Digital medicine as a whole system approach

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Zhongshan Ophthalmic Center: the Leading Eye Hospital in China

Leading public ophthalmic center in China offering top-notch service

The largest eye hospital in China

No. 1 in Asia; No. 6 in the world

No. 1 in China for consecutively **14** years

EduRank

14131 universities from 183 countries ranked across 246 topics

For Ophthalmology

#1 in Asia

#1 in China

SUN YAT-SEN UNIVERSITY

SCIMAGO INSTITUTIONS RANKINGS

Year	World	Asia
2022	11	2
2023	9	2
2024	**6**	**1**

International Societies Headquarters one of its kind in China

ASIA-PACIFIC ACADEMY OF OPHTHALMOLOGY

APAO

AACO Asia Office

The Only WHO Collaborating Centre for Eye Care and Vision in China

Digital Blue Ocean: Need New Navigation

A new era of unfamiliarity has clearly arrived, and the modern world that we were once familiar with has become a past unrelated to reality. —— Peter Drucker

Digitalization → Online → Intelligent

Internet

Internet of Entities

Mobile

Blockchain

Online Learning

Metaverse

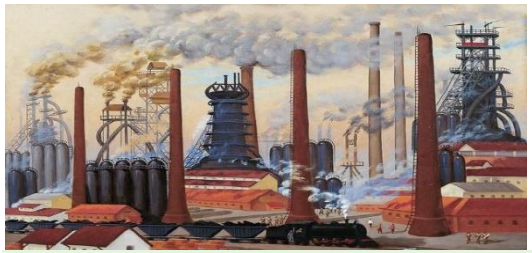
Tech advancement leads to societal leaps and medical development

Development of Society

Agrarian society

Labor/Tools

Industrial society



Engine/Electricity

Information society

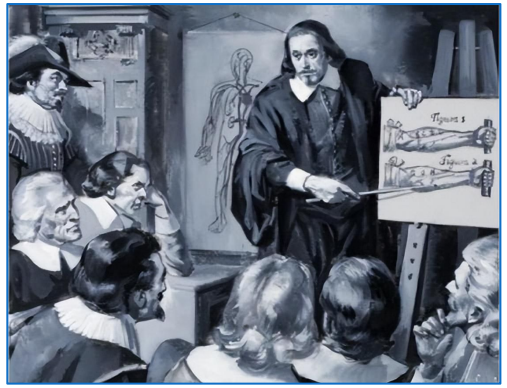
PC/Internet

Intelligent society

AI/Data

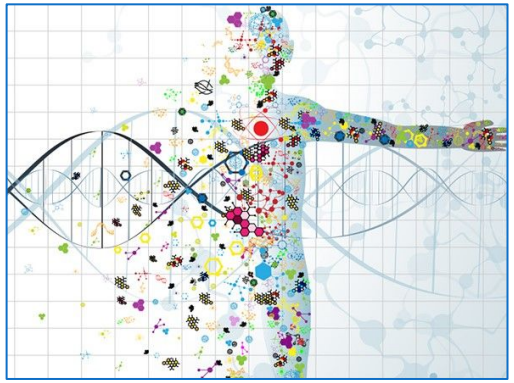
Development of Medicine

Modern Medicine

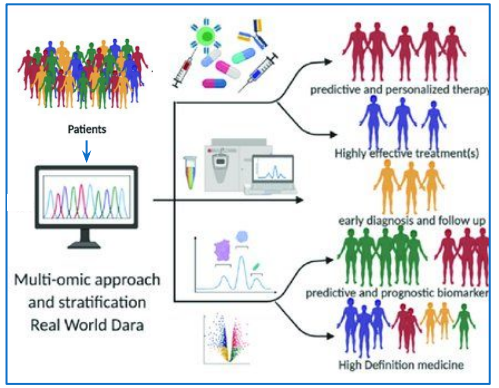


Evidence based medicine

Precision medicine

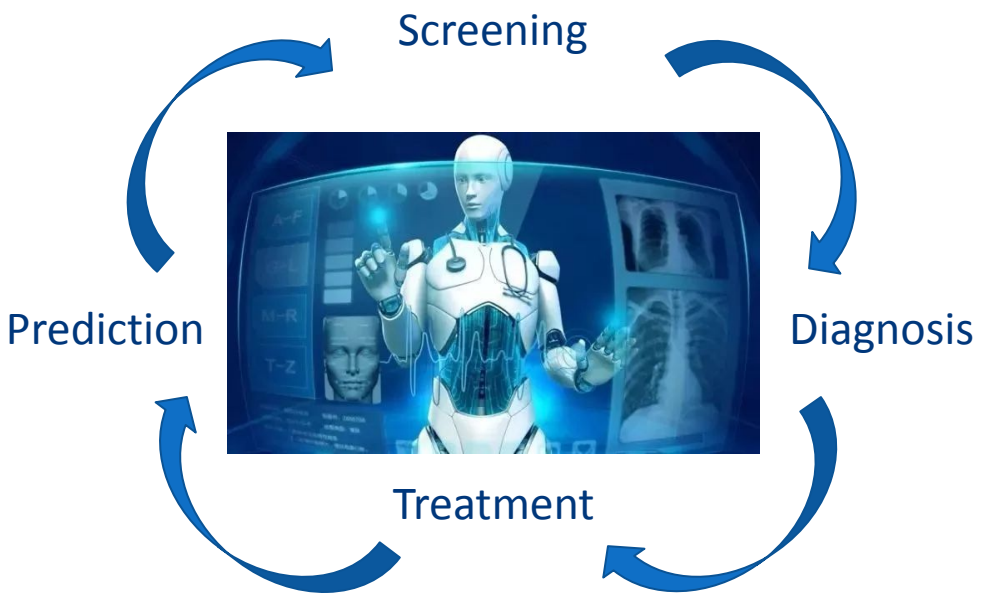


High-Definition Medicine

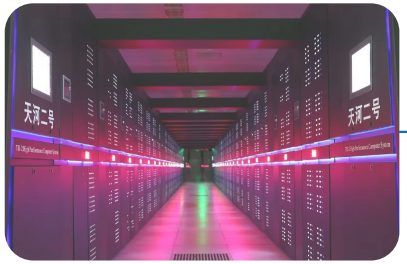


Collective Effort Fuels Success: Digitalization Requires Multidisciplinary Collaboration

An individual's medical profile is a series datasets

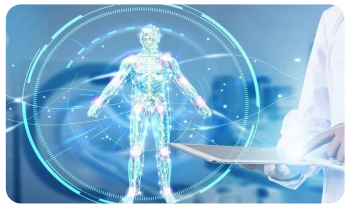


Diagnosis and treatment: Collection, processing, transmission, storage, utilization, sharing, application of medical information



- Medicine
- Computer
- Science
- Informatics
- Electronics
- Sociology
- .....

Computer vision



Digital Twin Theory

Eye-computer interface

Digital Therapy

Bionic Eye

Sensor Monitoring

Cloud Clinic

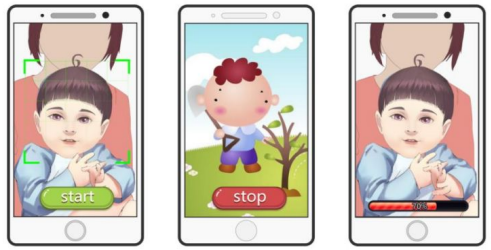
Smart Hospital

Smartphones enable home screening of visual impairment in infants

Digital medical technology breakthrough | Screening | Diagnosis | treatment | Follow-up | Predict

Watch animation to check eye diseases

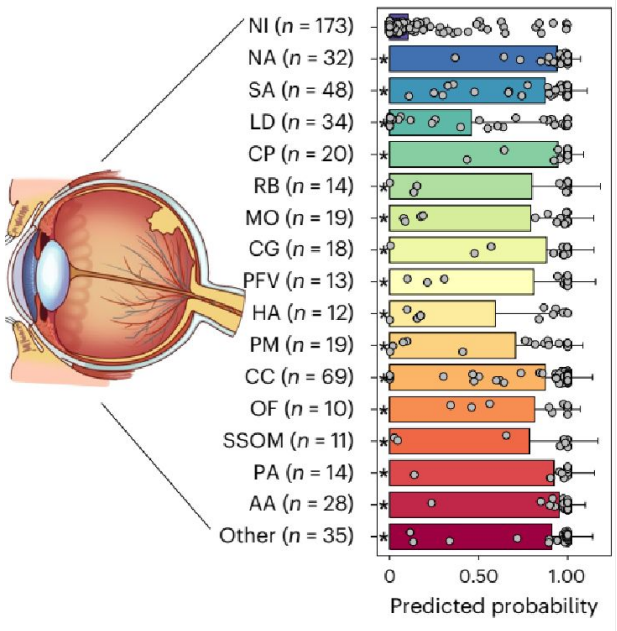
Home scene screening



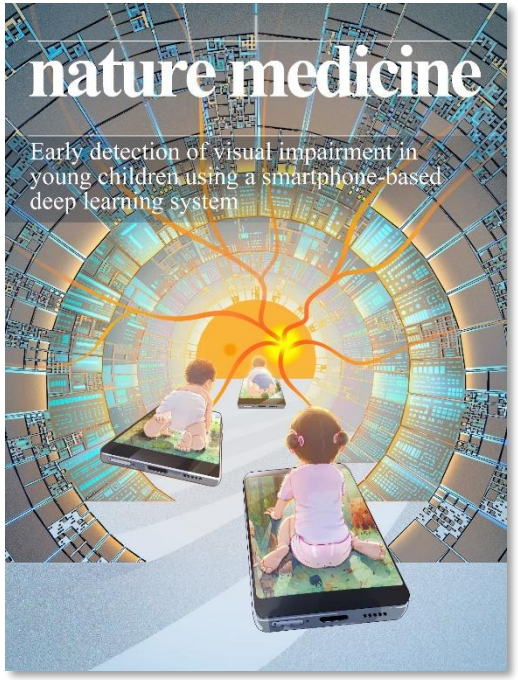
Induction of gaze behavior in infants

Data collection

Covers 16 blinding eye diseases in infants



The average screening accuracy rate exceeds 85%



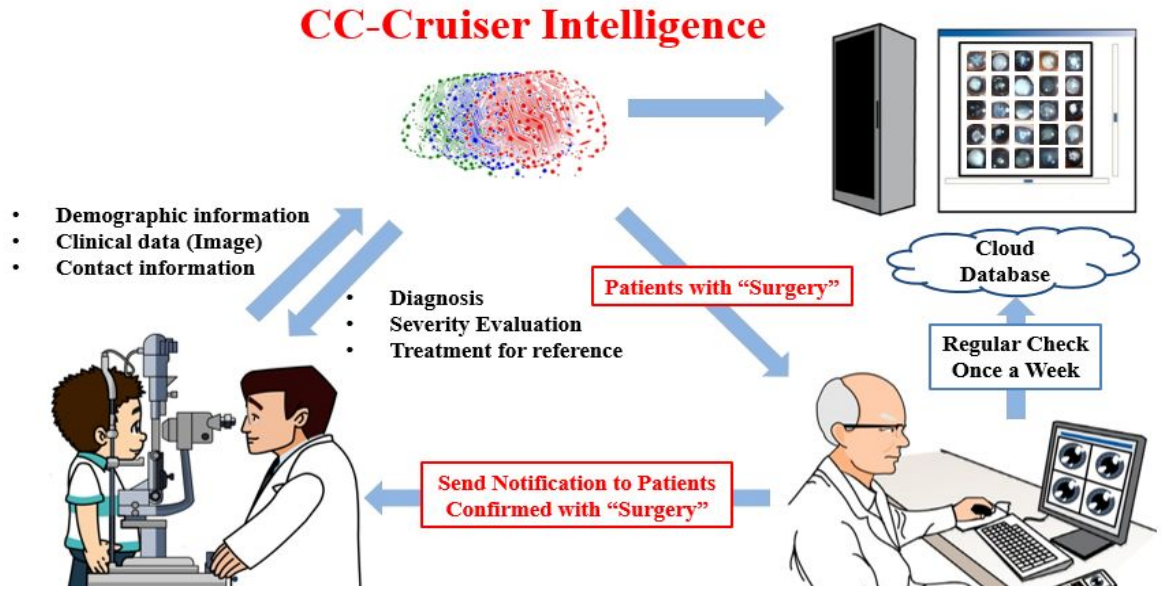
Using smartphones to record behavioral videos, the first "home" screening model for visual impairment in infants and young children has been created to enable early detection of blinding eye diseases

WB Chen,...HT Lin*. *Nature Medicine*. 2023

Make the microscopic early features of difficult eye diseases easier to detect

Digital medical technology breakthrough | Screening | **Diagnosis** | treatment | Follow-up | Predict

Few experts who have the technology to diagnose difficult and rare eye diseases



Young doctors can also diagnose difficult and rare eye diseases

Review and approval by senior experts

Cover paper

The promising future of machine learning: it will greatly enhance doctors' diagnostic capabilities

——Cover story

11 major AI events that have impacted the global medical community

——IEEE Spectrum 2017

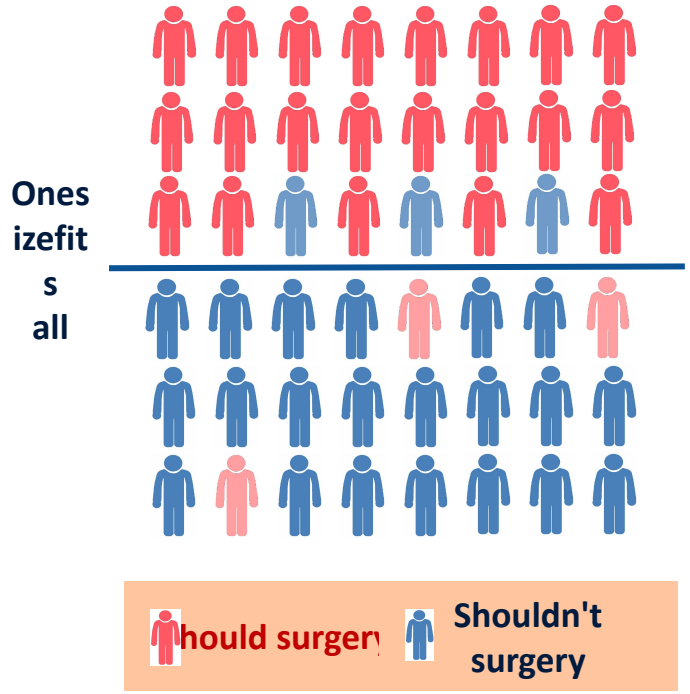
High-quality diagnosis and treatment intelligent cloud service improves the professional level of diagnosis

Lin HT* *Nature Biomedical Engineering*. 2017

Developing intelligent surgery-assisted personalized decision-making system

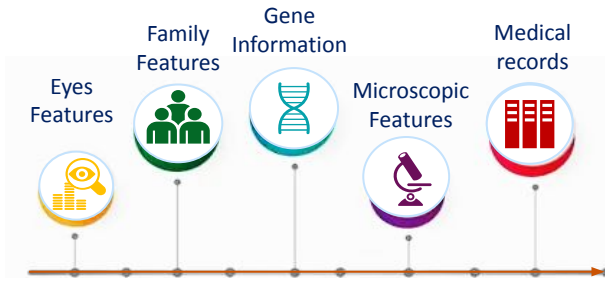
Digital medical technology breakthrough | Screening | Diagnosis | treatment | Follow-up | Predict

Imprecise surgical criteria



Intelligent surgical decision-making

Input



Clinical phenotype-bioinformatics-full diagnosis and treatment

Output

Surgery timing (× months later)

Surgery method (IOL, CE+IOL…)

95% accuracy

Visual acuity improved 3 times

Complications reduced 30%

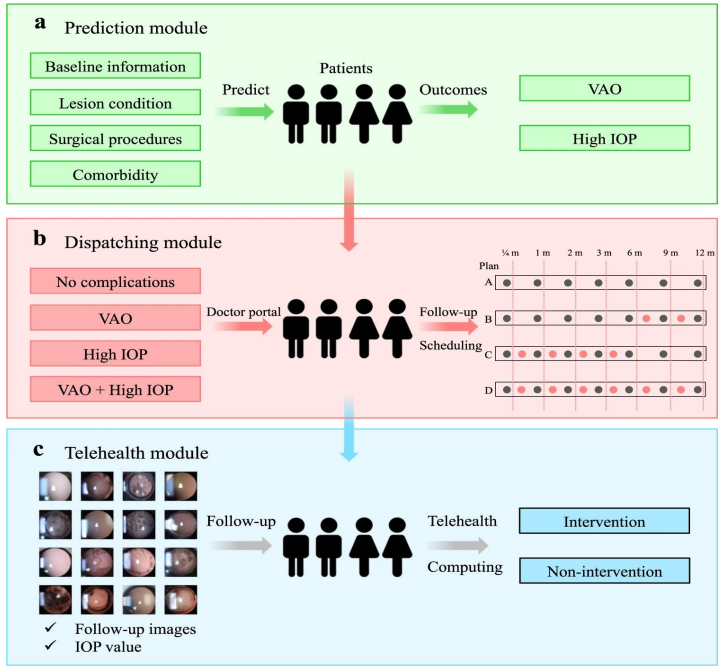
Personalized treatment plans to improve the prognosis of each patient

Lin HT* *International Journal of Surgery.* 2019

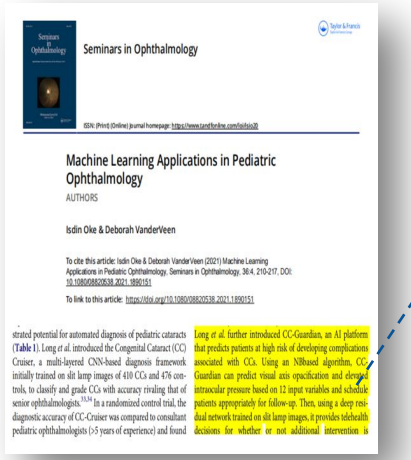
Create the first intelligent scientific follow-up system for difficult and rare eye diseases

Digital medical technology breakthrough | Screening | Diagnosis | treatment | Follow-up | Predict

Traditional chronic disease follow-up not only places a heavy burden on patients, but also fails to timely screen and intervene in complications.



- **Based on:**
  - Last follow-up
  - Overall trend of disease condition
- **Prediction:**
  - Follow-up time
  - Follow-up method


Seminars in Ophthalmology

Machine Learning Applications in Pediatric Ophthalmology

AUTHORS

Isdin Oke & Deborah VanderVeen

"An excellent example of digital health supporting clinical decision making"

—— Clinical expert at Harvard Children's Hospital Boston: Isdin Oke

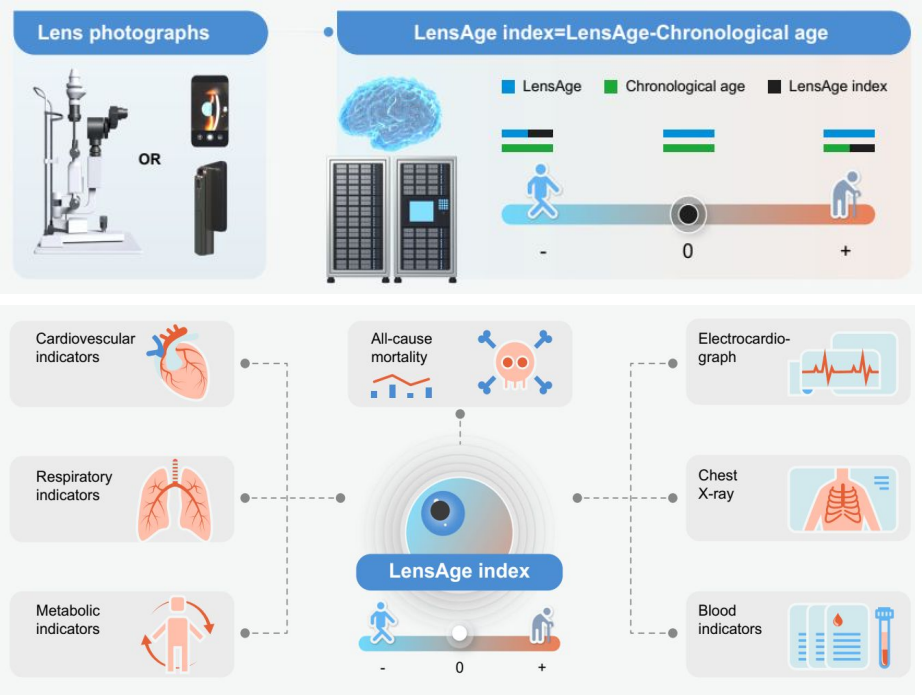
Seminars in Ophthalmology. 2021

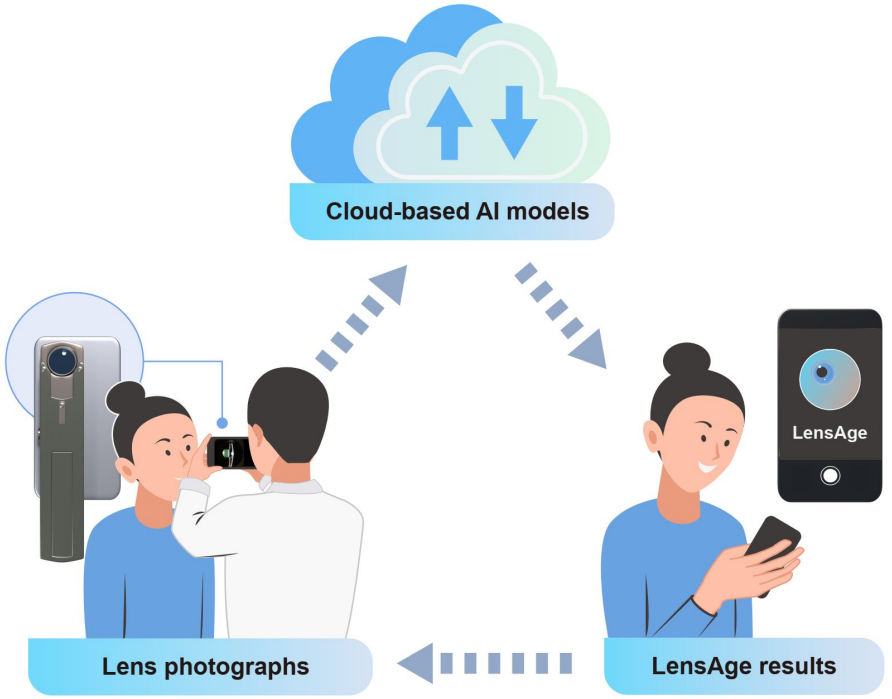
The accuracy rate exceeds 96%, the incidence of complications decreases by 60%, and the cost of saving patients exceeds 10,000 yuan per year

Lin HT* *Npj Digital Medicine*. 2020

Lens age predicts the risk of age-related diseases

Digital medical technology breakthrough | Screening | Diagnosis | treatment | Follow-up | Predict





- **Lens age reflects overall aging**
- **Predicts risk of major disease and death**

Mobile phone captures lens images - cloud analysis - outputs "lens age"

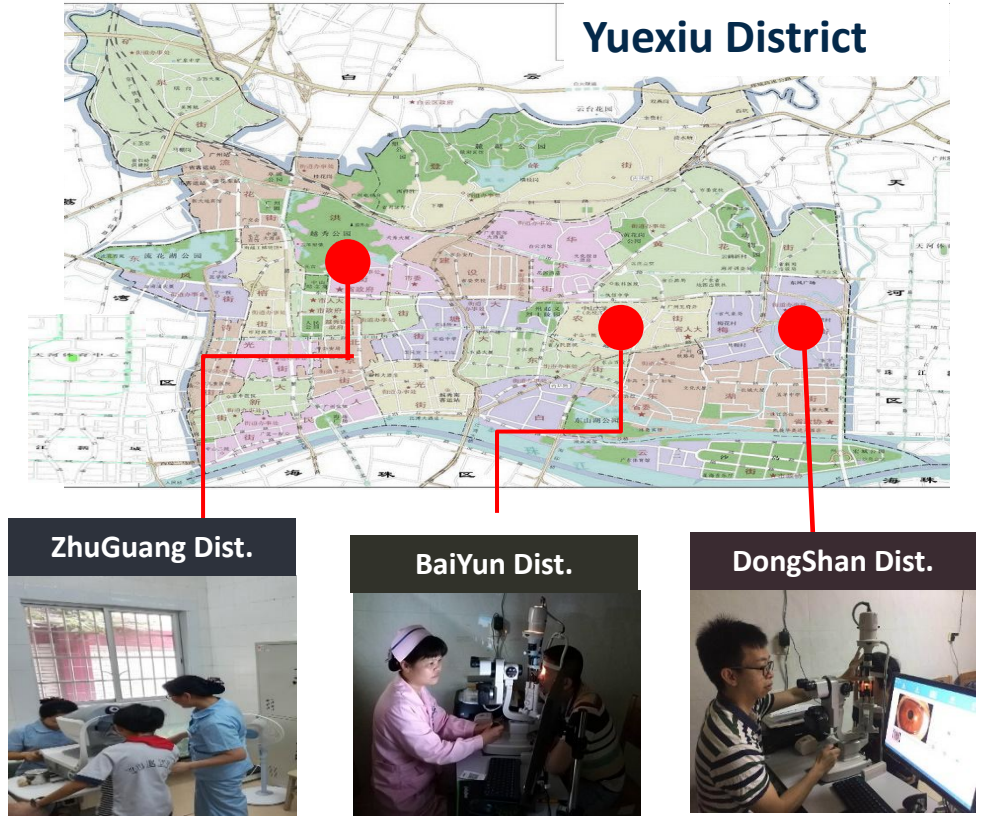
Self-assessment of the risk of aging diseases

RY Li, ... HT Lin*. *Nature Communications*. 2023

Patient-centered services: Extending high-quality medical services to the grassroots

Digital medical technology applications | Remote screening | Remote surgery | Economic Benefits | Privacy protection | Large-scale language model (LLM) full-process assistance

Smart mobile terminals (for personal and family use)



Basic inspection equipment: intelligent hardware, cloud platform (community and grassroots hospitals)

5G intelligent ophthalmic cruiser : less costs and more resources for patients

Digital medical technology applications | **Remote screening** | Remote surgery | Economic Benefits | Privacy protection | Large-scale language model (LLM) full-process assistance

Top algorithm integration

- Eye disease intelligent screening platform
- Automated and unmanned management
- Smart eye health manager

Technology support

- 5G independent core network
- Blockchain data integrated management platform
- Tianhe-2 computing power support

Full-cycle smart platform

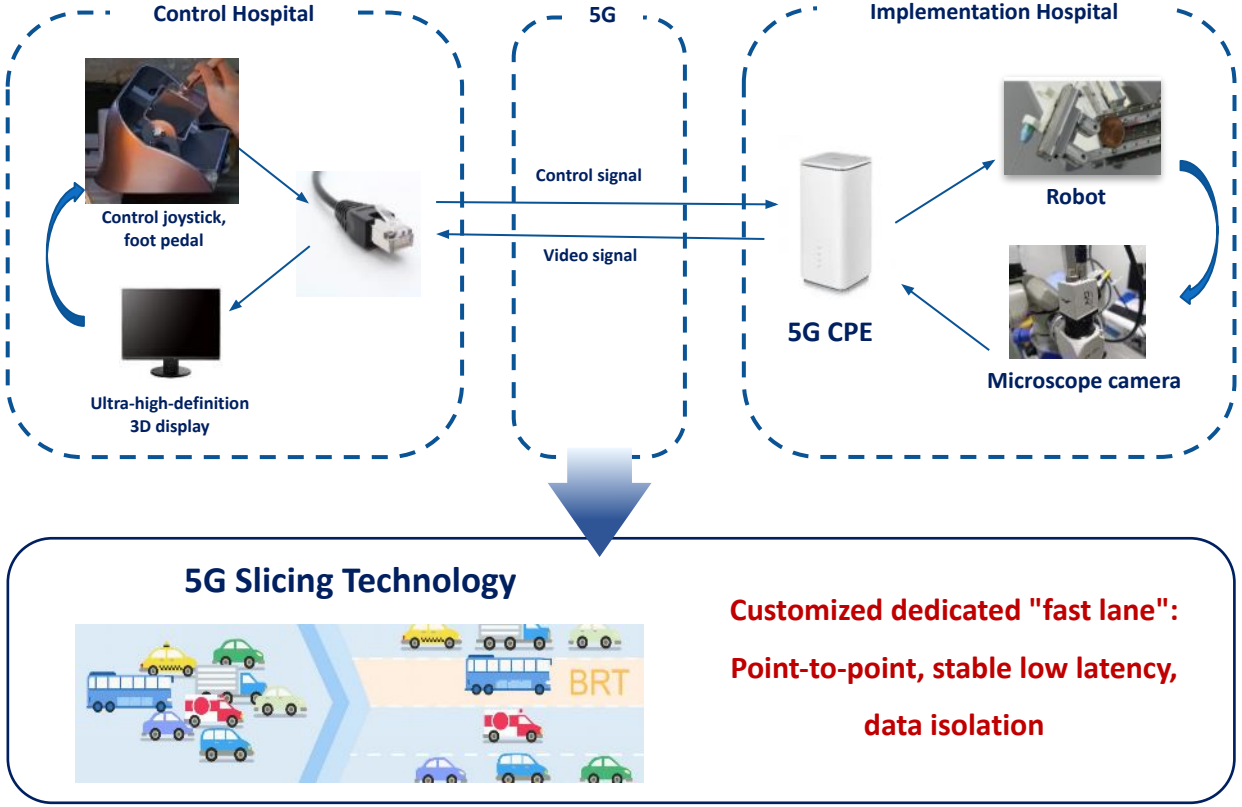
- Covering the entire diagnosis and treatment process
- Intelligent, integrated application platform

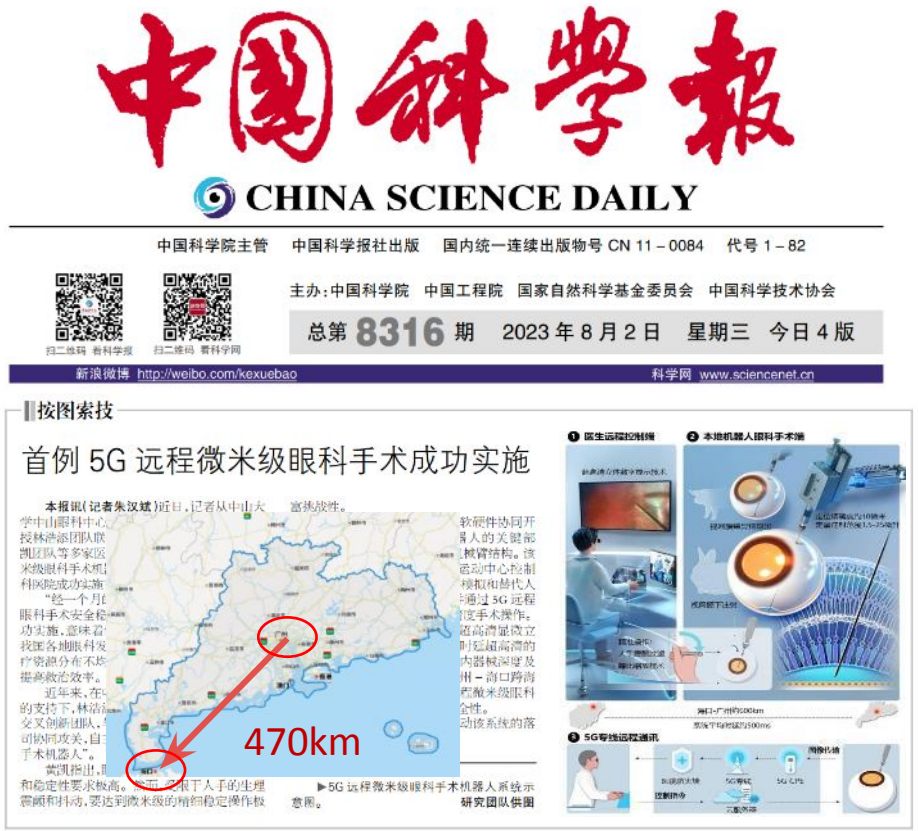
The world's first new smart medical complex that transcends time and space

It is gradually covering hospitals at all levels across the country, medical examination centers and countries along the Belt and Road Initiative

Cross-sea remote ophthalmic precision surgery

Digital medical technology applications | Remote screening | **Remote surgery** | Economic Benefits | Privacy protection | Large-scale language model (LLM) full-process assistance



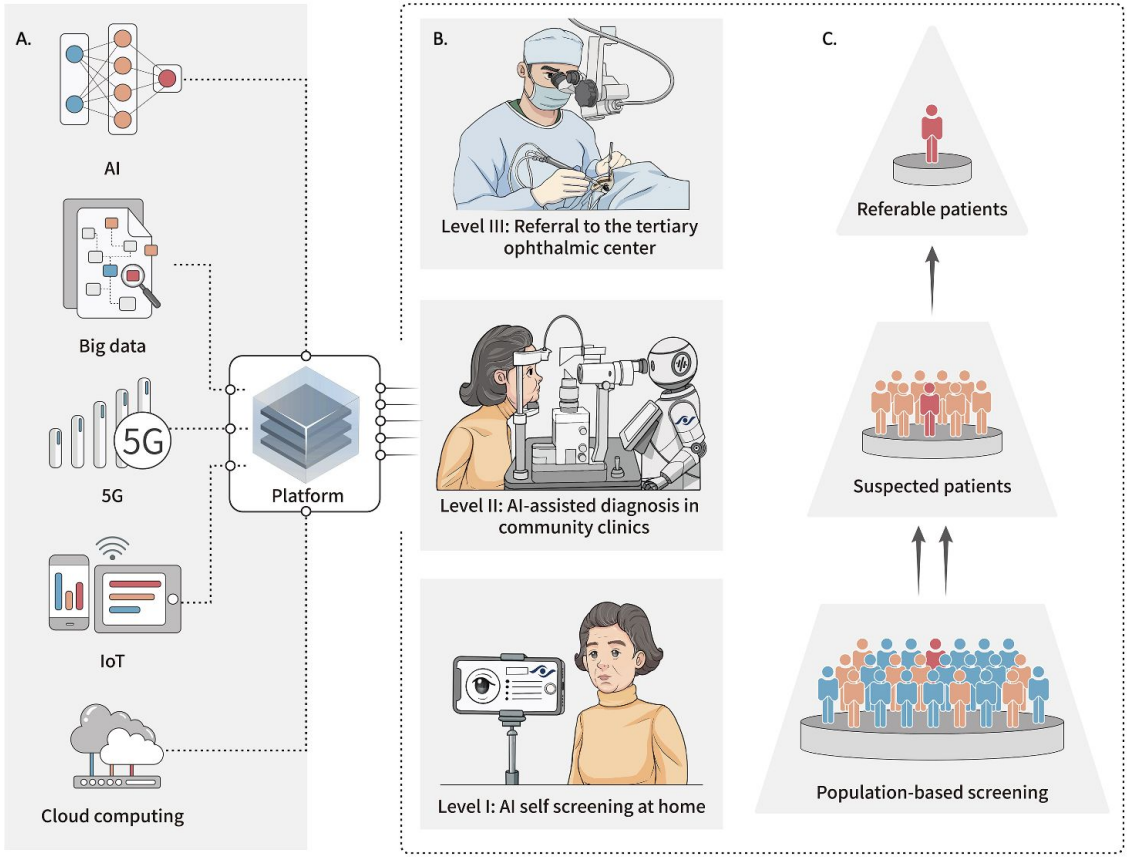


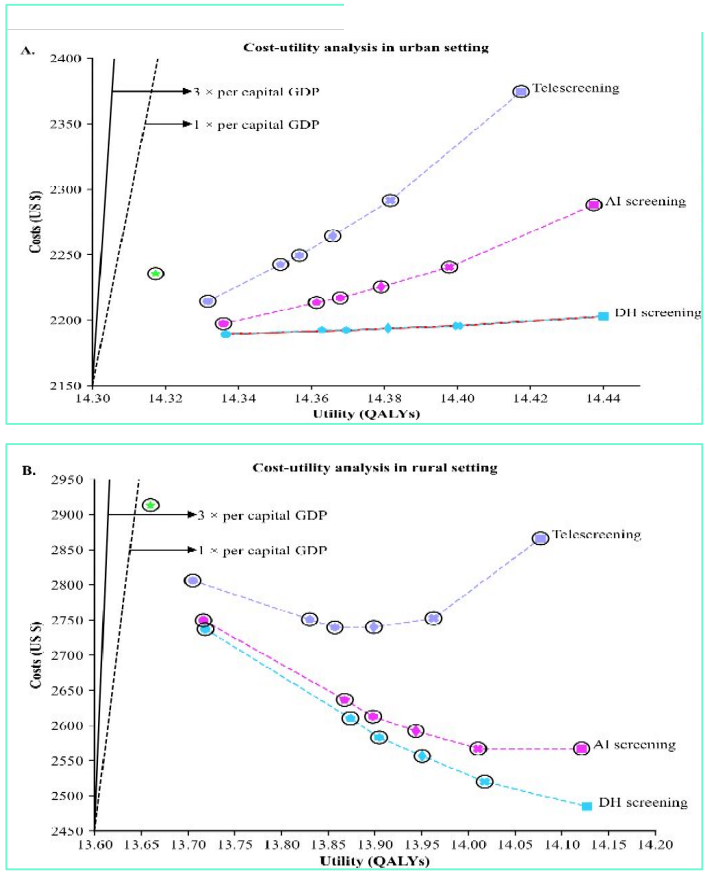
5G remote high-precision ophthalmic surgical robot enables micron-level remote surgery across the Qiongzhou Strait

AD XU,...HT Lin. International Journal of Surgery.* 2023

Smartphones make screening and treatment more cost-effective

Digital medical technology applications | Remote screening | Remote surgery | **Economic Benefits** | Privacy protection | Large-scale language model (LLM) full-process assistance



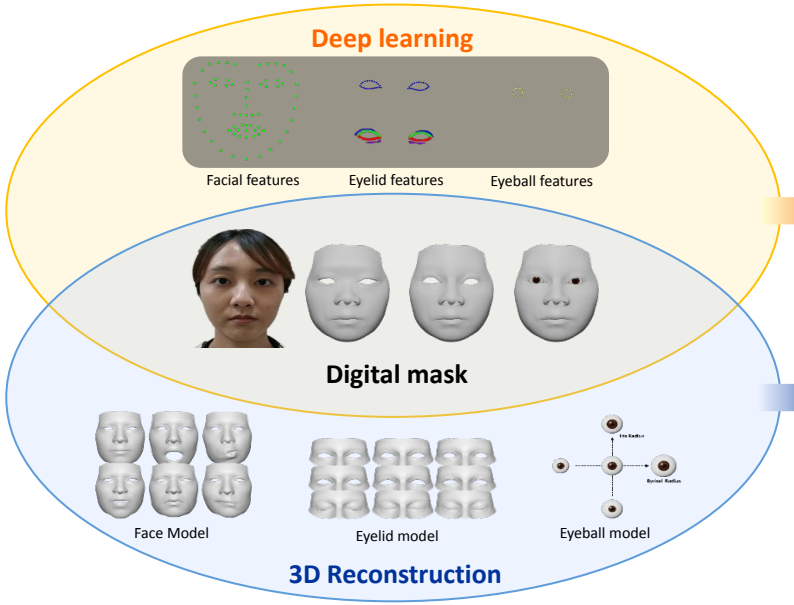


Annual digital screening is the most cost-effective screening model in both urban and rural areas.

*XH Wu, ..., HT Lin**. **Nature Communications. 2024**

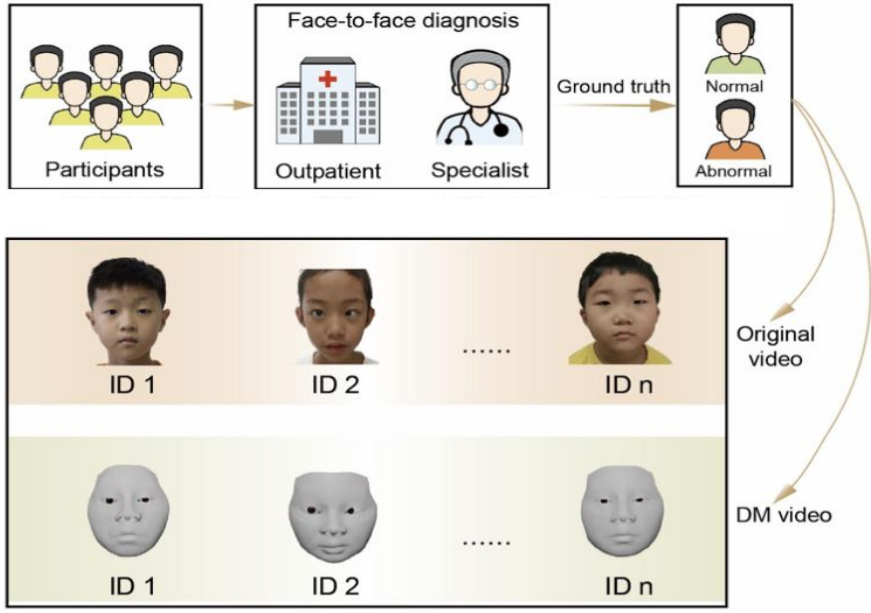
"Digital Mask" – privacy protection technology

- The face contains important biometric information and is the focus of personal privacy protection in the digital age.
- The biometric information of the face, especially the periorbital area, is an important basis for the diagnosis of eye diseases and eye-related systemic diseases.



Feature extraction:
- *Facial feature extraction*
- *Eyelid feature extraction*
- *Eyeball feature extraction*

3D reconstruction:
- *3D facial reconstruction*
- *3D eyelid reconstruction*
- *3D eyeball reconstruction*

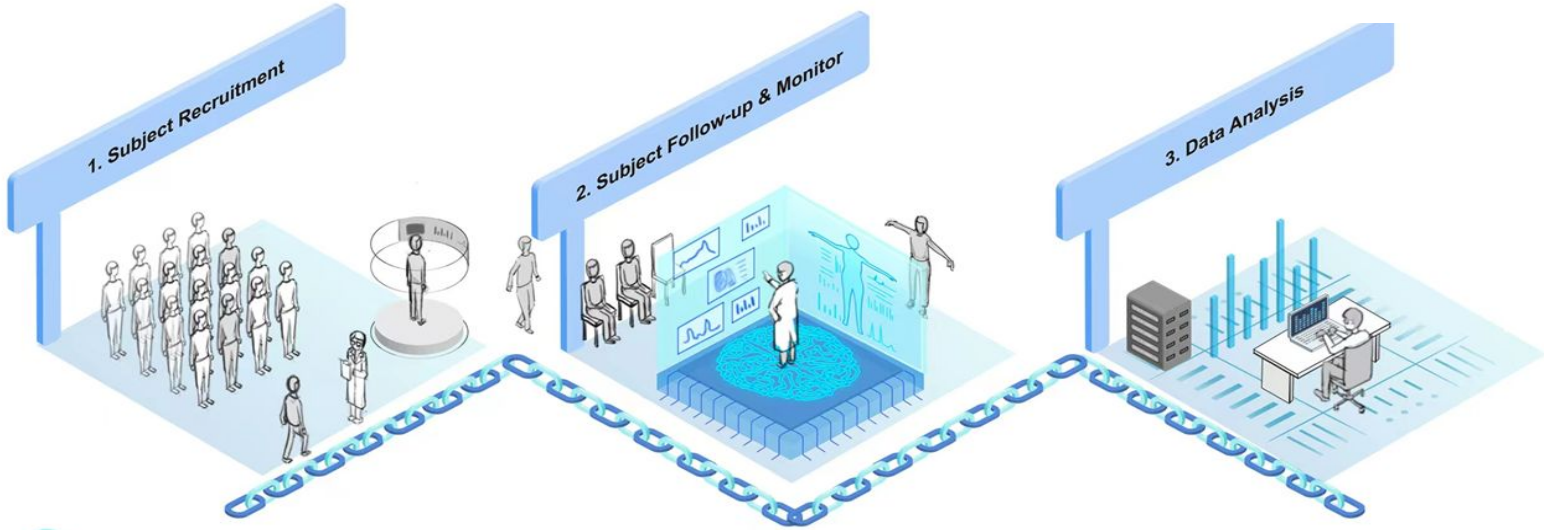


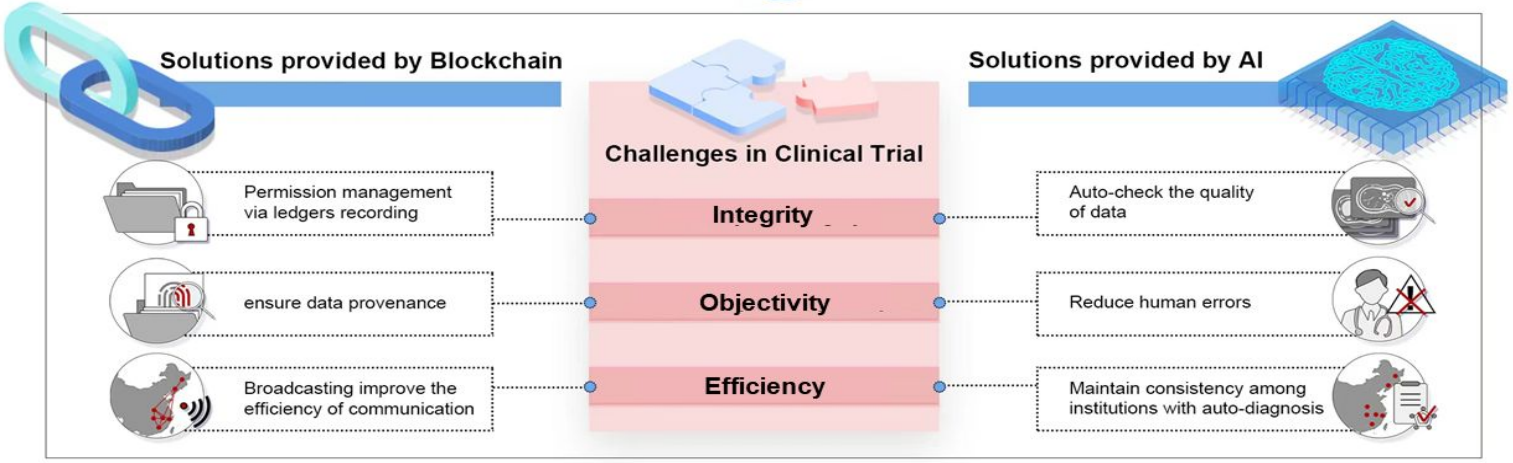
Based on 3D reconstruction and deep learning, we break through the technical bottleneck of facial image de-identification and solve the contradiction between privacy protection and digital diagnosis and treatment.

YH Yang,...HT Lin. Nature Medicine*. 2022

Blockchain + AI ensures data security throughout the entire clinical process

Digital medical technology applications | Remote screening | Remote surgery | Economic Benefits | **Privacy protection** | Large-scale language model (LLM) full-process assistance

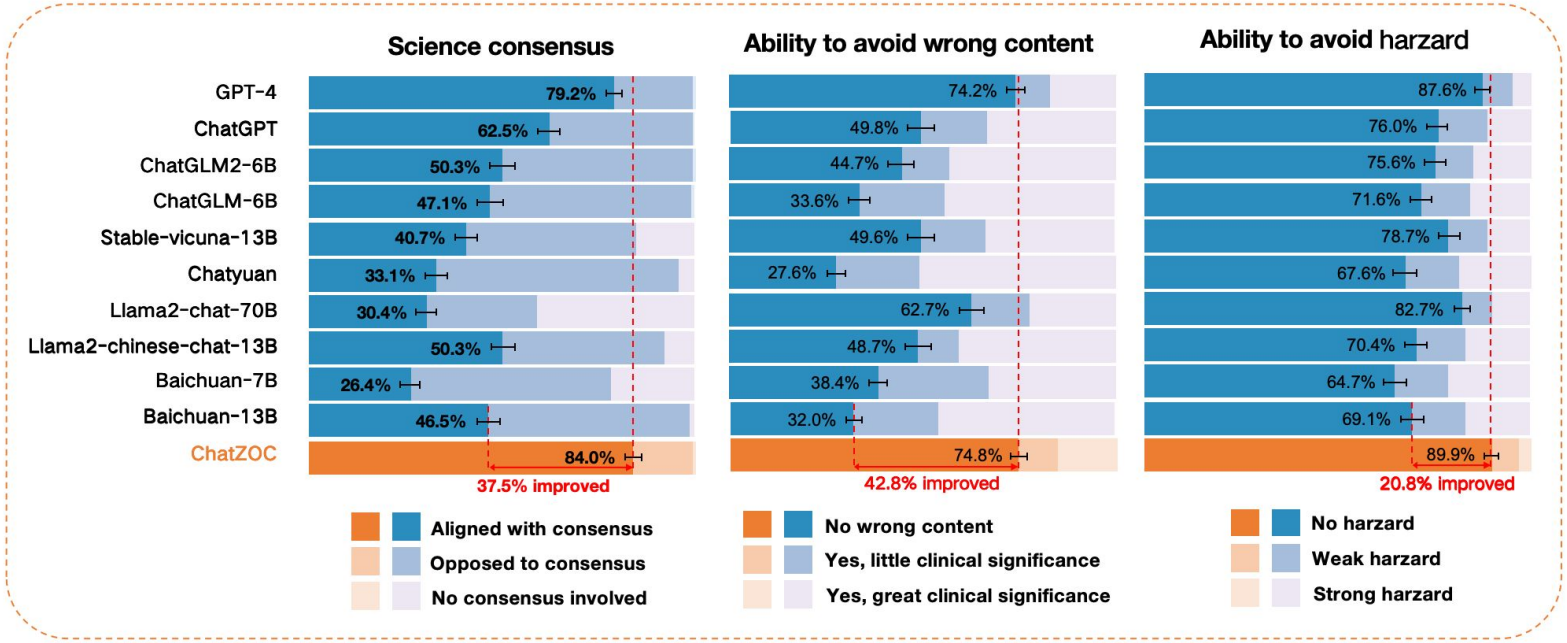




ChatZOC – Ophthalmic large language model

Digital medical technology applications | Remote screening | Remote surgery | Economic Benefits | Privacy protection | **Large-scale language model (LLM) full-process assistance**

Medical professional assessment	
Accuracy	Science consensus
	Missing content
	Possible bias
Utility	Correct understanding
	Correct retrival
	Correct reasoning
Safety	Ability to avoid wrong content
	Ability to avoid harm
	Severity of harm



Ophthalmology expertise and safety: A million-level eye disease knowledge base effectively improves medical expertise

Data Localization and Privacy: Achieving full-process localized training and usage to address data leakage issues.

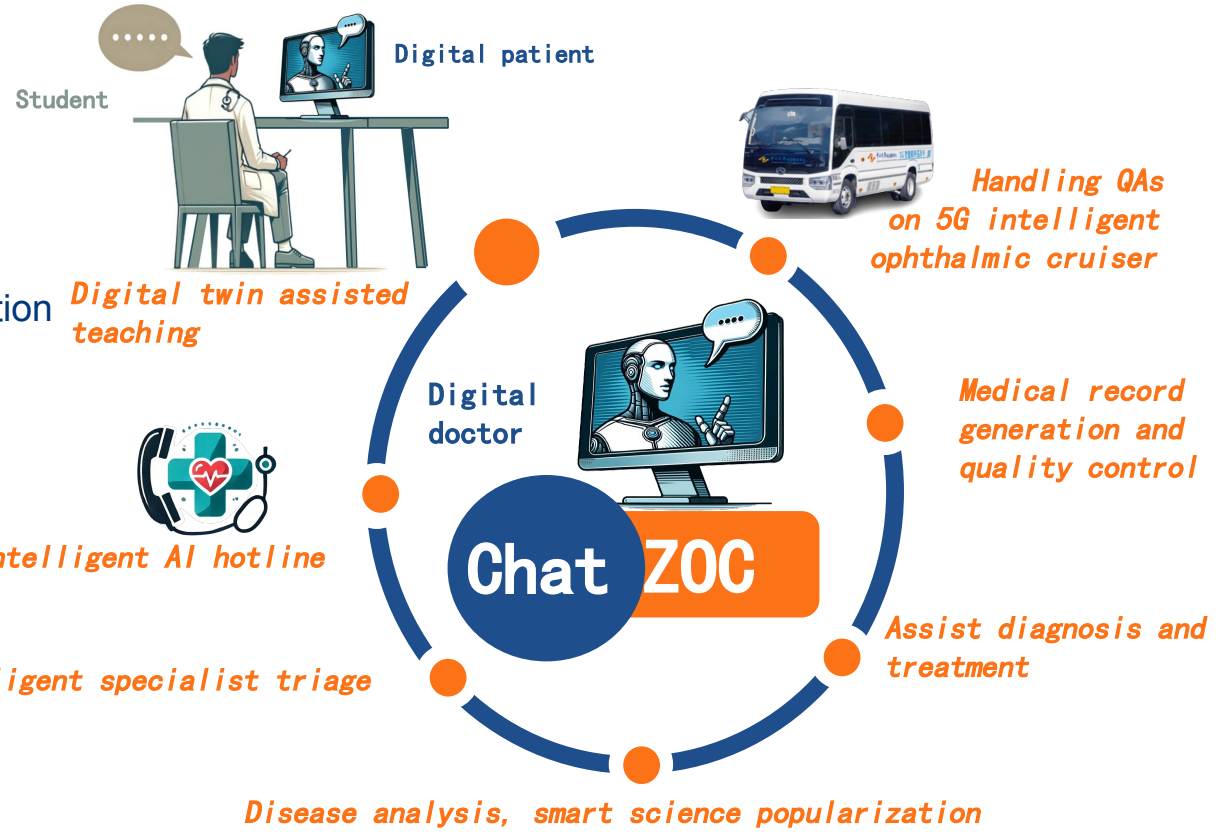
MJ LUO,...HT Lin*. *JAMA Ophthalmology* . 2024

ChatZOC assist in medicine, education, research and management

Digital medical technology applications | Remote screening | Remote surgery | Economic Benefits | Privacy protection | Large-scale language model (LLM) full-process assistance

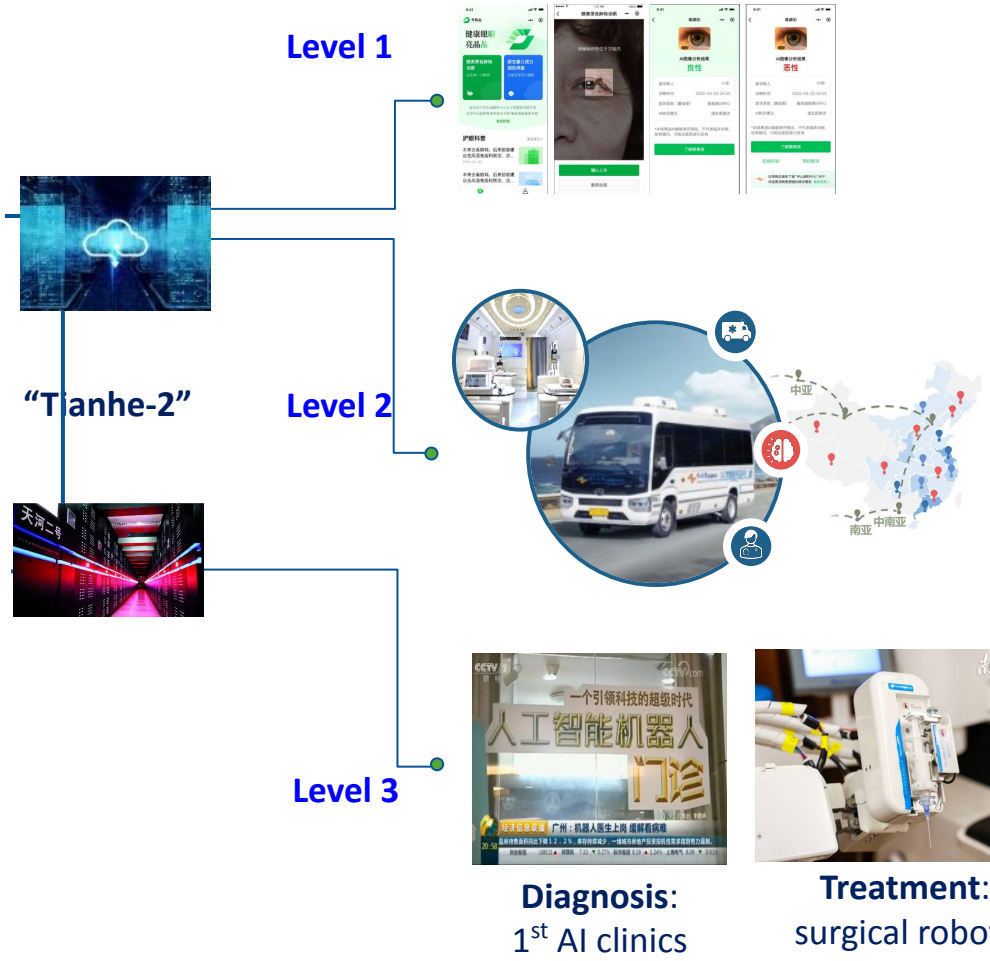
Problems to be solved

- Growing number of patients led to a shortage of clinical medical experts;
- Patients' requirement of doctors' accompany and consultation to reduce anxiety;
- Limited communication channels between doctors and patients and problems with medical services;
- The lack of standard patients in medical consultation teaching leads to unsatisfactory teaching results.



It has been calculated that it can support 1.5 million service sessions, freeing professional physicians from tedious and repetitive work and effectively improving the quality, efficiency and scope of medical services.

Innovative Three-Level Intelligent Referral Pattern



Level 1 : intelligent mobile terminal

(For personal and family use)

Level 2 : 5G-enabled intelligent ophthalmic cruiser

(Community and grassroots hospitals)

Level 3 : Intelligent professional equipment

(Tertiary comprehensive and specialized hospitals)

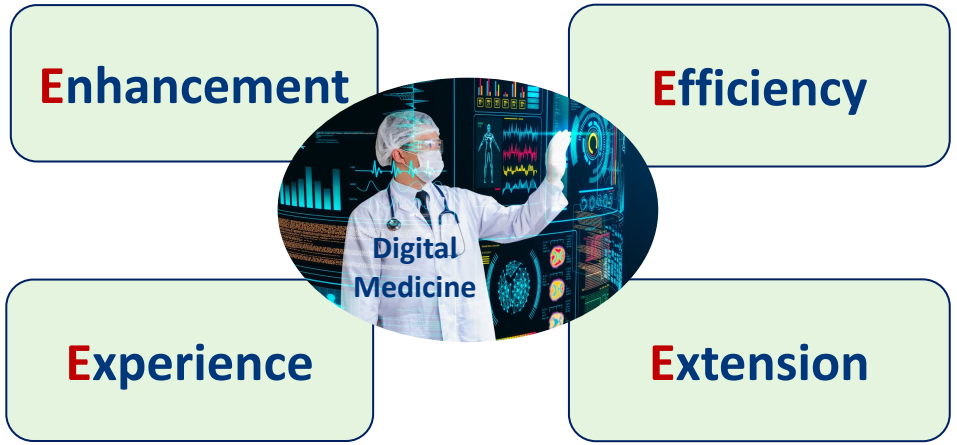
Diagnosis:
1st AI clinics

Treatment:
surgical robots

10 times efficiency boost, serving over 10 million individuals

Wu XH* . **Nature Communications** 2024

Digital health as a system approach to healthcare: Innovation Boosts Eye Health



Digital Medicine Improve Healthcare

High-quality | Economical | Efficient | Convenient | Comprehensive

Universal, Whole-life cycle, Full-dimensional healthcare

Medical Service

Screening → Triage → Diagnosis → Treatment → Follow-up

Lifestyle

Monitor → Intervene → Predict

Smart Sensors

Environment

Planning ↔ Protecting

Environment and myopia


Thanks
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