From COPD to COVID-19: The potential of FRI in general pulmonology

Technological advances have unleashed the potential to better treat prevalent lung diseases. Approaches like quantitative computerized tomography (CT) are increasingly used in routine care to guide the diagnosis, treatment, and follow-up of diseases like chronic obstructive pulmonary disease (COPD) in developed countries. Dr. Victor Kim, Professor of Thoracic Medicine and Surgery, explains how imaging technologies will soon play a bigger role in pulmonary care.

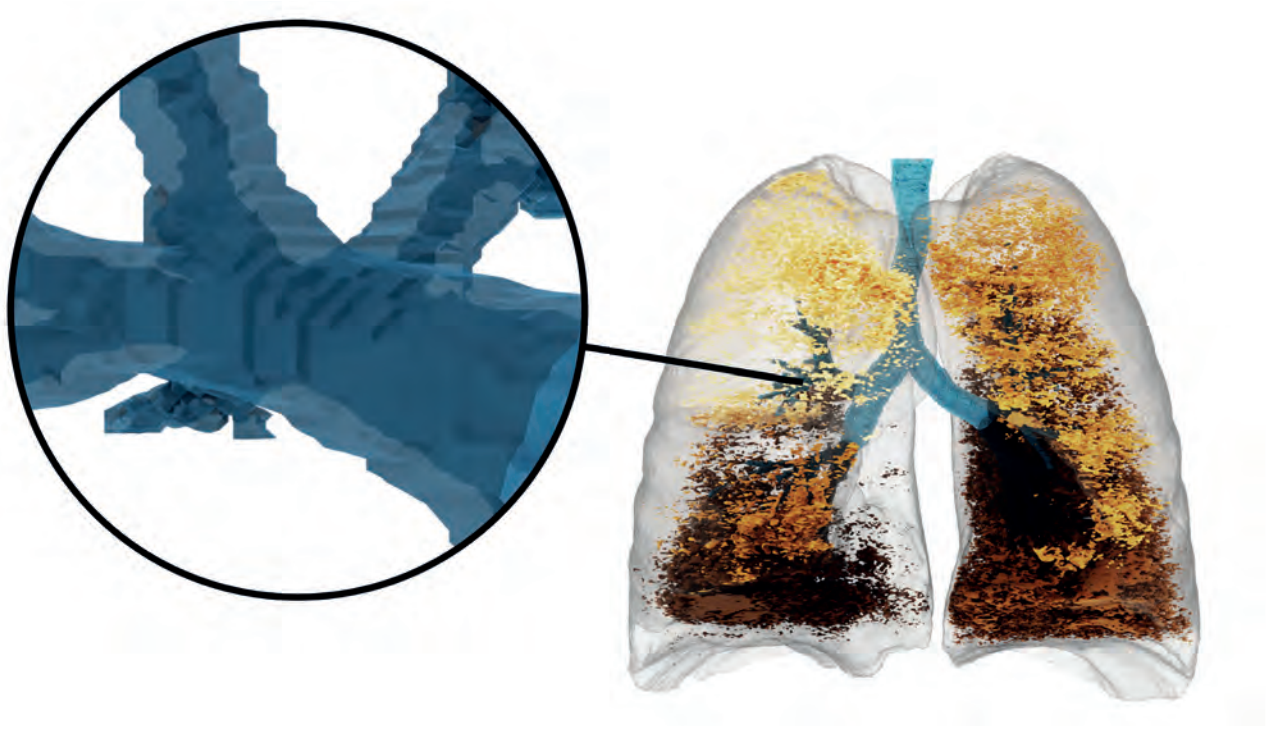
"A decade ago, we predominantly diagnosed lung diseases by surgical lung biopsy,' says Kim. "This involves exposing an already ill patient to the increased risks of an invasive procedure. Thanks to advances in technology, now we can use patient-friendly approaches like CT imaging, radiographic patterns, and genetic phenotyping to diagnose and categorize these individuals. These technological advances definitely provide better options of care for pulmonary patients."

QUANTITATIVE CT TECHNOLOGY IN COPD

In countries like the United States, CT scans have become commonly used to diagnose lung diseases and direct the course of treatment. With better resolution of CT scans, it is now possible to extract more information from these images. Quantitative CT (qCT), an umbrella term that describes technologies extracting numerical data from CT scans, such as FRI, can take this practice to the next level and create more data around pulmonary conditions.

VICTOR KIM

Victor Kim, MD, is a professor of thoracic medicine and surgery at the Lewis Katz School of Medicine at Temple University. He is a pulmonary, critical care, and sleep physician who is heavily involved in clinical and translational research in COPD, particularly chronic bronchitis.



The COPD community has a long history of employing qCT to guide patient diagnosis. Over the past 3 decades, techniques such as CT densitometry have been increasingly used to gather information about air trapping and airway abnormalities. "qCT provides more information than spirometry and chest X-rays. It allows us to make better-informed decisions in diseases like COPD," explains Kim. "We are currently using qCT to establish the extent and pattern of emphysema, which allows us to determine the patients' eligibility for procedures like lung reduction. There are emerging interventions for chronic bronchitis, and the ideal candidates for those are with less emphysema. qCT also plays a role in this setting. These quantitative technologies allow us to obtain otherwise unavailable information and significantly improve patients' lives," he adds.

THE POTENTIAL ROLE OF FRI

FRI does not have a place in the clinical practice of COPD yet, but it may in the future. "There is currently a lot of interest from the research community about using new CT technology to establish phenotypes for different lung diseases," clarifies Kim. "The ability of FRI to assess parameters like blood volume, dynamic airway volume, and total airway count will be paramount in this process." Most of the current reference studies to establish phenotypes in lung diseases were performed using pathology specimens; however, with the advent of non-invasive technologies providing more detailed data, as in the case of FRI, it might be possible to advance the field to a point where risky procedures can be completely avoided.

As new data on COPD imaging is generated, the utility of FRI in management of this disease improves. Kim states, "We have performed several multi-institutional research projects, looking at many COPD patients over 10–15 years using repeated imaging. The results of these studies are developing right now, which opens the door for technologies like FRI to provide relevant information on COPD progression."

"FRI could replace outdated technologies that we still use in routine clinical care," says Kim. "We currently use ventilation perfusion scans – a nuclear medicine study – to measure how much air is being ventilated into certain regions of the lung. This technique is cumbersome, but we still use it for surgical planning and transplantation. FRI could provide regional gas exchange data with greater detail. Thus, giving us a tool to treat patients with greater accuracy."

CHALLENGES IN GLOBAL IMPLEMENTATION

As more data emerges, the possible applications of FRI in lung diseases like COPD seem endless. Nevertheless, challenges still exist when it comes to worldwide implementation. The global guidelines for lung diseases are still based on the current standard of care, spirometry. Global guidelines consider healthcare settings that may not have access to such technologies, despite these technologies providing richer, more personalized information. Kim explains, "In developed countries, it is quite easy to do CT scans of lung patients. In our practice, we do it as a routine procedure, and you could apply FRI to those images to get a better idea of the patient's lung function. However, you also must consider the kind of care that patients get in low- and middle-income countries. It might be

> **The ability of FRI to assess parameters like blood volume, dynamic airway volume, and total airway count will be paramount in determining new phenotypes of lung disease.**

difficult to have access to CT scans in these countries, as some even struggle to have access to spirometry. So, global guidelines are currently cautious to advocate for widespread use of imaging tools, despite their clear potential." Countries that can afford to use imaging techniques will continue using them to improve patient care, and this will decrease the cost of CT scans over time, in turn making the technology more readily available to everyone.

USING FRI TO ADVANCED COVID-19 RESEARCH

The COVID-19 pandemic changed research priorities in pulmonology, and clinical centers worldwide had to rapidly adapt to deal with this new disease in the best way possible. Now with the number of long COVID patients increasing, new data are becoming available on potential treatments, diagnostic tools, risk factors, predictors for severe disease, and long-term phenotypes. Promptly generating reliable data to provide better care to these patients is of paramount importance. In the post-COVID era, researchers and clinicians will establish new collaborations with industry to test new technologies, enabling FRI to gain more visibility, perhaps even in clinical practice.

Kim was aware of FRI already before the pandemic, but he became more interested in the technology when he saw its potential to assess the pathophysiology of COVID-19 in a non-invasive way. So far, he has done two collaborations with Fluidda. The first focused on the relationship between blood volumes and post-COVID lung function [1]. The study found that patients with COVID-19 who had pulmonary vascular abnormalities at the time of hospitalization, especially in the medium and large vessels, were at higher risk of having low diffusion capacity of carbon monoxide (DLCO, a measure of lung function) even three months after discharge.

The second study included more patients and focused on patients who complained of breathlessness after COVID-19 [2]. Kim explains, "We found a relationship between alterations in the blood flow patterns of the lung and the perception of breathlessness after infection. These types of relationships are difficult to quantify based on traditional lung function parameters like exercise or physiology. So, having access to FRI was determinant in this case." The results of this study were presented at the 2021 annual meeting of the American College of Chest Physicians.

THE FUTURE OF FRI IN GENERAL PULMONOLOGY

The COVID-19 pandemic changed how the world looked at lung diseases, leading to a drastic change in research priorities and a worldwide interest in the consequences of neglecting holistic pulmonary care. This has opened the door for novel imaging technologies to become more readily available and play a more prominent role worldwide. Kim postulates, "I think that advanced radiology techniques like FRI will have a greater role in acute and outpatient care of pulmonary patients in the future. This technology could help us identify several phenotypes in lung disease, inform which patients are the best candidates for certain procedures, and determine how to treat patients with greater accuracy."

REFERENCES

1. Salerno D, Oriaku I, Darnell M, et al. Association of abnormal pulmonary vasculature on CT scan for COVID-19 infection with decreased diffusion capacity in follow up: A retrospective cohort study. PLoS One; 2021;16(10):e0257892.
2. Fleitas Sosa D, Oriaku I, Darnell M, Lanclus M, De Backer J, Salerno D, Kim V. Significant dyspnea in post-acute COVID-19 is associated with abnormal pulmonary vasculature on CT during the acute phase. Chest; 2021; 160 (4 Suppl): A520