

# Game Research on Doctor-Patient Relationship Under the Background of New Media

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## ABSTRACT

In recent years, contradictions between doctors and patients often occur. The main influencing factors of contradictions are asymmetric information and conflict of benefit game. Therefore, based on the information asymmetry theory, this paper analyzes the doctor-patient relationship under the intervention of new media from the perspective of evolutionary game. To construct the three-party evolutionary game model of hospital, patient, and new media, and analyzes the influence of each variable of the three parties on the doctor-patient relationship during the game process. Then, Vensim is used to stimulate and analyze the model based on the system dynamic. The simulation results show that the expected earnings of doctors giving service, patients receiving treatment and new media reporting positive news are all increasing through the game. The combination of hospitals giving service, patients receiving treatment and new media reporting positive news is the most beneficial strategy for all parties in the game.

**Keywords:** doctor-patient relationship, new media, evolutionary game

## 1. INTRODUCTION

In recent years, as the gap between China's medical and health industry and economic development is growing, the development of the medical and health industry cannot meet people's growing needs, and the doctor-patient relationship is increasingly tense. New media plays a very important role in the doctor-patient relationship as a tool to send information. Based on this, this paper explores the relationship among hospitals, patients and new media from the perspective of evolutionary game. Through the research, the conclusion can provide theoretical reference for solving the tense relationship between doctors and patients, effectively regulating new media reports, strengthening legislation, and balancing the tripartite relationship among hospitals, patients and new media.

## 2. LITERATURE REVIEW

Asymmetric information between doctors and patients is the main reason that affects the relationship between doctors and patients, which has been studied by domestic and foreign scholars. In 1963, Nobel laureate Arrow first proposed the concept of asymmetric information in doctor-patient relationship. He believed that doctors have professional and rich medical knowledge in the diagnosis and treatment of diseases, and patients must actively seek medical information from doctors[1]. Based on the study of asymmetric information between doctors and patients, Yin Lu and others analyzed the causes and influencing factors of 876 cases of complaints about medical disputes in a

tertiary hospital in Taizhou province. They believe that the influencing factors of the doctor-patient relationship included unexpected circumstances, communication and notification, service attitude, etc., and the hospital responsibility for medical disputes accounted for 67.12%[2]. In addition, through the use of descriptive analysis method to analyze 349 cases of medical cases in a corps tertiary hospital, the main influencing factors of treatment, medical ethics, doctor-patient communication, and other aspects problem can be found in medical disputes. The departments with high incidence are orthopedics, cardiothoracic surgery and emergency department. The main way to solve the problem is negotiation and reconciliation between hospitals and patients, and the responsibility of hospitals is relatively high[3]. The subsequent research added game model to enhance the applicability of solving the contradiction between doctors and patients. The dynamic game model is used to study the relationship between doctors and patients. It is concluded that the health administration department should disclose the medical information, justly deal with the medical disputes and establish the system of responsibility apportionment under the principle of openness, justice and fairness[4]. Xiongwei Wang and others believe that the doctor-patient relationship is subordinate to the social relationship, and the disputes between the doctor-patient relationship are inevitable. In the game process, the disputes between the doctor-patient relationship should be turned into a normal state, so as to turn the unfavorable elements in the development of the doctor-patient relationship into favorable influences[5]. Hongwei Pan et al constructed and compared the hospital-patient profits matrix under the game of economic interests

and culture power. They concluded that the medical disputes caused by asymmetric information can be eliminated under the effect of culture power[6]. Compared with the hospital-patient game, it provides a feasible new idea for the analysis of the doctor-patient relationship by adding the tool of information transmission (new media). By analyzing some evidence-based medical systems in the reports of medical disputes, Eysenbach G, Kummervoid concluded that there are subjective differences between readers and new media on the reports, so we should improve the evaluation of critical articles, avoid adverse consequences due to cognitive differences[7], which demonstrates the importance of new media in the doctor-patient relationship. On the other hand, through the study of 3,209 respondents, it finds that patients' access to medical information through online media and increase the ways of communication between doctors and patients are invisible methods to solve the asymmetric information between doctors and patients[8], which confirmed the role of new media in solving the problems of doctor-patient conflicts. In terms of improving doctor-patient relationship, new media can regulate news media reports according to law, strengthen the professional quality of medical personnel, and establish and improve the doctor-patient communication mechanism and trust mechanism[9].

For a long time, the problem of doctor-patient relationship has been existing and difficult to solve due to the uneven distribution of medical resources and the situation of supporting doctors with drugs, which are the problems that scholars pay great attention to. Based on the relevant studies that use hospital, patient, and new media as research objects and conducted by domestic and foreign scholars from different perspectives, this paper uses Vensim to build a model to explore the game process among hospitals, patients and new media, and analyzes the influencing factors of the doctor-patient relationship, so as to provide reference and suggestions for the mediation of doctor-patient contradiction.

### **3. GAME BEHAVIOR BEHAVIOR ANALYSIS OF MEDICAL DISPUTES UNDER THE INTERVENTION OF NEW MEDIA**

The interests of hospitals, patients and new media are different. By analyzing the interests of each party, we can understand the pursuit of maximum interests of all parties, which lays a foundation for the model construction.

#### ***3.1. Analysis of the benefits of the doctor***

As the provider of medical services, hospitals can obtain direct and invisible earnings by providing good services, such as improving social status. At the same time, the positive reports of new media can improve the patients' trust in the hospitals, enhance the popularity of the hospitals, and indirectly increase the extra earnings.

The low-quality medical services provided by hospitals will lose some direct and invisible earnings, such as reducing the social reputation of doctors. At the same time, the negative reports of new media will reduce the patients' trust and satisfaction with the hospital, indirectly lose part of the extra earnings, which is not conducive to the formation of long-term extra earnings of the hospital. The direct or indirect losses caused by the positive and negative reports of new media on doctor-patient conflicts vary with the specific situation.

#### ***3.2. Analysis of Patients' Benefits***

In the game process, most patients pay more attention to whether the hospital can provide patients with lower prices, better treatment effect, medical services and medical environment. If the doctors in the hospital do their duty and the patients cooperate with the treatment plan, both hospitals and patients will get the maximum earnings in the process of medical service. At this time, new media reports can strengthen the social reputation of hospital, improve patient satisfaction and trust, and increase the click rate of the report. If the doctors do not perform their duties, the patients will get lower quality medical services, which will increase the medical expenses and time cost. At this time, the new media provides a way for patients to report and complain. The combination of new media reports and complaints from patients can reduce the time cost of patients, and new media can get more attention.

#### ***3.3. New media interest analysis***

If the new media industry pays attention to the interests and ignores the ethics of media personnel for a long time, the doctor-patient relationship will be seriously affected. People's trust on new media will also be reduced. When the circumstances are serious, they should be punished by government departments. The new media industry raises employment requirements and strictly abides by the industry norms, which is conducive to the increase of future invisible earnings and the long-term development of new media.

### **4. CONSTRUCTION OF A GAME MODEL FOR MEDICAL DISPUTES UNDER THE INTERVENTION OF NEW MEDIA**

The survey shows that the doctor-patient relationship is affected by the direct earnings of the hospital, the additional welfares, the human cost of the patient, the cost of new media reports, the cost of supervision, and other factors.

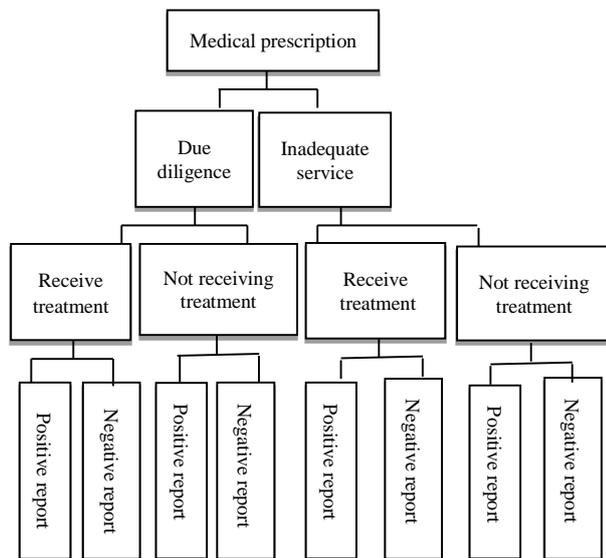
### 4.1. Behavioral decision-making of the three parties in the game between new media and doctors and patients

Suppose that the tripartite game behavior of hospital, patient, and new media is a limited strategy set of two elements. The hospital behaviour is composed of provide good service and provide bad service, which recorded as D1 and D2. The patient's behaviour is composed of choose to receive or not receive treatment, which is recorded as P1 and P2. New media, as a tool for both hospitals and patients to spread information in medical disputes, carries out positive and negative reports, which are recorded as G1 and G2.

In the process of medical disputes, the three parties change according to the strategies of each party in the game process. Any one of them will have an impact on itself due to the behavior changes of other subjects. Based on this, this paper digitizes the behaviour decision-making of the three parties of the hospital, patient, and new media. The following eight decisions are respectively the strategy sets of the game participants:

(D1, P1, G1), (D1, P1, G2), (D1, P2, G1), (D1, P2, G2), (D2, P1, G1), (D2, P1, G2), (D2, P2, G2), (D2, P2, G1).

### 4.2. The decision diagram and parameter annotations of the doctor-patient media game



**Figure 1.** The decision diagram of the doctor-patient media game Payout matrix of the tripartite game between doctor and patient media

According to the sequence of the game profit results shown in the picture 1, eight results are obtained in turn,  $\{(D1,P1,G1)=R11+R12-C11+R13-\Delta U1+R21+\Delta U2R31-C31+\Delta U3\}$ ,  $\{(D1,P1,G2)=R11+R12-$

$C11-H1-\Delta U1R21+\Delta U2R32-C32+\Delta U3-C33\}$ ,  $\{(D1,P2,G1)=R13-C31\}$ ,  $\{(D1,P2,G2)=-C11-C32-C33\}$ ,  $\{(D2,P1,G1)=R11+\Delta R1-C12-C13+R14-\Delta U1R22+\Delta U2-C2+R23R33-C31+\Delta U3\}$ ,  $\{(D2,P1,G2)=R11+\Delta R1-C12-C13-H2-\Delta U1R22+\Delta U2-C2+R23R34-C32+\Delta U3\}$ ,  $\{(D2,P2,G2)=R14-C12-C31\}$ ,  $\{(D2,P2,G1)=-H2-C12-C32-C34\}$ .

The direct earnings when hospital provide good service is R11, extra welfares (including social reputation, etc.) are R12. The hospitals additional earnings R13 are brought by the positive reports of new media. The earnings that the patients get when the new media report negatively is R21. The earnings of positive news reporting by new media is R31 including direct earnings and additional welfares. The earning of negative news reporting by new media is R32(R32>R31), including click rate, attention, etc. The cost of hospital provides good service is C11. The cost of new media reports positive news is C31, the cost of new media reports negative news is C32, and the opportunity cost of new media reports false news and punishes by government departments is C33. Additional losses for hospitals when new media reports negative news is H1. The excess earnings that the hospital obtains from providing bad service are greater than the direct earnings is R1.

Hospital provides bad service, the earnings of new media reports positive news is R33, the earnings of new media reports negative news is R34 (R34>R33). The earnings of patients, when new media reports negative news is R22 (R21>R22), monitoring the hospitals to save the earnings for the patients is R23. The extra earnings of medical speculation is R16 (R31> R16). The cost of hospitals questioned by patients and the cost that the patients need to pay when they questioned are C12 and C2. The opportunity cost of hospitals is punished by the government is C13. The opportunity cost by government department when discovering and punishing doctors in the negative reports of new media is C34. Compensation for the service violation caused by the hospital after suspected by the patient is R37. New media reports positive news to save the loss for the hospital is R14 (R13>R14). New media reports negative news brings additional losses to the hospital is H2 (H2>H1). The combination of new media reports and patient queries will bring earnings to the cooperation between new media and patients are  $\Delta U2$  and  $\Delta U3$ , but hospitals will lose earnings at this time is  $\Delta U1$ .

### 4.3. Model construction

Through the analysis of the hypothesis of the game behavior decision-making between new media and hospitals and patients in the Figure, the tripartite game matrix of hospitals, patients and new media established in this paper is shown in Table 1.

**Table 1.** Payout matrix of the tripartite game between doctor and patient media

Sufferer	Medical prescription	Positive report	Negative report
Receive treatment	Due diligence	R11+R12-C11+R13- ΔU1+R21+ΔU2R31-C31+ΔU3	R11+R12-C11-H1- ΔU1R21+ΔU2R32-C32+ΔU3- C33
Not receiving treatment		R13-C31	-C11-C32-C33
Receive treatment	Inadequate service	R11+ΔR1-C12-C13+R14- ΔU1R22+ΔU2-C2+R23R33- C31+ΔU3	R11+ΔR1-C12-C13-H2- ΔU1R22+ΔU2-C2+R23R34- C32+ΔU3
Not receiving treatment		R14-C12-C31	-H2-C12-C32-C34

**4.4. Analysis of the Tripartite Game Model of Doctor-patient Media**

The gambling process of doctors, During the game, hospitals, patients and new media should adjust their own strategies according to the changes of other subjects, and form a dynamic balance in the process of continuous change, so that all parties can get their own interests and form the best strategy combination. Therefore, in this paper, Malthus dynamic equation is used to simulate the game process of hospital, patient and new media repeatedly by using the replication dynamic mechanism. Suppose that the proportion of hospital provides good service is x, the proportion of hospital provide bad service is 1-x, the proportion of patients receive treatment is y, the proportion of patients don't receive treatment is 1-y, the proportion of new media positive reports is Z, the proportion of negative reports is 1-z, and the equation changes with time t. The expected earnings when hospital provide good service is E1, the expected profits when hospital provide bad service is E2, the expected earnings when patients receive treatment is E3, the expected earnings when patients don't receive treatment is E4, the expected earnings when new media report positive news is E5, the expected earnings when new media report negative news is E6.

The dynamic equation for duplication of medical due diligence services is,

$$F(x)=dx/dt=x(1-x)(E1-E2)=x(1-x)[y(R12-ΔR1)+z(R13-R14-H2+H1)+C12+C13-H1+H2]$$

) The replication dynamic equation of the patient receiving treatment is,

$$G(y)=dy/dt=y(1-y)(E3-E4)=y(1-y)[x(R21-R22+C2-R23)+R22+ΔU2-C2+R23]$$

The dynamic equation for copying positive reports in new media is,

$$H(z)=dz/dt=z(1-z)(E5-E6)=z(1-z)[xy·C34+x(R31-R32-R33+R34+C33-C34)-y·C34+R33-C31-R34+C32+C34]$$

Let x(1-x)=0, y(1-y)=0, z(1-z)=0 in the above equation, and the results of the three-party replication dynamic equation of the doctor-patient mediator are x=0, x= 1, y=0, y=1, z=0, z=1. At this time, the doctor, the patient and the new media are in balance. From this, the eight equilibrium

points are(0, 0, 0), (0, 1, 0), (0, 0, 1), (1, 0, 0), (1, 0, 1), (1, 1, 0), (0, 1, 1), (1, 1, 1).

According to table 2, there are two "Nash equilibrium" in this game, one is (1,1,1) to achieve a win-win situation among the three parties, and the other is (0,0,0), where all three parties lose. Therefore, hospitals provide good service, patients receive treatment, and new media report more positive news than negative news, so as to provide positive guidance for the medical disputes. At this time, the hospital, the patient and the new media will achieve a win-win situation and effectively alleviate the doctor-patient relationship.

**Table 2.** Analysis of the specific benefits of the tripartite game matrix of doctor-patient media

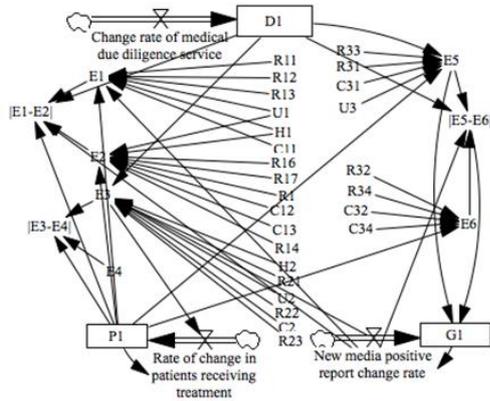
Sufferer	Medical prescription	Positive report	Negative report
Receive treatment	Due diligence	(1,1,1)	(1,1,0)
Not receiving treatment		(1,0,1)	(1,0,0)
Receive treatment	Inadequate service	(0,1,1)	(0,1,0)
Not receiving treatment		(0,0,1)	(0,0,0)

**5. SIMULATION ANALYSIS OF THE EVOLUTIONARY GAME OF DOCTOR-PATIENT DISPUTES UNDER THE INTERVENTION OF NEW MESIA**

The model is built to simulate the game process of hospitals, patients, and new media. Combined with the simulation results, the influencing factors of hospitals, patients, and new media are analyzed to provide suggestions and references for alleviating the doctor-patient relationship.

**5.1. Building an evolutionary game model based on VENSIM software**

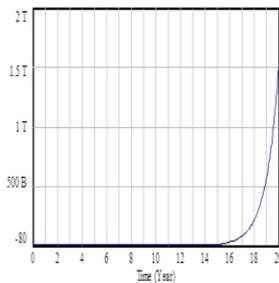
By using Vensim to simulate and analyze hospitals, patients and new media, the game model of the three parties is obtained, as shown in Fig. 2.



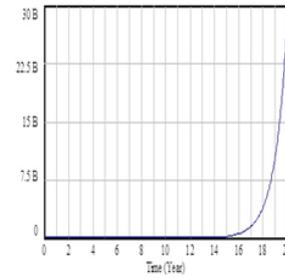
**Figure 2.** Three-party evolutionary game model of doctors, patients and media

**5.2. Building an evolutionary game model based on VENSIM software**

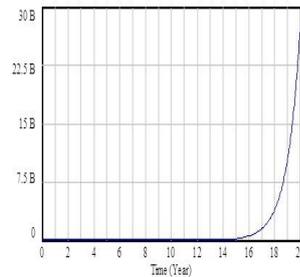
From Fig. 3, 4, and 5 the expected benefits of the doctor's due diligence, the patient's treatment, and the positive reports of new media show a slow growth trend in the early stage, and the fastest growth in the later stage.



**Figure 3.** Simulation results of expected benefits of due diligence service



**Figure 4.** The simulation results of the expected benefit of the patient receiving treatment



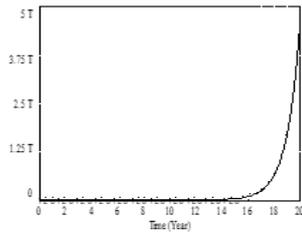
**Figure 5.** The simulation results of new media's positive reports on expected benefits

**5.3. Analysis of influencing factors**

In the process of the constant game between hospitals, patients, and new media, with the increase of time, the hospital, the patient and the new media gradually reach a balance, and finally get their own interests, forming a balanced situation of mutual restriction. in the process of tripartite game, the changes of different influencing factors have different degrees of influence on the strategy selection of the three parties.

**5.3.1. The impact of the additional benefits received by the doctor on the doctor's**

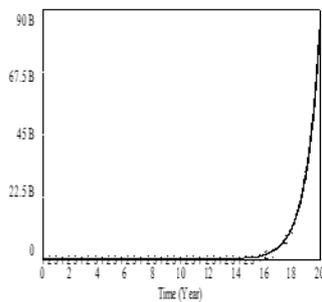
As can be seen from Fig. 6, the higher the additional welfares R12 (including social reputation) obtained by hospitals' service, the more expected earnings of hospitals' service, which indicates that encourage hospitals to provide good service can meet its higher level needs from the invisible earnings, and achieve the purpose of influencing the hospital strategic choice.



**Figure 6.** The effect of the additional benefits received by the doctors on the expected benefits of the doctors

*5.3.2. The impact of the cost of the patient's questioning on the patient's strategy when the doctor does not perform their duties*

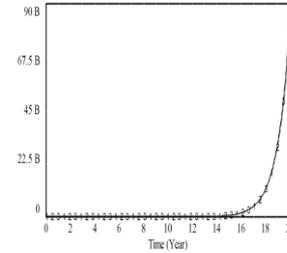
From Fig. 7, the expected earnings of patients' treatment increase with the increase of the cost  $C_2$  of patients' query when doctors do not perform their duties. When patients doubt that the cost of medical services is high, patients will also have higher expectations for the treatment effect they can achieve.



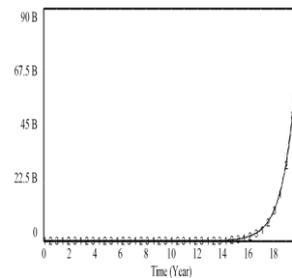
**Figure 7.** The impact of the cost of the patient's questioning on the patient's strategy when the doctor does not perform their duties

*5.3.3. The impact of new media cooperation benefits on new media strategies when new media and patients cooperate*

From Fig. 8 and Fig. 9, the positive or negative reports of new media have small interest gaps for the cooperation between new media and patients. New media adheres to the principle of media people, abide by professional ethics and relevant norms, and legally obtain profits is the best strategy.



**Figure 8.** The impact of new media cooperation revenue on the expected revenue of new media positive reports



**Figure 9.** The impact of new media cooperation revenue on the expected revenue of new media negative reports

**6. CONCLUSION**

The interests of hospitals, patients and new media are different. With the continuous game and adjustment of strategies, hospitals, patients and new media will choose to solve the doctor-patient relationship rationally in order to maximize their own interests. By constructing the tripartite game model of hospitals, patients, and new media, this paper analyzes the influence of new media strategy on hospitals and patients' game and discusses by combining the evolution strategy in the game. Finally, draws the following conclusions.

In terms of new media, with the emergence and continuous development of new media, it enriches the ways of patients' rights protection and reduces the cost of patients' rights protection. Based on the characteristics of new media digitalization and time travel, it can enhance the spread scope of comprehensive health education and contribute to the construction of harmonious doctor-patient relationship. On the medical side, an incentive mechanism should be established to strengthen the internal and external competition between the hospitals, encouraging proper competition at the same time. Moreover, actively develop tele-medicine on the basis of the characteristics of new media, implementing a hierarchical referral system to alleviate the uneven medical resources in our country, and completely improving the relationship between doctors and patients.

In terms of hospitals, incentive system needs to be established to strengthen the internal and external

competition of the hospital and encourage reasonable competition. In addition, we should actively develop telemedicine according to the characteristics of new media. To implement the hierarchical referral system to alleviate the imbalance of medical resources in China, so as to fundamentally alleviate the doctor-patient relationship.

In terms of patients, patients should actively understand the medical service on the basis of recognizing that there are still uncertainties in some aspects of medicine and the need for continuous development and progress.

In the terms of government, the government should learn from the Irish health department to set up a national third-party evaluation agency and establish an effective system to alleviate the doctor-patient relationship. At the same time, we can gain data through new media and other platforms to analyze the characteristics of diseases that need to go out to see a doctor in various regions of our country. Based on this, each province can cultivate medical students of a certain specialty and increase financial investment to optimize the allocation of medical resources in China. The implementation of telemedicine and the development of township medical services need government support.

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