



Editorial

Unveiling the digital renaissance of traditional Chinese medicine: a leap towards holistic healthcare and precision medicine

Lingyu Linda YE^{a, b, c}, Qinghua PENG^{b*}, Dayue Darrel DUAN^{a, b, c, d*}*a. School of Integrative Medicine, Nanjing University of Chinese Medicine, Nanjing, Jiangsu 210030, China**b. Research Institute of TCM Zhengzhou Phenomics, School of Traditional Chinese Medicine, Hunan University of Chinese Medicine, Changsha, Hunan 410208, China**c. The Academy of Phenomics of Traditional Chinese Medicine, Nanjing University of Chinese Medicine, Nanjing, Jiangsu 210030, China**d. Department of Pharmacology, Reno School of Medicine, University of Nevada, Reno, Nevada 89557, USA*

In the dynamic landscape of modern healthcare and precision medicine, the digital revolution is reshaping medical industries at an unprecedented pace, and traditional Chinese medicine (TCM) is no exception [1-4]. The paper “From digits towards digitization: the past, present, and future of traditional Chinese medicine” by Academician & TCM National Master Qi WANG (王琦), an outstanding figure in the field of TCM in China, who has constructed and improved six academic systems including TCM constitutionology, TCM andrology, Zangxiangology, TCM abdominal diagnosis, TCM healthcare, and TCM preventive medicine [5], offers a profound exploration of TCM’s journey into the digital age [4]. This editorial delves into the significance of TCM digitization, its potential to revolutionize healthcare, and the challenges that lie ahead.

TCM, with its rich heritage spanning thousands of years, is deeply rooted in the “Xiangshu (象数, image-number)” or “phenotype-numerology” thinking. This unique reasoning paradigm forms the bedrock of TCM’s digitalization [4]. The ancient wisdom of *Hetu Luoshu* (《河图洛书》) and *Yijing* (《易经》) has influenced TCM theory, where numbers and symbols are used to explain the relationship between human health, natural phenomena, and the universe. For example, the correspondence between the five visceral organs and the four

seasons-five directions, derived from Hetu, reflects how TCM uses numerology to understand physiological and pathological changes. This traditional thinking not only provides a theoretical basis for TCM digitization but also offers a distinct perspective that could enrich modern medical research.

The current digital-intelligent era presents both opportunities and challenges for TCM. On one hand, big data and artificial intelligence offer the potential to unlock the hidden value of TCM data. The development of TCM large models, such as Qihuang Wendao (岐黄问道) [6], is a significant step forward in leveraging these technologies. These models can analyze vast amounts of TCM knowledge, from ancient texts to clinical cases, and provide valuable insights into diagnosis, treatment, prevention, and research. On the other hand, TCM faces issues like low-quality data, lack of data standards, and insufficient data utilization as detailed in the paper by Dr. Qi WANG [4]. The subjective nature of TCM’s “Quxiang (取象, image acquisition)” and the differences between TCM and modern medical records pose challenges to digital transformation. TCM data often lacks quality. For instance, many senior TCM physicians’ handwritten medical records are difficult to collect, sort, save, and inherit, which restricts the efficient utilization of data. The personal experience-

*Corresponding author: Dayue Darrel DUAN, E-mails: dduan@medicine.nevada.edu. Qinghua PENG, E-mail: pqh410007@126.com.

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based Quxiang (image acquisition) in TCM leads to non-standardized and subjective data. The same or similar descriptions may correspond to different pathophysiological phenotypes, making it hard to improve data quality. There is a lack of unified data standards in TCM. Conventional TCM medical records have unique structures, featuring specialized TCM terminology, a mixture of classical Chinese and modern vernacular, and no consensus-driven terminological frameworks. Existing medical informatics tools, developed based on modern medical knowledge, cannot directly handle TCM data due to the lack of corresponding semantic recognition and translation capabilities for TCM theory and terminology. For example, the common English translation of “Pi (脾)” in TCM is “spleen”, but it should be pointed out that the concept of “Pi” in TCM theory and “spleen” in western medicine anatomy are not exactly equivalent. In western medicine, “spleen” refers to a substantial organ located in the upper left of the abdominal cavity, which is mainly involved in physiological processes such as immune response, filtering blood, and storing blood cells. The “Pi” in TCM is a broader concept, which not only covers some functions of the digestive system, such as transporting water and grains (digesting and absorbing nutrients in food), transporting liquid (regulating water metabolism), but also involves the generation of Qi (气) and Xue (血), the absorption and collection of blood, and is also closely related to emotions, and function of muscles, limbs, etc. Therefore, when it comes to TCM-related content, “spleen” can be supplemented with explanations, such as “Pi in TCM theory has broader functions than the spleen in western medicine”, in order to convey its meaning more accurately.

Insufficient data utilization: TCM data is under-utilized. The problems in data quality and the lack of standards impede the in-depth analysis and application of TCM data. High-tech information technology is limited in its intervention in TCM practice because of these data-related issues.

Clinical practice-related challenges: (i) subjectivity in diagnosis. TCM’s “Quxiang” heavily relies on individual practitioners’ personal experience, lacking objective qualitative or quantitative standards. This subjectivity makes it difficult to standardize diagnosis and treatment processes. For example, different TCM doctors may have different interpretations of the same patient’s symptoms, leading to inconsistent diagnoses and treatment plans. (ii) Inconsistent curative effects. In clinical practice, the application of TCM’s Xiangshu models for diagnosis and treatment depends highly on personal perception and intuition. This results in limited reproducibility of therapeutic effects and curative outcomes, which restricts the overall development of TCM. For instance, the same TCM formula may have different effects on different patients,

even if they have similar symptoms, due to the lack of standardized diagnosis and treatment methods.

Inheritance-related challenges: the inheritance of TCM Masters’ and veteran practitioners’ academic expertise is urgent but faces difficulties. Their handwritten medical records and the lack of a standardized way to record and transmit their experience make it hard to inherit their knowledge effectively. The subjective nature of TCM diagnosis and treatment also makes it challenging to standardize the inheritance process. For example, it is difficult to teach and learn the unique diagnostic and treatment skills of TCM masters without a standardized system. However, by following the five-level transformation pathway of objectification, standardization, informatization, transformation, and intelligentization, TCM can overcome these obstacles [4].

The application scenarios of TCM digitization are diverse and far-reaching. In platform construction, National key Laboratories for interdisciplinary integration can drive cutting-edge research. For knowledge inheritance, digital technologies can preserve and transmit the academic thoughts and clinical experience of veteran TCM practitioners more effectively. Ancient book utilization can be enhanced through artificial intelligence (AI)-powered platforms, uncovering hidden knowledge. Service innovation can create new models of TCM healthcare delivery, such as the “Digital TCM Practitioner” system for remote consultation. Equipment development can lead to the creation of digital auxiliary diagnostic tools and intelligent therapeutic devices. Industrial transformation can improve the quality of Chinese herbal medicines and promote the development of digital Fangji (方剂) and intelligent herbal medicine.

Looking ahead, the future of TCM digitization is promising. The development of a phenome-based big data platform system for TCM constitutions and Zhenghou (证候) can enable personalized health management on a large scale [2, 4]. By creating an AI-based nine-constitution model and conducting in-depth research on latent correlations, TCM can provide more targeted preventive and therapeutic measures. Moreover, TCM should embrace multidisciplinary integration while maintaining its essence. It is crucial to balance the use of data-driven approaches with the intuitive and empirical knowledge that is inherent in TCM. Digitalization enables the systematic collection of phenomic data in TCM. Through the use of electronic medical records, wearable devices, and image-recognition technologies, a large amount of data on patients’ symptoms, tongue images, pulse conditions, and facial features can be collected. For example, some TCM hospitals have adopted digital tongue-imaging systems to capture high-resolution images of patients’ tongues, which can be stored and analyzed for changes over time [6]. The cutting-edge phenomics provides a rich and detailed new approach to TCM digitalization [1-3]. By leveraging

digital technologies to capture, analyze, and apply TCM phenomic data, it is possible to enhance the accuracy and effectiveness of TCM diagnosis and treatment, promote precision medicine and personalized healthcare, and contribute to the overall improvement of public health^[1-3].

In conclusion, TCM digitization is not just about adapting to the digital age but also about redefining the future of healthcare. It has the potential to combine the best of traditional wisdom and modern technology, offering more comprehensive, personalized, and effective healthcare solutions. As TCM embarks on this digital journey, it is essential to address the challenges, foster innovation, and promote interdisciplinary collaboration. The digital renaissance of TCM holds the key to unlocking its full potential and contributing to the global healthcare landscape, ultimately serving the goal of “Healthy China” and beyond.

Competing interests

Qinghua PENG and Dayue Darrel DUAN are editorial board members for *Digital Chinese Medicine* and were not involved in the editorial review or the decision to publish this article. All authors declare that there are no competing interests.

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