterns of patients, future studies can explore the influencing factors behind their behaviors, enrich the types of regulatory variables and present the mechanism of doctor-patient behaviors in a more systematic way [15]. Finally, with the increasingly close integration of enterprises and network technology, various product communities, brand communities and other online virtual communities have been widely used in enterprises, the information interaction patterns proposed in this study can also be applied to other communities.

This study also provides practical implications for operators of the OHC. The OHC can provide patients with dedicated doctors to facilitate long-term tracking and management of patients' physical conditions, reducing the waste of medical resources caused by repeated inquiries from different doctors. Then, according to the characteristics of different departments, the managers can adjust the existing service mode, which with high proportion of final offline solutions, ensured that corresponding doctors can be recommended for offline diagnosis and treatment. At the same time, innovate service forms and expand medical service channels, so that the seamless connection between offline professional medical institutions and online platforms can be increased.

There are some limitations in this study. First of all, due to the limitation of data acquisition workload, we only selected Chunyu Doctor as the representative of the OHC, and collected 1260 conversation data under the online consultation section. Future research will broaden the types of the OHC and expand the data sources of the sample. Secondly, this study only uses qualitative analysis to reveal the information interaction patterns and characteristics behind the data, which fails to answer some implicit questions, such as how the duration and the language style of doctors affect the follow-up consultation behavior of patients. In the future, the research design will be further improved, and multiple research methods will be used to answer these questions to further verify the results of this study, so as to obtain more effective and reliable conclusions.

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