

KEEP UP WITH INCREASING DEMANDS

USING AI TO BETTER MANAGE COVID-19 (Updated May 2020)

Lunit, a medical AI software company that develops AI-powered detection of lung diseases via chest x-ray images, has released a special version of its AI software, Lunit INSIGHT CXR for COVID-19 in late March.

Given the fact that COVID-19 is known to cause pneumonia and that our AI is capable of accurately detecting lung diseases—including pneumonia—from chest x-ray images, we have released the software in anticipation to contribute to the battle against COVID-19.

Since the release, we have received interests from healthcare providers around the world, and as of mid-May 2020, we now have our product deployed in **10 locations throughout different countries using our solution for COVID-19 management.**



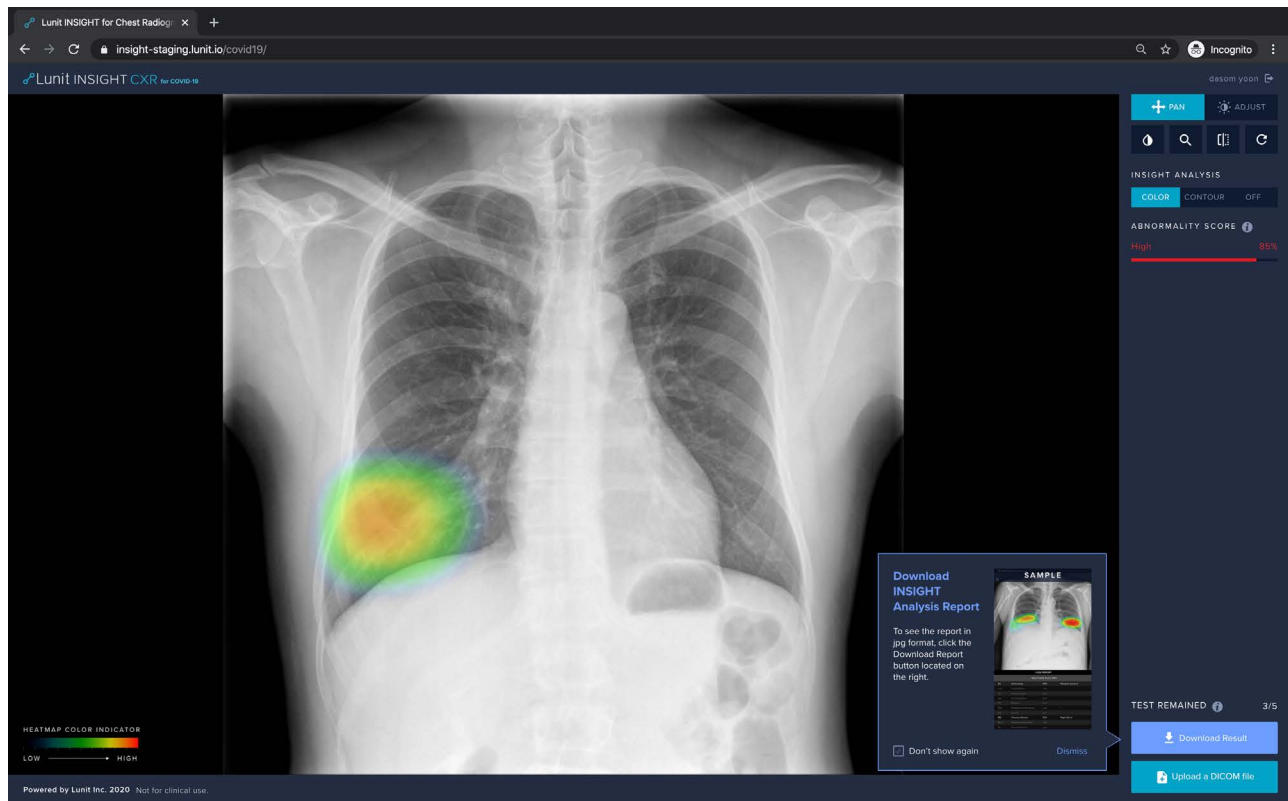
Global locations that currently use Lunit AI solution or in demo, for COVID-19 management

1. LUNIT INSIGHT CXR FOR COVID-19 IN ACTION

How it Works

- Analyzes consolidation (including ground-glass opacity, GGO) within seconds
- Localizes consolidation via heatmap
- Provides the abnormality score, reflecting the probability of the existence of consolidation
- AI results help the user make clinical actions according to the interpretation.

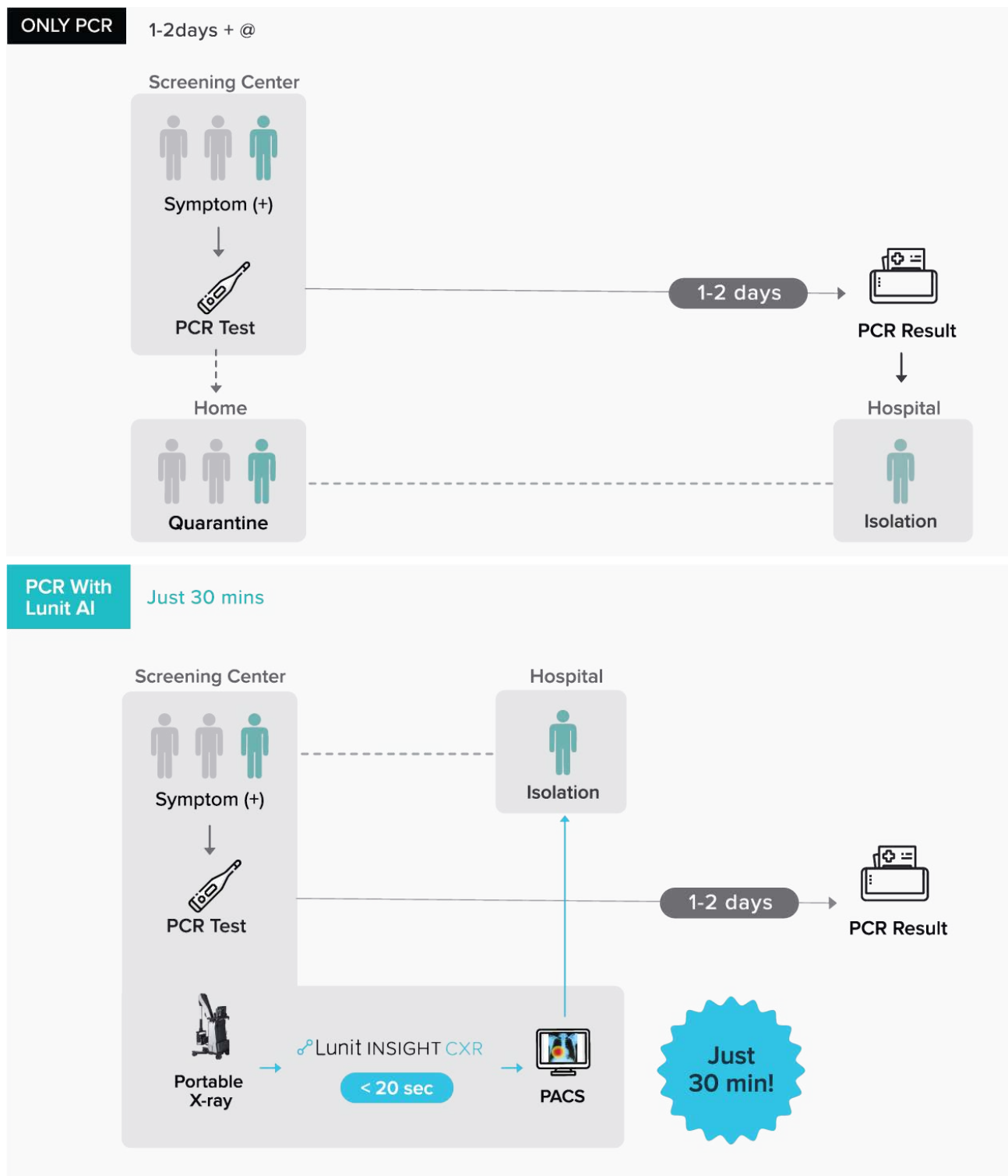
AI can support during case overload, including COVID-19, which can likely lead to low reading quality due to pressure and strain in the healthcare system.



Online trial page of Lunit INSIGHT CXR for COVID-19

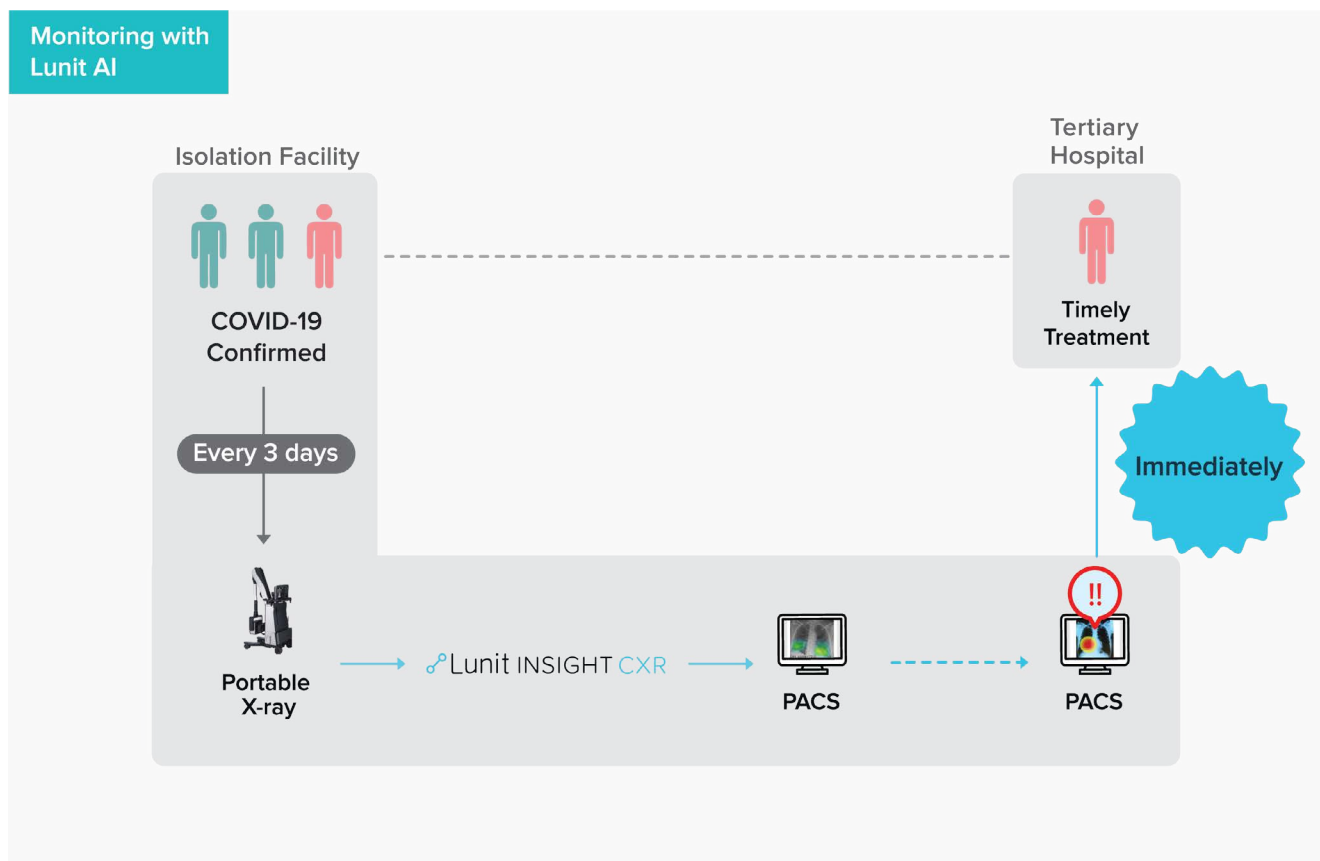
Assist in Triageing Patients

- **Target:** Symptomatic patients visiting screening centers, Emergency Room, and etc.
- **Method:** AI-aided chest x-ray interpretation during patient overflow can help earlier detection of coronavirus-suspicious pneumonia cases, subsequently leading to prompt isolation and treatment while awaiting RT-PCR results.



Assist in Monitoring Patients

- **Target:** Patients with COVID-19 who are admitted to hospitals, community isolation facilities, and etc.
- **Method:** AI-aided chest x-ray exams through mobile x-ray devices, conducted on a regular basis, can help monitor the progression and/or regression of pneumonia on lung images.



2. GLOBAL USE CASES OF LUNIT INSIGHT CXR FOR COVID-19 DETECTION (As of May 2020)

- Sao Paulo, Brazil — PreventSenior
- Jakarta, Indonesia — Dr. Cipto Mangunkusumo National Public Hospital (RSCM)
- West Java, Indonesia — Rumah Sakit Universitas Indonesia (RSUI)
- Daegu/Seoul, South Korea — Seoul National University Hospital
- Vimercate, Italy — Vimercate Hospital
- Meylan, France — Vizyon

Brazil

In Brazil, **Lunit AI has been installed at more than 11 hospitals** including PreventSenior, one of the largest hospital networks in Brazil with 8 locations throughout the metropolitan region of Sao Paulo. This institution is one of the COVID-19 detection centers that use chest x-ray screening for patients with mild symptoms.

In May, the institution has **deployed Lunit INSIGHT for the analysis of more than 20,000 chest x-ray images** suspected of coronavirus infection. Medical workers here are telling us that Lunit INSIGHT CXR is providing great help “especially for patient triage,” as the hospital is “overflowing with patients while the number of radiologists remains low.”



A medical worker at one of the COVID-19 centers in Brazil is using Lunit INSIGHT CXR to examine a chest x-ray image. [photo by PreventSenior]

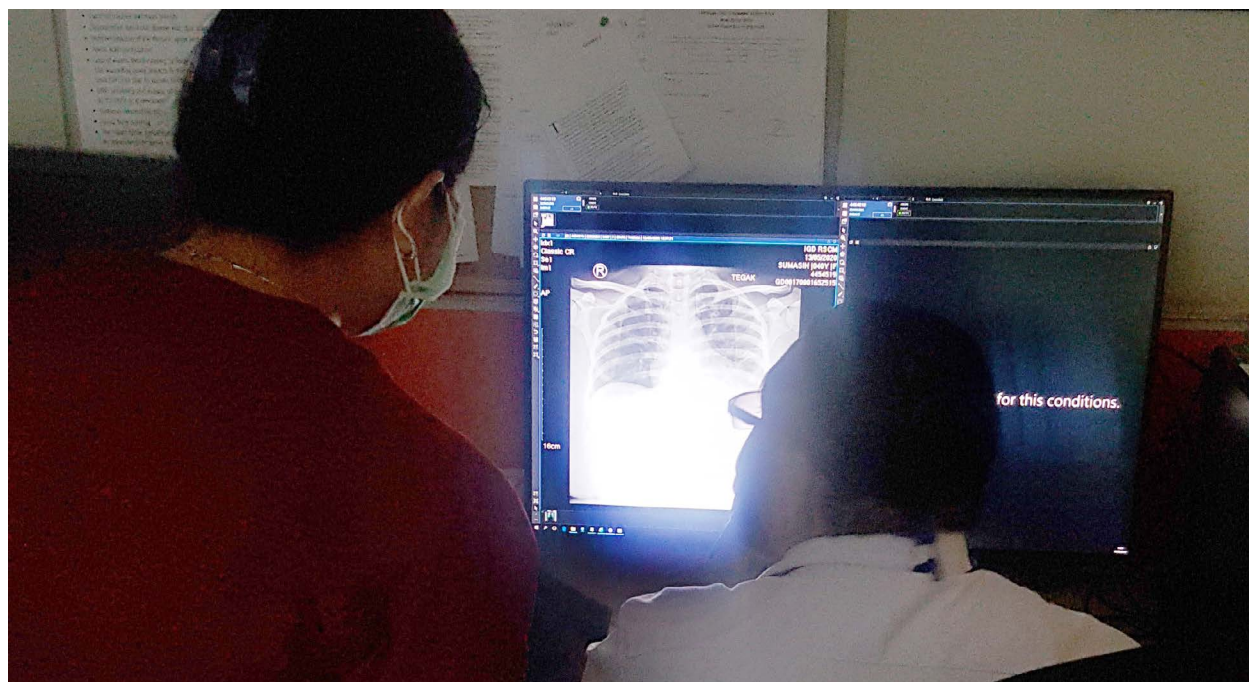
Indonesia

In Indonesia, Lunit's AI is currently in demonstration at Dr. Cipto Mangunkusumo National Public Hospital (RSCM) and Rumah Sakit Universitas Indonesia (RSUI), located in Jakarta and West Java, respectively. Both hospitals have COVID-19 patients hospitalized, with primary screening done with clinical exam, and chest x-ray used as a supporting tool for decision-making during triage of suspected patients. PCR tests are conducted in limited capacity, only for patients with definite symptoms and positive imaging signs prioritized due to lack of resources.

From early stages during admission to in-patient, routine chest x-ray is conducted in one to three days of frequency, depending on the symptoms. The hospitals use mobile x-ray in the isolation room and dedicated wards. AI analysis results are accessible directly from the PACS worklist and viewer, integrated into the radiologist's daily diagnostic workflow.

The radiologists can easily refer to the AI results when reading studies. For example, they can adjust the reading order according to the complexity and urgency of studies determined based on the AI findings and scores.

A radiologist from the hospital says that Lunit's AI is expected to provide assistance mostly on triage, as the AI is able to detect subtle changes on chest x-ray images. "We still rely on clinical findings and PCR results for treatment decisions. But we are **expecting the AI to be useful in triage and also comparing the consolidation findings during follow-up x-rays**, which can be used in radiology reports."



Radiologists in RSCM Indonesia is examining the chest x-ray image of a COVID-19 patient using Lunit INSIGHT CXR for COVID-19. [photo by RSCM]

South Korea

In South Korea, Lunit INSIGHT CXR has been deployed to assist the diagnosis of COVID-19 patients from Daegu, the hardest-hit city where 62% of the entire domestic cases has been diagnosed. Seoul National University Hospital has built a healthcare center in Daegu, where physicians remotely examine patients via video call.

The patients' chest x-ray images from Daegu are sent directly to radiologists in Seoul, where Lunit INSIGHT CXR is used for the instant detection and diagnosis of COVID-19. The system **enables prompt and early discovery of severe patients** who are then sent directly to larger hospitals for proper treatment.



A doctor at COVID-19 clinic near Daegu, working with Seoul National University Hospital, is examining a patients' chest x-ray using Lunit INSIGHT CXR. [photo by SNUH]

Italy

In Italy, Lunit AI is being used in Vimercate hospital, through partnership with Fujifilm. The hospital is based in Lombardia, Italy, and takes around 160,000 radiology exams in a year with 17 radiologists and 19 technicians. The COVID-19 crisis has brought a need to improve workflow by easing the burden of reading a mass amount of exams.

AI findings are integrated into the Fujifilm Synapse platform which the hospital uses for reading radiologic images. According to the hospital, Lunit INSIGHT is used for every chest x-ray analysis, including ER patients with respiratory symptoms, patients with COVID-19, before dismissing a patient with disappeared symptoms, and before hospitalizing a patient for surgical operation to evaluate the feasibility of anesthesia.

Users can quickly identify severe cases; the doctors at Vimercate says that prioritizing the worklist with AI score and results helps radiologists report immediately for patients with findings.

The hospital has a protocol for COVID-19 that all patients are screened with chest x-ray. Screening frequency is defined by the clinical course of each patient.

The hospital has been using the AI-integrated system on a daily basis since the end of March. Currently, Lunit INSIGHT analyzes approximately 45 chest x-rays images per day in Vimercate.

Lunit is also in discussion with another health facility in Milan, for an installation of the AI software.

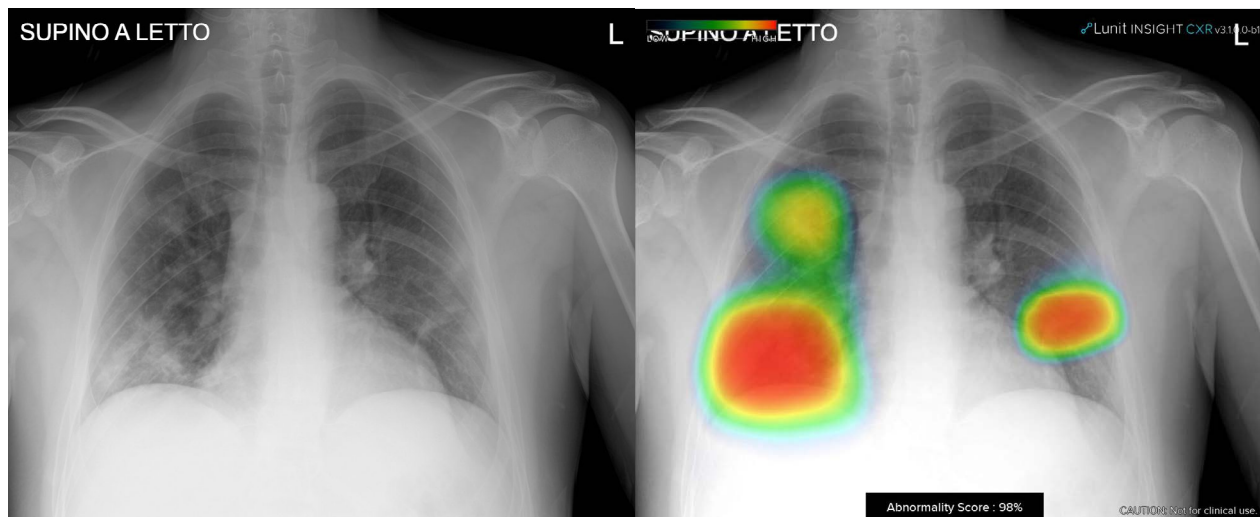
France

In France, Lunit is in partnership with Vizyon, a teleradiology firm that specializes in providing a platform for AI software by connecting the technology to hospitals. Vizyon is using Lunit AI in analyzing the images they receive from the clients. Lunit is also providing a demo to one of the hospitals in France for assistance in on-site triage.

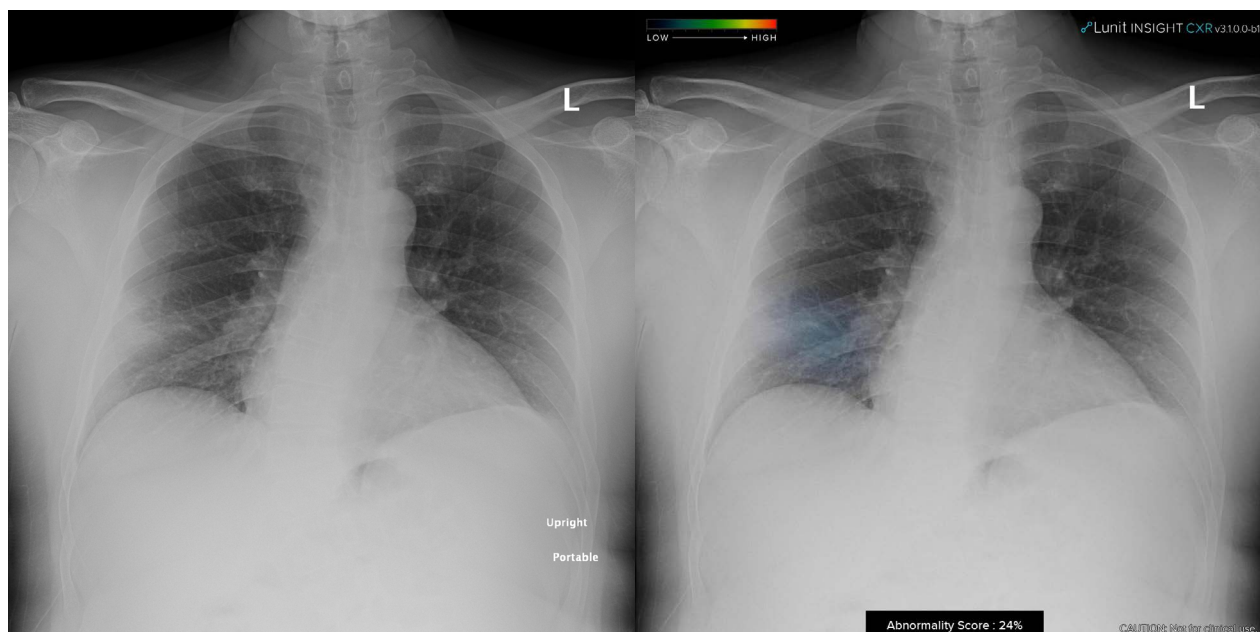
Dr. Pierre Durand from Vizyon says that during patient triage, Lunit INSIGHT CXR for COVID-19 can **accelerate the decision-making of patients with symptoms while awaiting PCR results**. Upon showing a symptom, the patient is tested with both PCR and AI-assisted chest x-ray, with the latter providing an analysis result in less than 5 minutes. The doctor, upon reviewing the analysis made by AI, can promptly decide whether to send the patient back home or to the Emergency Hospital, depending on the severity. PCR results generally take six to 24 hours, risking a longer window of contamination while awaiting results, a longer gap of treatment, and a possible hospital overload.

3. SAMPLE COVID-19 CASE

A study conducted by a US hospital shows that COVID-19 cases with visible radiologic abnormalities on CXRs (n=135) are detected by Lunit INSIGHT CXR with a sensitivity of 95.0%. Sample COVID-19 cases from Italy, and the US that were detected by Lunit INSIGHT CXR are presented below (1).

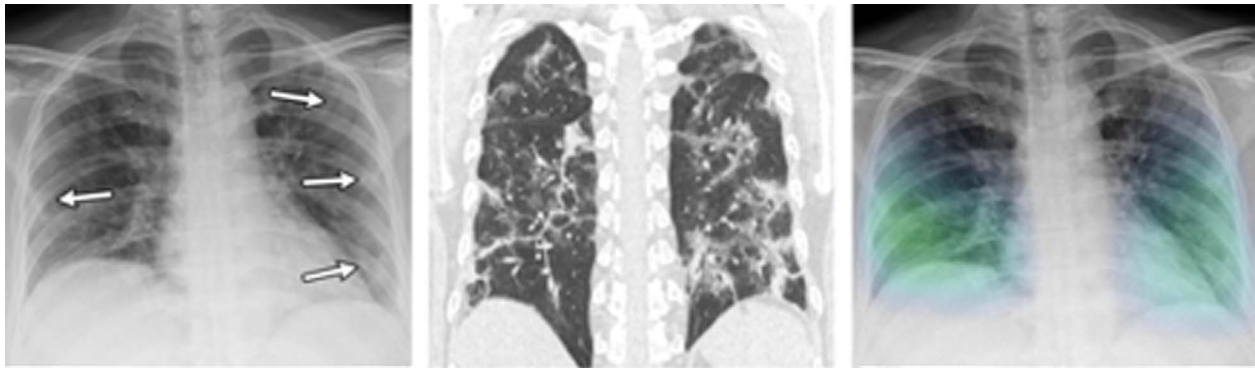


1. In this image from an Italian hospital, there are multiple nodular opacities in both lungs. The Lunit INSIGHT CXR has correctly localized the lesions with the abnormality score of 98%.

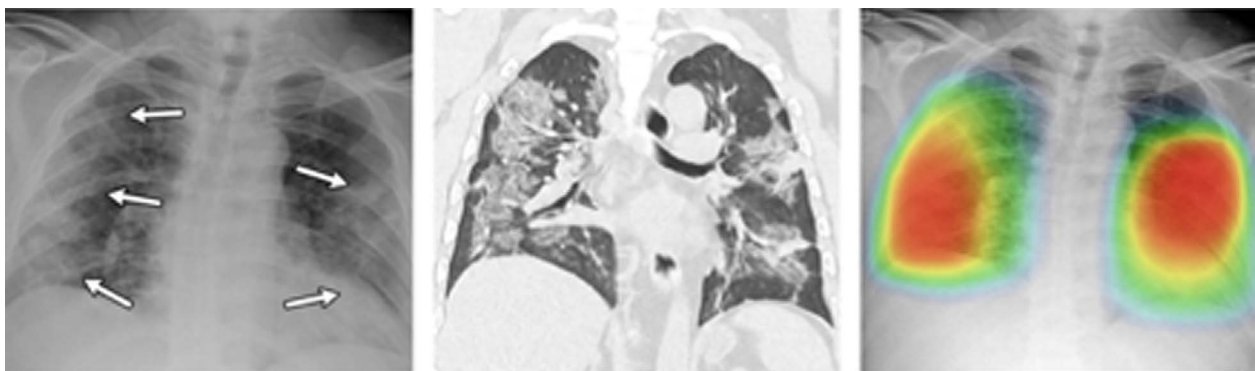


2. In this image from a U.S. hospital, there are ill-defined peribronchial opacities in the right lower lung zone. The Lunit INSIGHT CXR has correctly localized the lesions with the abnormality score of 24%.

Below are 3 additional PCR confirmed COVID-19 cases from South Korea that were detected by Lunit INSIGHT CXR. CT scans of the patients in coronal views are presented along with CXR and AI output.



1. In this chest radiograph of a 41-year-old female patient, there are multifocal bilateral increased opacities in peripheral distribution (arrows). CT scan shows irregular ground-glass opacities and consolidations in both lungs. The AI algorithm has correctly localized the lesions.



2. In this chest radiograph of a 55-year-old male patient, there are multifocal bilateral patchy consolidations (arrows). CT scan shows bilateral patchy consolidation/GGOs. The AI algorithm has correctly localized the lesions.



3. In this chest radiograph of a 48-year-old male patient, there are diffuse GGOs in the bilateral lungs (arrows). CT scan shows bilateral diffuse GGOs with subpleural predominance. The AI algorithm has correctly localized the lesions.

**Lunit is committed to protecting the personal information of patients. In this document, all image data have received IRB approval from research institutions and/or have been anonymized.*

4. SUGGESTED USE OF LUNIT INSIGHT CXR IN COVID-19 TESTING

- Use as a **supportive tool during case overload**, which can likely lead to low reading quality
- Use with **portable x-ray devices to fast-track test results and decision making** in advance to the PCR results
- Use when **regular monitoring is required among patients showing mild symptoms**, in order to identify and/or triage patients by the progression of symptoms

The current COVID-19 epidemic is burdening health care providers around the world and straining the system, with massive demands for tests, diagnosis, and treatment. While PCR is generally being used to test and identify COVID-19, CXR can also be a fast, effective, and affordable modality to evaluate COVID-19 related pneumonia (1),(2). However, limitations remain as the massive shortage of interpreting radiologists exists as a hurdle for extensive conduction of test and diagnosis of COVID-19 via CXR.

We have discovered that with Lunit INSIGHT CXR, detection of COVID-19 pneumonia in the level of radiologists is viable, with the AI instantly interpreting CXRs to select suspicious cases that warrant further action to whether or not isolate the patient even before PCR confirmation. Therefore, the use of Lunit INSIGHT CXR may be beneficial as a triage tool for non-radiologists, or even for non-doctors in extreme cases.

Media Coverage featuring Lunit around COVID-19

1. Hospitals Deploy AI Tools to Detect COVID-19 on Chest Scans, [IEEE Spectrum](#) (31 Mar 2020)
2. The healthiest countries to live in, [BBC](#) (20 Apr 2020)
3. Doctors are using AI to triage covid-19 patients. The tools may be here to stay, [MIT Tech Review](#) (23 Apr 2020)
4. AI Software Gets Mixed Reviews for Tackling Coronavirus, [Wall Street Journal](#) (4 May 2020)



About Lunit INSIGHT CXR

The software, developed by Lunit, is a state-of-the-art AI solution for chest x-ray analysis, detecting 10 different radiologic findings including lung nodule, consolidation, and more with 97-99% accuracy. Lunit INSIGHT CXR is designed to help radiologists detect more and better, alleviating the burden coming from routine chest x-ray interpretations.

The software has received CE mark and has been featured in major publications such as *Radiology*, *JAMA Network Open*, *European Radiology*, and *Clinical Infectious Diseases*.

As of March 2020, Lunit INSIGHT CXR has analyzed more than three million chest x-ray images from over 80 countries around the world.

For any questions, please contact us at contact@lunit.io

Publications of Lunit INSIGHT CXR

1. Nam JG, Park SG, et al. Development and Validation of Deep Learning-Based Automatic Detection Algorithm for Malignant Pulmonary Nodules on Chest Radiographs. *Radiology*. 2018 Sep 25:180237
 2. Hwang EJ, Park SG, et al. Development and Validation of a Deep Learning-Based Automatic Detection Algorithm for Active Pulmonary Tuberculosis on Chest Radiographs. *Clinical Infectious Diseases*. 2018 Nov 12.
 3. Hwang EJ, Park SG, et al. Performance Validation of a Deep Learning-Based Automatic Detection Algorithm for Major Thoracic Abnormalities on Chest Radiographs, *JAMA Network Open* 2019
 4. Hwang EJ et al. Deep Learning for Chest Radiograph Diagnosis in the Emergency Department, *Radiology*. 2019 Oct 22
 5. Kim HJ et al. Test-retest reproducibility of a deep learning–based automatic detection algorithm for the chest radiograph, *European Radiology*. 2020 Jan 03.
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References

1. American College of Radiology. (2020). ACR Recommendations for the use of Chest Radiography and Computed Tomography (CT) for Suspected COVID-19 Infection. Retrieved from <https://www.acr.org/Advocacy-and-Economics/ACR-Position-Statements/Recommendations-for-Chest-Radiography-and-CT-for-Suspected-COVID19-Infection>
2. Mossa-Basha M, Meltzer CC, et al. Radiology Department Preparedness for COVID-19: Radiology Scientific Expert Panel. *Radiology*. 2020 Mar 16:200988