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Commentary

Artificial intelligence advanced imaging report standardization and intra-interdisciplinary clinical workflow

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In this article of *EBioMedicine*, the authors show that the novel lung intelligent image layout system (IILS) developed deploying deep learning on chest Computed Tomography (CT) images has the potential for generalized applications in standardized e-film and visualized structured reports [1]. This suggests that the invented IILS may achieve imaging report standardization during regular follow-up, improve the clinical workflow, and expedite the diagnosis and referral of pulmonary nodules, thereby facilitating earlier treatment and improved clinical outcomes. To understand the importance of this invention, we need to expose the problems in the clinical imaging diagnose.

Above all, at least in China, there is currently no standardized mode for medical imaging layout and reports, and many obstacles exists for hospitals in terms of information sharing and consultation. Additionally, for the diagnosis of pulmonary nodules, the reports generated by dry laser film fail to show the nodules, let alone the key images. The large number of invalid images makes the existing layout mode unfriendly to both patients and doctors, which also results in a mass of time consuming in diagnosis. In current China's healthcare system, there is always a fight against the limited doctors and a large number of patients throughout the clinic service process. Besides, regarding the hardware, many modern computers do not come with CD drivers or the (USB) ports that makes it impossible to reuse the image reports obtained different hospitals. The authors proposed this standardized film system, which seems to put forward a good solution, but needs to be built on good algorithm.

The standardization of clinical imaging procedure is a specific problem derived from clinical practice, which meets the needs of modern translational medicine. Early in 2003, Goldberg and colleagues questioned the standardization of image-guided tumor ablation, terminology and reports in *Radiology* [2]. This proposal will facilitate achievement of the group's main objective: improved precision and communication in this field that lead to more accurate comparison of technologies and results and ultimately to improved patient outcomes, which is, to some extent, similar to the idea of Dr. Bing Zhang's team that aims to solve specific clinical problems related to translational medicine. However, different research fields have their own characteristics with solutions adopted varies a lot.

For the tools developed to detect diseases and lesions, a series of effective accomplishments have been done [3,4]. These achievements were still with substantial difficulties in applying to large scale clinical practice due to its uncertainties in reliability. However, the breakthrough in the field of visual recognition [5] and the establishment of the ImageNet database [6] did promote the progress of artificial intelligence. In 2007, Hinton and colleagues proposed an algorithm for effective training in the feedforward neural network, which greatly improved the accuracy of image recognition [7]. At the same time, advances in computer hardware and software have also helped the field flourish. Hosny and colleagues stated that these methods could impact multiple facets of radiology, with a general focus on applications in oncology and advanced the medical world, but the process will definitely face sufficient challenges [8]. The good results achieved by Dr. Bing Zhang and colleagues have also fulfilled the predictions and forward-looking views.

Recently, several studies related to deep learning-based pulmonary nodules detection emerged [9,10], and all of these studies have made great progress and breakthroughs in the exploratory studies on the detection and classification of various types of pulmonary nodules. Nevertheless, these achievements were generally limited by a relatively small sample size, which has been improved by Dr. Bing Zhang's team with a sufficient image produced by almost all the imaging manufactories on the market and all sizes of pulmonary nodules. In this way, it is beneficial for the IILS to take a solid step in applying to the real medical world and realize translational medicine.

Currently, something much more exciting is emerging. The first Artificial Intelligence (AI) solutions that create value in clinical practice. Undoubtedly China owns one of largest medical markets in the world, with a dual characteristic of developed and developing nature. The economy of China plays an important role worldwide which means that advanced technologies will likely be applied in Chinese medical market. There are quite a few events that put AI in the spotlight. These events, like the clinical application of the AI plus pulmonary nodules screening are fantastic opportunities to assess the solutions that fit hospital and patient needs. Bing Zhang and her colleagues observed these clinical demands and conceived ingenious design that combination of artificial intelligence and clinical application. The authors carried out a

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scientific demonstration on the optimization of the whole clinical workflow, which makes it credible and achievable from a scientific and engineering point of view. Two vivid videos enable readers to intuitively understand why IILS and how to apply IILS in the clinical practice. Meanwhile, the triumph of IILS and other academic conferences or related literatures also shed a certain sense of crisis to human experts, i.e., AI would outperform human experts in terms of detecting pulmonary nodules and judging lesion malignancy.

Several questions remain. The data set used for model development is not comprehensive enough. For example, IILS can be only used for chest scanning by now, and is a cohort-specific tool just for Chinese population and it would end up with high false positives if deploying to other cohort such as American and other human races. IILS also fails to enroll the images with complete pathologic features and age bracket, and lacks long-term test for application including hardware stability and the capability to handle extreme situations. All of which suggests that a plenty of room still remains for IILS to perfect. Presumably a substantial reformation on the traditional clinical workflow and the permeation of human-machine coupled concept still get a long way to go.

The invention presented in this study pioneered the idea of human-machine coupling and some relevant operators will be unnecessary due to the invention of the IILS, which includes two deep learning models first applied to clinical medicine, Faster RCNN and ResNet. Superior to the traditional manual system, the IILS will be promoted and applied to other imaging methods, such as magnetic resonance imaging and imaging of other parts of the body. The IILS will be integrated into radiology workflows by series connection instead of parallel connection to considerably simplify and optimize the clinical workflow and to benefit more doctors and even patients during regular follow-up. With the advent of the information era, over the next decades, more goals could be fulfilled by the IILS when supporting regions with insufficient healthcare resources. In any case, the IILS shall open a new window for clinical application of AI.

Conflict of interests

The author declares no conflict of interest.

Authors' contribution

Jie Tian wrote and edited the manuscript.

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