Practices and Challenges of 5G Internet + Healthcare

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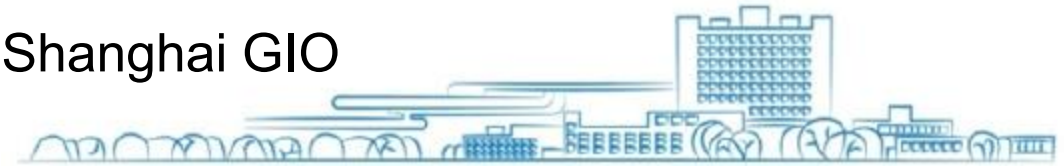


"Internet + Healthcare" has become a national strategy

National law: *The Basic Healthcare and Health Promotion Act* was enacted on June 1, 2020

State Council: Opinions on Promoting the Development of "Internet + Healthcare" (State Council Office issuance No. 26, 2018)

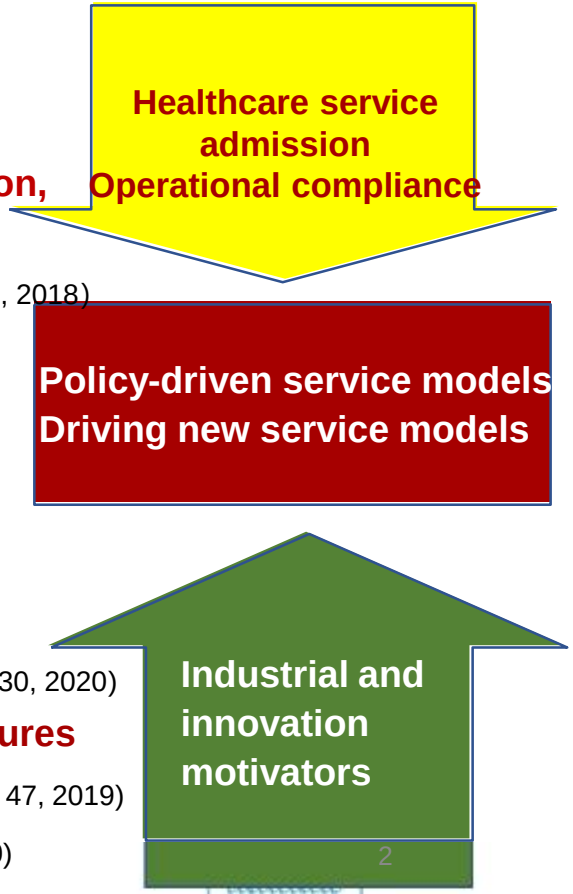
- Defined the healthcare service system, technical support system, and monitoring & security assurance system.

National Health Commission (NHC): Defined requirements for healthcare service admission, operations, and regulations.

- *Notice on In-depth Development of the "Internet + Healthcare" for the Benefits of the People* (NHC planning issuance No. 22, 2018)
- *National Healthcare Big Data Standards, Security, and Service Management* (NHC planning issuance No. 23, 2018)
- *Online Healthcare Management*, *Online Hospital Management*, *Telemedicine Service Management* (NHC healthcare management issuance No. 25, 2018)
- *Notice on Piloting "Internet + Care"* (NHC Office letter No. 80, 2019)
- Notice on Technical Specifications and Financial Management for the "Internet + Healthcare" Projects of Public Medical Institutions (NHC finance letter No. 202, 2020)
- Notice on Further Promoting the Development and Standardized Management of Online Healthcare (NHC Office letter No. 330, 2020)

National Healthcare Security Administration: Defined pricing and payment security measures

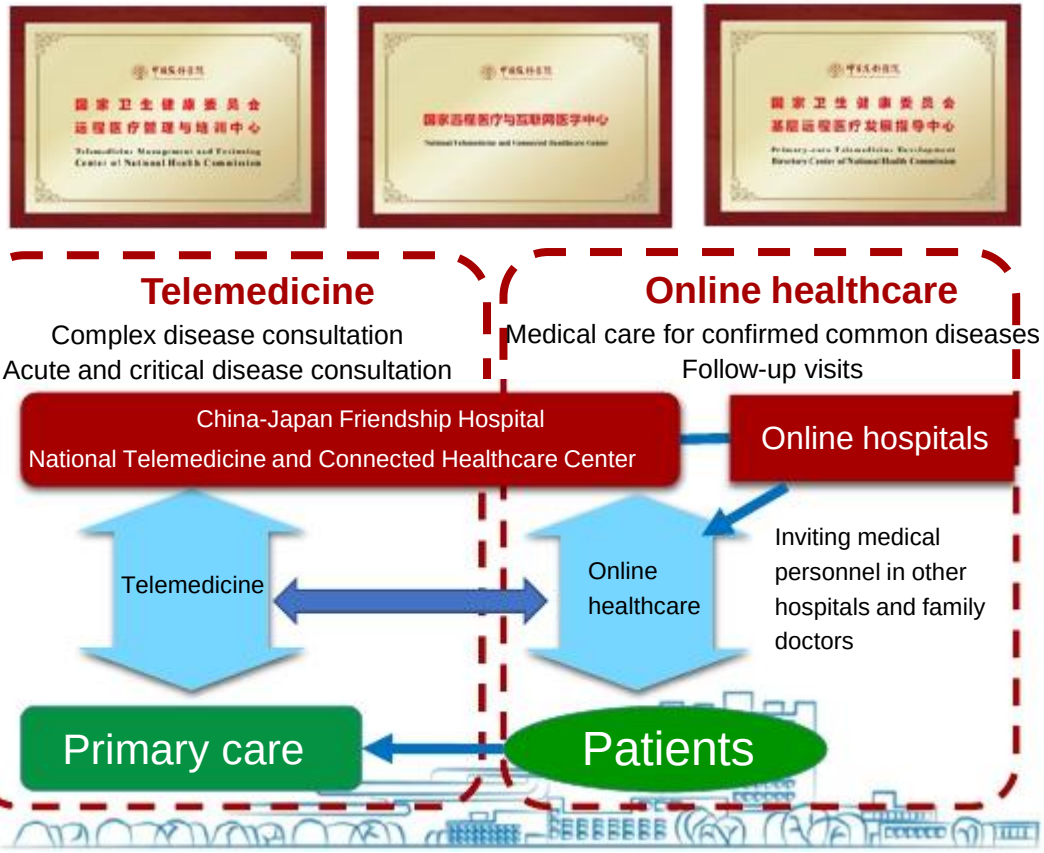
- *Guidelines on Improving the Pricing and Insurance Payment Policy for "Internet+" Healthcare Services* (NHSA issuance No. 47, 2019)
- *Guidelines on Promoting "Internet+" Medical Insurance Services During the Prevention and Control of COVID-19* (May 2020)
- *Guidelines on Improving the Insurance Payment for "Internet+" Healthcare Services* (NHSA issuance No. 45, 2020)



From telemedicine to online hospitals: Concept evolution and connotation extension

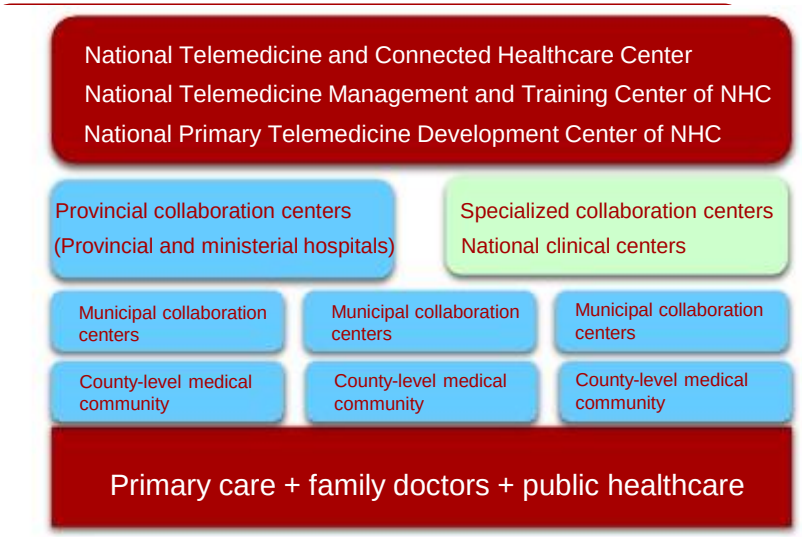
NHC: *Online Healthcare Management (Provisional)*, *Online Hospital Management (Provisional)*, *Telemedicine Service Regulations (Provisional)*

- **Telemedicine**: **One of the first piloting hospitals**
  - Helping primary hospitals improve capabilities
  - A new model of consultation between medical institutions
- **Online healthcare: One of the first hospitals to provide online healthcare in Beijing**
  - A new healthcare model, but initial diagnosis cannot be provided online.
  - Transition to virtual space for healthcare service provision
- **Online hospitals: One of the first online hospitals in Beijing**
  - Hospital-led transition to go beyond distance limits
  - Optimizing service admission, operations, and regulations



Developed core elements: Network, talent, and technology

- **Regional collaboration mechanism: Medical institution cooperation**
  - 75 provincial hospitals and 24 provincial telemedicine collaboration centers
  - 102 municipal collaboration centers
  - Connecting 5,400+ hospitals across the country
- **Medical talent pool: A framework of the expert working committee**
  - 26 specialized fields and 26,000+ doctors in China
- **Technical platforms: In-hospital information system + External application platform**
  - Connected with telemedicine centers of hospitals
  - Level 4 of national healthcare information sharing standardization
  - Initial results of AI R&D and applications



National teleconsultation platform for severe COVID-19 cases

- **Teleconsultation for severe COVID-19 cases:** Nationwide; integration of Chinese and Western medicine
  - NHC: *Notice on Carrying out Teleconsultation for Severe COVID-19 Syndromes in National Telemedicine and Connected Health Center* (NHC Office letter No. 153, February 21, 2020)
- **Remote support for consultation of serious syndromes in areas with high infection rates:**
  - Joint Prevention and Control Mechanism General Team of the State Council on Responding to COVID-19: Notice on Carrying out Online Services to Support Pandemic Control and Prevention in Hubei (February 26, 2020)

Respiratory specialist consultation for severe COVID-19 cases in Xinjiang

Prof. Chao Enxiang participated in remote consultation and discussions for severe COVID-19 cases with Hubei Provincial Hospital of Integrated Chinese & Western Medicine, Wuhan Leishenshan Hospital, and Shenzhen No. 3 People's Hospital

"Internet + Healthcare" has been applied in multiple areas

Reliable multiple connections, high throughput, low latency, strong computing, fixed + mobile networks

Remote consultation

Multi-disciplinary consultation

Remote teaching and ward round by experts

Radiation therapy guidance

China-Kazakhstan joint consultation

Remote diagnosis

Remote consultation

Remote diagnosis

Remote B-scan

Remote ECG

Cloud-based test analysis

Online healthcare

Online follow-up visits

e-Prescription

Medicine delivery to homes

Medicine delivery to nursing houses

Online healthcare + Easy health insurance claims + Medicine delivery to home

- Follow-up consultation at home: **Reducing exposure to the pandemic**
  - Text, image, voice, and video communication between patients and doctors
  - Linked accounts between elder users and their families
- e-Prescription and medicine delivery to homes
- Easy health insurance claims in Beijing: Patients only need to pay the parts that are not covered in the health insurance.

5G advantages match requirements for digital healthcare

- ✓ Increasingly connected
- ✓ Increasingly mobile

Equipment upgrade

Business innovation

Technology innovation

- ✓ Ubiquity
- ✓ Convenience
- ✓ Mobility
- ✓ Stability
- ✓ Safety

As networks become a bottleneck, new technologies are required

High throughput eMBB
- Massive data transmission
- HD video interaction
- Real-time data query on the cloud

Low latency URLLC
- No frame freezing or packet loss
- Latency < 20 ms
- Onsite interaction without waiting

- ✓ High-throughput data sharing
- ✓ A large number of devices are connected concurrently
- ✓ Long interaction delay

Multiple connections mMTC
- Terminal/Sensor cluster access
- Multi-scenario and multi-terminal
- Multi-point concurrency and multiple audiences

5G healthcare led by the National Telemedicine and Connected Health Center

- ✓ **National telemedicine networks:**
  - 24 provincial remote centers/95 provincial hospitals, 102 city medical alliances, and 5,400+ hospitals
  - 28 expert working committees and 23,000+ specialists
- ✓ **The China-Japan Friendship Hospital has all required 5G resources in key areas:**
  - Synchronous service provisioning from China Mobile, China Telecom, and China Unicom: 470+ micro base stations and 4 macro base stations;
  - Covering six key areas: Telemedicine, outpatient clinic, examination, some wards, teaching buildings, research centers, parking lots, and aprons)
  - Phase 2 construction: Adding 500+ more micro base stations.
  - The SA backbone network has been connected.
- ✓ **Connected to more than 200 hospitals with 5G networks in China**
- ✓ **Multi-scenario applications:**
  - Telemedicine (hardware/software-based video, interactive, and live broadcast)
  - Smart dermoscopy and smart digital stethoscope
  - Ultrasound (robotic arm), endoscope, and pathological scan

New healthcare infrastructure: 5G + Internet + Intelligent systems

Research on the Standard Requirements for the Application of 5G Technologies in the Health Industry, Legal Affairs Division, (Subject No. 20200104)

Published standards to help the research team ensure consistency and quality
Guiding standardized and normalized construction of 5G networks at hospitals

Summarizing standard parameters through case studies

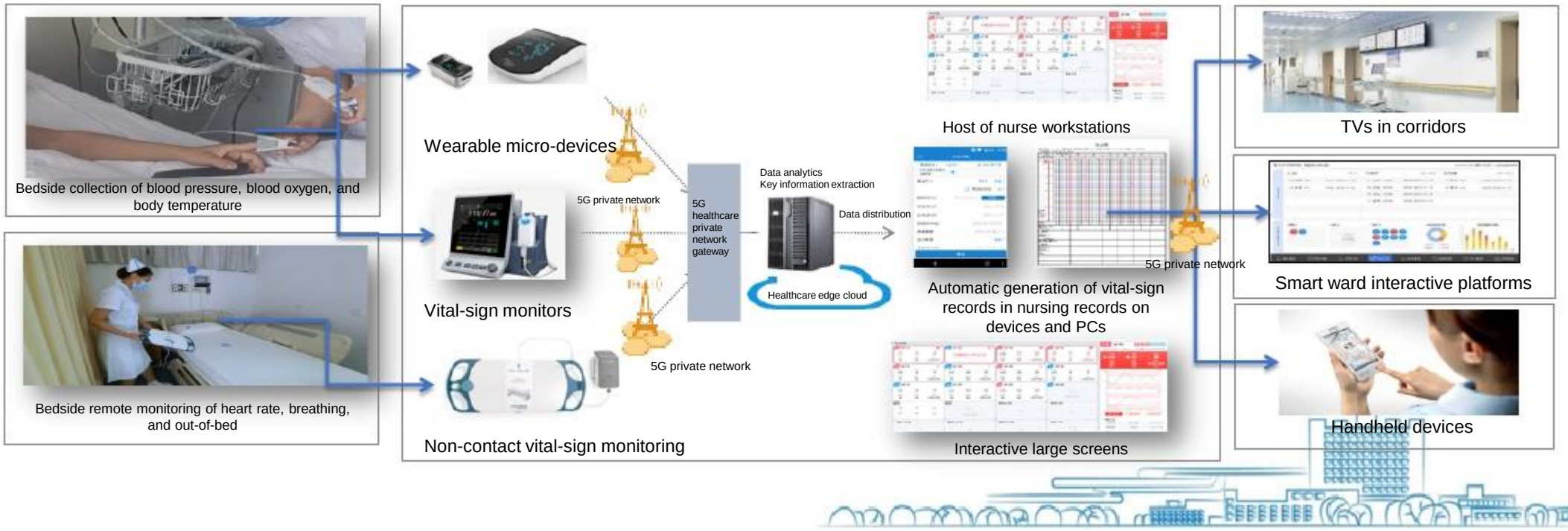
1 **Standards for radio access networks**

2 **Standards for terminals**

3 **Standards for MEC**

5G-based dynamic physiological examination for treatment and healthcare

System upgrade based on 5G mobile access and MEC
AI-powered smart healthcare systems, wearable device data upload, and teleconsultation



5G-based remote, real-time ultrasound consultation

Mobile, real-time, HD, and synchronous

Remote ultrasound diagnosis equipment

- **Bedside ultrasound equipment is convenient for critically ill patients**
  - Ultrasonic equipment beside the bed or in operating rooms, ICUs, etc.
  - Experts on the remote platform
- **Remote training improves the ultrasound capabilities of primary hospitals**
  - Primary hospitals are more likely to make misdiagnosis and missed diagnosis in ultrasound testing. Upper-level hospitals can guide and train lower-level hospitals through remote ultrasound diagnosis systems.

Remote ultrasound diagnosis systems

5G remote treatment: Ultrasound-guided minimally invasive surgeries by acupotomology for pain treatment

- **Surgical demonstration training**
- **Real-time online consultation during surgeries**

- ✓ **Sharing special treatment technologies with primary hospitals**
- ✓ **Effective local treatment for patients**

- ✓ HD video: Synchronous dual streams
  - HD dynamic ultrasound imaging: Remotely synchronous visuals
  - Remote, real-time communication + outdoor communication
- ✓ Low latency: (< 10 ms)
  - Remote, real-time observation of anatomical structure and depth
- ✓ Mobility: Video carts
  - Easy to move and change angles
  - Reducing wires in the treatment room

5G module terminals + mobile video carts

5G-based, digital, intelligent auscultation applications at primary hospitals

Auscultation by human ears
Listening subjectively
Human ears: 20 Hz to 20,000 Hz

Digital stethoscopes
Recording objectively
AI: 0–50,000 Hz

- Equipped **more than 20** medical institutions
- Served **more than 30,000** times
- Built a lung sound database with **more than 400,000** standard sounds
- **Standard sounds of lung sound database**
  - Pulmonary infection
  - Bronchial asthma
  - Chronic obstructive pulmonary disease
  - Interstitial lung disease
  - Bronchiectasis
  - Pneumoconiosis/silicosis
  - Cough sound database
- **Standard sounds of noise database**

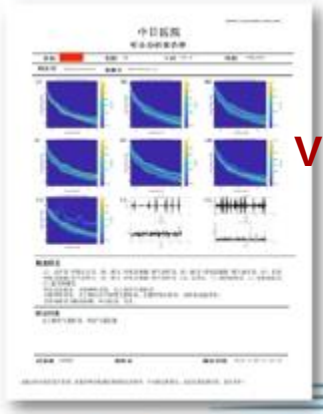
Assisted medical teams in combating COVID-19 in Wuhan

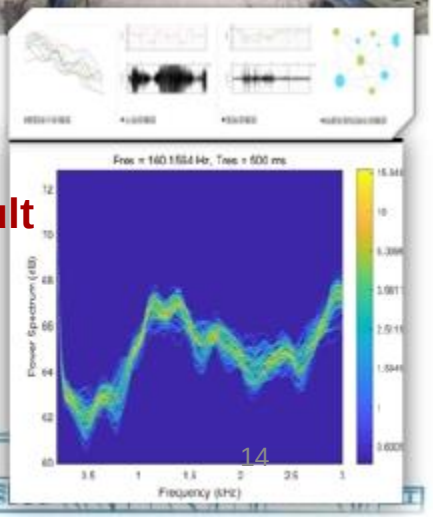
Helped doctors hear the lung sounds of patients infected with COVID-19 for the first time

Advantages of digital intelligent stethoscopes

- ✓ **Early detection:** Collection of wider range of sounds enables early detection of small lesions
- ✓ **Objective records** promote unified diagnosis and quantified research
- ✓ **Data sharing** facilitates remote expert consultation and follow-up visits online
- ✓ **Intelligent analysis** helps doctors at primary hospitals learn anytime and anywhere
- ✓ **Economic and convenient**, suitable for chronic disease management at primary hospitals

Visualized result reports





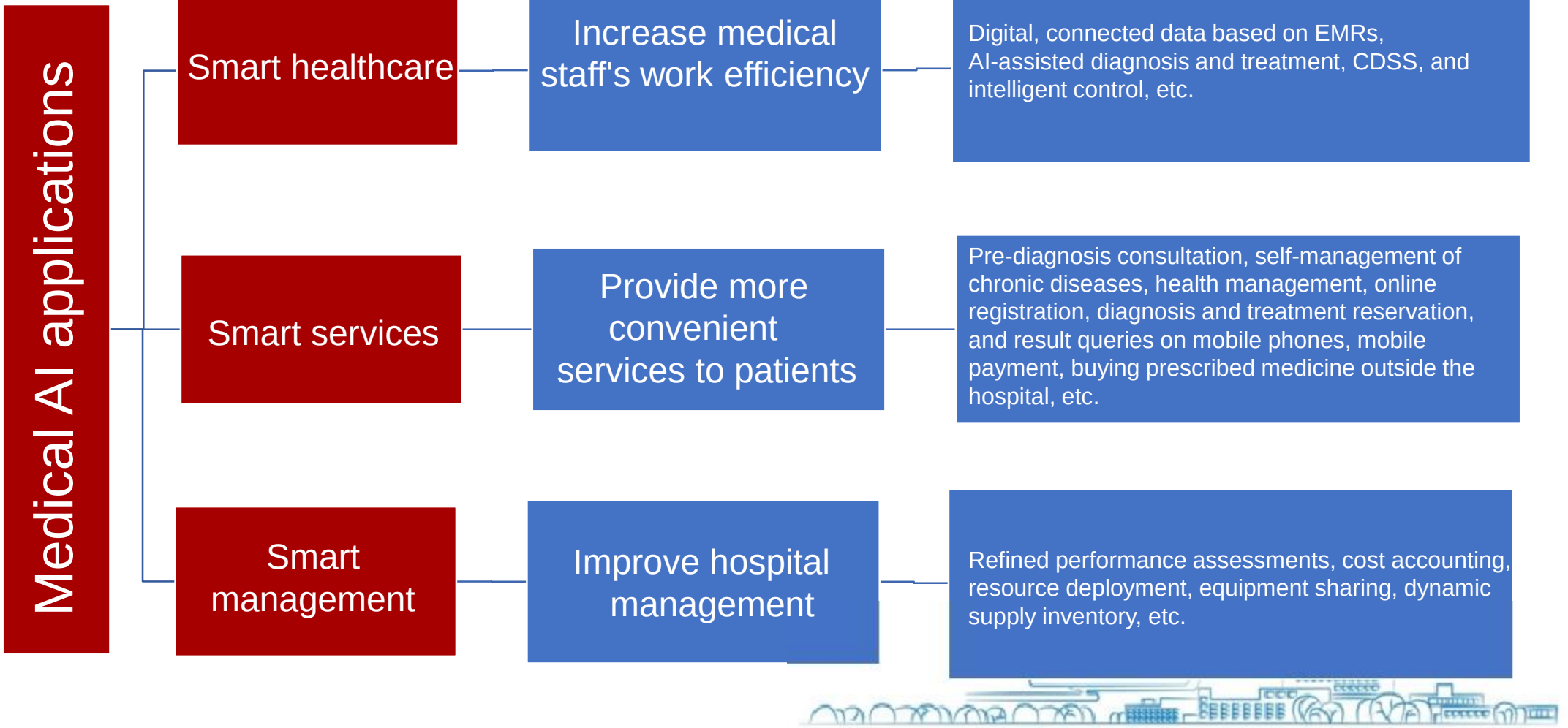
Smart diagnosis: R&D and application of AI image analysis for skin diseases through 5G mobile devices + MEC

R&D system of China-Japan Friendship Hospital
Identification of benign and malignant tumors: 91.2%
Disease type identification: 81.4%

Able to accurately identify 17 types of skin tumors
Benign tumors: Seborrheic keratosis, verrucous epidermal nevus, epidermal nevus, dermatofibroma, hemangioma, pigmented nevus (intradermal nevus, compound nevus, junctional nevus, blue nevus)
Malignant tumors: BCC, melanoma, Paget disease, squamous carcinoma, etc.
Borderline tumors: Solar keratosis, Bowen's disease

hand-held dermoscope + **Cloud-based MIIS system** + **Youzhi AI** + **Multi-functional workstation**

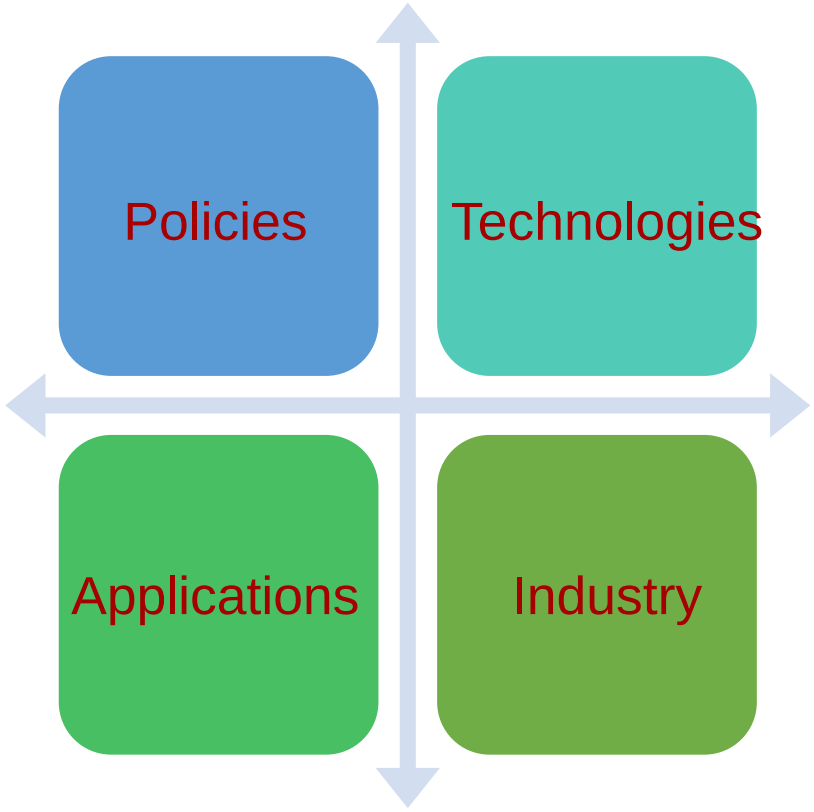
Smart hospital



Questions regarding AI applications in healthcare

- ✓ What is the direction of national policies?
- ✓ How can I apply for medical admission?
- ✓ How can I obtain Class III medical devices?
- ✓ Are there any standards for reference?
- ✓ How can I obtain medical big data?

- ✓ How does the medical community view AI?
- ✓ How can I convince clinicians to accept my AI products?
- ✓ Which fields can AI be applied to?
- ✓ How do I set a charged item?
- ✓ How can an application cover a wide range of primary hospitals with low cost?

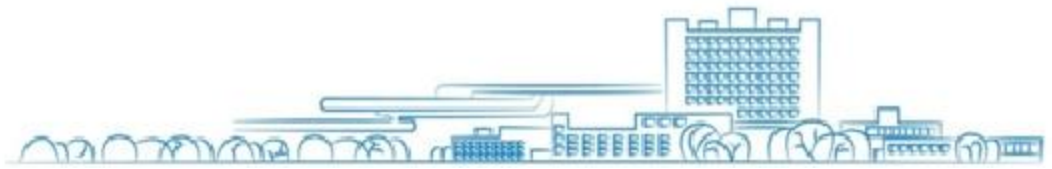


- ✓ How do I use machine learning?
- ✓ Neurons, deconvolution...?
- ✓ How do I establish a knowledge base?
- ✓ Are mathematical models available?
- ✓ What should I do without big data?

- ✓ Is AI restricted by the big data industry?
- ✓ Can big data standards be established?
- ✓ How do I calculate the investment and return?
- ✓ Application first or standard first?
- ✓ How can I envision a bright future and tell stories to investors?

Seize opportunities with a correct attitude to strike a balance between development and regulation

Correct direction	Aim for public welfare in the medical reform and adhere to the principle of hierarchical diagnosis and treatment.
Correct strategies	Establish an innovation system that integrates healthcare and engineering and engages the industry, academia, and research institutes.
Correct attitude	Respect scientific laws and stay modest and rigorous; conduct in-depth surveys to identify rigid demands.
Correct positioning	Complement each other's advantages with partners to build an ecosystem.

Feel free to offer suggestions

Thank you!