

# **AI System for Pulmonary Imaging Diagnosis in the Prevention and Control of COVID-19: InferRead CT Pneumonia**

## **1. Overview:**

The situation of COVID-19 prevention and control is still serious. With both imported cases and local transmission cases accumulated more than 80,000 worldwide as of March 2020, the outbreak becomes harder to monitor. There must be a more favorable screening system and more effective diagnosis and treatment to prevent the virus from spreading further. The goal of the pandemic control is to achieve “Early detection, early diagnosis, early quarantine, early treatment”.

It is a crucial task to make chest computed tomography scan (CT) + AI screening become the front-line screening and diagnosis measures for COVID-19. When used together with polymerase chain reaction (PCR) test, they form a more sensitive and complete examination procedure (to determine quarantine, treatment and prognosis). Furthermore, the data based on CT + AI are objective and unified, which are conducive to the formation of a rapid direct reporting system. It has therefore become an important decision-making basis for current epidemic monitoring and control.

## **2. Major problems currently faced in the prevention and control of COVID-19**

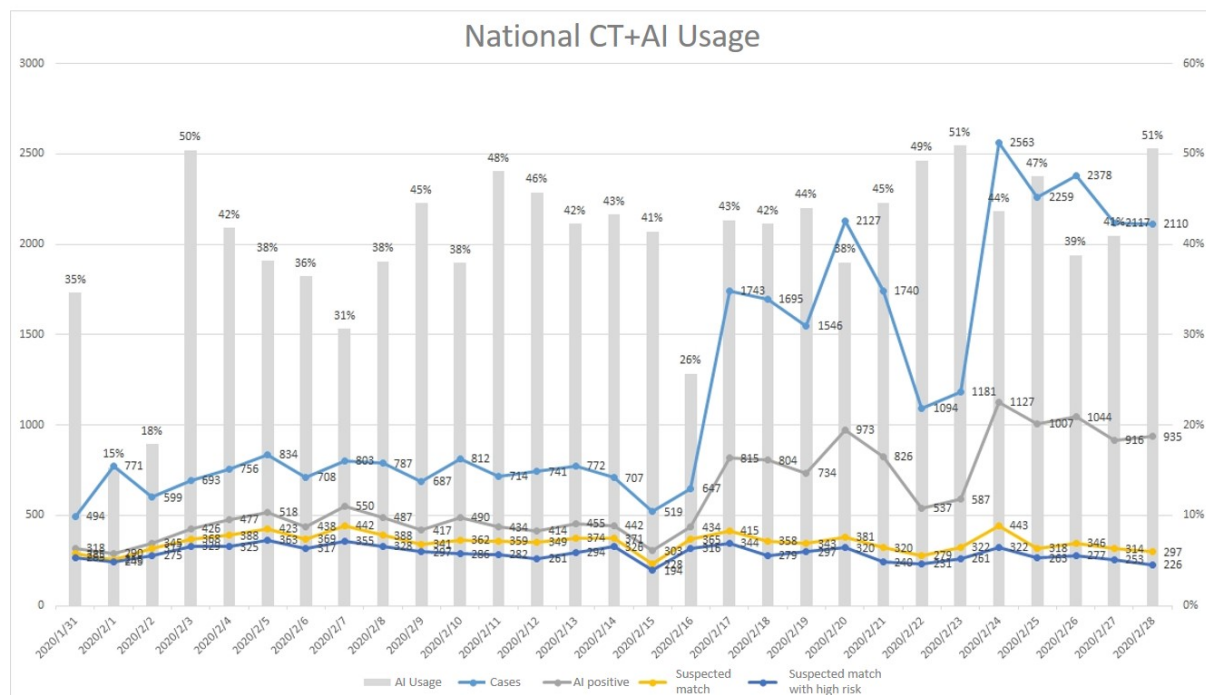
- 1) Reverse transcription polymerase chain reaction (RT-PCR) is the gold standard with high specificity. However, it has problems such as long detection time, complicated external procedure, requiring continuous detection and quality control of RT-PCR kits.
- 2) It has been clinically confirmed that the disease could hide from detection. In multiple cases, PCR results appear negative yet CT manifests as pneumonia, and these cases are later confirmed to be diagnosed with COVID-19. Hence, CT detection should play a greater role.
- 3) To form treatment plans, progress assessments, and prognosis judgements, CT results are needed. Measurements such as density and volume must be read from CT images, but these measurements of the pneumonia region are often hard to be evaluated by the human eye. AI can provide better measurements.
- 4) COVID-19 is a new type of disease, which may cause misdiagnosis, missed diagnosis, and delay of the patient's diagnosis may happen in regions where the epidemic occurs unexpectedly.
- 5) COVID-19 is mostly insidious and easy to occur from the outer lung field. Imaging reading has to be very careful and can be time consuming. In a concentrated outbreak region, medical resources are extremely scarce. Valuable medical resources should be used more in complex treatment and complex cases, repeated labor should be taken over by machines.
- 6) For the overall epidemic situation, the raw data reports could cause a time lag in judgement, which may affect the best timing for epidemic control.

### 3. InferRead CT Pneumonia: AI Imaging Diagnosis System for COVID-19

#### 1) Product development and progress:

Infervision Technology became aware of the seriousness of the epidemic before the Chinese New Year holiday and formed a “COVID-19 Task Force”. Infervision contacted Wuhan Tongji Hospital, Zhongnan Hospital of Wuhan University, Shenzhen Third People’s Hospital (National Infectious Diseases Clinical Research Center) to collect relevant information and had received positive responses from these institutions. Infervision has since started a two-way cooperation for joint research, to develop the new COVID-19 AI solutions right by clinical needs. After 1000+ cases of clinical tests, the model performed well with a sensitivity of 98%.

As of February 28, Infervision’s InferRead CT Pneumonia has been applied/ deployed in 40 Chinese hospitals inside the epidemic areas and outside. The AI solution has screened more than 45,000 cases of suspected pneumonia, and has established 32 scientific research projects with hospitals / research institutes (6 of which are provincial government-funded projects). The cumulative number of research contributions has reached 15 (2 articles published in journals, including the Chinese Radiological Society and JAMA), and a total of 7 software copyrights and patents have been applied, of which 2 have been already obtained.



Statistical data of Infervision assisting hospitals for COVID-19 screening

#### 2) The latest diagnosis and treatment plan

With the spread of COVID-19 epidemic, relevant experts organized by the National Health Commission of the People's Republic of China and National Administration of Traditional Chinese Medicine jointly released the "Diagnosis and treatment plan for COVID-19 virus infection (sixth edition)". It describes the detailed criteria for diagnosing and assessing the condition using CT.

According to the clinical analysis conducted by an expert team lead by academician Dr. Zhong Nanshan, targeting at 31 provincial administrative regions and 552 hospitals in China, involving nearly 1,100 patients with COVID-19 diagnosed: when they were admitted to the

hospital for CT examination, 76.4% of patients have pneumonia impressions in CT imaging. Ground-glass shadows (50%) and patchy shadows in both lungs (46.4%) are found, by which the vast majority of severe patients can be diagnosed. If the CT examination, PCR test and clinical symptoms are combined, the accuracy of the diagnosis could reach 97%.

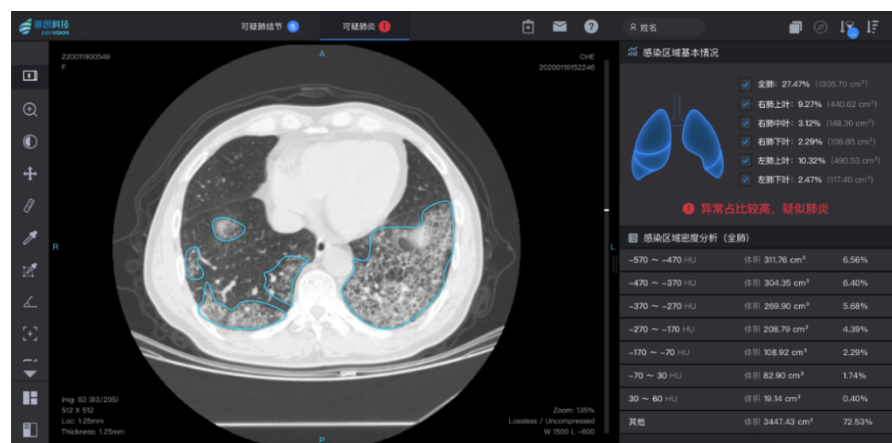
Based on the new diagnosis and treatment plan, imaging data as well as standard diagnostic guidelines, Infervision has developed an AI solution assisting COVID-19 screening and epidemic monitoring system, which can help hospitals quickly set up a new COVID-19 diagnosis system, promote the standardization of work, rationalize the workflow, and improve the efficiency of diagnosis and treatment. InferRead CT Pneumonia improves the hospital's treatment capacity and quality as well as medical safety.

### 3) Main functions of the Infervision COVID-19 AI system:

- **Rapid screening and alert function:** when viewing the patient's CT image on doctor workstation, InferRead CT Pneumonia will automatically prompt to indicate whether the current patient is suspected of COVID-19 infection and give a corresponding warning.

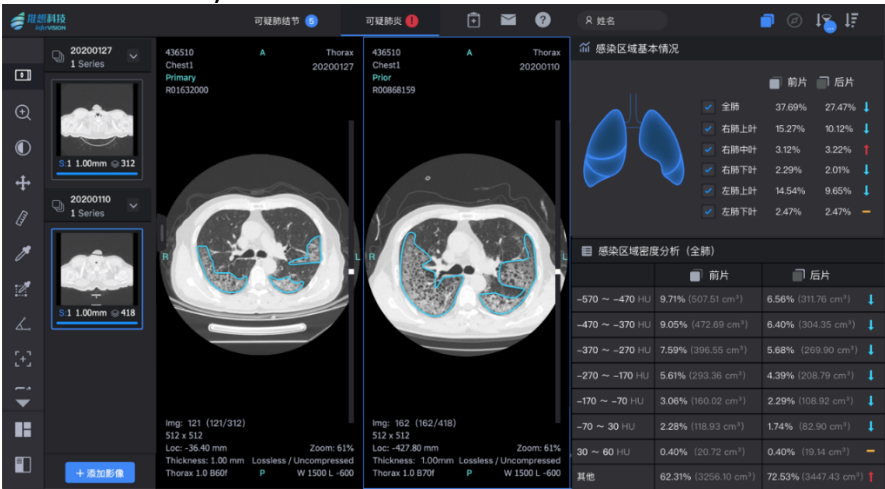


- **Accurate diagnostic aid function:** After opening the patient's CT series, doctor can use InferRead CT Pneumonia for lung segmentation, while checking and segmenting the inflammatory areas in the lung field. The AI system will also give the number of affected lung lobes and the degree of lung infection, assisting doctors to assess the patient's lung infection, and to provide a basis for diagnosis and treatment.



- **Automatic condition and efficacy evaluation function:** The AI systems provides a fully automated co-registration function, comparing the CT images of the same patient over different time periods. In doctors' daily work, comparison between CT images of the same patient is an important part and can help assess the progress of infection and efficacy of the treatment objectively. However, this work can be extremely time-consuming and tedious, subtle development can be easily neglected. Using the co-registration function,

doctors can compare chest CT images in detail, assess quantitative indications, and evaluate treatment efficacy.



- **COVID-19 detection and triage function:** Once a suspected case is detected, the system promptly warns for high-risk cases at the top of the work list and highlights the details of all suspected cases. Medical workers can take timely quarantine measures to prevent cross-infection during the waiting process and to treat severe cases in time.



- **Real-time surveillance of regional epidemics:** After the deployment of the InferRead CT Pneumonia in all medical institutes within the region, the system can collect data from all hospitals, form detailed report regarding examination numbers, number of suspected cases, ratio of suspected cases, generating a regional epidemic surveillance information network that provides fast, accurate, and intuitive data analysis results for epidemic management.



#### 4) Case analysis using InferRead CT Pneumonia

##### Case 1:

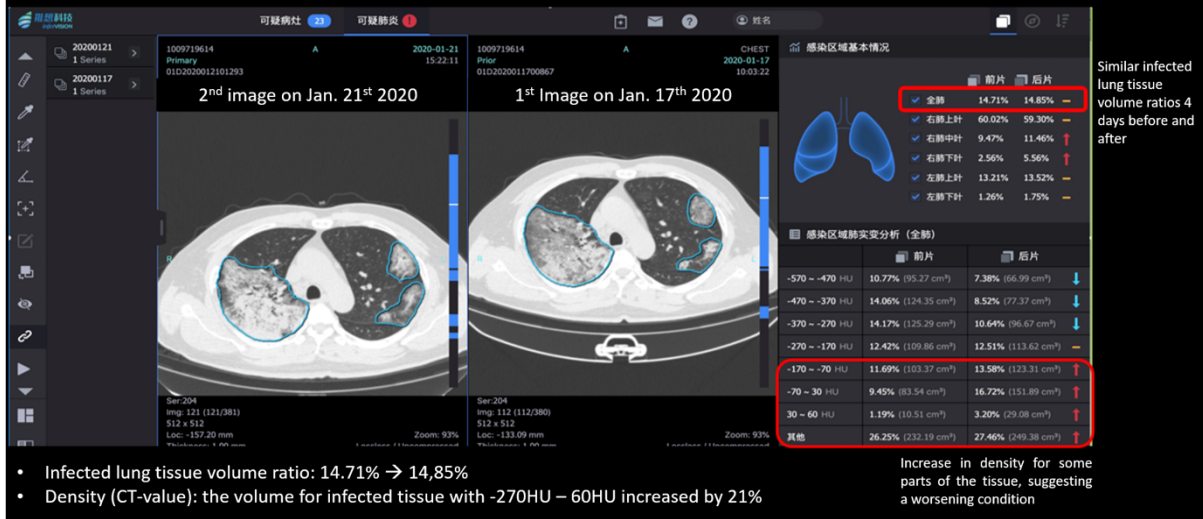
- The AI result of this case came out before the RT-PCR result, and the AI gives a high-risk warning, which has been later proven to be consistent with the diagnosis.





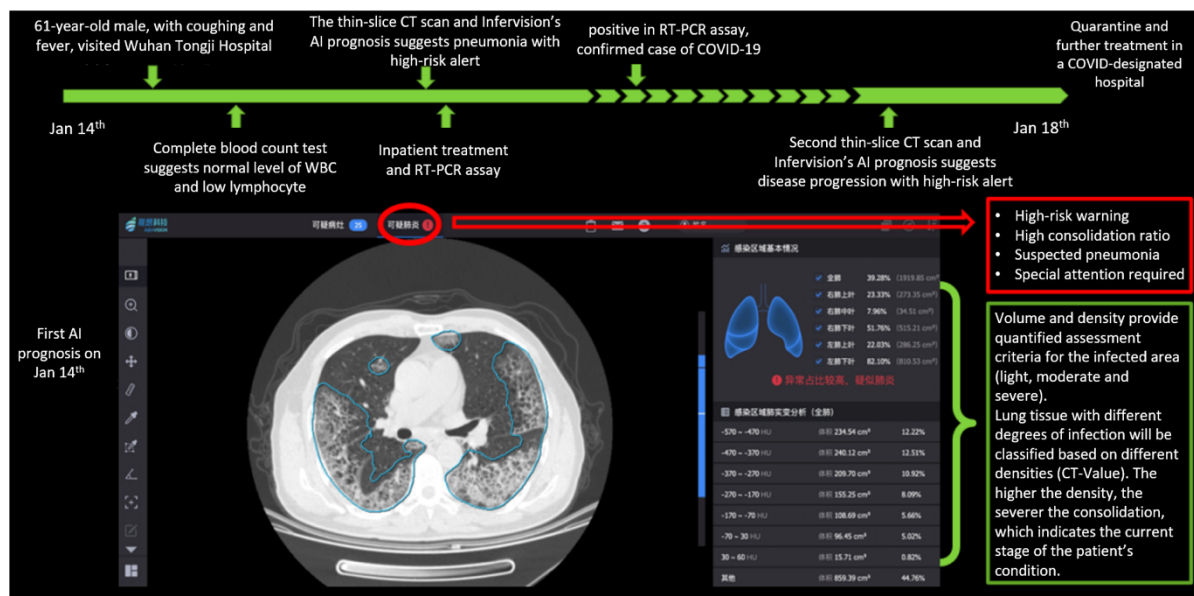
- Co-registration shows no significant changes in the lesion volume, but an increase in lesion density. It also aligned with clinical symptoms, and the patient was transferred to specialized hospital for quarantine and treatment.

- Follow up after 4 days – infection volume did not enlarge, but density increased, which indicates a worsening condition.
- Double dimensions (volume and density) provide a more precise diagnosis

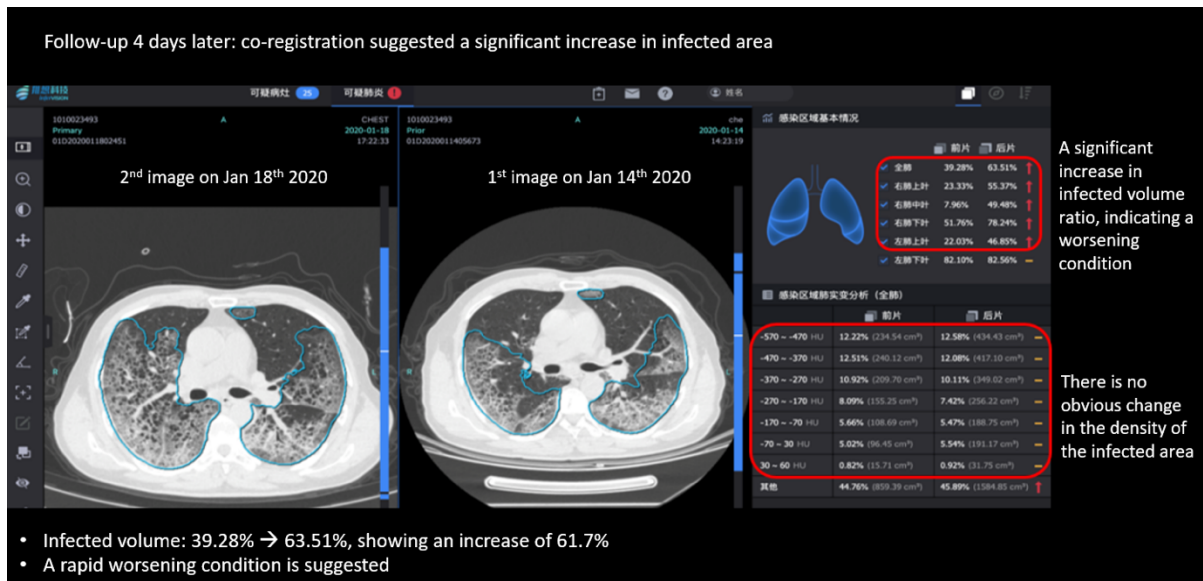


## Case 2:

- The AI result of this case came out before the RT-PCR result, and the AI gave a high-risk warning, which has been later proven to be consistent with the diagnosis.
- Co-registration showed significant increase in lesion area and gave warning. It also aligned with clinical symptoms, and the patient was transferred to specialized hospital for quarantine and treatment.
- InferRead CT Pneumonia provides accurate clinical analysis based on volume and density, accurately determining the prognosis of the disease.



*Faster than PCR, with accurate analysis in area and density*



*AI system running co-registration, comparing both volume and density of two exams. In this particulate case, the density hardly changed but the lesion volume increased.*

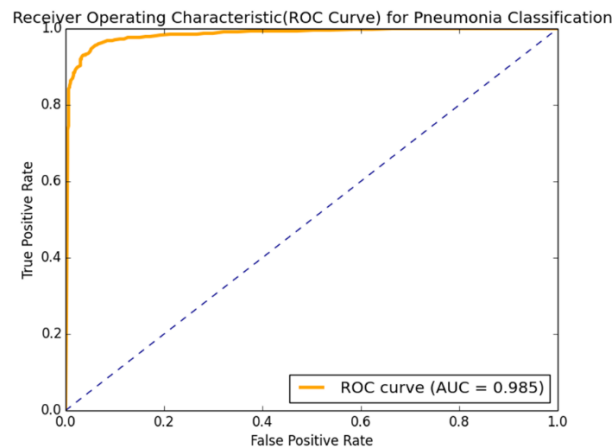
## 5) Customer Evaluations - Wuhan Tongji Hospital



*Doctors in Wuhan Tongji Hospital are using InferRead CT Pneumonia on a daily basis*

Developed in cooperation with Wuhan Tongji Hospital, Wuhan Zhongnan Hospital and Shenzhen Third People's Hospital (National Center for Clinical Research of Infectious Diseases), InferRead CT Pneumonia has been deployed in all three hospitals, and used in hospital's clinical workflow. The results are as follow:

Around one thousand cases consisting of both positive and negative COVID-19 (in which negative cases often claimed coughing or fever and did not actually get COVID-19) were analyzed. Sensitivity = 98.32%, specificity = 81.72%, AUC = 0.985



*AUC is often used as an indicator of the quality of AI models. The range is 0-1. The larger the more accurate of the AI. InferRead CT Pneumonia has achieved 0.985.*

The head of radiology in Wuhan Tongji hospital, Liming Xia (doctoral supervisor, editorial board member of Chinese Journal of Radiology, participated in the 11th Five-Year National Science and Technology Support Program) has given InferRead CT Pneumonia the following positive comments:

- Increasing efficiency of doctors' diagnosis. Several designated hospitals are overcrowded. The long waiting time for patients raises the risk of cross-infection. InferRead solution has helped reduce the waiting time for the patients.
- Fast measurements on lesion density, form, and volume; helping doctors to make even more accurate diagnosis in a shorter period of time.
- Co-registration has effectively helped doctors in the comparison of exams. Fast measurements of the changes between exams, has helped doctors more accurately and quickly evaluate patients' condition and treatment efficacy.

## 6) Media coverage

Mainstream media including Xinhua News Agency, Wall Street Journal, People's Daily Online, Reference News, Beijing Daily, Beijing Satellite TV, Beijing Youth Daily, Phoenix Daily, Economic Daily, Nikkei, The Lancet, have given reports on the InferRead AI system for COVID-19: InferRead CT Pneumonia. In particular, both of the Wall Street Journal and the Lancet had special report on InferRead this week. The Lancet website published a reviewing article praising China's use of artificial intelligence technology to fight the epidemic and suggested that the technology can play a greater role.

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who was reprimanded by Chinese authorities for warning about the virus, highlights the plight of clinicians on the frontline.

"An [article in JAMA](#) states that human-to-human hospital-associated transmission accounted for 41% of all cases in a study of patients at Zhongnan Hospital of Wuhan University," Chen notes. "We also know that more than 1000 hospital staff in the city of Wuhan have been confirmed infected."

This is where [InferRead's AI application](#) could help. From a lung CT scan, the AI is designed to quickly detect lesions of possible coronavirus pneumonia, to measure its volume, shape, and density, and to compare changes of multiple lung lesions from the image, which all provide a quantitative report to assist doctors making fast judgement. "While a manual read of a CT scan can take up to 15 minutes, AI can finish reading the image in 10 seconds." Application of this technology in COVID-19 has not yet been published in a peer-reviewed journal.

Chen adds that in Wuhan, where there are far too many cases to test and PCR-based diagnosis takes too long (sometimes over a week), CT imaging with AI could serve as a surrogate for doctors when fast judgement is needed. "Doctors no longer need to engage in the lengthy process of manually reading images one by one to identify high risk cases, while coronavirus-probable patients wait around the hospital posing a severe risk of infecting other patients and hospital staff."



On February 26, the top tier international technology magazine "WIRED" published on Infervision in China in the headline article "Chinese Hospitals Deploy AI to Help Diagnose COVID-19". Excellent performances in clinical application during the COVID-19 epidemic are mentioned and praised in the article. In the article, they interviewed Haibo Xu, head of Radiology in Zhongnan Hospital of Wuhan University, and shared his experience of using InferRead CT Pneumonia in the frontline of the epidemic. He said: " InferRead CT Pneumonia can identify the signs of the virus, help doctors diagnose suspected cases quicker, take quarantine or treatment as soon as possible, and relieve the pressure of doctors." It is also the first time "WIRED" gives pass on such high kudos to a Chinese AI company, and it is expected that the application experience of AI by Infervision in China will be shared globally.

### **Appendix: A brief introduction of Infervision**

Infervision is a world-leading medical AI company, adhering to the vision of "using advanced technology to improve human life". Utilizing deep learning technology, Infervision has created medical AI solutions for different using scenarios such as diagnostic aid, medical quality control, healthcare management and scientific research innovation. Infervision solutions have been installed and used in around 400 hospitals worldwide and have processed over 14 million medical cases. At the same time, Infervision is also a candidate for the "Key Tasks of the New Generation of AI Industry Innovation" of the Ministry of Industry and Information Technology in China. In 2020, Infervision strives to take medical image processing to a new level.

Infervision uses deep learning to analyze medical image data such as DR, CT and MRI to provide doctors with accurate and efficient diagnostic tools, thereby reducing the workload of doctors and allowing radiologist to focus more on diagnosis. At present, Infervision has developed InferRead CT Lung, InferRead DR Chest, InferRead CT Stroke, InferRead CT Bone, InferQC for quality control and solutions for other clinical scenarios. Among them, InferRead CT Lung has been applied for NMPA registration for Chinese market since December 2019, which is currently in technical review stage. InferRead CT Lung has been certified with CE mark by British Standard Institute in February 2020.