Research on the Planning of an Intelligent 5G Remote Medical Information System for a Large Hospital in a Certain City

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Abstract
Driven by the "Healthy China 2030" strategy and the new medical reform policies, large hospitals are facing problems such as difficulties in sinking high-quality medical resources, inconvenience for patients in remote areas to seek medical treatment, and low efficiency of remote treatment for emergency diseases. Taking a third-class A general hospital in a certain city as the research object, this paper combines its characteristics of a wide service coverage radius (including 12 districts and counties), high demand for primary referral, and urgent need for emergency response to public health emergencies to plan and construct an intelligent telemedicine information system based on 5G technology. With "5G + AI + medical data interconnection" as the core, the system integrates four core functional modules: remote consultation, remote surgical guidance, remote monitoring, and emergency rescue command, solving the pain points of traditional telemedicine such as "high latency, poor image quality, and poor data interaction". Through technical feasibility demonstration and benefit calculation, the research shows that the system can shorten the response time of cross-regional remote consultation to within 3 minutes, increase the accuracy of difficult case referral in primary hospitals by 60%, and achieve 100% coverage of remote guidance for emergency rescue. It provides a implementable planning plan for large hospitals to build a "regional medical collaboration network" and helps realize the equalization of high-quality medical resources.
Keywords: Large Hospitals; 5G Technology; Telemedicine; Information System Planning; Medical Resource Collaboration

1 Introduction

1.1 Research Background

Currently, the uneven distribution of medical resources in China is a prominent issue. According to the "2024 China Health Statistics Yearbook", Class III-A hospitals, which account for only 12% of the total number of hospitals nationwide, undertake 45% of the diagnosis and treatment tasks for difficult and severe cases. Meanwhile, the proportion of senior physicians in primary-level hospitals in remote counties is less than 8%, leading to the widespread phenomenon of "serious diseases requiring treatment in provincial capitals and minor illnesses involving long queues" [1]. At the same time, sudden public health emergencies (such as urgent case referrals and disaster medical rescue) impose higher requirements on the "real-time and stability" of telemedicine. Traditional telemedicine systems based on 4G or fiber optics, due to latency (typically>100ms) and bandwidth limitations, cannot meet the needs of high-frequency interactive scenarios such as remote surgical guidance and real-time transmission of vital signs.

The "Announcement on the Acceptance Results of the 5G+ Healthcare Application Pilot Project" jointly released by China's Ministry of Industry and Information Technology and National Health Commission in 2023 clearly outlined the target: "By 2025,5G coverage in secondary and above hospitals should exceed 90%, with telemedicine services reaching all county-level medical consortia" [2]. Against this

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policy backdrop, a major city hospital serving as a regional medical hub urgently needs to develop an intelligent telemedicine information system compatible with 5G technology, addressing challenges in coordinating medical resources.

1.2 Research Significance

1.2.1 Theoretical Significance

This study pioneers the integration of 5G's core capabilities—low latency (<1ms), massive bandwidth (10Gbps), and massive connectivity (1 million devices/km²)—with telemedicine's clinical application requirements. By developing a three-dimensional alignment model encompassing technology, functionality, and real-world scenarios, it bridges the gap in existing research where technical specifications dominate over medical context adaptation. Furthermore, through analyzing system data security frameworks and regional healthcare collaboration mechanisms, the research provides fresh theoretical perspectives for strategic planning in the 5G+ healthcare sector.

1.2.2 Practical Significance

For target hospitals, the system extends their medical service coverage by distributing high-quality resources to primary-level hospitals in surrounding districts and counties, thereby alleviating pressure on their own facilities. For patients at the grassroots level, it enables access to expert consultations from tertiary hospitals without long-distance travel, reducing healthcare costs. For regional medical systems, the system establishes a three-tier telemedicine collaboration network (city-county-township) to enhance overall public health emergency response capabilities, including remote screening of infectious diseases and disaster medical rescue guidance.

1.3 State of Research at Home and Abroad

1.3.1 State of research abroad

International 5G telemedicine research has entered the stage of practical implementation. In 2022, Seoul National University Hospital in South Korea achieved "5G + remote robotic surgery" by controlling a surgical robot via 5G networks to perform laparoscopic cholecystectomy, with latency controlled within 0.8ms and a success rate of 98.5%[3]. The "5G remote monitoring system" developed by Johns Hopkins Hospital in the United States can transmit real-time ECG and ventilator data of critically ill patients, enabling cross-continental expert guidance. Its core advantages lie in "multimodal data fusion transmission" and "AI-assisted anomaly early warning" [4]. However, foreign systems often rely on unified medical data standards (such as HL7 and FHIR), which lack compatibility with China's medical data privacy protection policies (such as the Personal Information Protection Law).

1.3.2 State of domestic research

Domestic research has focused on "5G+regional medical collaboration". For instance, the "5G Telemedicine Platform" jointly developed by Guangdong Provincial People's Hospital and China Mobile covers 21 county-level medical consortia, enabling remote consultations and image analysis. However, system stability remains to be optimized in high-concurrency scenarios (such as simultaneous consultations across multiple sites during public health emergencies)[5]. The "5G+Emergency Rescue System" developed by the Second Affiliated Hospital of Zhejiang University School of Medicine can transmit vital signs data of casualties via drones, but has yet to establish a complete closed-loop remote service covering "pre-hospital emergency care-in-hospital diagnosis and treatment-post-hospital rehabilitation" [6].

In summary, domestic and international studies have validated the feasibility of 5G technology in telemedicine. However, given the characteristics of China's large hospitals—wide service coverage,

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strong demand for grassroots collaboration, and high data security requirements—how to build an intelligent telemedicine system with "full scenario coverage, full data interoperability, and comprehensive security protection" remains a key challenge for current research breakthroughs.

1.4 Research Methods and Technical Routes

1.4.1 Research Methodology

1. Literature research method: sort out the domestic and foreign 5G telemedicine related literature and policy documents, and clarify the theoretical basis and technical standards of system planning.
2. Field research method: Conduct field visits to the target hospital (including 3 branch hospitals and 8 counterpart support primary-level hospitals), interview clinical experts (30), primary-level medical staff (50), and patients (200 cases) to clarify the system functional requirements and pain points in the scenario.
3. Feasibility analysis method: The feasibility of the system implementation is demonstrated from three dimensions: technology (5G network coverage, equipment compatibility), economy (construction cost, operation income), and policy (data privacy protection, medical qualification).

1.4.2 Technical Approach

1. Comprehend policies and literature, analyze the current situation of domestic and foreign research, and determine the core research issues;
2. Investigate the needs of target hospitals and primary medical institutions, and clarify the application scenarios and functional pain points of the system;
3. Design system architecture, core modules and technical solutions, and formulate data security and collaboration mechanisms;
4. Carry out feasibility demonstration, put forward system implementation steps and safeguard measures;
5. Summarize the research results, predict the application benefits and optimization direction of the system.

2. Remote medical care status and demand analysis in target hospitals

2.1 Basic Information of Target Hospital

The target hospital is the only Grade III-A general hospital in the city, serving a population of approximately 8 million. It has 45 clinical departments and 20 medical technology departments, with the Cardiovascular Medicine Department, Neurosurgery Department, and Critical Care Medicine Department being provincial key specialties. The hospital currently operates a telemedicine system built on 4G networks, which only supports basic video consultation functions. Its services cover 8 county-level hospitals and 32 township health centers. However, in 2024, remote consultations accounted for merely 3.2% of total medical services, significantly lower than the national average for Grade III-A hospitals (8.5%) [7].

2.2 Pain point analysis of existing telemedicine models

Through field investigation, it is found that the existing telemedicine system in the target hospital has the following core problems:

1. Network performance limitations: With an average latency of 120ms in 4G networks, scenarios like remote surgical guidance and real-time ultrasound examinations frequently experience frame stuttering and operation delays, causing 23% of remote medical consultations to be interrupted due to "poor experience". Additionally, high-definition imaging data (approximately 500MB per file) uploaded from primary hospitals via CT and MRI scans requires 20-30 minutes for transmission,

significantly reducing diagnostic efficiency.

2. Incomplete functional coverage: The current system only supports "video consultation + basic medical record transmission", lacking core functions such as remote monitoring (e.g. real-time vital signs monitoring for chronic patients), emergency rescue guidance (e.g. remote diagnosis during ambulance transportation), and remote surgical demonstration, which cannot meet the "multi-scenario, full-process" medical needs of primary hospitals.

3. Inadequate data interoperability: The lack of unified data standards between target hospitals' HIS, EMR, and LIS systems and primary healthcare facilities necessitates manual data entry and medical record uploads during teleconsultations, with 40% of procedures requiring manual input. Furthermore, inadequate data privacy protections expose sensitive patient information (e.g., infectious disease histories) to transmission risks, resulting in 15% of patients refusing remote consultations due to "privacy concerns" [8].

4. Delayed emergency response: During public health emergencies (e.g., mass casualty treatment in traffic accidents), the current system cannot enable "simultaneous consultation across multiple sites". Expert guidance must be communicated individually via phone, with an average response time of 45 minutes, missing the optimal treatment window (e.g., the golden hour for brain injury treatment is within 1 hour).

2.3 System Requirements Analysis

2.3.1 Functional Requirements

Based on the research results, the system needs to meet the functional requirements of four types of users, namely, "target hospital, primary medical institution, patient, and management", as follows:

● Target hospital end: High-definition remote consultation (supporting 4K resolution and simultaneous access of multiple experts), remote surgical guidance (real-time transmission of surgical field with operation marking), remote image review (high-definition images loaded in seconds with AI-assisted diagnosis), and emergency rescue command (real-time multi-site coordination with dynamic casualty updates).

● Primary healthcare institutions: One-click patient data upload (integrating with local HIS systems), remote monitoring data transmission (supporting devices like blood glucose meters and ECG monitors), remote instructional learning (live surgical broadcasts and case discussions), and referral scheduling (prioritizing expert appointments and diagnostic resources at target hospitals).

● Patient-side: Remote consultation booking (select department/expert, schedule appointment), home monitoring (wearable device data automatically uploaded, abnormal warning), diagnosis report inquiry (remote consultation conclusion, examination results pushed in real time), health consultation (online answer medication, rehabilitation questions).

● Management Console: Remote medical data analytics (consultation volume, success rate, department distribution), resource management (expert scheduling, equipment utilization), quality control (medical record archiving, satisfaction assessment), and emergency response (one-click activation of multi-site collaboration for public health emergencies).

2.3.2 Non-functional requirements

1. Performance requirements: Network latency <1ms, bandwidth support ⩾1Gbps, HD video transmission (1000MB) <10 seconds, system support for ⩾500 concurrent users (support for 50 remote sites to conduct remote diagnosis and treatment simultaneously).

2. Security Requirements: Comply with the Data Security Law and Personal Information Protection Law. Implement data transmission encryption (using China's national cryptographic algorithm SM4),

access control with tiered permissions (expert/primary care physician/patient), and full-process operation logging (retained for at least 5 years).

3. Compatibility Requirements: The system must support integration with existing HIS, EMR, and LIS systems (compatible with HL7, FHIR, DICOM3.0 standards), and be compatible with common monitoring devices (e.g., Mindray and Philips monitors) and imaging equipment (GE and Siemens CT scanners) used in primary care hospitals.

3. Smart 5G Telemedicine Information System Planning for a Major City Hospital

3.1 System Design Principles

1. Scenario-oriented principle: Starting from the four core scenarios of "remote consultation, remote surgical guidance, remote monitoring and emergency rescue", the system functions are highly matched with the actual medical needs.

2. Advanced Technology Principle: The system adopts 5G standalone (SA) mode and integrates AI, cloud computing, and edge computing technologies to ensure leading performance, meeting future telemedicine upgrade requirements for the next 3-5 years.

3. Security compliance principle: Data security is integrated into the whole process of system design, in line with the regulations on medical data privacy protection, and risks of data leakage and abuse are avoided.

4. Scalability Principle: The system architecture adopts a modular design, supporting the addition of new features (such as remote rehabilitation guidance and AI-assisted medication recommendations) and expanding service coverage (such as adding access to primary-level hospitals).

3.2 System Architecture

Based on the concept of "hierarchical design, centralized control, and distributed deployment", the overall system architecture is divided into five layers, from bottom to top, namely, infrastructure layer, network transmission layer, data layer, application layer, and user layer, as follows:

3.2.1 Infrastructure layer

- 5G network infrastructure: In collaboration with local operators, 455G SA base stations will be deployed in target hospitals and primary care facilities to achieve full 5G coverage in service areas. Additionally, 5G indoor distribution systems (DAS) will be installed in critical areas including operating rooms, ICUs, and emergency departments to ensure stable network signals.
- Hardware equipment: The target hospital is equipped with remote surgery guidance robots (e.g., Da Vinci Xi), 4K ultra-high-definition cameras, and high-definition imaging workstations; primary hospitals are equipped with standardized remote diagnosis and treatment terminals (including video capture devices and imaging transmission modules); patient devices include smartphones, smart wristbands, and home monitoring devices.
- Computing resources: Adopting a "cloud + edge" hybrid deployment model, the core database and management system are deployed in the cloud (hospital data center), while edge computing nodes are deployed at the edge (local in primary hospitals) to achieve localized preprocessing of high-definition images and low-latency real-time data transmission [9].

3.2.2 Network Transport Layer

The core uses 5G SA network and combines the following technologies to ensure transmission performance:

- Network slicing technology: Assigns dedicated 5G network slices (with guaranteed bandwidth of 1 Gbps) to telemedicine systems, isolated from regular civilian networks, ensuring low latency and

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high reliability (Quality of Service (QoS) ⩾99.99%) for medical data transmission [10].
● Edge computing technology: Computing resources are deployed at the edge node of the primary hospital to compress the uploaded high-definition images (from 500MB to 50MB) and preprocess the real-time monitoring data locally (such as screening abnormal values), reducing the amount of data transmission and latency.
● Data encryption transmission: The "end-to-end encryption" mechanism is adopted. The diagnosis and treatment data (video, image, medical records) are encrypted and transmitted through the national encryption algorithm SM4. The key is centrally managed by the hospital data center to prevent data theft and tampering during transmission.

3.2.3 Data Layer

Build a unified data center to solve the problem of data islands, including:
● Data collection: The system interfaces with target hospitals 'HIS, EMR, LIS systems and primary healthcare institutions' information systems to gather patient profiles, medical records, test reports, and imaging data. It also integrates data from wearable devices (e.g., heart rate, blood glucose levels) and emergency response data (e.g., casualty positioning, vital signs) at rescue sites.
● Data standardization: Utilizing the HL7 FHIR international medical data standards, we structure unstructured data (e.g., handwritten medical records) and semi-structured data (e.g., PDF reports), while standardizing data formats and codes (e.g., ICD-10 disease codes, LOINC test item codes).
● Data Storage and Management: Utilize distributed databases (e.g., Hadoop) to store massive data (with an estimated initial volume of 50TB), while establishing a dual-layer backup system (local and remote disaster recovery) to ensure data security and availability. Patient-sensitive information such as names and ID numbers is processed through data anonymization technology to comply with privacy protection requirements.

3.2.4 Application Layer

The application layer serves as the core functional component of the system. It constructs four core application modules based on resources provided by the data middle platform.
1. Teleconsultation Module: Enables 4K ultra-HD video consultations (supporting up to 16 concurrent expert connections), featuring an integrated electronic whiteboard for image annotation and medical record management, instant file transfer for high-definition image sharing, and AI-assisted diagnosis with automatic lesion detection and treatment plan recommendations. It also supports two modes: "Scheduled Consultation" (expert appointments 24 hours in advance) and "Emergency Consultation" (instant response within 3 minutes)[11].
2. Remote Surgical Guidance Module: Through 5G network, it transmits surgical field in real time (4K picture quality, latency <1ms). Experts can mark key surgical points and send operation instructions through remote control panel. It also supports surgical video recording and playback for postoperative review and training of grassroots doctors.
3. Telemonitoring Module: Enables real-time transmission of vital signs (heart rate, blood pressure, blood glucose, etc.) for critically ill patients in primary care hospitals and chronic disease patients (e.g., hypertension, diabetes) at home. The system automatically sets alert thresholds and sends real-time alerts to target hospital specialists and primary care medical staff when data anomalies occur. It also generates health trend reports to assist specialists in adjusting treatment plans.
4. Emergency Rescue Command Module: During public health emergencies (such as traffic accidents or infectious disease outbreaks), this module enables one-click activation of multi-site coordination. It enables real-time data transmission to ambulances (via 5G vehicle terminals for vital signs

monitoring), primary hospitals (for on-site treatment updates), and target hospitals (for expert guidance). The system automatically generates an emergency rescue command map that dynamically displays station locations, resource allocation, and patient status, assisting management in resource allocation [12].

3.2.5 User Layer

Provide appropriate access terminals and interfaces for different user groups:

● Expert terminal: Supports desktop (Windows) and tablet (iOS/Android) devices, with an intuitive interface integrating consultation, surgical guidance, and monitoring data viewing.

● Primary care terminals: Provide standardized diagnosis and treatment terminals (including touch screen and HD camera), support basic operations such as patient information upload, image sharing and consultation request initiation, and reduce the threshold of use.

● Patient terminal: Accessible via WeChat Mini Programs or the official app, it supports remote consultation booking, health data queries, and online consultations. The interface is designed with a simple and intuitive layout, tailored to the needs of elderly users.

● Management terminal: A web-based management platform supporting desktop access, providing data visualization reports (such as consultation trend charts and resource usage pie charts), permission management, and quality supervision to assist management decision-making.

3.3 Core Technical Solutions

3.3.1 5G Network Optimization Technology

To ensure system stability in scenarios with high concurrency and high bandwidth requirements, two key optimization techniques are adopted:

1. Dynamic bandwidth adjustment technology: Through real-time network traffic monitoring by AI algorithms, the bandwidth is automatically increased to 1.2Gbps for high-bandwidth scenarios such as remote surgical guidance and HD image transmission, and reduced to 500Mbps for ordinary video consultation scenarios to avoid resource waste [13].

2. Multi-path transmission technology: Deploy "5G+optical fiber" dual-link backup between the target hospital and key primary-level hospitals (such as county-level central hospitals). When the 5G network signal fluctuates, the system automatically switches to the optical fiber link (latency <5ms) to ensure uninterrupted diagnosis and treatment.

3.3.2 AI-assisted Diagnosis and Treatment Technology

Deep integration of AI technology at the application layer to improve the accuracy and efficiency of remote diagnosis and treatment:

● AI-assisted imaging diagnosis: By integrating deep learning-based image recognition models (e.g., pulmonary nodule detection and cerebral hemorrhage identification), the system automatically analyzes CT and MRI scans uploaded by primary hospitals, generating preliminary diagnostic reports (including lesion location, size, and risk level) to assist experts in rapid assessment, reducing the average image reading time from 15 minutes to 3 minutes [14].

● AI-powered diagnosis and treatment recommendation: Leveraging a 30-year database of complex cases from target hospitals (over 100,000 cases), the system automatically matches similar cases and corresponding treatment plans based on patient symptoms and test results when primary hospitals initiate consultations, providing expert references.

3.3.3 Data Security Technology

Build a three-tier data security system to ensure compliant use of medical data:

1. Transmission layer protection: All transmitted data is encrypted using the national cryptographic

algorithm SM4, while a dedicated VPN channel ensures network isolation between the target hospital and the primary hospital to prevent data interception.

2. Data Layer Protection: The database employs dual safeguards of "tiered access control and data masking". Only authorized experts can access complete medical records, while primary healthcare workers and patients can view only non-sensitive information pertaining to them. Additionally, data access logs are maintained to record all operations (including operator, time, and content), with retention periods of at least 5 years [15].

3. Application-layer protection: Implement "account password + facial recognition" two-factor authentication during system login to prevent account theft; establish a secondary approval mechanism for high-risk operations (such as modifying diagnostic reports or downloading imaging data) to ensure compliant data usage.

3.4 System Implementation Steps

In order to ensure the smooth implementation of the system, the implementation will be carried out in three stages, with a total cycle of 18 months:

3.4.1 Preparation phase (1-3 months)

1. Complete the cooperation contract with local operators and equipment suppliers (such as Huawei, Mindray), and clarify the responsibilities and progress of 5G base station construction and hardware equipment procurement;

2. Conduct comprehensive training programs: Provide "5G Remote Surgical Guidance" training (≥20 hours)for target hospital specialists, and deliver "System Basic Function Usage" training for primary healthcare workers across all partner primary hospitals.

3. Finalize system requirements and technical solutions, and obtain approval from the hospital ethics committee (including compliance with patient data usage).

3.4.2 Construction and pilot phase (4-12 months)

1. Complete 5G infrastructure construction: Deploy 5G SA base stations and indoor distribution systems in target hospitals and three key primary-level hospitals (county-level central hospitals) to achieve full network coverage in pilot areas;

2. Build the core system architecture: Complete the development of data middleware and application layer modules, along with hardware installation and debugging, to achieve integration with the target hospital's HIS and EMR systems;

3. Pilot operation: Remote consultation and monitoring functions were tested in pilot primary hospitals, with 100 remote diagnosis and treatment cases completed. User feedback was collected and the system was optimized (such as adjusting the accuracy of AI diagnostic model and simplifying the operation process).

3.4.3 Full-scale promotion phase (13-18 months)

1. Expand system coverage: Complete 5G network deployment and system access for the remaining 5 county-level hospitals and 32 township health centers, achieving full coverage of medical institutions at the "city-county-township" three levels;

2. Launch full-function services: introduce remote surgical guidance and emergency rescue command modules, organize 1-2 emergency drills for public health emergencies (such as simulating the treatment of a large number of injured people in traffic accidents), and test the emergency response capability of the system;

3. Establish a long-term operation mechanism: Formulate daily maintenance procedures (such as daily network detection and monthly data backup) and performance assessment standards (such as

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workload statistics of remote expert consultation) to ensure the continuous and stable operation of the system.

4 System feasibility demonstration and benefit analysis

4.1 Feasibility Study

4.1.1 Technical Feasibility

The current 5G technology is ready for large-scale application, with the coverage rate of 5G base stations in the main urban area and various districts of a certain city reaching 95%, providing the network foundation for the system. Meanwhile, enterprises such as Huawei and ZTE have launched mature "5G + healthcare" solutions (such as Huawei's 5G medical industry terminals), whose hardware compatibility and stability have been clinically verified. The existing information systems (HIS, EMR) of the target hospital support HL7 FHIR standard interfaces, enabling seamless integration with the new system, with no major technical barriers.

4.1.2 Economic feasibility

The total construction cost of the system is approximately 8 million yuan (including 3 million yuan for 5G base station construction, 3.5 million yuan for hardware equipment procurement, and 1.5 million yuan for system development). The funding comes from two sources: 60% from the hospital's special informatization fund and 40% from local government medical informatization subsidies. Benefit analysis shows the system will generate three core benefits after operation:

1. Reduce the cost of medical treatment for patients: Patients at the primary level do not need to travel long distances, saving transportation and accommodation costs of about 1,500 yuan per person per time. Based on the annual remote diagnosis and treatment volume of 10,000 cases, the annual savings of patients' expenditure is 15 million yuan;
2. Improve hospital operation efficiency: Remote consultation can reduce the pressure of outpatient treatment in the target hospital, release 20% of the resources of expert outpatient treatment, and is expected to increase the annual revenue of routine diagnosis and treatment by 8 million yuan;
3. Save medical resource cost: Reduce unnecessary referrals in primary hospitals through remote guidance, and reduce referral costs (such as ambulance costs and repeated examination costs) by about 3 million yuan per year.

In conclusion, the system is expected to recover the cost in 2.5 years, with high economic feasibility [16].

4.1.3 Policy feasibility

The system development fully aligns with national policy directives. The "14th Five-Year National Health Plan" explicitly states "accelerating 5G applications in telemedicine and establishing regional medical collaboration networks." A municipal government's 2024 work report has designated "promoting 5G telemedicine system construction in tertiary hospitals" as a key public welfare initiative, backed by policy support and financial subsidies. Furthermore, the system's data security framework complies with China's Data Security Law and Personal Information Protection Law, having passed preliminary review by the local health commission, ensuring policy compliance.

4.2 Benefit Analysis

4.2.1 Social benefits

1. Promote the equalization of medical resources: The system will radiate the high-quality resources of the target hospital to remote districts and counties, and the accuracy rate of diagnosis of difficult cases in the primary hospital will be improved from 65% to 98%, making it a reality for patients in the

primary hospital to "see the third-level experts at home";
2. Improve public health emergency response capacity: In public health emergencies, the system can realize the seamless connection between "pre-hospital emergency treatment and in-hospital diagnosis and treatment", shorten the response time of treating the seriously injured from 45 minutes to 10 minutes, and significantly improve the success rate of treatment;
3. Promoting the improvement of the level of primary medical care: Through remote teaching and surgical guidance, the annual training time of primary medical staff has increased by 120 hours, and their professional ability has been significantly improved. By 2025, the proportion of primary hospitals independently carrying out the diagnosis and treatment of common diseases is expected to increase from 70% to 90%.

4.2.2 Economic benefits

1. Benefits to the hospital: The annual revenue of the target hospital from remote consultation (calculated at 500 yuan per time) can reach 5 million yuan, and the annual operating cost can be reduced by 2 million yuan through resource optimization (such as 30% improvement in expert time utilization), and the comprehensive annual revenue is about 7 million yuan;
2. Social benefits: Reduce the indirect expenses such as transportation and accommodation caused by patients seeking medical treatment across regions, saving about 20 million yuan of social medical costs annually; at the same time, reduce the rate of repeated examination in primary hospitals (from 25% to 8%), saving about 5 million yuan of medical resource consumption annually.

5 System guarantee measures and optimization direction

5.1 Safeguards

5.1.1 Organizational safeguards

A "5G Telemedicine System Construction Leading Group" led by the hospital director was established, with members including the information department, medical department, clinical department directors and representatives of grassroots hospitals, and the responsibilities of each department were clearly defined:

- Information Department: Responsible for system technology development, network maintenance and data security;
- Medical Department: Responsible for developing remote diagnosis and treatment procedures, expert scheduling, and quality supervision;
- Clinical department: Participate in system requirement design, function testing and clinical application;
- Primary hospitals: Cooperate to complete network deployment, equipment debugging and personnel training.

5.1.2 Institutional Safeguards

1. "Remote Diagnosis and Treatment Operation Procedures": specifies the standard procedures for remote consultation and surgical guidance (such as patient informed consent and requirements for diagnosis and treatment record archiving);
2. "System Security Management System": specifies data access rights, backup frequency, emergency response procedures, and prevents data leakage and system failure;
3. "Performance Assessment System": The workload of remote diagnosis and treatment by experts will be included in the evaluation of professional titles and the evaluation of excellence and first-class indicators to stimulate their enthusiasm for participation.

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5.1.3 Talent Security

Recruit 2-35G network engineers to handle daily system maintenance. Select 30 clinical experts with rich experience (covering key departments such as cardiovascular and neurosurgery) to form a telemedicine expert team, providing regular skills training. Train 100 system operators for primary hospitals, ensuring each grassroots site has at least 2 medical staff proficient in system operations.

5.2 Optimization Direction

5.2.1 Technical Iteration and Optimization

The innovation introduces two cutting-edge technologies: 1) 5G-Advanced technology: When 5G-Advanced(5.5G) technology matures, it will increase network bandwidth to 10Gbps and reduce latency to 0.1ms, enabling "real-time control" for remote robotic surgery and further expanding telemedicine applications; 2) Blockchain technology: Leveraging the "tamper-proof" feature of blockchain, it establishes a trust mechanism for medical data sharing, facilitating cross-hospital interoperability (e.g., between target hospitals and tertiary hospitals in neighboring provinces) to resolve the issue of "data incompatibility for remote medical care".

5.2.2 Function Expansion and Optimization

New remote rehabilitation guidance module: Integrating data from rehabilitation robots and smart devices to provide home-based rehabilitation guidance (including limb function training videos and progress monitoring) for discharged patients, forming a "diagnosis-rehabilitation" full-process service. Enhanced chronic disease management: For patients with chronic conditions like hypertension and diabetes, personalized management plans combining "AI medication reminders, dietary recommendations, and exercise plans" have been developed to reduce readmission rates (targeted to decrease from 12.3% to 8%).

5.2.3 Service Scope Optimization

Gradually expand the system's service scope from "medical diagnosis and treatment" to "public health services": provide remote vaccination guidance (such as storage and administration protocols for vaccines at primary healthcare facilities); offer remote infectious disease screening services (like remote imaging diagnosis for influenza and tuberculosis), supporting regional public health prevention and control.

6 Conclusions and Outlook

6.1 Research Conclusions

This study focuses on a large tertiary hospital in a city, where a 5G-based intelligent telemedicine information system was developed through demand research, system design, and feasibility analysis. The research demonstrates:

By integrating 5G, AI, and data interconnection technologies, this system effectively addresses the pain points of traditional telemedicine-such as high latency, limited functionality, and data connectivity issues-while meeting the needs of four core scenarios: remote consultation, surgical guidance, patient monitoring, and emergency rescue. The system demonstrates feasibility across three dimensions: technical (5G network coverage and device compatibility), economic (cost-controlled and profitable), and policy (alignment with national guidelines). It is projected to recoup costs within 2.5 years, delivering significant social and economic benefits. Through organizational, institutional, and talent support measures, the system ensures stable operation and provides replicable, scalable planning solutions for large hospitals to build "regional medical collaboration networks".

6.2 Future Outlook

With the continuous development of medical informatization and 5G technology, intelligent telemedicine information system will evolve in three directions:

● Deeper technological convergence: The future will see the integration of "5G+AI+IoT+metaverse", such as building a "virtual operating room" through metaverse technology, enabling experts to gain an immersive experience of remote surgical guidance.

● Wider service coverage: from "regional collaboration" to "cross-regional collaboration", realizing the interconnection of provincial and national telemedicine networks, so that patients in remote areas can also enjoy the diagnosis and treatment services of top experts in the country;

● More intelligent personalized services: Based on the health data of patients in the whole life cycle, the AI algorithm generates personalized diagnosis, treatment and health management plans for "one person, one policy", promoting the transformation of telemedicine from "disease treatment" to "health maintenance".

Data Availability Statement

Data will be made available on request.

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Conflicts of Interest

The author(s) declare no conflicts of interest.

Ethical Approval and Consent to Participate

Not applicable.

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