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RESEARCH ARTICLE

Applying Agile Governance in Urban Smart Healthcare: Insights from Zhengzhou, China

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ABSTRACT

Smart healthcare improves the efficiency and accuracy of medical services, reduces costs, and enhances patient engagement and satisfaction through the adoption of advanced technologies such as artificial intelligence, big data analytics, and the Internet of Things. Agile governance provides healthcare organizations with the flexibility, collaboration, and innovation needed to successfully transition to smart, patient-centric care, thereby delivering greater clinical value and improving patient outcomes. However, current research has not yet fully revealed how agile governance promotes and optimizes urban smart healthcare, and relevant case studies are rare. In this context, using a systematic analytical framework and the medical system of Zhengzhou as a case study, this paper delves into how agile governance enhances urban smart healthcare through improved sensitive perception, rapid response, and coordination and balance mechanisms. The study finds that, through these three aspects of agile governance, the urban medical system can more accurately perceive healthcare needs, respond swiftly to medical events, and effectively coordinate the allocation of medical resources. This improves the accessibility and quality of medical services, meeting the increasingly diverse healthcare needs of residents.

INTRODUCTION

In the context of rapid globalization and technological advancement, social structures and demands are undergoing profound changes. Traditional healthcare cannot meet everyone's needs due to the significant population growth. Despite having excellent infrastructure and advanced technologies, medical services remain inaccessible and unaffordable for many people (Raoof et al., 2022). The substantial rise in the number of individuals with chronic illnesses, including the elderly and disabled, has created an urgent demand for a new and innovative healthcare model (Nasr et al., 2021).To address this challenge, innovative solutions are urgently needed to meet the growing and diverse health demands.

Smart healthcare is an advanced health service system that uses modern technologies like IoT, big data, cloud computing, and AI to transform traditional medical systems, making healthcare more efficient, convenient, and personalized through the use of wearable devices and mobile internet to dynamically access information and connect all stakeholders in the medical ecosystem, facilitating informed decision-making and rational resource allocation (Fan et al., 2016; Ghazal et al., 2021; Tian et al., 2019). Additionally, the integration of big data analysis into healthcare, especially within smart cities, enhances overall quality of life by using data from wearable devices, electronic health records, and social media to comprehensively understand community health needs, leading to targeted interventions, preventive strategies, and optimized resource allocation, thus reducing costs and improving efficiency (Berros et al., 2023). Overall,

smart healthcare represents an advanced stage of information construction in the medical field, characterized by continuous monitoring and treatment, cost reduction, and personalized, timely medical services driven by data (Zeadally et al., 2020). However, smart healthcare also faces a range of challenges across technical, procedural, and management aspects. From a technical perspective, data compatibility and consistency, as well as security and privacy protection, are primary concerns. Security protocols such as blockchain are needed to ensure safe data communication and prevent data breaches and unauthorized access (Sundaravadivel et al., 2017; Zeadally et al., 2020; Raoof et al., 2022). Procedurally, smart healthcare lacks comprehensive guidelines and procedural documents, leading to unclear development goals and inefficient resource allocation. Some smart healthcare technologies are still in experimental stages, requiring substantial funding for maintenance and upgrades, and premature implementation may introduce unknown risks (Tian et al., 2019).

Agile governance enables governments to swiftly respond to social demands in today's dynamic and digital environment, leveraging technological advancements to provide efficient public services. It integrates agile and lean practices with governance capabilities to achieve adaptability, human-centeredness, inclusiveness, and sustainability in policy-making while promoting multi-stakeholder collaboration (Lubinga et al., 2022; Luna et al., 2013; Elmi et al., 2018).

In the realm of smart healthcare, the application of agile governance is crucial as it effectively addresses rapidly changing environments and complex challenges. By adopting modern development approaches, healthcare institutions can swiftly adapt and develop new health solutions, including telemedicine and digital health applications, to meet growing demands. Agile governance emphasizes adaptability, flexibility, and efficient execution, which not only enhances the resilience of healthcare systems against risks but also fosters innovation and continuous improvement, ensuring the success and sustainability of digital transformation. It also strengthens institutional capabilities, organizational development, and employee responsiveness, addressing issues such as service discrimination and inefficiencies in public service delivery, while promoting public interest and welfare through ethical strategies and collaborative relationships (Widyastuti, 2022).

The development of Zhengzhou's smart healthcare adopts an internationally oriented model, focusing on constructing city and district-level platforms using cloud computing and storage technologies. It encompasses three types of smart health cloud services based on electronic medical records and resident health databases: healthcare, public health, and health management. This study employs a system analysis framework, using Zhengzhou's healthcare system as a case study, to explore the application of agile governance in urban smart healthcare. Through an in-depth analysis of sensitive perception, rapid response, and coordination mechanisms, the research aims to reveal how agile governance can enhance the adaptability and efficiency of healthcare systems, optimize resource allocation, and ultimately achieve more efficient healthcare services and higher-quality medical outcomes.

AIGLE GOVERNANCE AND SMART HEALTHCARE

The concept of Agile Governance originates from the "Agile Methodology" in software engineering. Qumer (2007) defined it as an integrated framework that is streamlined, collaborative, and communication-focused, designed to enhance agile business value through economical and adaptable controls, processes, and structures. Luna., et al (2010) further emphasized IT governance within Agile Governance, focusing on ICT infrastructure that supports strategic business objectives. Luna., et al (2014) expanded the definition to encompass a broader scope, describing Agile Governance as the ability of human societies to rapidly and sustainably adapt to environmental changes through the coordinated integration of agile, lean, and governance capabilities. This evolution has extended its application beyond enterprise management to the digital economy, emerging industries, and government sectors. Agile is a recent phenomenon, with most governments still adapting to it. In broader administrative terms, it means efficiently responding to evolving public demands. Agile methods are applied in the redesign and digitalization of public services, integrating internal and external users from the start. Unlike traditional top-down decision-making, agile governance

incorporates feedback from all stakeholders to enhance service delivery efficiency while addressing public values such as fairness and social responsibility (Mergel et al., 2021). Agile governance is characterized by rapid response, user-centeredness, iterative improvement, cross-departmental collaboration, and flexibility, aiming to improve service experience and governance quality through continuous innovation (Li & Teng, 2023; He & Wang, 2023).

Agile governance is critical for public health amidst the disruptions and challenges faced by the healthcare sector. It ensures that healthcare organizations can swiftly adapt to the evolving landscape characterized by new technologies, changing demographics, and external pressures. By fostering adaptability, innovation, and effective leadership, agile governance enables public health entities to maintain resilience, optimize efficiency, and deliver high-quality care in dynamic and uncertain environments. This approach is essential for navigating complexities and ensuring continuous improvement in healthcare service delivery (Widyastuti, 2022). As digital health and its technologies gain traction and healthcare costs rise, healthcare organizations face the imperative to innovate and deliver enhanced value to patients and clinicians. However, their current governance and technological frameworks are typically risk-averse, limiting flexibility for essential transformations. To address these challenges, some healthcare organizations are adopting principles from the Agile Manifesto, akin to practices in the software industry (Kokol, 2022). During the COVID-19 pandemic, health organizations enhanced their agility through innovative technology ecosystems that integrated various information systems to improve governmental decision-making. This integration facilitated better management of the crisis by allowing for rapid adjustments to strategies in response to the evolving situation and the lack of knowledge about the new virus. Agile governance thus enhances the public health system's responsiveness, adaptability, and overall efficiency, ensuring that it can meet the health needs of the population more effectively, both during crises and in regular healthcare delivery (Valentim et al., 2021). When rethinking healthcare for an aging society, the principles of agile governance become especially important. It promotes the rapid integration of innovative technologies such as robotics and sensors to reduce the burden on caregivers and lower healthcare costs. The flexibility and openness to innovation inherent in agile governance enable public health systems to more quickly adapt to the needs of an aging society, providing personalized, high-quality services (Kumorotomo, 2020). Mutiarin., et al (2021) believed that by adopting agile governance in the formulation of public health legislation, responding to public health crises, and addressing emergent issues, the government can enhance service accessibility and efficiency. This approach also improves digital literacy among the public and boosts the responsiveness and adaptability of the public health system, thereby better serving the health needs of the population.

ANALYTICAL FRAMEWORK

Agile governance focuses on strategies to address uncertainties in natural environments and is inherently reactive. Its main goal is to manage changes and complexity in innovation, making both agility and adaptability essential in uncertain situations (Janssen & van der Voort, 2020). It emphasizes swift policy execution and quick responses. Sun & Geng (2023) noted that agile governance should be customer-oriented and responsive, with a focus on both the speed and promptness of response, representing a new paradigm in public service delivery. Emergency governance involves rapid responses and significant government intervention, transitioning from direct control to coordination, collaborative decision-making, and shared value creation, rather than narrow political agendas (Bache & Flinders, 2004; Rahman et al., 2024, Jam et al., 2011). Key concepts in agile governance also include "Collaboration" and "Balance." Collaboration involves multi-party participation, including government, private sectors, NGOs, and citizens, promoting information sharing and dynamic communication. Balance ensures fair stakeholder consideration, resource allocation, and the harmony between short-term needs and long-term sustainability. It includes risk management and policy consistency to prevent conflicts and ensure coordination. Strengthening interdepartmental collaboration and decision-making responsibilities is crucial, and formalizing these practices can enhance their value and synergy (He & Wang, 2023). Rong (2022) suggested that the implementation of agile governance relies on three core mechanisms, which

progress sequentially in terms of time and conditions: the sensitive perception mechanism is responsible for early identification and diagnosis of issues; the rapid response mechanism swiftly takes action and provides feedback upon issue confirmation; and the coordination and balance mechanism provides necessary platform and technological support to ensure governance processes are both agile and orderly, avoiding hasty responses.

It can be seen from Fig 1 that the sensitive perception mechanism enhances public health governance by providing capabilities for rapid response and precise decision-making through real-time monitoring and data analysis. It plays a critical role not only in disease surveillance and control but also in fostering coordination and collaboration among various departments within the public health system. The rapid response mechanism is at the core of agile governance, crucial for enhancing government adaptability and building public trust. In the field of public health, this mechanism uses digital transformation to create public value while ensuring fairness and accessibility of public services. In advancing digital transformation, governments adopt a citizen-centric approach, design widely applicable interactive interfaces, and retain traditional service methods to meet the public service needs of all citizens, including vulnerable groups. The coordination and balance mechanism in public health ensures the equitable balancing of interests among stakeholders and sustainable operation of processes. Through integrated operational systems spanning departments, hierarchies, and regions, this mechanism optimizes collaborative response processes and integrates systems and platforms. It facilitates unified deployment, standardization, and authorization, and develops application scenarios tailored to different roles' needs. In public health, the coordination balance mechanism enhances governance entities' decision-making and response capabilities. By prioritizing subordinate principles, fostering collaborative linkages, and shaping platform integration processes, it strategically supports agile governance. This ensures swift responses of public health policies and services to societal needs and challenges, achieving effective management and service optimization. It enhances the adaptability and innovation of public health systems, ultimately promoting improved public health and well-being. In smart healthcare, this mechanism promotes inter-departmental and inter-institutional cooperation to effectively allocate and utilize medical resources. It establishes a unified medical information platform to facilitate data sharing and business coordination among healthcare institutions, insurance companies, pharmaceutical suppliers, and other stakeholders.

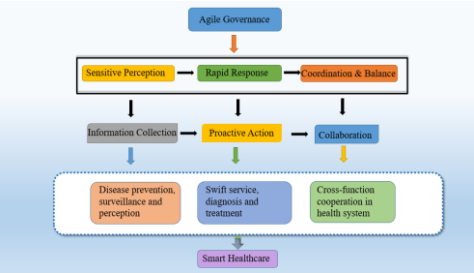

Fig 1. Analytical Framework of Agile Governance's Advancement to Smart Healthcare

CASE ANALYSIS FROM THE PERSPECTIVE OF AGILE GOVERNANCE

Smart Healthcare in Zhengzhou

Since the introduction of the "Internet Plus" action plan at the 2015 in China, "Internet plus Healthcare" has become one of the first industries to launch. Up to present, the National Telemedicine and Internet Medical Center of China has conducted an annual average of over 5,000 remote consultations for complex cases, saving grassroots patients more than 70 million yuan in medical costs. By implementing the primary physician team system, the center has reduced the scheduled consultation appointment cycle from 7 days to 2 days. For critical and severe cases, consultations are responded to immediately and completed within 2 to 4 hours, while emergency rescues can establish a remote collaborative information channel within 30 minutes. "Internet plus Nursing," artificial intelligence-assisted diagnostic systems, and 5G networks have become buzzwords in the healthcare field. As the application of "Internet Plus" in healthcare and health

services continues to deepen, the public enjoys more convenient and higher-quality medical services, experiencing more precise and intelligent health and chronic disease management. Since April 12, 2018, China has successively passed the "Opinions on Promoting the Development of Internet Plus Healthcare," and issued supporting documents such as the "Internet Diagnosis and Treatment Management Measures," "Internet Hospital Management Measures," and "Telemedicine Service Management Specifications."

Zhengzhou City in He'nan Province stands as one of the pioneering cities in China's initiative to establish a national smart city. With a concentrated effort on the domain of smart healthcare within He'nan Province as new model of a smart city, the integration of "Internet + medical health" is being propelled. Fig 2 presents the general framework of smart healthcare system in Zhengzhou. In pursuit of the objectives such as the interconnection of medical and health data, emphasis on demand, secure data sharing, and assistance in decision-making analysis, the Zhengzhou Comprehensive Health Information Platform has been successfully constructed. A standardized system for health and epidemic prevention information data in Zhengzhou's health sector has been instituted. As of now, it has integrated with 33 secondary-level or above public hospitals across the city, where patients' in-hospital medical records and health information are uploaded to this platform. The platform has accumulated over 2.1 billion data entries, concerning the health information of more than 4.22 million individuals.

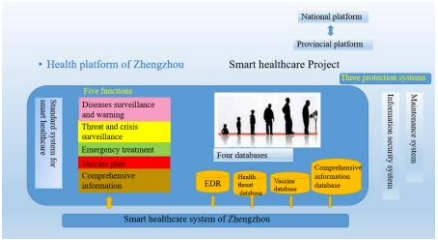

Fig 2. General Framework of Smart Healthcare System in Zhengzhou

(Cited from Chen[32])

Case Analysis Based on Sensitive Perception Mechanism

In agile governance, sensitivity pertains to the capability to swiftly address changes and uncertainties in the environment. It involves the proactive identification of potential risks and vulnerabilities and adjusting governance processes to minimize their effect on project results. Smart healthcare refers to the integration of advanced technologies into the healthcare system to improve the quality, efficiency, and accessibility of healthcare services, of which the wearable technology is one of the key components. In Zhengzhou, smart healthcare has been extensively implemented, in particular, for the senior citizens.

Smart Yellow Wristband

On May 20, 2017, the first "Smart Yellow Wristband" designated distribution agency in Henan Province was officially inaugurated at Zhengzhou People's Hospital. This marked a significant advancement for Zhengzhou in the fields of smart healthcare and smart elderly care. The introduction of the Smart Yellow Wristband has provided Alzheimer's disease (senile dementia) patients with enhanced safety and brought peace of mind to their families.

The Smart Yellow Wristband exemplifies the sensitive perception mechanism in agile governance through its real-time location tracking and one-touch SOS emergency call functions. The real-time location tracking feature allows family members to dynamically monitor the elderly person's whereabouts, quickly identifying any potential risks of them going missing, and enabling timely intervention and response. This immediate feedback and processing of location data demonstrate a rapid sensing capability of environmental changes. On the other hand, the one-touch SOS emergency call function enables elderly individuals to instantly send a distress signal in case of an emergency, ensuring swift assistance in crisis situations. This design reflects a sensitive perception and rapid response mechanism to sudden events,

significantly enhancing the safety of the elderly and showcasing agile governance's efficient handling of elder safety issues.

EDR (Electronic Disease Record) in Zhengzhou

The Electronic Disease Record (EDR) is a pivotal component of the Zhengzhou Smart Public Health Project, designed to support person-centered disease control business concepts. It utilizes information technology to enhance the quality, efficiency, and standardization of disease control operations. The EDR system is built on the regional health platform electronic health records (EHR) to facilitate a dynamic management approach that addresses the fragmentation of information, the blockage of business processes, and the compartmentalization of work.

The implementation of the Electronic Disease Record (EDR) system has significantly enhanced the efficiency of public health services across various aspects. The implementation of the Electronic Disease Record (EDR) system in the Zhengzhou Smart Public Health Project exemplifies the sensitive perception mechanism in agile governance. It can be seen from Fig3 that, firstly, the system has strengthened the monitoring of epidemics through real-time surveillance and early warning, which not only improves the scientific basis of government decision-making but also ensures the timeliness of preventive and control measures, allowing the government to promptly adjust public health measures. It supports comprehensive health management from hospitals to community services and achieves full traceability of vaccines, ensuring safety and effectiveness. Secondly, by transforming the reporting process from single-disease to multi-disease reporting centered on individuals, the EDR system has effectively reduced the workload of medical staff and improved the efficiency of work processes. Additionally, the system supports comprehensive life-cycle health management, establishing a coherent health management system that spans from hospitals to community services. In terms of vaccine management, the EDR system has achieved full traceability of vaccines, ensuring the safety and effectiveness of vaccinations. Lastly, through mobile applications, the public has access to convenient online health services, including inquiries, consultations, and appointment scheduling, which significantly improve the efficiency and quality of public services. Overall, the EDR system demonstrates how agile governance uses sensitive perception mechanisms to optimize the responsiveness and quality of public health services.

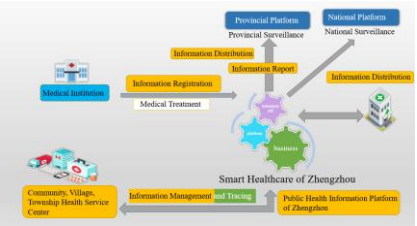

Fig 3. Electronic Disease Record Workflow (Cited from Chen et al., 2020)

Case analysis based on Rapid Response Mechanism

Rapid response are crucial in smart healthcare. Implementing rapid response can reduce hospital mortality rates and in-hospital cardiac arrest incidents. By early identification of clinical deterioration, rapid response enables medical teams to act quickly, preventing severe complications, especially in non-intensive care settings. Integrating rapid response with smart healthcare technologies allows for real-time monitoring and data analysis. Utilizing electronic health records and advanced analytics, healthcare providers can better track patient vitals and activate the rapid response team based on predefined criteria. Furthermore, it fosters collaboration among diverse healthcare professionals, which is essential in smart healthcare environments to ensure swift responses to patient needs.

The Application of "Zhenghaoban App"

The "Zhenghaoban App" is a convenience service application launched by the Zhengzhou municipal government. It integrates various governmental and lifestyle services, aimed at improving citizen efficiency

and convenience through digital means. Zhengzhou has accelerated the residents' health information sharing mechanism, launching the "Manage All Things on One App" initiative in the medical and health field, among the 19 items already available on the "Zhenghaoban App", six of them belong to public health. Integration of physician, nurse, and medical institution information with the app and Zhengzhou Municipal Government Service Network has eliminated the redundancy of data entry by approval staff. Leveraging the digital resident health platform, the app offers various convenient health services such as "electronic health cards, family doctors, medical maps, vaccine scheduling, birth certificates, health records," etc., presenting public health, medical resources, vaccine schedules, birth certificates, and other public concerns in a unified format for easy access. Through data sharing and utilizing the electronic health record browser, our city's hospitals (including grassroots medical institutions) allow medical staff to access all patient visit information in hospitals of Zhengzhou upon patient authorization, facilitating comprehensive access to the National Health Information Platform.

According to search results, Zhengzhou's resident population at the end of 2023 was 12.828 million, with approximately 100,000 births annually. This indicates a large number of procedures required for newborn registrations. Prior to the introduction of the newborn registration feature on the "Zhenghaoban App", citizens had to go through a series of scattered and time-consuming procedures for handling newborn-related administrative tasks. These procedures involved multiple administrative agencies, such as public security, social security, hospital and medical insurance center. Citizens had to personally visit these agencies to submit paper applications and fill out lengthy registration forms. This process not only posed a challenge to time efficiency but also increased administrative burdens due to information silos, where citizens often had to provide the same information to different agencies, leading to data inconsistencies. Furthermore, the lack of an integrated feedback mechanism made it difficult for citizens to track the progress of their applications in real-time, resulting in insufficient transparency and increased uncertainty. The extensive use of paper documents also placed a burden on the environment and increased the security risks associated with storing and transmitting personal information. Overall, the traditional newborn registration process exhibited significant deficiencies in terms of efficiency, convenience, information security, and user experience, necessitating optimization through technological innovation and service integration. The newly introduced "Newborn Registration" function is widely welcomed, facilitating household registration, insurance registration, birth certificate and social security card application simultaneously through data exchange with public security, social insurance, hospitals and medical insurance departments, greatly enhancing convenience for the public. As can be seen from Fig 4, it is a comprehensive and cross-functional system, where one click in the system will initiate the data exchange and sharing among four different departments, thus handling four registrations in one platform, which is timesaving and cost saving for citizens.

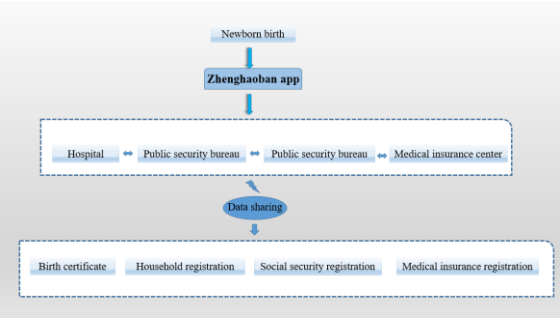

Fig 4. Diagram for Certificates of Newborn Birth (New System)

Agile governance is a framework designed to align customer-focused objectives with agile practices within an organization. This model of governance prioritizes adaptability, openness, and the delegation of decision-making authority to teams, enabling them to respond effectively to customer needs (Buresh, 2008)[27]. The

"Smart Healthcare" section, launched on the "Zhenghao ban" homepage under the "Smart City" column, provides comprehensive health services to citizens through features such as the electronic health card, family doctor services, examination and test records, medical maps, and vaccination records. These features demonstrate agile governance's rapid response mechanism within the urban healthcare system. The introduction of the electronic health card simplifies the medical process, allowing citizens to use their electronic health code to access services at 61 medical institutions, significantly improving convenience by enabling "code-based" and "card-free" visits. This move showcases agile governance's quick response in enhancing service efficiency. The family doctor function enables citizens to quickly sign up at primary healthcare institutions for services like elderly check-ups, diabetes, and hypertension follow-ups, with the "no waiting for minor illnesses, immediate service upon signing" model highlighting agile governance's flexibility in resource allocation, reducing wait times, and improving service timeliness. The examination and test record feature allows citizens to view all their examination and test records from medical institutions throughout the year, facilitating self-health management and providing valuable references for physicians, thus enhancing the convenience and effectiveness of health management and reflecting agile governance's swift response in information sharing. Additionally, the vaccination record function enables parents to plan their children's vaccination schedules in advance, improving the standardization and timeliness of vaccinations and further optimizing public health services. These functionalities collectively illustrate agile governance's ability to rapidly adjust and optimize services in the urban healthcare and public health sectors.

Case analysis based on Coordination and Balance Mechanism

By officially recognizing cross-departmental collaboration, overall efficiency and effectiveness are improved, promoting an open attitude towards agile transformation and demonstrating the critical role of collaboration in agile governance (Mergel, 2023). Agile coordination structures adopt horizontal networks to lessen dependency on hierarchies and address horizontal administrative divisions. Empowering local teams and individuals to make on-the-ground decisions in urgent situations ensures that responses are tailored to the latest time-sensitive information available (UCLG CGLU, 2021).

New 120 Emergency Response Model –"Admission Upon Boarding"

In emergency medical care, accurately determining the patient's specific location and condition is critical to the effectiveness of the treatment. However, due to information asymmetry and a lack of real-time data, the golden window for rescue is often missed, posing a major challenge for the current emergency system. Modern medicine is increasingly specialized, which can lead to fragmented care and poor communication between departments, wasting time and potentially worsening the patient's condition. The application of smart medical technology provides a new solution to this problem, enabling rapid diagnosis and multidisciplinary comprehensive treatment in the shortest possible time.

Smart healthcare integrates various information technologies and medical resources to achieve real-time monitoring and analysis of the patient's location and condition. In this new model, when an ambulance receives an emergency call, the smart medical system quickly acquires the patient's precise location and initial condition assessment. Based on this real-time data, the system can automatically recommend the most suitable hospital and guide the ambulance along the fastest route. As soon as the patient boards the ambulance, the smart medical system begins interfacing with the hospital's emergency response system, transmitting the patient's basic information and condition data in advance. This allows the hospital to prepare in advance, open a green channel, and ensure that the patient receives immediate care upon arrival. Practice in Zhengzhou has shown that the application of smart medical technology significantly improves emergency response efficiency, as the patient has completed part of the admission process during transport, greatly reducing wait times.

In November 2020, a young girl was struck by a speeding truck, resulting in multiple injuries, severe bleeding, and unconsciousness. Due to the severity of her injuries, both the local hospital and Zhengzhou Central Hospital dispatched ambulances for rapid transport. Upon her arrival at Zhengzhou Central

Hospital, she was immediately taken to the ICU through the green channel. As can be seen from Fig 5, four departments including the urology department, the obstetrics department, the hepatobiliary surgery department and the orthopedics department performed a multidepartment information sharing and cooperation, and after the multidisciplinary care, she was off the ventilator and transferred to a general ward within five days.

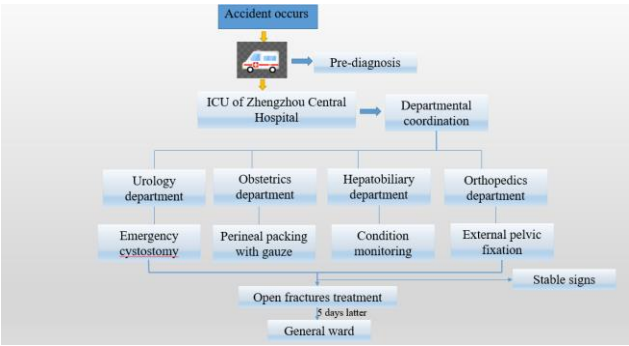

Fig 5. Diagram for New 120 Emergency Response

Agile governance, through its coordination and balance mechanism, integrates various information technologies and medical resources to achieve real-time monitoring and analysis of patient location and condition. Upon receiving an emergency call, the intelligent medical system quickly acquires the patient's precise location and initial condition assessment. By utilizing open data and transparent processes, it transmits this data in real-time to relevant medical institutions, ensuring that the ambulance delivers the patient to the most suitable hospital in the shortest time possible. As soon as the patient is onboard, the intelligent medical system begins interfacing with the hospital's emergency handling system, pre-transmitting the patient's basic information and condition data. This ensures that the hospital is prepared in advance, opens a green channel, and achieves seamless cross-departmental collaboration. This mechanism not only significantly reduces the patient's waiting time and improves treatment efficiency but also helps the hospital quickly assess risks, allocate resources reasonably through real-time data analysis, and ensure the patient receives the most appropriate treatment. This guarantees the optimal use of resources and achieves a balance between short-term needs and long-term sustainability.

Telemedicine Center

Telemedicine revolutionizes traditional medical practices by allowing patients to receive healthcare services through telecommunication. This innovation fosters new relationships between smaller and larger hospitals and between patients and hospitals in general. Teleconsultation, telediagnosis, and telemonitoring enable patients and smaller hospitals to leverage the resources of larger medical institutions. This is especially beneficial for those in rural areas where healthcare infrastructure is less advanced than in urban centers (Wang & Gu, 2009). According to Khodadad-Saryazdi (2021), telemedicine offers numerous advantages for the healthcare system, patients, and healthcare professionals. It can significantly expand healthcare services to rural areas, improve access to specialized medical care, and enable remote monitoring and home care for patients. This technology not only enhances the quality and reach of healthcare but also promotes more efficient use of medical resources, reduces the burden on healthcare facilities, and supports continuous patient care outside traditional clinical settings. Furthermore, telemedicine can lead to better health outcomes by facilitating timely interventions and fostering a more proactive approach to health management.

Established based on tiered diagnosis and treatment, Zhengzhou Central Hospital's Telemedicine Center has developed over 8 years into a new healthcare ecosystem represented by three main services: remote electrocardiogram diagnosis, remote imaging diagnosis, and remote consultations. In the first quarter of 2021, there were 197 cases of remote consultations conducted. The remote electrocardiogram serves 73 medical consortium units, conducting a total of 40,959 regular electrocardiogram remote diagnoses.

Additionally, the remote imaging service collaborated with 57 medical consortium units, conducting 24,035 remote imaging diagnoses in the first quarter. The mechanism of agile governance is also fully reflected in telemedicine, which significantly enhances the accessibility of medical services, enabling patients in remote or hard-to-reach areas to receive high-quality medical care and reducing geographical and economic barriers. By facilitating remote consultations with experts, it optimizes the allocation of medical resources and alleviates the burden on urban hospitals. This process embodies the collaborative mechanism of agile governance, achieving efficient use of medical resources through multi-party cooperation and information sharing. The Telemedicine Center improves efficiency and reduces costs by facilitating rapid assessment and diagnosis, promoting collaboration between medical institutions, and reducing unnecessary hospital visits and repeat examinations. This mechanism not only enhances the adaptability and flexibility of medical services but also improves the accuracy and timeliness of medical decisions through dynamic communication and real-time feedback. This reflects a balance between short-term needs and long-term sustainability. The normalization of telemedicine improves service accessibility and quality, optimizes resource allocation, reduces costs, increases patient satisfaction, and brings significant social and economic benefits. This balancing mechanism ensures the fair distribution and effective utilization of medical resources, meets the medical needs of different regions and groups, and achieves the long-term sustainable development of medical services.

CONCLUSION

This study explores the catalytic role of agile governance in smart healthcare, using Zhengzhou's healthcare system as a case study. It demonstrates how agile governance, characterized by rapid response, user-centeredness, iterative improvement, cross-department collaboration, flexibility, and innovation, effectively responds to rapidly changing environments and complex challenges. The integration of traditional healthcare systems with modern technology in Zhengzhou shows significant potential, optimizing healthcare resource allocation, improving service efficiency, and enhancing patient experience through initiatives. Future research should examine the economic feasibility, cost-effectiveness, and long-term impact of smart healthcare technologies, explore strategies for cross-departmental data sharing and privacy protection, and integrate emerging technologies like AI and machine learning to enhance medical services further. These efforts will guide the development of smart healthcare and agile governance, fostering innovation and continuous improvement in medical services.

Author contributions

Zhao Lin wrote the first draft of the manuscript. Dr. Rizal contributed to manuscript revision, read, and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Ethics approval

Not applicable.

Ethics statements

Patient consent for publication

Not applicable.

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Not applicable.

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