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Navigating Automation: Challenges and Opportunities for Medical Practice and Education

Fernando Fernández González

- ***is a Medical Doctor in Neurophysiology and Neurology,*** *with over 55 years of experience in healthcare. He also received specialized training in Biological Engg. Dr. Fernández-González served as a Medical Doctor and Head of Clinical Neurophysiology at Hospital Central de Asturias, Spain from 1994 to 2005.*
- *From 1982 to 1992 he also worked with the Spanish Health Ministry as assessor for New Health Care Technologies, acting as the Director responsible for assessing and implementing new medical devices and innovative health care technologies at the Spanish NHS. Furthermore, he served as an Advisor for NATO on healthcare technologies.*
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- *Her research interests include Integrated Management, Busi Process Management, Service Quality, and Trust. She has pu numerous business articles and several academic papers in t With extensive international experience in 65 countries,*
- *She is a solid professional specializing in a wide range of are strategies to enhance competitiveness. She encourages positi and works collaboratively to provide high value towards a be*

0. THE CHINESE HEALTHCARE REVOLUTION

Flying into to new er

... IT HAPPENS WHEN THE TECHNOLOGICAL REVOLUTION IN MEDICINE & HEALTH CARE SPREAD AROUND THE WORLD.

1. AIM

Flying into to n

Critical examination of automation's challenges and opportunities in medicine, and their implications for future medical education, is essential.

This paper explores these challenges and proposes enhancements for medical and healthcare training.

Systemic and complex thinking, combined with professional attitudes and soft skills such as communication, compassion, empathy, respect, and ethics, are crucial.

2.1 CONTEXT

Flying into to n

In healthcare automation is rapidly transforming the sector by utilizing advanced technologies such as robotic process automation and Artificial Intelligence (AI) [1] across strategic, key, and support processes [2].

This technological shift may represent true *disruptive innovation* [3] presenting numerous opportunities alongside several threats, including those related to cybersecurity.

This was the favorite toy as a gift for Christmas 20

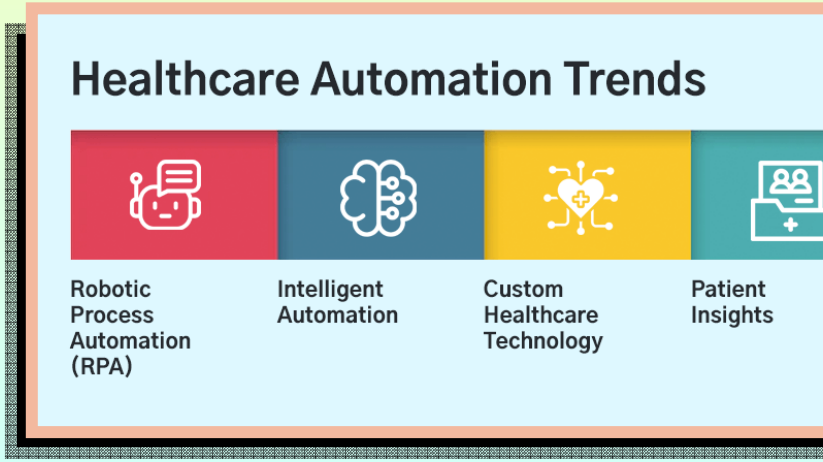
1. Automationedge, 2024; Automationanywhere, 2022; Bajwa et al., 2021
2. Kotler, Berger & Bickhoff, 2016
3. Christensen, Raynor & McDonald, 2015; LSE, 2024
4. Kshetri, 2017

2.2 CONTEXT

Flying into to n

In the Springer Handbook of Automation, edited by Shimon Y. Nof, *automation* is defined as the technology by which a process or procedure is performed with minimal human assistance.

This encompasses mechanical devices, electronically controlled machines, robots, and software systems that automatically process data. The handbook provides a comprehensive overview of automation's history, technological advancements, benefits, risks, and its applications across various domains and levels.



Nof, S. Y. (Ed.). (2009). *Springer Handbook of Automation*. Springer. https://doi.org/10.1007/978-3-540-78831-7

2.3 CONTEXT

Flying into to n

As a key pillar of Cybernetics —*a science at the intersection of technology, biology, and social sciences*— AI is a major focus in modern medical technology. It shapes our understanding of complex systems and rapidly transforms our world.

AI has been applied in various areas, including epidemiology, diagnostic assistance, therapeutic indication, robotic surgery, medical imaging (such as radiology, MRI, and ultrasound), and biological studies ranging from genetics to biochemical laboratories.

However, automation is not the ‘panacea’. **AI is a tool.**

2.4 CONTEXT

Automation is not the ‘panacea’.

AI is a tool

That is an important perspective: AI is a tool to enhance our capabilities, not a cure-all solution. This is important not only to indicate and clarify it to medical students, but also to the general public.

The human being is not a set of parts, but a systemic whole in itself and in its interactive relationship with the environment, with all the subjectivity that this entails.


Flying into to n

2.5 CONTEXT

Flying into to n

Sir William Osler was a Canadian physician and one of the *Big Four* founding professors of Johns Hopkins Hospital[1]. Osler created the first residency program for the training of physicians specializing in different areas, an evidence-based training.

He wrote:

> "*The practice of medicine is an art, not a craft; a calling, not a business; a vocation in which your heart will be exercised as well as your head" [...] "It is an art because it works with ambiguity and intuition (clinical eye)*"

. Founded in 1889, Johns Hopkins Hospital and its school of medicine are considered to be the founding institutions of modern American medicine and the birthplace of numerous famed medical traditions, including rounds, residents, and house staff

3.1 HUMAN INTUITION & CLINICAL EYE

Flying into to n

Artificial intelligence (AI), as we know it today, does not have intuition in the human sense of the term.

Human intuition is based on a complex of subconscious information processing, previous experiences, and emotional patterns, which can emerge as mental pictures involuntarily or voluntarily as a perception not based on certainties but on clear "déjà vu" (already experienced) within an ambiguous scenario, something that cannot be directly replicated in AI systems.

However, there are certain aspects of modern AI that can resemble intuition, although they function completely differently.

3.2 HUMAN INTUITION & CLINICAL EYE

Flying into to n

Why does AI not have “human” intuition?

1) *Rule-based and data-driven processing*: AI, especially machine learning systems or neural networks, does not “intuit” in the human sense. Instead, it relies on analyzing large volumes of data and learning patterns from that data.

For example, an AI that is trained to recognize images of cats does not “feel” that it is seeing a cat, but rather has learned to identify specific patterns (e.g., shapes, colors, edges) that correspond to the category “cat” in previously labeled data.

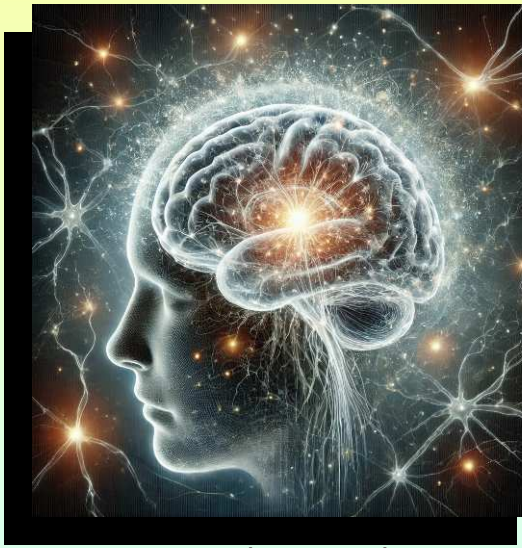
There is a wealth of excellent information on Artificial Intelligence and healthcare

3.3 HUMAN INTUITION & CLINICAL EYE

Flying into to n

Why does AI not have “human” intuition?

2) *No conscious experiences*: Humans have conscious experiences and a subjective perception of the world that affects our intuition. Human intuition involves emotions, implicit memory, and brain processes that have been developed over years or even a lifetime. In contrast, an AI has no self-awareness, emotions, or subjective experience. Its “knowledge” is limited to the data and algorithms it was trained with.



Human consciousness is more than the central nervous system

3.4 HUMAN INTUITION & CLINICAL EYE

Flying into to n

Why does AI not have “human” intuition?

3) *Lack of emotional or social context:* Human intuition is also based on emotional and social factors, such as instinct or personal experiences. For example, a human may have an intuition about whether someone is telling the truth or not, based on nonverbal cues and subtle emotions.

AI does not experience these emotions or have a social context of its own. Its decisions are based on mathematical and probabilistic criteria.

The role of e-Learning for the Future Health Care: a reflexion.
23-ICIT / 13-15 May 2019

4.1 WHAT DOES IT MEAN TO BE A DOCTOR ?

Flying into to n

This designation for a person comes from the linguistic root *med-* in Greek μέδομαι (*médomai* = to think, to meditate, to care) and corresponds to the Latin verb *medeor* (to care), from which *meditari* (to meditate) is derived, with this root also giving us *remedium* (remedy).

Therefore, a doctor is someone who thinks, meditates, and cares, applying remedies and licensed to exercise its skills, abilities and knowledge on humans.

A doctor cannot think digital, a doctor applies analogue critical thinking.

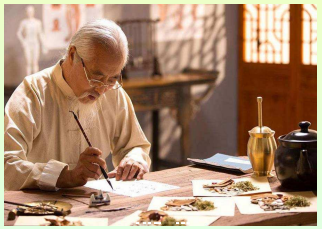
4.2 WHAT DOES IT MEAN TO BE A DOCTOR ?

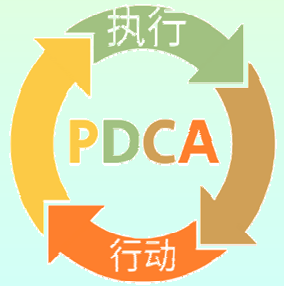
Flying into to n

This is related to the Deming PDCA cycle for continuous improvement (Deming, 1982).

Thus, the general scheme that defines a doctor is:

1) to think, meditate, direct;
2) to care for, take care of;
3) to heal, remedy;
4) to follow up and assess.





From Johns Hopkins Hospital

AI may support in these processes.

A doctor cannot think digital, a doctor applies holistic analogue critical thinking .

4.3 WHAT DOES IT MEAN TO BE A DOCTOR ?

Flying into to n

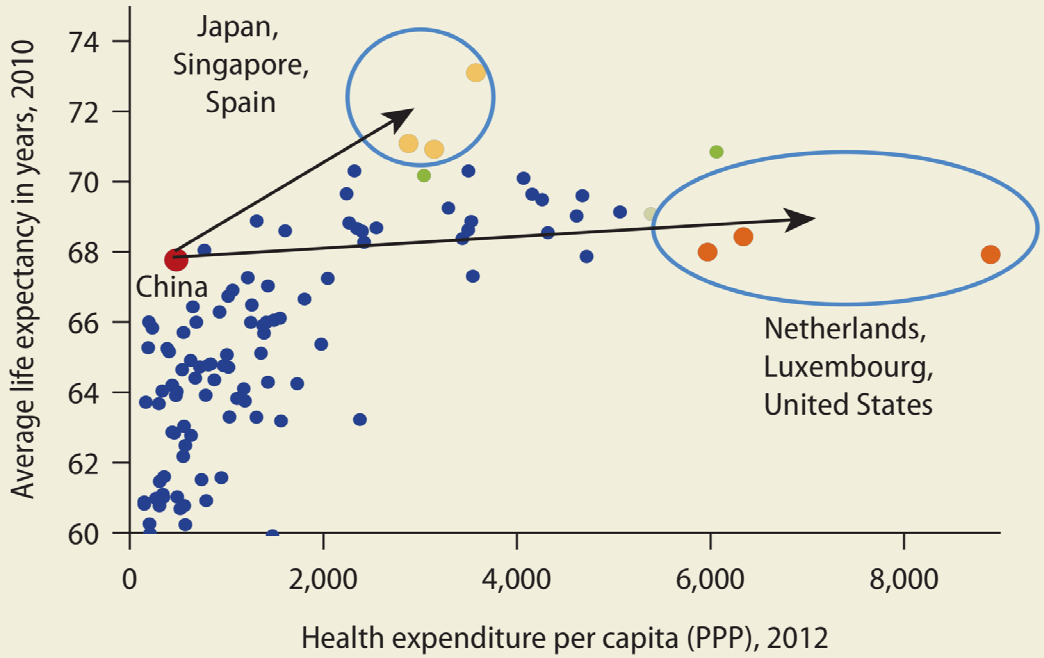
Spain
Spain's healthcare system is widely recognized for its efficiency, high-quality services, and accessibility. Spain offers a decentralized, publicly funded healthcare system, with universal coverage provided to all citizens and residents.

Public healthcare is free at the point of service, although patients may need to pay a portion of the cost for prescriptions. Spain is known for its emphasis on primary care, with family doctors serving as the first point of contact for medical services. Specialist care is typically accessed via referrals, and Spain's network of public hospitals is known for its advanced technology and excellent patient outcomes.

Spain consistently ranks high for its strong performance in preventive healthcare, particularly in areas such as vaccinations, cancer screening, and cardiovascular disease prevention.

These countries excel in healthcare through a combination of universal coverage, advanced medical and hospital facilities, and a focus on patient rights and outcomes. Their systems provide timely, high-quality care, often backed by robust insurance models, making them stand out in Europe and beyond.

Life expectancy relative to per capita health expenditure, selected countries, early 2010s.



Source: Economist Intelligence Unit 2014; WHO (various years).
Note: PPP = purchasing power parity.

Spain is recognized for its effective & efficient Healthcare system

4.4 WHAT DOES IT MEAN TO BE A DOCTOR ?

Flying into to n

The COVID-19 pandemic has shown how the role of the “family doctor” has been lost in Western countries, with patients first turning to expensive hospital-based medicine. This has led to an unforeseen degree of inefficiency. Inefficiency of systems based on private care and care focused on the hospital and not on living units. This inefficiency has resulted in a major economic insult to countries with medicine where high per capita health expenditure takes precedence over average life expectancy.

frontiers | Frontiers in Public Health

Barefoot doctors: A solution to the dilemma of COVID-19 prevention and control in rural areas of economically underdeveloped countries

Shi-Wei Hu*

Review Article on Medical Artificial Intelligent Research

Using artificial intelligence to improve medical services in China

Several scientific articles have revitalized the figure of the Chinese “barefoot doctor” experience as a fundamental substrate for healthcare, as well as the importance of AI in covering the different health levels for prevention, assistance and therapy.

5.1 AN OLD BUT NEW MEDICAL PRACTICE

Health technology has a knock-on effect on citizens.

Hospital emergency departments provide fast care, access to advanced technology, and innovative protocols and procedures for all patients who enter through their doors. In an aging society, annual flu epidemics block hospitals.

The principles of Alma-Ata (1978) under the slogan "Health for all by the year 2000", promoting primary healthcare have been swept away by the attraction of hospital technology, while these technological advances have been ignored for their application to primary care.

[*For example, effective 0.5 Tesla magnetic resonance (MRi) has been ignored when it was available and possible to apply it in rural areas "smartMri+AI" instruments, on the contrary, hospitals use 3.0Tesla MRi, sometimes unnecessary*]

5.2 AN OLD BUT NEW MEDICAL PRACTICE

Flying into to n

Cybernetics is defined as: "*a transdisciplinary science at the intersection of technology, biology and social sciences".*

For the 21st century, "cybernetic healthcare practitioners" are needed. Many current medical specialties will see their needs reduced. For example, those medical specialties related to tests based on pattern recognition.

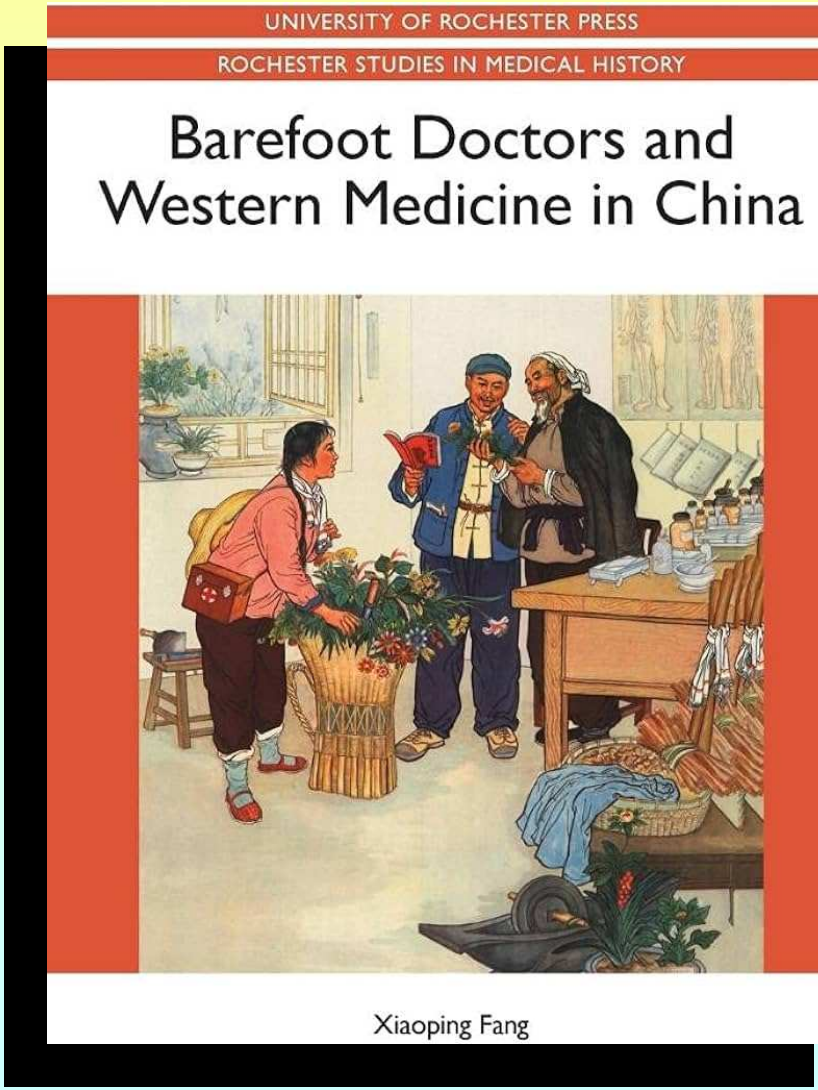
Will be required medical practitioners with the skills, abilities and knowledge to communicate not with machines only, but with computer engineers, chemists, biologists, not necessarily clinical physicians, who will occupy responsibilities currently exclusive to medical graduates.

5.3 AN OLD BUT NEW MEDICAL PRACTICE

Flying into to n

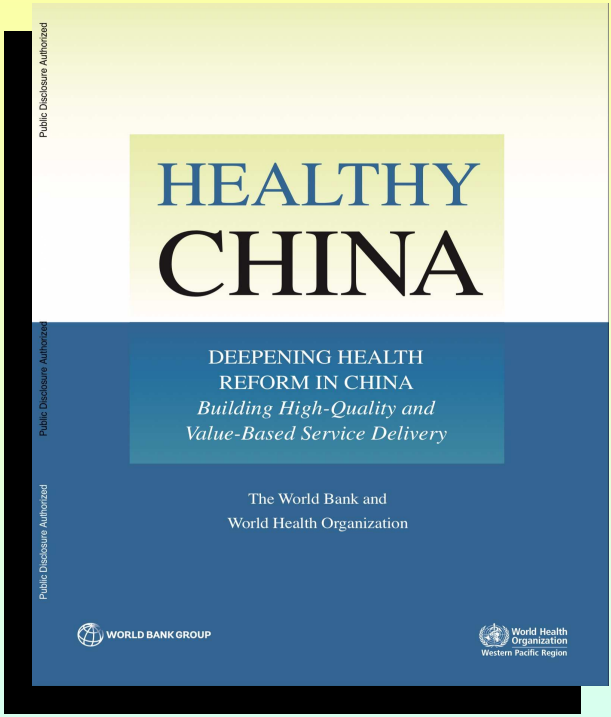
A change in the health system is required, not copying models from the 20th century, but rather based on the new paradigm of complexity, not mechanistic.

Doctors who know how to communicate with artificial intelligence and who know how to differentiate between uncertainty and ambiguity, between complicated and complex, thinking and acting not based on the disease but on the sick person and their socio-family environment.



5.4 AN OLD BUT NEW MEDICAL PRACTICE

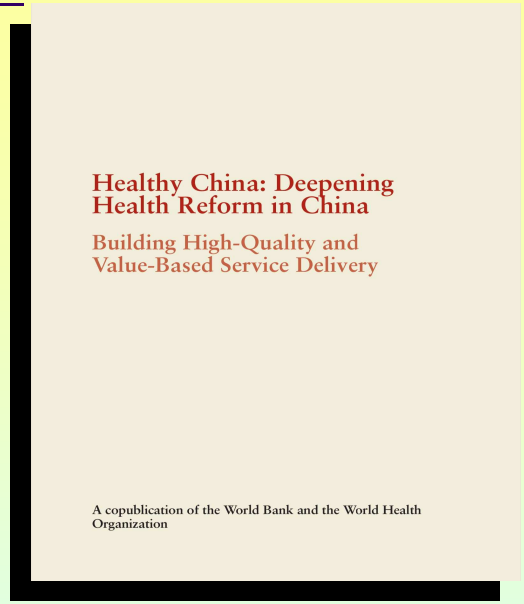
The report “Healthy China: Deepening Health Reform in China,” jointly published by the World Bank and the World Health Organization in collaboration with the Chinese government, provides a comprehensive analysis of China’s health system and proposes strategies to improve the quality and efficiency of health services in the country.



China, as western countries, faces a growing burden of chronic diseases and a rapidly aging population, putting pressure on the existing health system.

China’s health system has traditionally been hospital-centered, which can lead to inefficiencies and high costs in health care. **Remember 1978s Alma-Ata**.

5.5 AN OLD BUT NEW MEDICAL PRACTICE



- **Transition to People-Centered Care**: A health care model that prioritizes primary care and service integration, focusing on patient needs, is proposed.
- **Strengthening primary care**: Improving the quality and accessibility of primary care services to reduce reliance on hospitals for basic care.
- **Implementing integrated care**: Fostering coordination between different levels and health care providers to ensure continuity in patient care.
- **Basic goal**: Building a high-quality, value-based health system that is sustainable and capable of meeting current and future public health challenges. Implementing integrated care: Fostering coordination between different levels and health care providers to ensure continuity in patient care.

5.6 AN OLD BUT NEW MEDICAL PRACTICE

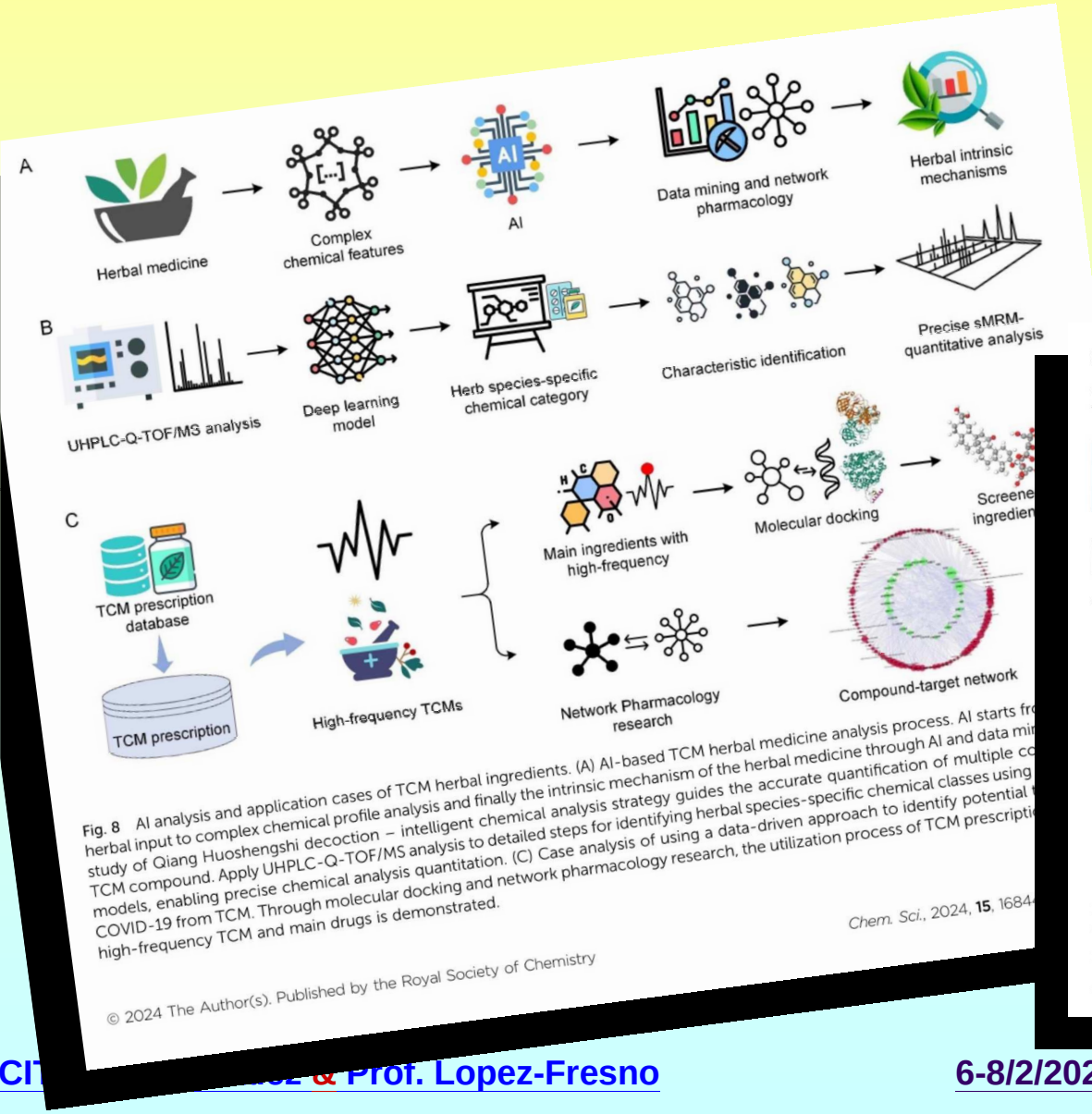


Fig. 8 AI analysis and application cases of TCM herbal ingredients. (A) AI-based TCM herbal medicine analysis process. AI starts fr herbal input to complex chemical profile analysis and finally the intrinsic mechanism of the herbal medicine through AI and data mi study of Qiang Huoshengshi decoction – intelligent chemical analysis strategy guides the accurate quantification of multiple co TCM compound. Apply UHPLC-Q-TOF/MS analysis to detailed steps for identifying herbal species-specific chemical classes using models, enabling precise chemical analysis quantitation. (C) Case analysis of using a data-driven approach to identify potential COVID-19 from TCM. Through molecular docking and network pharmacology research, the utilization process of TCM prescripti high-frequency TCM and main drugs is demonstrated.

Chem. Sci., 2024, 15, 1684

Traditional medicine is not only being revisited in China in the current technological revolution.

Chemical Science

ROYAL SOCIETY OF CHEMISTRY

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Cite this: *Chem. Sci.*, 2024, **15**, 16844

AI empowering traditional Chinese medicine?

Zhilin Song,†[ab] Guanxing Chen†[c] and Calvin Yu-Chian Chen *[abdef]

For centuries, Traditional Chinese Medicine (TCM) has been a prominent treatment method in China, incorporating acupuncture, herbal remedies, massage, and dietary therapy to promote holistic health and healing. TCM has played a major role in drug discovery, with over 60% of small-molecule drugs approved by the FDA from 1981 to 2019 being derived from natural products. However, TCM modernization faces challenges such as data standardization and the complexity of TCM formulations. The establishment of comprehensive TCM databases has significantly improved the efficiency and accuracy of TCM research, enabling easier access to information on TCM ingredients and encouraging interdisciplinary collaborations. These databases have revolutionized TCM research, facilitating advancements in TCM modernization and patient care. In addition, advancements in AI algorithms and database data quality have accelerated progress in AI for TCM. The application of AI in TCM encompasses a wide range of areas, including herbal screening and new drug discovery, diagnostic and treatment principles, pharmacological mechanisms, network pharmacology, and the incorporation of innovative AI technologies. AI also has the potential to enable personalized medicine by identifying patterns and correlations in patient data, leading to more accurate diagnoses and tailored treatments. The potential benefits of AI for TCM are vast and diverse, promising continued progress and innovation in the field.

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rsc.li/chemical-science

6.1 The rural but also urban barefoot doctor

This is an iconic text that represent a pragmatic, community-based approach to health care. It was created and updated in China during the Cultural Revolution to train rural workers in basic medical practices and subsequently translated and published in othe countries, including USA, Spain & Latin América, etc.

➡ This underlines the global relevance of the barefoot doctors to guide public health, healthcare and basic medical care.

[*In Spain it was used by the Social Institute of the Navy to provide remote assistance to civil fishing sailors, and implemented by the Teleónica Foundation during the 1980s*]

6.2 The rural but also urban barefoot doctor

China has been implementing significant reforms to its medical education system to standardize and improve the quality of training for healthcare professionals.

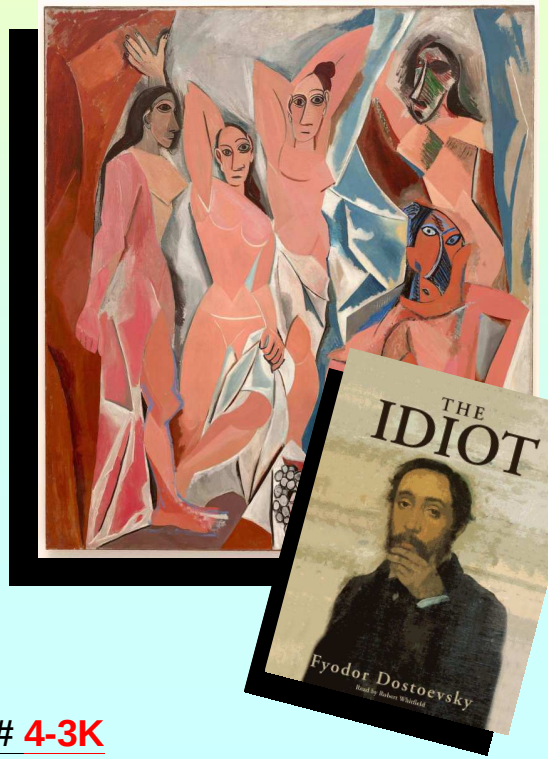
- Historically, there were various educational programs of 3, 5, 7 and 8 years, resulting in heterogeneous and uneven training among physicians. To address these disparities, the Chinese government has promoted the unification and standardization of educational programs, focusing mainly on the 5+3-year program to train physicians with uniform competencies across the country.

In addition, medical education accreditation agencies have been established and have received international recognition, such as that granted by the World Federation for Medical Education (WFME). This recognition ensures that accreditation decisions are valid and that graduates of accredited institutions meet global standards of medical competence.

6.3 The rural but also urban barefoot doctor

These reforms reflect China's commitment to improving the quality of medical care and ensuring that healthcare professionals are well prepared to meet current and future challenges in the healthcare field. Similar criteria have been given in the West.

- But, in these cases, the changes introduced are not so much in the programs and areas of theoretical and practical knowledge, but in the basic training of the doctor.
- That is, in ethical capacities, resilience, assertiveness, cross-cultural diversity, and holistic sociocultural training.
- These attributes are considered the foundation of “clinical intuition”. Thus, various universities begin training by teaching students how to “interpret a pictorial work of art” or analyzing a Tolstoy novel or one by Agata Christi.



6.4 The rural but also urban barefoot doctor

China used this model successfully during the 1960s and 1970s, training health workers to provide basic care and public health in rural areas. Although these programs were designed to address immediate needs, they also contributed significantly to training a generation of physicians with sensitivity to disadvantaged communities.

➢This type of experience can greatly enrich formal medical training and strengthen profesional's connection to the realities of community health systems. We postulate that this care practice can improve the selection of future physicians.

6.5 The rural but also urban barefoot doctor

In countries, regions or communities with high costs of studying medicine, it is more common for students to seek a quick return on their investment by specializing in lucrative areas.
In contrast, in systems with free public medicine or scholarships, students may be more motivated by vocation, since the financial barrier is lower.

It is possible to be a doctor without a clearly defined vocation, but this presents significant challenges for both the professional and his or her patients. But medicine is a demanding career that requires not only technical skills and knowledge, but also empathy, commitment and the ability to deal with emotionally complex situations.

7.1 PROPOSAL

Medicine is a demanding career that requires not only technical skills and knowledge, but also empathy, commitment and the ability to deal with emotionally complex situations.

We postulate that a young person trained for one year as a barefoot doctor (six months of theory and six months of practice) with a barefoot doctor mentor will determine whether he really has a calling or is motivated only by economic-social interests. This selective period will be accompanied by technological support from "AI ad hoc".

7.2 PROPOSAL

This one-year period will serve to filter capacities, skills, interests and decision making. A period of hardship, difficulties, frustrations and contact with the reality of everyday life will strengthen him rationally and emotionally, allowing him to decide whether or not to continue with his career as a doctor and ultimately making him more human and sensitive to ordinary people. This is how he will form his self-image as a medical doctor, because a physician must above all demonstrate dignity and humility in his actions.

7.3 PROPOSAL

Selection should be focused on building the values that usually characterize barefoot doctors:

1. **Barefoot doctors often come from the same areas they serve.** Which allows them to better understand people's needs, beliefs, and cultural practices. They will learn about connection to the community; attention to vulnerable populations: They are committed to providing health services in marginalized communities that lack access to professional doctors. In general, they will learn Empathy and Social Commitment.

2. **They work with limited resources and know how to find practical solutions to complex problems.** They will learn about efficient use of resources. Additionally, they will learn to adapt to adverse conditions, such as lack of equipment, medicines, or adequate infrastructure. They will learn about flexibility. In general, they will learn Simplicity and Adaptability.

7.4 PROPOSAL

3. Beyond treating diseases, they educate communities about healthy habits, hygiene, and disease prevention. They will learn about Health promotion. They will promote self-care with the active participation of communities in their well-being. Therefore, they will learn community empowerment. In general, they will learn about the ability to promote Health Education of Citizens and Health Prevention.

4. They prioritize the well-being of people over economic or bureaucratic interests based on minimum ethical principles. They will learn to offer care with a human, close and respectful approach to patients and will learn to offer personalized care. In general, they will be trained in Humanity and Ethics.

7.5 PROPOSAL

5. They often work in difficult environments. Facing long hours, adverse weather conditions and material limitations while still providing care, they will develop resilience and coping skills in the face of challenges. Their main motivation is the desire to serve, beyond economic or professional rewards and therefore they will develop a Vocation of service, along with Resilience and Determination.

1. Empathy and Social Commitment.
2. Simplicity and Adaptability.
3. Ability to promote Health Education of Citizens and Health Prevention.
4. Humanity and Ethics.
5. Vocation of Service, Resilience and Determination.

7.6 PROPOSAL

Selectivity

- ✓ One year as a barefoot doctor mentor and with the support of “AI ad hoc

Period 5+3

- ✓ Five years of undergraduate studies to become a clinical physician
- ✓ Three years for specialist qualification and MD (research thesis)

Period plus

- ✓ A lifetime of continuous improvement

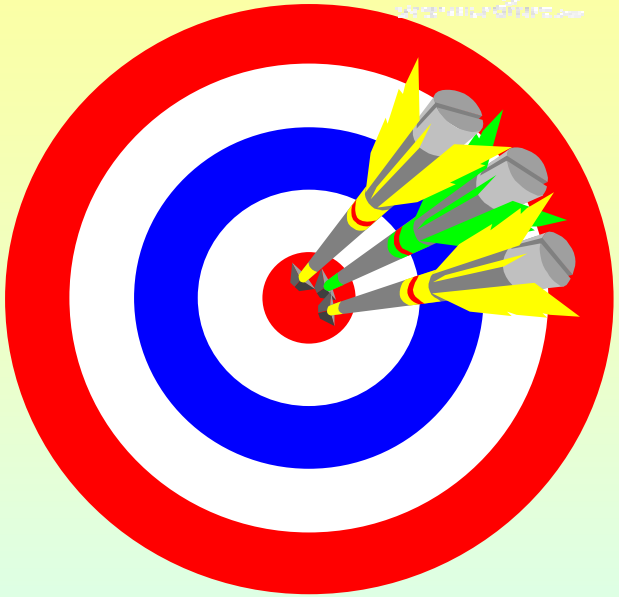
Perhaps some requirements are necessary for other non-medical or non-health professions, simply to be able to communicate with new cibernetic technologies without losing sight of their fellow citizens and the importance of face-to-face communication.

8. CONCLUSION

- Navigating the integration of automation in medical practice and education presents both challenges and opportunities.
- Embracing systemic and critical thinking, alongside fostering professional soft skills, is essential to harness the benefits of AI and transform the medical profession into a multi-disciplinary field.
- Education and training should be designed from a complex, holistic perspective, rather than an analytical and mechanistic one, where meta-learning plays a key role.

For the FULL Conf. Paper, please read App. 4-3K

? ? ? - Q&A - ✓ ✓ ✓



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