ITU KALEIDOSCOPE
ATLANTA 2019

PREPARING FOR THE AI ERA UNDER THE DIGITAL HEALTH FRAMEWORK

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4-6 December
Atlanta, Georgia, USA

What are we talking about when we talk about ICT for health?

* Word cloud statistics for all papers of Kaleidoscope

What this paper is going to deliver:

- Key Concept
- Framework of “ICT for health”
- Interaction between health and ICT
- Towards AI for health era

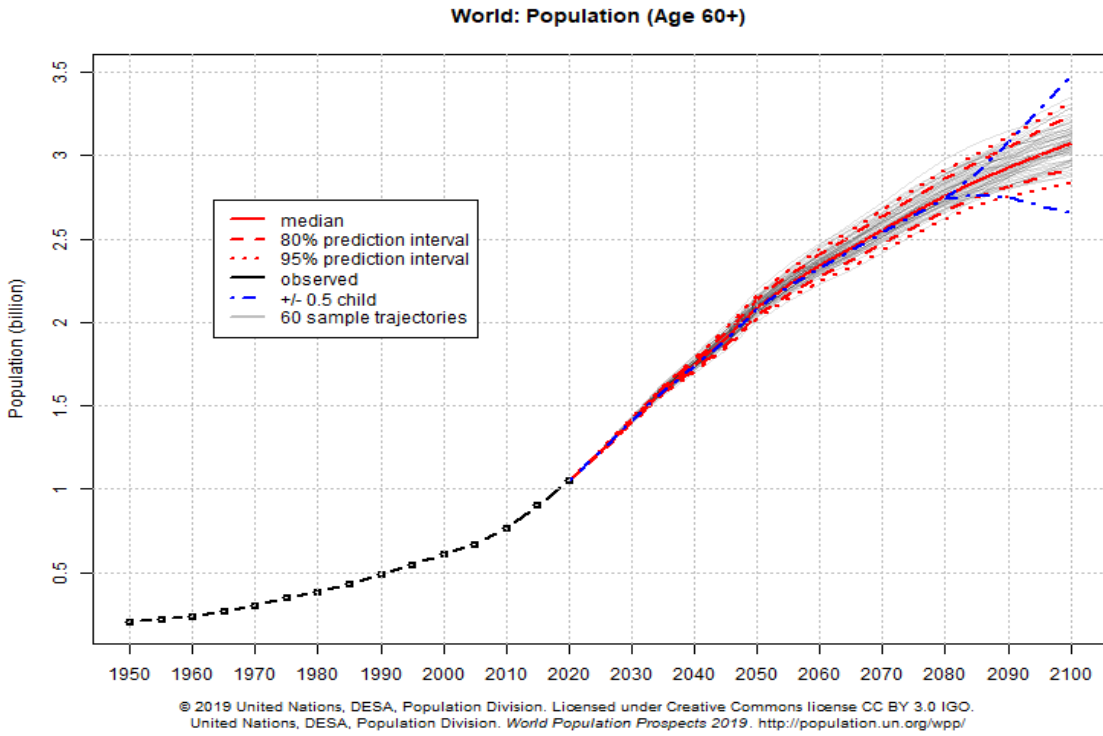
KEY CONCEPT

The field of **digital health** is dynamic and progressing rapidly. **eHealth, medical informatics, health informatics, telemedicine, telehealth and mHealth** are some of the terms that have been used over the last five decades, depending on the available technologies and accessibility of the baseline infrastructure. These terms have been used to describe the application of information and communication technologies (ICTs) to areas of health, health care and wellbeing. More recently, the term digital health has been selected to embody integration of concepts yet be flexible enough to foster diversity of purposes, technologies and other specificities.

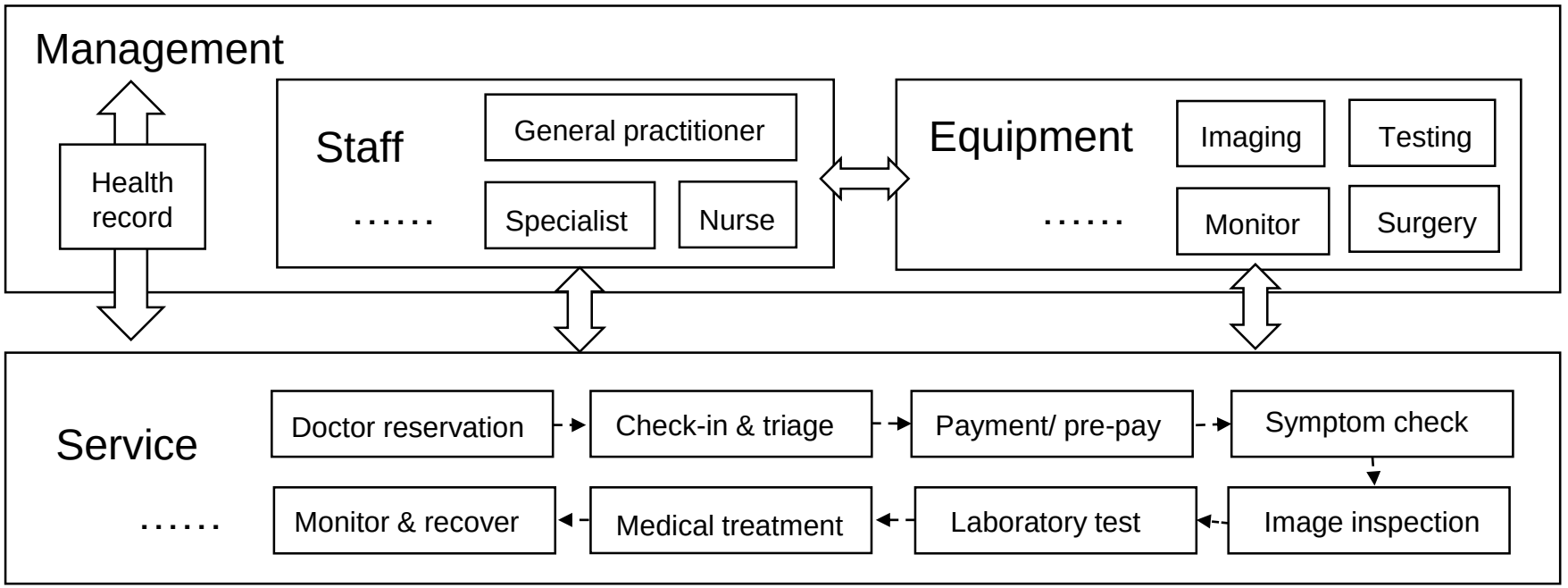
From “Global Strategy on Digital Health 2020-2024”, WHO

Health Side

- Demand: aging trend
  - over age 65 (16%) in 2050
  - chronic diseases
- Supply: lags behind
  - 4.1% growth of radiologists
  - 30% growth of images
- Gap between supply and demand is waiting for new technological productivity to be filled.



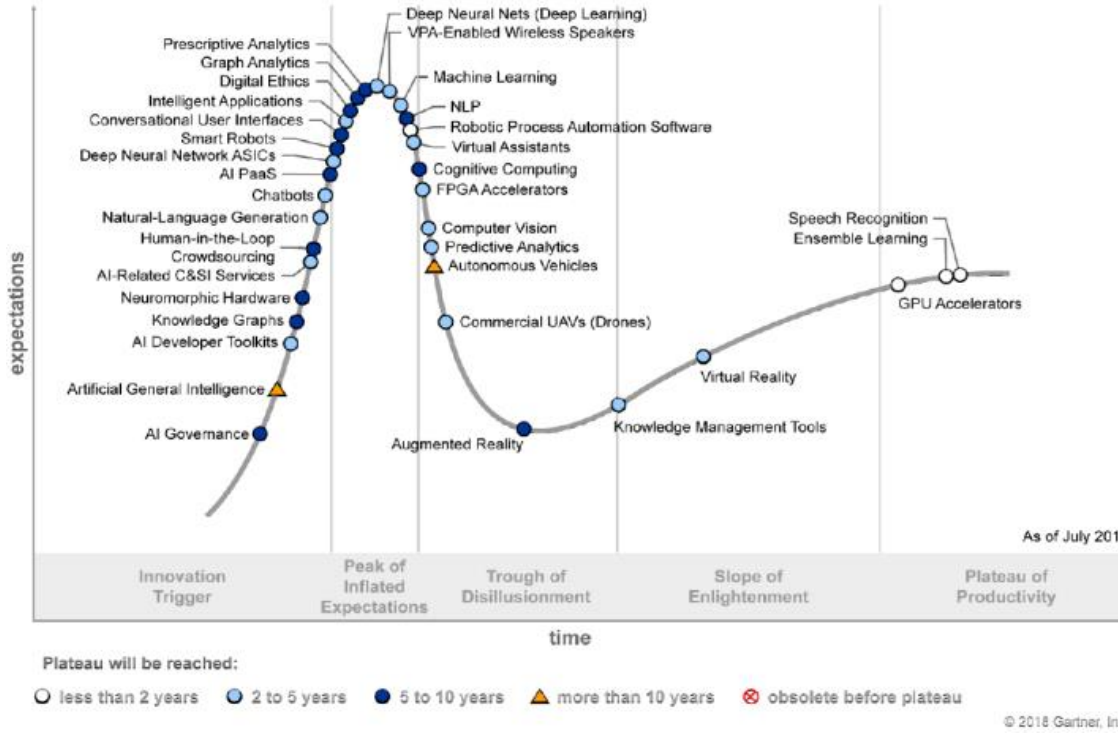
Health Framework



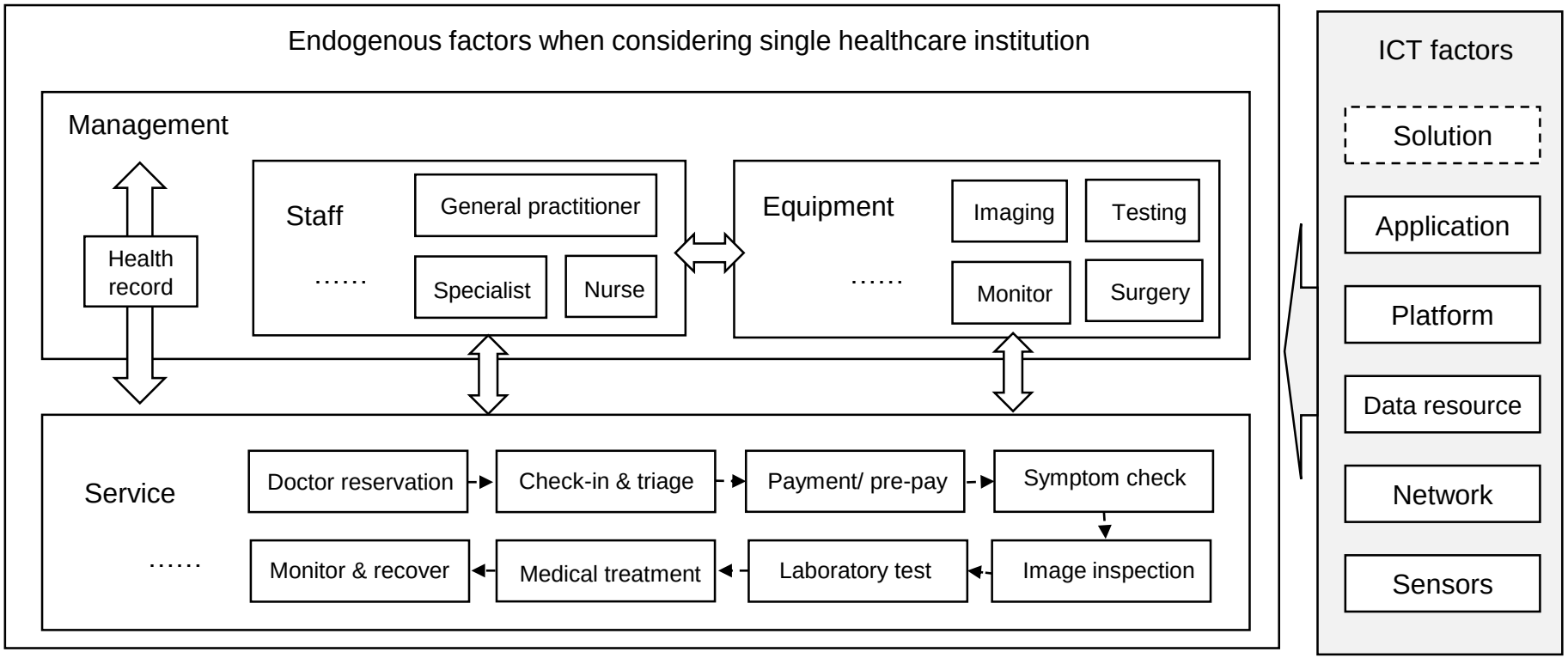
Endogenous factors when considering single healthcare institution

ICT Penetration

- Arrival of the fourth industrial revolution
  - Fifth generation (5G) communications
  - Machine-to-machine (M2M) communications
  - Cloud computing
  - Internet of things (IoT)
  - Big data
  - AI and machine learning(ML)
  - etc.



Digital health framework



Development Track

Key mode:

- Start from: 1960s
- Digitization of data;

Landmark event:

- hospital information system (HIS)
- management information system (MIS)

Stage 1: Institutional informationization

Key mode:

- Start from: late 1980s
- Community network

Landmark event :

- electronic health records (EHR)
- nationwide health information network

Stage 2: Regional informationization

Key mode:

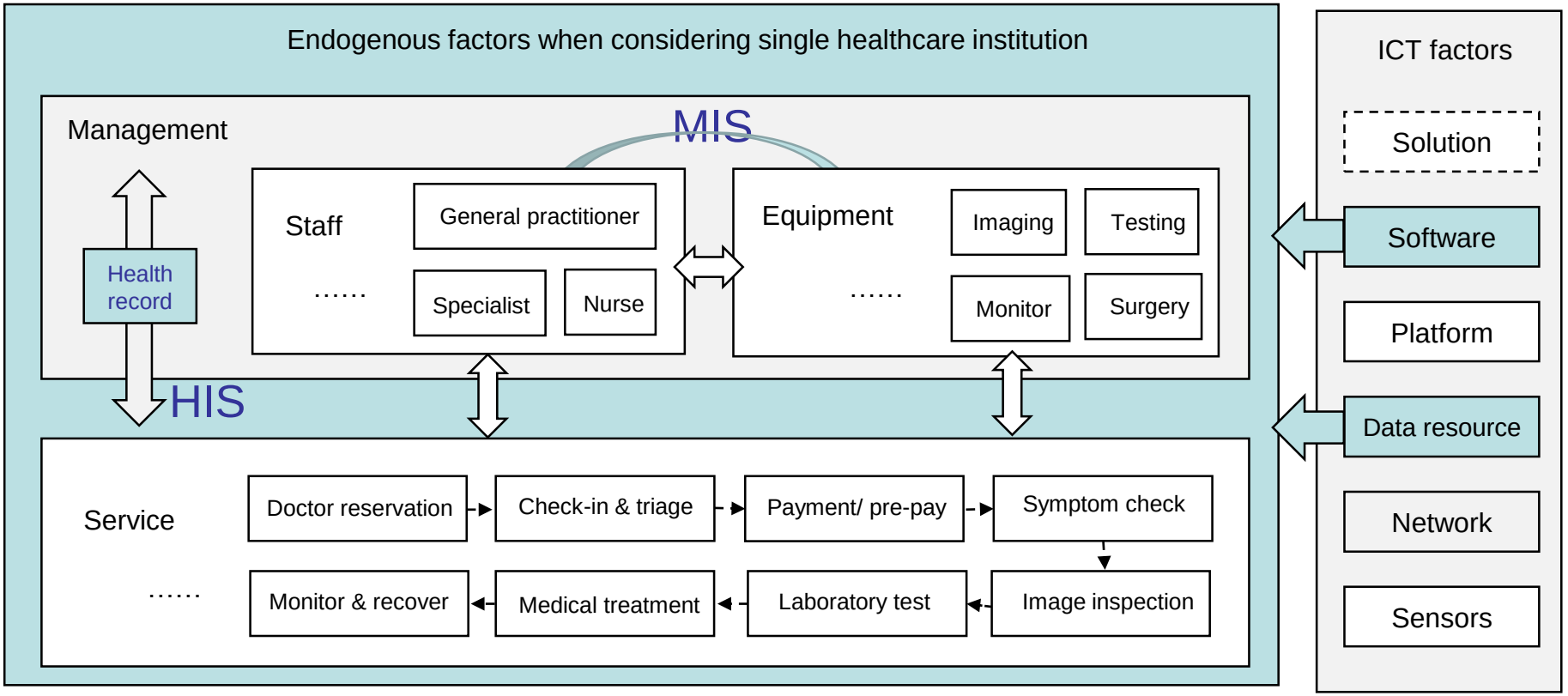
- Big data
- Computing platforms
- Personalized applications

Landmark event :

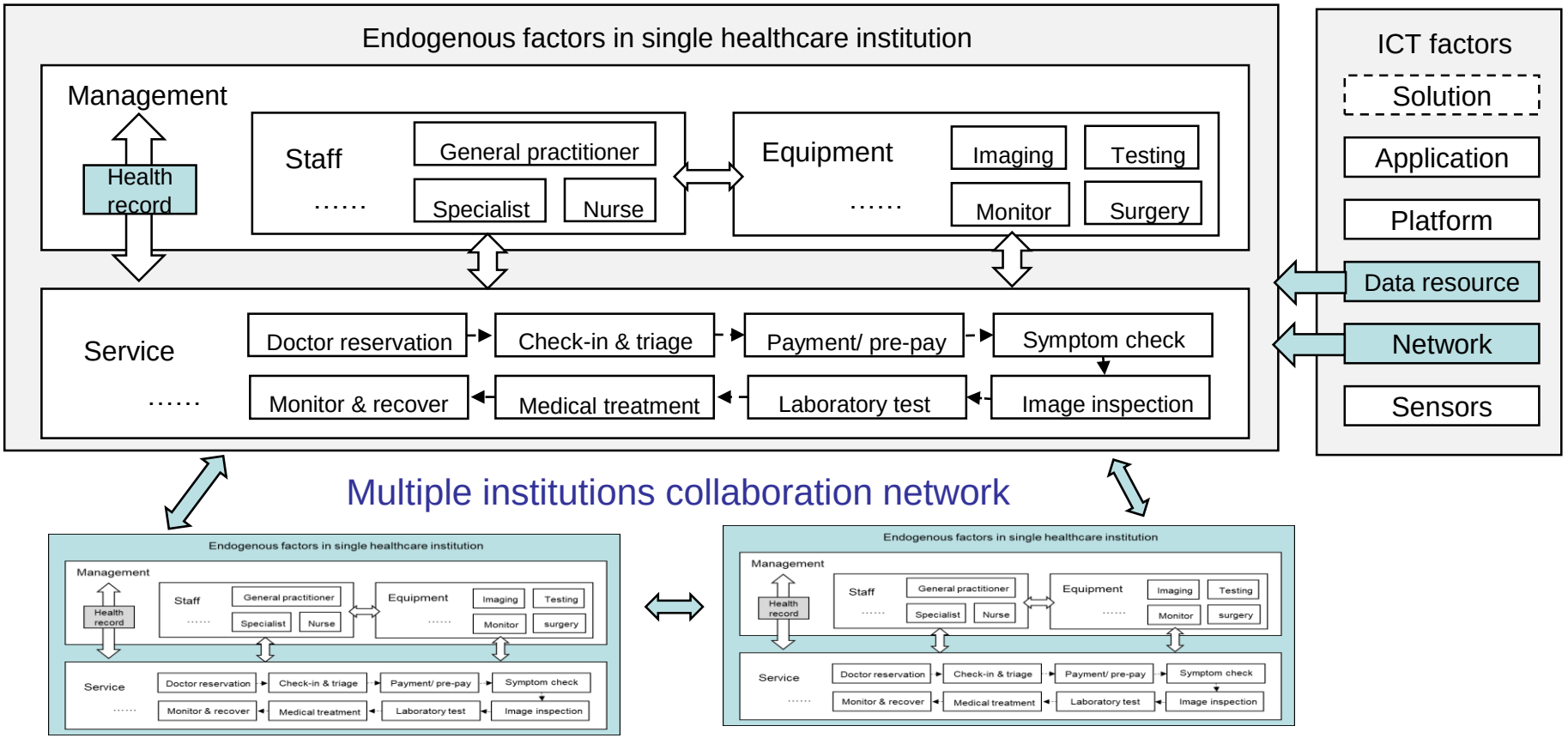
- AI/ML
- Auxiliary diagnosis
- IBM Watson
- DeepMind

Stage 3: Service intelligentization

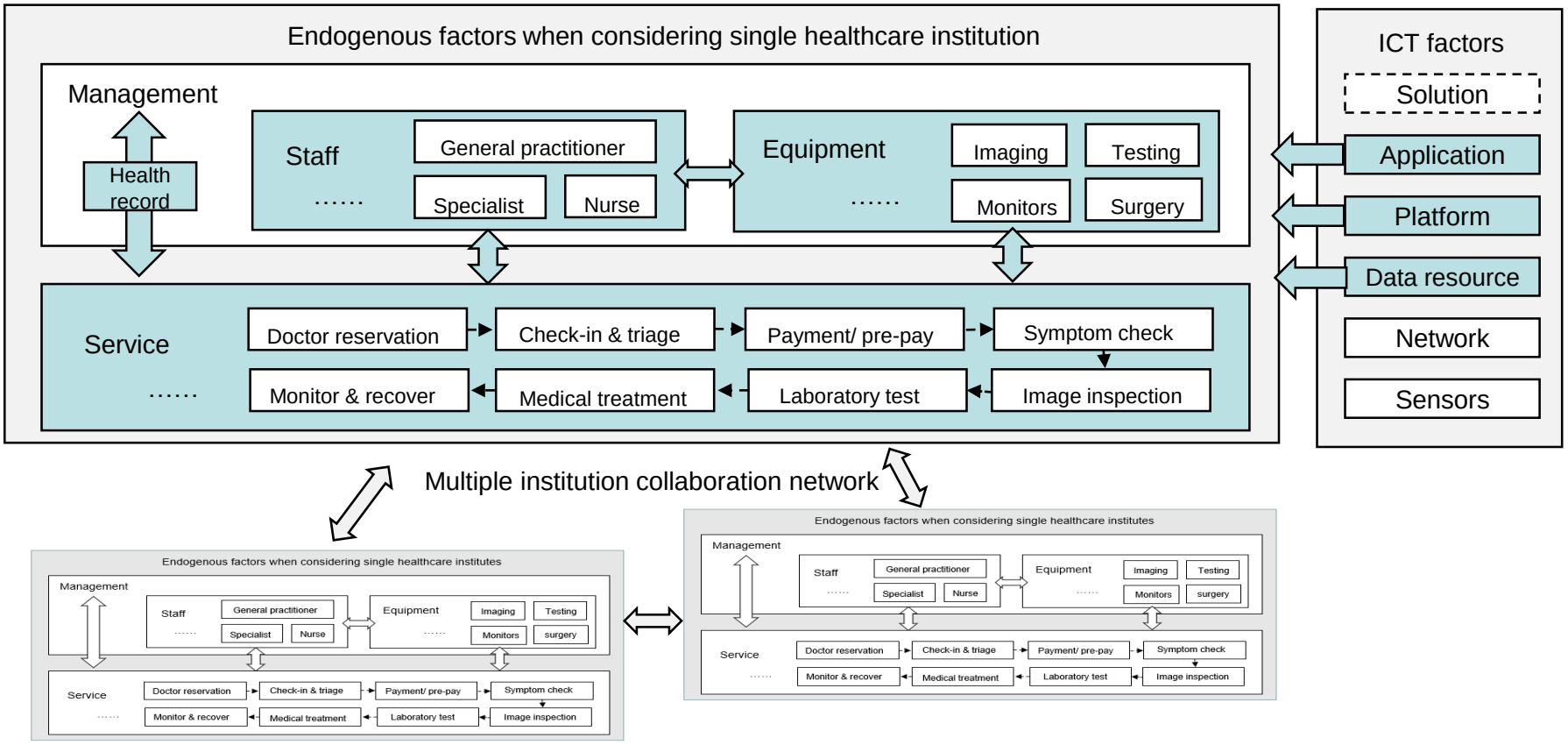
Stage 1: Institutional informationization



Stage 2: Regional informationization



Stage 3: Service intelligentization



AI ERA is coming…

- Following the track of service intelligentization, AI is one of the most significant trends in ICT.
- Frequent and intensive national strategies on AI also have their priority on the development of Ai for health.
- The following sections extract the interaction of AI on digital health separately from the stage 3 and discuss the preparation.

Country	Policy	Release
US	Preparing for the Future of Artificial Intelligence	2016.10
	The National Artificial Intelligence Research and Development Strategic Plan	2016.10
	Artificial Intelligence, Automation and the Economy	2016.12
	Artificial Intelligence and National Security	2018.07
	Executive Order on Maintaining American Leadership in Artificial Intelligence	2019.02
	The National Artificial Intelligence Research and Development Strategic Plan:2019 Update	2019.06
EU	Artificial Intelligence for Europe	2018.04
	Declaration of Cooperation on Artificial Intelligence	2018.04
	European Coordinated Plan on Artificial Intelligence	2019.2
UK	Artificial intelligence: opportunities and implications for the future of decision making	2016..11
	Growing the Artificial Intelligence Industry in UK	2017.10
	AI in the UK_ ready, willing and able？	2018.04
	Industrial Strategy: Artificial Intelligence Sector Deal	2018.04
China	A new generation of artificial intelligence development planning	2017.07
Japan	Next generation artificial intelligence promotion strategy	2016.7
	Artificial intelligence technology strategy	2018.6

AI FOR HEALTH

Key Factors of AI

Data

Images
Records
Health data
.....

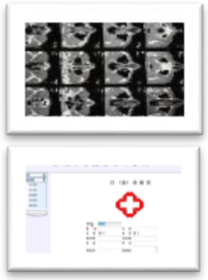
Computer abilities

CPU GPU
FPGA ASIC ...
Task deployment

Algorithm

Deep learning & Machine Learning
Medical knowledge atlas
Natural language processing
.....

BLACK BOX from user perspective



Input

AI Platform

EARLY SCREENING
AUXILIARY DIAGNOSIS
Remote Monitoring
Health management
.....

Output

DATA: Comprehensive description

- **Horizontal expansion**
  - Full coverage of a life cycle
  - Keen perception of sensors
  - Strong analytical ability of AI
  - **Active health**: from “treat diseases” to “prevent diseases”, alleviating the gap between supply & demand
- **Vertical expansion**
  - Deep description of life
  - From the individual level, anatomical level, tissue, metabolism, to protein, genetic aspects.
  - **Precision medicine:** genome sequencing technology & cross-application of big data.

COMPUTING ABILITIES: Customized

- **Processors**
  - Central processing unit (CPU)
  - Graphics processing unit (GPU)
  - Field-programmable gate array (FPGA)
  - Application specific integrated circuit (ASIC) : **will be the largest by 2025**

- **Network architecture**
  - Combination of cloud and edge computing to support flexible requirements.
  - **Cloud:** pay-per-use, on-demand access, training task
  - **Edge:** adaptive to application scenarios, inference tasks

ALGORITHM: integrated with health process

- **Service integration**
  - reservation, triage, payment, symptom check, image inspection, laboratory test, medical treatment, monitoring.
    - AI Virtual assistant
    - Medical imaging aided diagnosis
    - Clinical decision support system (CDSS)
- **Management integration**
  - Effective control of staff and equipment inside the institution
    - Staff management: performance appraisal & auxiliary talent training, etc.
    - Equipment & drug operation: IoT sensors and AI analysis on equipment failures; drug mining and drug optimization.

Industry perspective

COMPANY & PRODUCT

- Demand analysis
- Feature design
- Model development
- Product internal testing
- INDUSTRY BENCHMARK ASSESSMENT

REGULATORY AUTHORITY

- Submit an application
- Reports review
- CLINICAL TRIALS
- Application passed

UPDATE & ROBUSTNESS

USERS

- Industrial application

Technical perspective

Data

Images
Records
Health data
.....

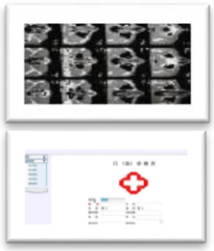
Computer abilities

CPU GPU
FPGA ASIC ...
Task deployment

Algorithm

Deep learning & Machine Learning
Medical knowledge atlas
Natural language processing
.....

Users' perspective



Input

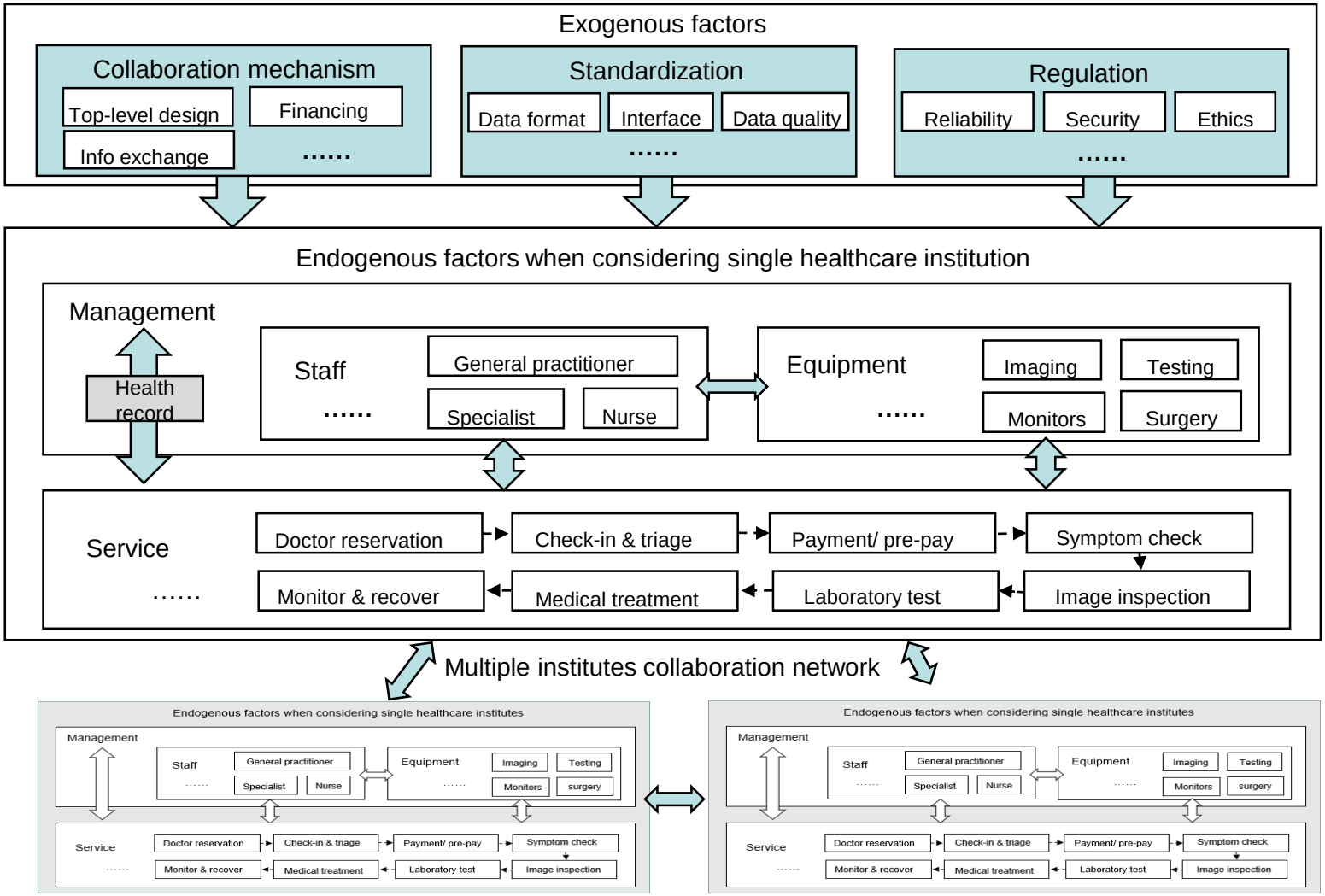
AI Platform

- EARLY SCREENING
- AUXILIARY DIAGNOSIS
- Remote Monitoring
- Health management
- .....

Output

CORRESPONDING PREPARATION

- **Collaboration mechanism:** Expertise from the health and AI community are of great importance to promote this cross-domain task.
  - Top-level design, Information exchange, Financing…
- **Standardization:** act as an accelerator for integration innovation under the overview control of the collaboration mechanism.
  - Data format and interface; Data quality and evaluation methods…
- **Regulation:** define the bottom line of the industry and maintain its legality.
  - Reliability, Security, Ethics …


Exogenous factors
Collaboration mechanism
Top-level design
Financing
Info exchange
.....
Standardization
Data format
Interface
Data quality
.....
Regulation
Reliability
Security
Ethics
.....
Endogenous factors when considering single healthcare institution
Management
Health record
Staff
General practitioner
Specialist
Nurse
.....
Equipment
Imaging
Testing
Monitors
Surgery
.....
Service
Doctor reservation
Check-in & triage
Payment/ pre-pay
Symptom check
Image inspection
Laboratory test
Medical treatment
Monitor & recover
.....
ICT factors
Solution
Application
Platform
Data resource
Network
Sensors
Multiple institutes collaboration network
Endogenous factors when considering single healthcare institutes
Endogenous factors when considering single healthcare institutes

CONCLUSION

"What are we talking about when we talk about ICT for health? "

- Key Concept: Clear its core position for "Digital health"
- **Framework:** draft of digital health framework and corresponding factors
- **Interaction** between health and ICT factors : through different stages
- Towards AI for health era: Supplement for exogenous factors

ACKNOWLEDGEMENT

I would like to thank Mr. Yuntao WANG, Ms. Weimin ZHANG from CAICT for the data and cases from first-hand industrial research, and Dr. Tao WANG for reading a first version of this editorial. In addition, many thanks to Dr. Gauden GALEA and Ms. Mengji CHEN from WHO for providing many valuable suggestions during the writing process.

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Thank you