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Comparative Study on Global Development Strategies of Artificial Intelligence in Healthcare

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Abstract: This study compares the artificial intelligence (AI) development strategies related to healthcare in the United States, the United Kingdom, Japan, India, and China that have been released publicly since 2015. The analysis reveals that infrastructure investment and the industrial landscape are the core components of these strategies. China's strategy is well developed and ranks second only to the United States in many aspects. However, China still faces several critical challenges: lack of holistic planning and development paths, unclear development focus, lack of effective engagement of the health data infrastructure with AI applications, an unbalanced framework of interdisciplinary skills, and insufficient regulation policies for AI applications. To promote AI applications in Chinese healthcare, we should clarify the strategic value of AI for healthcare advancement, focus on major health needs, prioritize the construction of data infrastructure and platforms, establish interdisciplinary research institutes to develop innovative AI applications, and promote scientific research of regulatory mechanisms.

Keywords: healthcare; artificial intelligence; international comparison

1 Introduction

As a leading strategic technology, artificial intelligence (AI) has become the essential driving force for a new era of industrial revolution. As a critical strategic technology to enhance national competitiveness and safeguard national security, AI significantly influences the world's major developed countries. The scientific and technical competition among the countries striving to lead the world's AI revolution is becoming increasingly fierce. The AI strategic landscape combined with scientific foresight will directly affect the power and effectiveness of a country's initiatives in this international competition and likely have significant and far-reaching impacts on international political and economic patterns. In the field of medicine and healthcare, AI can be currently applied to solve several prominent problems, such as the acute shortage of high-quality resources and the substantial discrepancies in the regional medical services provided through innovative transformations to the industrial supply side by optimizing stock and supply management and by promoting intelligent upgrades of key drugs and medical equipment. Of great significance for China will be the enactment of a national strategic plan of "AI+ Healthcare" as soon as possible that will benefit the implementation of "Healthy China" and "innovation-driven development." This is also significant for promoting the medical and health industry as a cornerstone of the national economy.

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In this paper, we aggregated all content related to AI development strategic planning since 2015 from five of the world's major countries with specific focus on the field of healthcare. Characteristics of the strategic "AI+" landscape in healthcare in the selected countries were analyzed both individually and combined through horizontal comparison, after which the competitiveness of future international trends based on China's "AI+ Healthcare" were predicted. Our specific purpose was to provide references for China's strategic development and planning of AI in the field of healthcare.

2 National AI strategy planning in medical health

As of April 2019, at least 35 countries worldwide have issued AI strategic plans, all of which attach significant importance to the development and application of AI technology in specific fields. In particular, the United States, the United Kingdom, Japan, India, and China have emphasized the application of AI technology in the field of medicine and health. The following is a review of the relevant strategic plans of these countries over the past five years with a focus on analyzing their respective AI landscapes and the evolution of their strategic plans.

2.1 The United States

In October 2016, the White House Office of Science and Technology Policy (OSTP) released a planning report titled *Preparing for the Future of Artificial Intelligence.* It proposed 23 recommendations regarding management, data, talent, research, investment, and policy. One recommendation stated that federal agencies should prioritize open training data and open data standards for AI, and the link between AI and data science was highlighted simultaneously in several recommendations [1]. *The National Artificial Intelligence Research and Development Strategic Plan* issued in the same month mentioned the following potential benefits of AI in medicine: AI can support bioinformatics systems that identify genetic risks from large-scale genomic studies (e.g., genome-wide association studies and sequencing studies), and they can predict the safety and efficacy of new pharmaceutical products. AI techniques allow assessments across multidimensional data for studying public health issues, provide decision support systems for medical diagnoses, and prescribe treatments. AI technologies are required for the customization of drugs for individuals that in turn can result in increased medical efficacy, patient comfort, and reduced waste [2].

The National Institutes of Health (NIH) is specifically responsible for the nationwide management of medical research in the United States and for promoting the development of AI in the field of medical and health. NIH was the first to focus on the construction of a biomedical data infrastructure. In June 2018, the *NIH Strategic Plan for Data Science* was released. It posited that technological innovations like machine learning, deep learning, AI, and virtual reality could revolutionize biomedical research within the next decade. The plan also suggested that NIH must integrate its existing data science efforts into the larger data ecosystem and take full advantage of existing and emerging data management and technology achievements, new computing platforms, and innovative tools [3].

Since 2019, the US federal government has enacted several AI-related policies to accelerate the development of AI applications. In February, the *American Artificial Intelligence Initiative* was launched to develop AI in accordance with five key aspects: investment in AI research and development, release of AI resources, formulation of AI governance standards, increase the number of trained AI specialists in the workforce, and international participation with the intention of maintaining US global AI dominance. In June, *The National Artificial Intelligence Research and Development Strategic Plan: 2019 Update* was released. An eighth strategy was added, namely, Expand Public-Private Partnerships to Accelerate Advances in AI, and the existing seven strategies were updated and expanded [4]. Strategy 2: Develop Effective Methods for Human-AI Collaboration was updated to include that ongoing research of NIH in natural language processing based on a database of 96.3 million facts extracted from all MEDLINE citations maintained by the National Library of Medicine. In addition, construction of the standardization and evaluation system of the public data sets—as well as the application of AI in the medical fields—were also emphasized in other strategies.

2.2 The United Kingdom

In October 2017, the UK government published a white paper titled *Industrial Strategy: Building a Britain fit for the future*, in which the four priorities related to the growth of AI and the data-driven economy were identified: (1) position the UK as a global center for AI and data-driven innovation; 2) support various sectors to boost their productivity through AI and data-analytic technologies; 3) lead the world in the safe and ethical use of data and AI

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to instill confidence and provide clarity to citizens and businesses; and 4) help people develop the new skills needed for jobs of the future [5]. In April 2018, the UK issued a policy document, *I Industrial Strategy: Artificial Intelligence Sector Deal*, that aimed to secure their global leadership in AI. This Sector Deal reinforced the five foundations of the industrial strategy: ideas, people, infrastructures, business environment, and places. The UK government planned to invest an additional £406 million (~US$504 million) to strengthen the education of science, technology, engineering, and math (STEM) skills, augment their digital infrastructure with a public investment of over £1 billion, and strive to focus on solving issues related to data openness and improving data availability. The UK government also created the new AI Council, the AI Office, and the Center for Data Ethics and Innovation (CDEI). CDEI is an important part of the UK government's AI program. By leveraging the CDEI, the UK hopes to maintain its leadership in global AI ethics research and promote themselves as a potential global leader in the field.

In the field of healthcare, £210 million from the Science and Technology Facilities Council (STFC) is being used to fund research in early identification of data diagnoses and precision medicine (including the use of AI to analyze digital pathological medical images). This financial support is slated to continue for subsequent policies. In November 2018, the UK government announced a reallocation of £50 million to further develop AI applications in the medical sector to promote early diagnoses of diseases like cancer and improve the efficiency of patient care. In addition, five AI medical technology centers have been established to jointly develop additional intelligent medical imaging analysis applications with research institutions and enterprises to provide better clinical decisions and outcomes for patients. In February 2019, the National Health Service (NHS) announced that it would open a joint unit called NHSX to accelerate the NHS's digital transformation. In August 2019, the NHS invested £250 million to establish a national AI laboratory to promote the application of AI technology in the UK medical field.

2.3 Japan

Japan was the second country worldwide to formulate a national budget for AI strategies. Prior to this initiative, the government's priorities for science and technology focused on a "robot-driven new industrial revolution." In January 2016, the Japanese government expressed its intentions to be the first country in the world to establish a "super-intelligent society" (Society 5.0) featuring a high degree of integration of cyberspace and physical space that would have a significant worldwide impact [6]. In March 2017, Japan released their *Artificial Intelligence Technology Strategy* in which they posited that the integration of AI and other related technologies would provide the possibility of solving numerous social problems. The initial strategy guidelines suggested that AI technology should be used as a service, that is, "AI as a service (AIaaS)." By combining AI with different types of data and the application and expansion of AI technology into various fields, Japan proposed a road map of industrialization featuring the fusion of AI and other related technologies, and the important role of data was emphasized in each stage. Health, medical care, and welfare formed one of the three major areas of the primary theme, and a detailed industrialization roadmap for this area was introduced in the strategic plan. Japan is also the only country in the study to offer a clear development path in the field of medicine and health (Fig. 1) [7]. For the development of AI applications in that field, Japan's intentions and goals were very clear, that is, to build a society featuring healthy living and longer lifespans that promotes the prevention of diseases and elevates Japan as a leader in that industry. The data infrastructure would need to be constructed first, followed by gradual improvements in the intelligence of medical and nursing robots together with more convenient and intelligent health management and medical services built around individuals as the focus of development. In the 2017 fiscal budget, Japan's Ministry of Health, Labour and Welfare allocated JPY¥470 million (~US$4.35 million) for empirical research on clinical AI data systems and JPY¥180 million to support new drug research and development activities using AI [8].

2.4 India

To keep pace with the rapid development of AI in China and promote India's own AI revolution, an Indian think tank named NITI Aayog was chosen by Indian Prime Minister Narendra Modi to conduct research using AI technology to mitigate several economic and social needs of the country. In June 2018, NITI Aayog released a discussion paper titled *National Strategy for Artificial Intelligence* under the unique strategic brand of "AI for All" that aimed to leverage AI to simultaneously stimulate the economy, social development, and comprehensive growth. It would also serve as a "garage" for emerging and developing economies to ensure that India has an opportunity to play a greater role going forward in the global economy and maintain its status during the transition era [9]. The strategy stated that superior research capabilities have typically been the cornerstone of leadership aspirations in emerging technologies and the effective realization of growth potential requires expertise in both

core and applied research. The paper proposed a two-tiered institutional structure to drive India's AI development: the Centre of Research Excellence (CORE) and the International Centre for Transformational Artificial Intelligence (ICTAI). CORE now focuses on basic research and serves as ICTAI's technology provider, while ICTAI focuses on the marketization of emerging technologies and the development and deployment of application-based research in important social areas. In May 2019, NITI Aayog submitted a proposal to the Mistry of Finance requiring an investment of 750 billion INR (~US$9.9 billion) over the next three years to establish a platform for analysis and knowledge assimilation (AIRAWAT) to support current research and development in India through a common cloud platform. At the same time, the strategy also called upon the government to actively promote the development of AI and to ensure all of the following: application of AI to the entire value chain; deployment of market-based mechanisms for building the National AI Market (NAIM); focusing on data acquisition, data annotation, and model deployment; actively seeking the participation of all stakeholders to simplify the collaboration to reduce the time and cost of collecting data and data annotation; achieving unified deployment of multiple solutions to realize the full scale and network effect.

In the strategy, healthcare was to remain as a developmental priority with a core goal of improving the accessibility and affordability of high-quality healthcare. NITI Aayog is also discussing the establishment of a national pathological image database and cancer imaging biological database complete with labeling and classification functions, and they hope to use AI technology to reduce costs and provide clinical decision support to improve the effect of cancer diagnoses and treatment.

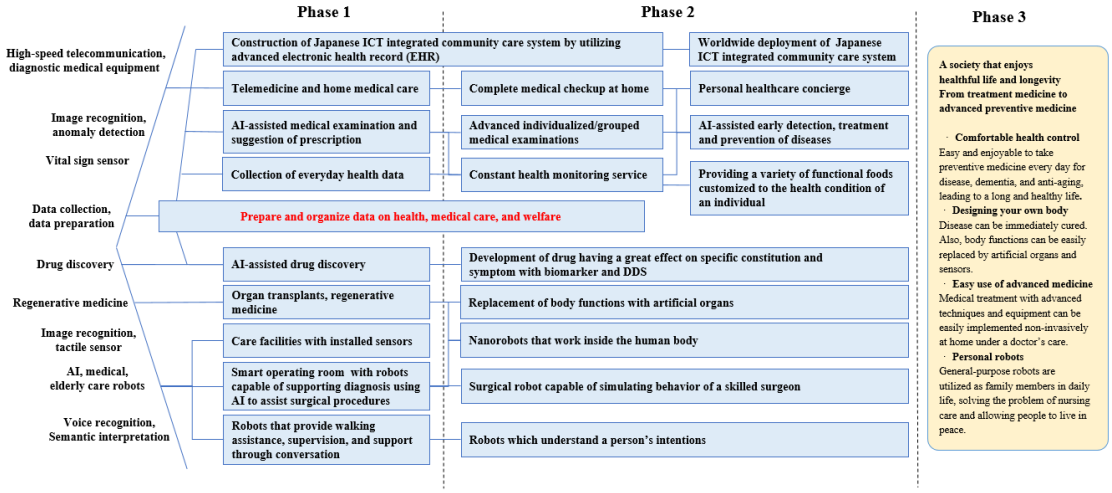

Fig. 1. Industrialization roadmap projected by the fusion of AI and other related technologies (health, medical care, welfare).

2.5 China

In July 2015, China released the *Guiding Opinion of the State Council on Actively Promoting the "Internet+" Action Plan*, in which AI was put forward as one key area. It also proposed to build support for very large-scale deep learning in new computing clusters (mass training resources), strengthen AI-based resources, and construct innovative public service platforms to further advance core technological research, development, and industrialization. In July 2017, the state council released the *Development Plan for the New Generation of AI* as a long-term development plan for AI in China. It proposed the development of convenient and efficient intelligent services, including intelligent medical care and intelligent health and elderly care for key tasks to facilitate a safe and convenient intelligent society. It also proposed plans to demonstrate how AI technology applications could be strengthened in major fields like health security [10]. In December 2017, the Ministry of Industry and Information Technology released the *Three-Year Action Plan to Develop the Next-Generation Artificial Intelligence Industry (2018–2020)* that proposed the establishment of international competitive advantages in several key areas focused on the medical field to expand the clinical application of medical image-assisted diagnoses and other systems [11]. In June 2019, the Ministry of Science and Technology issued the *New Generation AI Governance Principles: Developing Responsible AI*, within which they proposed the development of responsible AI that conforms to human values and ethics, avoids misuse, and prohibits abuse and misapplication [12]. In August 2019, the same ministry issued the *National New Generation Artificial Intelligence Open Innovation Platform Working Guidelines*,

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around which the *Development Plan for the New Generation of AI* laid out significant application requirements for the key tasks involved in the organizational construction niche. In principle, a new-generation AI open innovation platform would be built for each specific niche [13].

Specifically in the field of medicine and health, in January 2017, the National Health Commission released the *13th Five-Year National Population Health Informatization Development Plan* that emphasized the leading role of AI, including the use of medical robots and other advanced technologies and equipment products in population health informatization and the application and development of big data in healthcare. In May 2018, the Office of the State Council issued the *Opinions on Promoting the Development of "Internet+ Medical and Health*," to promote the following: "Internet+" AI application services; research and development of AI-based decision support systems for clinical diagnoses and treatment; strengthening the integration, sharing, and application of clinical and scientific data; and support for the research and development of health-related AI technology, medical robots, large-scale medical equipment, emergency rescue medical equipment, 3D printing, and technology for the manufacturing of biomaterials and wearable devices, etc. [14].

3 Comparative analysis of national AI strategy planning in medical health

A comparative analysis of the AI strategic plans in healthcare of five countries revealed that all of them formulated corresponding AI development strategies based on their own actual conditions and industrial advantages (Table 1). The key points of the plans focused on the following: the construction of data and infrastructure platforms, the establishment of innovative research organizations, forming a landscape of key areas, the formation of talented teams, and improvements to the supporting governance systems. At the same time, the AI development policies of all five were closely linked to their original science and technology development strategies. These policies not only highlighted the key applications of AI in different fields but were also conducive to making full use of their respective existing advantages in specific fields to release the full production potential of AI in these fields as quickly as possible [15].

3.1 "AI + Healthcare" programming features comparison

Among the five countries studied in this paper, the United States has a very clear AI strategic development system that promotes the development of AI strategic implementation framework based primarily on the *National Artificial Intelligence Research and Development Strategic Plan*. The NIH is responsible for AI investment and management in the field of medicine. The strategic planning of AI in the United Kingdom is encompassed within the field of industrial strategy, and special emphasis is placed on a combination of AI development and digital economy strategies. In several policy documents, including *Industrial Strategy: Building a Britain fit for the future* and *Industrial Strategy: Artificial Intelligence Sector Deal,* the digital economy and AI are closely related, and AI development for the medicine and health field is also incorporated. The NHS established NHSX to promote specific digital processes for medicine and health. Relying on its global leadership in the field of intelligent robots, Japan is committed to driving the revolution through robots. This is also the focus of their development strategy for AI in the field of medicine and health. India hopes to make use of AI to gain greater global influence. Presently, NITI Aayog is mainly responsible for the development of a research infrastructure and pilot AI applications in the field of medicine and health.

China also has a comprehensive strategic deployment based on the *Development Plan for the New Generation of AI* to guide the development of the new generation of AI. Industry planning has been extensive, but the focus on construction has been less prominent.

3.2 "AI+ Healthcare" key tasks comparison

Healthcare is a core area related to people's livelihood and well-being, and all five countries have focused primarily on their national conditions and requirements—after accounting for upgrades to currently advantageous sectors of their respective healthcare industries—to identify additional key development projects in sectors requiring improvement in the respective fields. The world faces common health problems: serious chronic diseases, aging populations, intensified global burdens like the risk of infectious diseases, and medical security systems. Therefore, AI applications in the field of medicine among countries tend to be very similar. They generally focus on disease diagnosis equipment, early identification, drug development, cancer therapy, surgical robots, auxiliary robots, and so on. However, priorities vary according to different national circumstances. For example, Japan is

facing a serious shortage of children in a rapidly aging population, thereby resulting in a severe financial burden for the social security system, including medical care and welfare, and a severe shortage of nursing staff. At the same time, there are many natural disasters like earthquakes in Japan. A strategic position of using AI to cope with the aging problem is clearly emphasized in the country's strategic development, and additional priority is given to the development of AI to solve deficits in the medical and health workforce. Search and rescue robots for use after natural disasters are also prominently mentioned. As a major producer of generic drugs for cancer treatment, India attaches great importance to the application and development of AI in that field. If they can achieve sound and innovative development according to their strategy, India may impact the global pharmaceutical industry in the future.

Table 1. Comparison of the global development strategies of AI for healthcare.

Country	National requirements	Key tasks	Infrastructure
United States	The US healthcare system in general "emphasizes treatment over prevention." The United States leads the world in healthcare expenditure, although their average life expectancy is lower than that of the OECD countries, and their average has declined several times in recent years.	Medical diagnoses; surgical robots; AI medical wearable devices.	Data: Focus on developing data infrastructure and constructing a modern ecosystem of biomedical data science; develop shared common datasets to increase access to them.
United Kingdom	Medical services are in short supply and costs are rising; medical staff enthusiasm is low; patient queues for hospital stays are too long; medical resources are transferred to private hospitals; there is high investment but the expected results are not achieved; and people's dissatisfaction with medical security has increased.	Improve early diagnoses of cancer and other diseases; patient care efficiency; imaging diagnoses.	Data: Build a strong digital and telecommunication infrastructure and launch a data ethics and innovation center; improve the existing data infrastructure to deliver higher quality public data. Platform: Medical AI technology center; National AI laboratory.
Japan	Japan is the world's most rapidly aging country with fewer children, more older people, and fewer people overall; By 2030, more than 40 percent of the population will be elderly, with high accompanying social security costs and a shrinking workforce; Japan is prone to frequent earthquakes, and the relief work caused by natural disasters is substantial.	Early detection of dementia and other diseases; medical diagnostic equipment; drug discovery; chromosome screening; auxiliary diagnoses and treatment; surgical robots; nursing robots.	Data: Prepare AI performance evaluation data, such as standard picture data sets; strengthen the specialized institutional system responsible for data maintenance (NICT, JST, RIKEN); three centers, NICT, RIKEN and AIST, are responsible for data maintenance and data coordination with the health department. Platform: Develop a realistic simulation environment; AI cloud; and cloud-based open tools.
India	There are large gaps in the availability of quality healthcare throughout the country, and the quality of medical services is inconsistent; there is also a lack of qualified health personnel and infrastructure; personal health spending accounts for 70% of total health spending, one of the highest out-of-pocket ratios in the world.	Personalized treatment; early identification of potential epidemics; imaging diagnoses and prevention techniques.	Data: Create pathological image database to provide high-quality labeled pathological data set; discuss the establishment of a cancer imaging biobank to study the imaging correlation of cancer phenotypes. Platform: Build the AIRAWAT cloud platform.
China	The severity of an aging population is becoming more difficult to manage; by 2020, the population aged 60 or above will reach about 255 million, or ~17.8% of the total population; chronic non-communicable diseases becoming a main burden; dearth of quality health personnel; lack of autonomous and controllable high-end medical equipment.	Machine intelligence assisted personalized diagnosis; precision therapy assisted decision support systems; intelligent medical and health equipment; assisted rehabilitation and care; surgical robots; intelligent nursing robots.	Data: Interconnected population health information platform; large-scale deep learning with the new computing cluster; extensive training resources. Platform: Strengthen the construction of innovative platforms, such as AI basic resources and public services; create niche AI innovation platforms.

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The unbalanced distribution of medical resources in China is a serious problem. In the key tasks, the strategic connection between "Internet+" and AI is emphasized as one method to extend the service space to realize the transformation of China's "Internet+" industrial advantages into AI application development.

3.3 "AI+ Healthcare" infrastructure investment comparison

Among the five national AI strategic plans, the first stage in the implementation path is usually an investment in infrastructure, in particular, the underlying data management framework. Countries like the United States and the United Kingdom that already have advanced data infrastructure systems emphasize the establishment of more shared and open public data sets based on existing data. However, in India, the original data base was comparatively insufficient. Instead, they have established vertical systems, such as a tumor image database and a cancer biological database. Research centers are their foundation for research and development and for sustaining innovation momentum. The United Kingdom attaches great importance to the establishment of a network of research centers and joint research institutions to maintain advanced AI research capabilities, while India emphasizes the establishment of basic research and applied research centers as well as the relationship between the two. For platform construction, each country has its own characteristics. Japan proposed the establishment of a realistic simulation environment, India established a common cloud platform for organizational communication and resource sharing, while China proposed the implementation of new generation AI open innovation platforms to promote technological innovation and the transformation and application of these achievements.

3.4 Key gaps in China's "AI+ Healthcare" strategy

The comparative analysis of the focus on technological landscapes in the AI strategic plans of the five countries as well as China's key gaps are shown in Table . In terms of system frameworks specifically designed for the medical and health field, China lacks a clear AI development path compared to those of leading countries. Public and enterprise investments as well as application research related to production remain unclear, and the strategic linkage between them remains inadequate. In the process of promoting the integration of AI into the real economy, most efforts have concentrated on specific AI applications in various fields; however, the core strategic relationship between AI and "supply side structural reform" has not been clearly defined [15]. The important strategic values of AI for promoting supply side reforms for healthcare have not been emphasized.

Table 2. Key gaps in China's national AI strategic development plan in the field of healthcare.

Planning content	Leading country	Landscape focus	China's key gaps
System framework	Japan, United States	Development framework and path of holistic medical AI systemization	Lack of overall planning and guidance for medical artificial intelligence
Technological development	United States, China	Carefully consider basic research investment and establish an open innovation platform	—
Infrastructure	United States, United Kingdom	AI healthcare data sets; large computing power infrastructure	Lack of connection between data infrastructure in the field of medicine and health and the construction of AI data infrastructure; insufficient attention to the field of computing power
Talent protection	United States	AI talent gradient construction; chief scientist team construction	Failure to carefully consider the structural imbalance of interdisciplinary talents in the fields of medicine and AI
Approval supervision	United States	Regulatory scientific research	No approval supervision mechanism applicable to AI
Privacy security	United Kingdom	Standards and regulations; laws and regulations	Lack of legislative protection for medical data assets and the weak foundation of ethical security systems

In terms of infrastructure construction, the United States' AI strategy for medicine and health is effectively linked to the development of data science, thereby facilitating the seamless incorporation of the well-established health and medical data infrastructure into the strategic AI landscape. The UK's fiscal commitment to infrastructure is also clear. Comparatively speaking, although China also emphasizes the construction of data infrastructure, the existing health information platform is scattered across several systems, and no effective connection and linkage has been formed between medical science development and AI application. In terms of the development of highly skilled personnel, the dearth of specialists who master both medical science and AI as required in the field has been largely overlooked. In addition, the sound institutional management system and regulatory scientific research in the United States can quickly adjust and adapt to applications of AI in medical and healthcare, thus providing effective support for the orderly development of the industry. Although China has the ability to adjust rapidly from top to bottom, there are still obvious deficiencies in the development of supervision science. Finally, despite China attaching great significance to the key ethical and security issues related to the development of AI, there is a significant gap between the relevant standards and norms and the legal and regulatory policies compared with those in the United Kingdom and the United States, and the overall formulation of standards in this regard lacks the guidance of a single influential global voice.

4 Suggestions for the key contents of China's "AI+ Healthcare" strategic planning

4.1 Attaching importance to the strategic value of AI in the field of healthcare

The Healthy China 2030 initiative raised the requirements and standards for the development of China's medical and health fields. Essentially, the country must achieve health equality by 2030 when its main health indicators will be expected to rank satisfactorily with those of high-income countries. The health of a population is an important symbol of national prosperity and pride. With an aging population, environmental changes, and transformed lifestyles, demands for better medical and healthcare have increased sharply for all ages in China. The burden of healing the sick and the high incidence of mental illness threaten the health of the Chinese workforce. Chronic non-communicable diseases have become the main cause of death for residents, and the social impact of diseases is overwhelming. Further, China's existing medical and health service supply system is structurally imbalanced with insufficient total volume and a limited growth rate. The shortcomings in research and development and limited innovations related to critical drugs and medical devices are obvious, as are the general lack of conceptual, technological, and system innovations. It is suggested that a special plan for the development of medical AI applications should be established to clarify the development path, build upon the advanced expertise of leading countries, promote the application and development of AI in the field of medicine and health, and coordinate closely with the existing industrial strategic plans and overall economic and technological strategies.

4.2 Addressing the major needs of people's health

Looking at the main areas of national emphases, the core components are generally built upon specific national conditions in the medical and health fields of each country. In the national context pertaining to China's health sector, many suggest that most of the attention should be placed on the following: promotion of better health and the aging population; problems related to the field of medicine and health; AI implementation for clinical diagnoses and treatment, innovative drug research and development; precision health management; and reasonable medical insurance control. At the same time, medical equipment is an indispensable tool for modern medicine, but China has long relied on imports to fulfill its requirements. AI technology has brought historically significant opportunities for industrial transformation to medical equipment manufacturing. By maximizing their opportunities in this critical period of intelligent upgrades for medical equipment, China may be positioned to surge ahead in the field. Therefore, supporting the development of intelligent industries focusing on domestic substitutions and upgrades to high-end medical and other equipment is highly recommended.

4.3 Clarifying medical and health data infrastructure and platform construction as priorities

Medical and health data form the basic necessary infrastructure for the development of AI applications, and all leading countries worldwide regard data as a strategic priority. China manages the world's largest health and medical data resources, but there is a significant gap in data availability compared with other major countries. Capitalizing on the benefits of data-driven medical AI applications requires an effective link between existing

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medical and health data planning and AI development strategies. This must also prioritize the development of the medical and health data infrastructure suitable for AI development and also accelerate resource value conversion. As a data resource leader, China should also be encouraged to do the following: promote the construction of a national medical/health big data sharing platform, focus on solving the two major problems of data quality and sharing, and emphasize the standardization of data governance. At the same time, “AI+ Healthcare” is one of the most active initiatives in the field. The construction of medical and health subsectors should be prioritized in the development of innovative sharing platforms to accelerate the orderly growth of the industry.

4.4 Establishing an “AI+ Healthcare" interdisciplinary research organization to promote applied innovation

A new scientific research paradigm based on big data and AI is taking shape, and it requires closer interdisciplinary integration. Establishing cross-research centers has become a strategic choice for numerous countries. The key to the application of AI in the field of medicine and health is the participation of experts. To promote continuous innovation in this field, stable organizational guarantees are required. Some suggest that by relying on national medical research centers and other related institutions, a series of medical AI cross-research centers in key disease fields can be established to form an effective industry–university–research institution partnership and a transformation mechanism to accelerate cross-training talents, promote the research and development of intelligent diagnoses, develop treatment and health management applications, and improve the success and conversion rates of new drug research and development using AI technology.

4.5 Strengthening investment in regulatory scientific research in the application of AI in the field of healthcare

A core factor of strategic planning is to mitigate the governance risks precipitated by AI while promoting its development. The quality and safety of medical and health services and applications are directly related to the lives and health of people, and the implementation of “AI+ Healthcare” must also be strictly regulated by the industry. Delays in the current regulatory system have limited the development of the industry to some extent. Investments in regulatory scientific research should be augmented to provide a scientific basis for establishing an inclusive, prudent, and effective regulatory mechanism that covers the entire life cycle of innovative services and application products.

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References

[1] Executive Office of the President National Science and Technology Council Committee on Technology. White House report: Preparing for the future of artificial intelligence [J]. Information Security and Communications Privacy, 2016 (12): 9–14. Chinese.

[2] National Science and Technology Council. The national artificial intelligence research and development strategic plan [R]. Washington DC: National Science and Technology Council, 2016.

[3] National Institutes of Health. NIH strategic plan for data science[R]. Bethesda: National Institutes of Health, 2018.

[4] Select Committee on Artificial Intelligence of the National Science& Technology Council. The national artificial intelligence research and development strategic plan: 2019 update [R]. Washington DC: Select Committee on Artificial Intelligence of the National Science& Technology Council, 2019.

[5] Energy Department for Business, Industrial Strategy. Industrial strategy: Building a Britain fit for the future [R]. London: Energy Department for Business, Industrial Strategy, 2017.

[6] Zhu Q C, Wang S. Japan’s “Society 5.0”: The strategic vision, challenges and influence [J]. Japanese Studies, 2018 (2): 60–86. Chinese.

[7] Strategic Council for AI Technology. AI technology strategy [R]. Tokyo: Strategic Council for AI Technology, 2017.

[8] China Academy of Information and Communication Technology, China Artificial Intelligence Industry Innovation Alliance. The observing of artificial intelligence strategy and policy (2019) [R]. Beijing: China Academy of Information and Communication Technology, China Artificial Intelligence Industry Innovation Alliance, 2019. Chinese.

[9] NITI Aayog. National strategy for AI discussion paper [R]. New Delhi: NITI Aayog, 2018.

[10] State Council of the PRC. The plan for development of the new generation of artificial intelligence [R]. Beijing: State Council of the PRC, 2017. Chinese.

[11] Ministry of Industry and Information Technology of the PRC. A three-year action plan to develop AI (2018—2020) [R]. Beijing: Ministry of Industry and Information Technology of the PRC, 2017. Chinese.

[12] China's National Professional Committee on Next Generation AI Governance. Principles of the next generation AI governance—Develop responsible AI [R]. Beijing: China's National Professional Committee on Next Generation AI Governance, 2019. Chinese.

[13] Ministry of Science and Technology of the PRC. Guidelines for the construction of the new generation of AI innovation platforms[R]. Beijing: Ministry of Science and Technology of the PRC, 2019. Chinese.

[14] General Office of the State Council of the PRC. Opinions on promoting the development of "Internet Plus Healthcare" [R].Beijing: General Office of the State Council of the PRC, 2018. Chinese.

[15] Jia K, Guo Y H, Lei H Z, et al. Comparative study on international public policy of artificial intelligence: History, characteristics and enlightenment [J]. E-Government, 2018 (9): 78–86. Chinese.