Research on Public Health Emergency Warning and Prevention and Control Mechanism Based on "Blockchain + Big Data" Technology

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Keywords: Blockchain, Big data, Public health, Emergency warning, The emergency prevention and control

Abstract: In the process of COVID-19 response, problems in China's major epidemic prevention, control system and public health emergency management system have gradually emerged, such as delayed judgment of public health events, concealment and omission of the epidemic, misallocation of medical resources and lag of supplies information. The frequency of public health emergencies increases gradually, which has a serious negative impact on a country's social development and economic growth. Therefore, in order to effectively respond to emergencies in the field of public health, minimize or avoid the harm to the society and the public and improve the government's emergency response capacity, this project proposes a public health emergency warning and prevention and control mechanism based on the "blockchain + big data" technology.

1. Introduction

In order to improve the public health emergency management system, this paper proposes a public health emergency warning and prevention and control mechanism based on the "blockchain + big data" technology. The emergency management system consists of two parts: the public health emergency warning mechanism and the public health emergency prevention and control mechanism. To monitor the dynamic development of public health through the emergency warning mechanism, coordinate and supervise the process of public health treatment through the emergency prevention and control mechanism, so as to provide reference for the improvement of the national public health emergency management system and the improvement of the prevention and treatment system for major epidemics

2. Content Overview

2.1 Public Health Emergency Warning Mechanism

The public health emergency warning mechanism is shown in figure 1. Through literature retrieval and field research, the emergency warning index system was constructed, and the emergency public health event was judged based on big data. When the outbreak is confirmed, the data in the emergency warning mechanism will be continuously monitored and analyzed to determine the stage of the epidemic in real time and take corresponding emergency response measures.
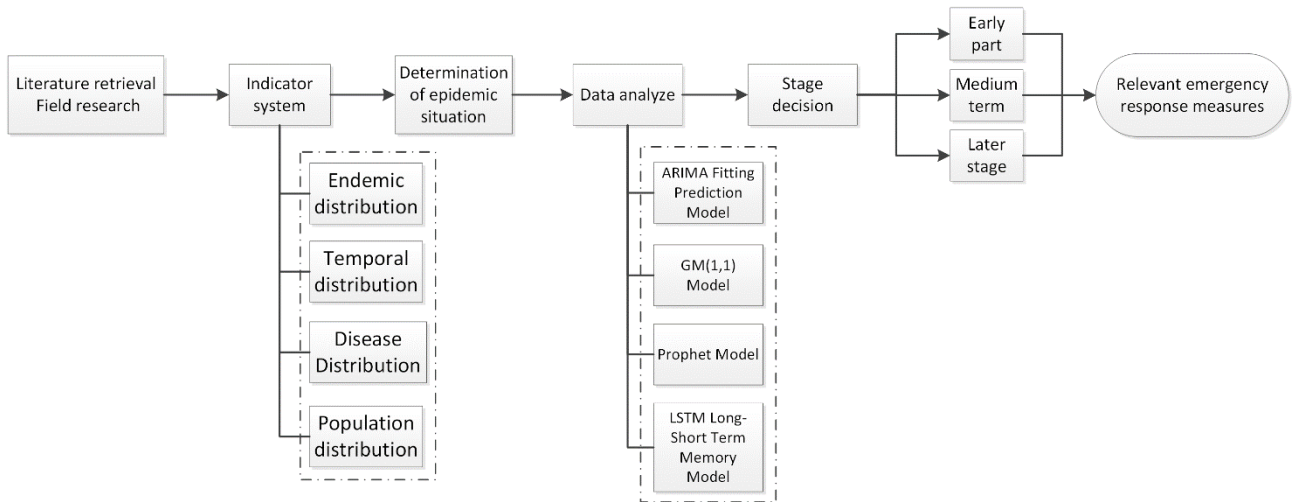
Fig. 1 Public Health Emergency Warning Mechanism

1)The public health early warning database system can automatically determine the epidemic stage according to the hierarchical index system, and realize the early detection and determination of the epidemic by using the characteristics of real-time release of blockchain technology and whole-network supervision.

2)The intelligent monitoring and warning module of big data monitors the epidemic data through comparative analysis and prediction of the model. When the abnormal indicators reach the warning threshold, the smart contract will initiate the warning and take relevant emergency response measures to attract the attention of all parties in advance. This mechanism is conducive to improving the coordination mechanism for the study, assessment, decision-making and prevention and control of major public health risks and improving the credibility of public management.

2.2 Public Health Emergency Prevention and Control Mechanism

The public health emergency prevention and control mechanism is shown in Figure 2.Using block chain's character of non-tamper and distribution, the real-time information of medical resources and emergency supplies information are input information sharing system, through the medical treatment system and material management system, respectively to provide the fixed-point hospital treatment and the masses with effective information and supplies. Thereby achieve mechanisms within the entire regulation, reduce the regulatory costs. At the same time, according to the feedback information, the system launches deployment requirements, thereby improving the quality of public service efficiency, improve public services.
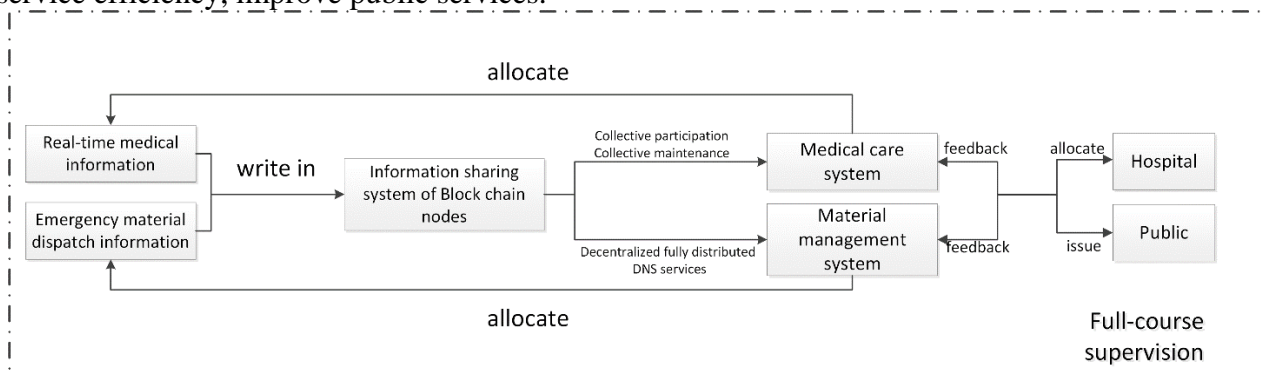

Fig. 2 Public Health Emergency Prevention and Control Mechanism

1)The medical treatment system releases real-time medical information through blockchain, realizing the information sharing among all the staff. In this way, the consultation time is greatly saved, and the public health service and medical service are effectively coordinated and seamlessly

connected, so as to improve the working mechanism of combining prevention and treatment, joint prevention and control.

2)The material management system is an inventory system based on block chain. The demand for medical supplies is listed in detail and presented dynamically according to the number of patients. Block chain record the entire network, the whole process, all transaction data, all data is cut in all nodes and the whole net have them, social material donations and scheduling information more transparent, more traceable data to behavior, to ensure that the important goods and materials management, scheduling and monitoring, so as to ensure the supply of relief supplies during the period of outbreak and reasonable use.

3. Overview of Project Innovation Features

3.1 Blockchain Scenario Application Design

This project uses the new network information technology—blockchain to promote the innovation and improvement of the system and mechanism of major epidemic early warning,　prevention and control measures, which will help further improvement of China's ability to respond to major public health emergencies.

3.2 The Application of Big Data and Econometric Model

The collected data are preprocessed and measured by statistical analysis, chi-square goodness of fit test and variance analysis. ARIMA fitting prediction model, GM(1,1) model, Prophet model and LSTM long and short term neural network model are used to make comparative analysis and prediction of the epidemic situation, so as to judge the epidemic stage from the phenomenon to the essence and provide data support for emergency warning.

3.3 The Construction of Hierarchical Index System

In combination with the current list of public health emergency reports and classification standards, this project constructs a three-level emergency warning indicator system for the identification and capture of suspicious and abnormal indicators in the early warning database system by the big data intelligent monitoring system, so as to further track the epidemic stage and give real-time warning by using the block chain technology.

3.4 The Two Mechanisms Provide New Thinking for Improving the Public Health Emergency Management System

Through the construction of public health emergency early warning mechanism，public health emergency prevention and control mechanism, the two mechanisms can interact and cooperate, providing new ideas for the improvement of public health emergency management system.

4. Implementation Ideas

4.1 Research Framework

4.2 Implementation Idea Description

1) Literature Review and Current Situation Analysis
To review the relevant theories of public health, based on the internal information of the health system, such as disease control, health supervision, medical services, public health emergency reporting system, special monitoring of key infectious diseases and public health supervision and monitoring, and put forward the problems of public health management.
2) Construction of Emergency Warning Index System

Based on case analysis, the key indicators are refined, and a three-level emergency warning indicator system is constructed, as shown in table 1, to judge and evaluate public health events. The application scenarios of

block chain technology are designed in the block body of block chain, and the theoretical analysis framework is constructed based on the spatial path.
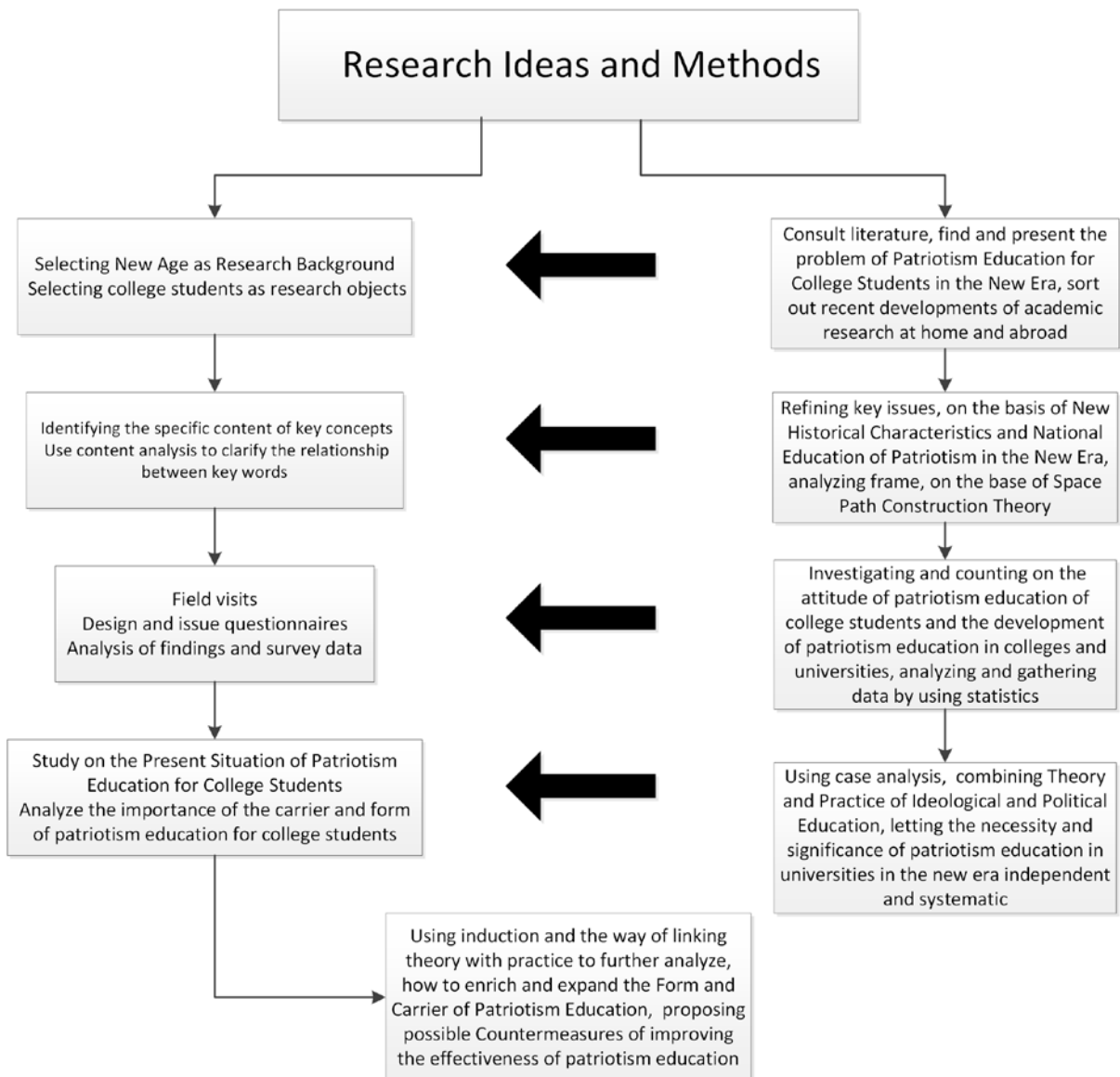

Fig.3 Research Ideas and Methods

Table 1 Emergency warning index system

Level 1 indicators	Secondary indicators	At this stage	Ideal goal
Regional distribution	Involve provinces		
	Diffusion trend		
	Whether there are imported cases in the surrounding area		
Time distribution	Maximum incubation period		
	Area unit average incubation period		
Distribution of disease	The name of the disease		
	Disease types		
	Rare disease		
Population distribution	cases		
	Age distribution of onset		
	The patients' previous medical history		

3) Field Research and Interviews

Online distribution of questionnaires and access to official data; Offline visit hospitals and community health service institutions to investigate and collect specific data.

4) Design and Operate Research Scheme

Block chain and big data are used to design application scenarios for public health emergency warning, prevention and control mechanisms, and test and verify them according to the technical environment.

4.3 Emergency Warning Mechanism

The ethereum blockchain technology is used to create storage records using smart contracts, which generate smart contracts that allow content to be written and deleted according to the constraints in the contracts. Big data intelligent monitoring early warning module uses statistical analysis, chi-square goodness of fit test, variance analysis and econometric analysis on the collected data pretreatment, when abnormal suspicious indicators are caught, it will save the content of cases, and through the ARIMA fitting forecast model and GM (1, 1) model, the Prophet model and LSTM short - and long-term through comparison between neural network model to predict, automatically determine the outbreak phase and displays a warning information, through the block chain network remote warning. The workflow of the public health emergency warning mechanism is shown in Figure 4.

4.4 Public Health Prevention and Control Mechanism

The medical resource information sharing system uses the technology of Consortium blockchain and Hyperledger Fabric, based on the distributed point-to-point network, so as to establish a medical treatment system with collective participation and collective maintenance, realize the medical resource information sharing. The material supply management system uses Hyperledger Composer to create a blockchain application for material management, allocation and monitoring. Block chain technology connects social material donation scheduling and medical material needs through data transmission services between various nodes in the network, and can monitor the status and integrity of material delivery, and whether the data transmitted by the material donation and scheduling institutions have been tampered, thus ensuring the true transparency of material donation and delivery. The workflow of the public health prevention and control mechanism is shown in Figure 5.
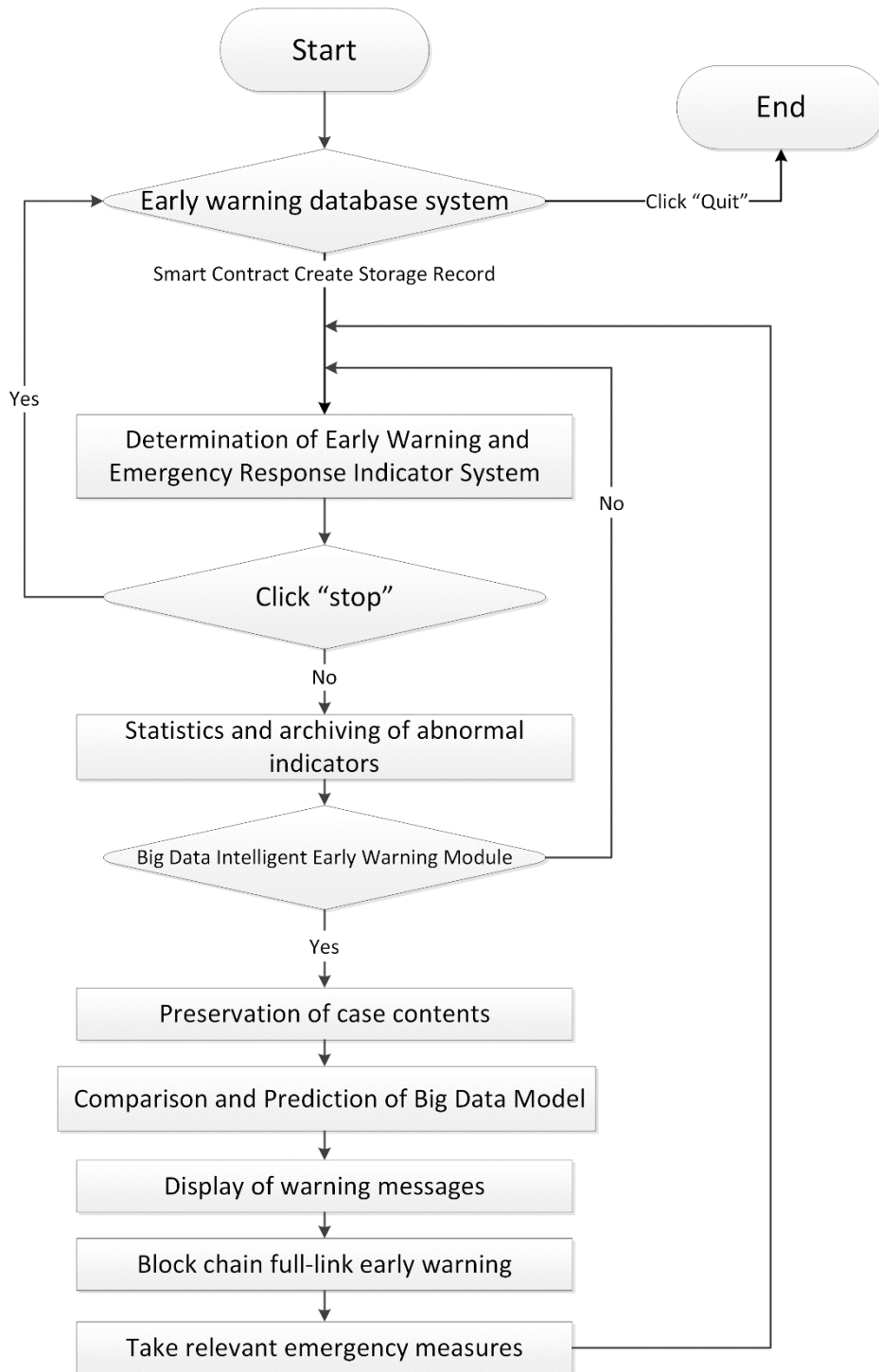
Start

End

Early warning database system — Click "Quit"

Smart Contract Create Storage Record

Yes

Determination of Early Warning and Emergency Response Indicator System

No

Click "stop"

No

Statistics and archiving of abnormal indicators

Big Data Intelligent Early Warning Module

Yes

Preservation of case contents

Comparison and Prediction of Big Data Model

Display of warning messages

Block chain full-link early warning

Take relevant emergency measures

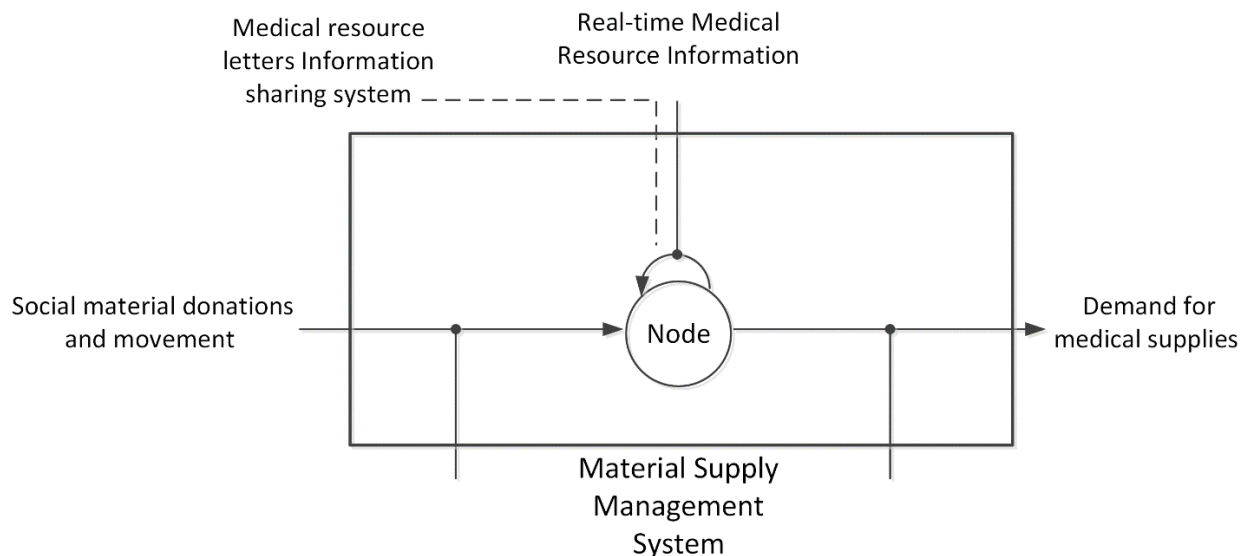Fig. 4 The Workflow of the Public Health Emergency Warning Mechanism

Fig. 5 The working process of public health prevention and control mechanism

5. Conclusions

Through the analysis of the governance of summing up the current public health industry present situation and existing problems in responses to the COVID-19, using a blockchain and big data technology to create intelligent contracts and chain block application, set up based on the technology of "block chain + big data" public health emergency early warning and control mechanisms, further from the system and mechanism innovate the major outbreak early warning, prevention and control measures and improve the level of the ability to deal with major public health emergencies. Combined with the research on public health emergency warning and prevention and control mechanism based on "blockchain + big data" technology, this paper proposes suggestions on the optimization and improvement of China's public health emergency management and prevention and control system at the present stage, hoping to provide reference for the prevention and control of public health emergencies.

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