Future of XRAYS

Trendy vývoje digitální radiografie a systémů PACS v lékařství

Krzysztof Szczepański

GE Healthcare

Across the globe **people are living longer** while the proportion of the population that requires the most medical services is rising. X-ray technologists, radiology administrators, and radiologists are required to manage an **ever-increasing number of cases** as x-ray imaging is often the entry point to diagnostic imaging, accounting for **60% of all imaging studies** conducted[2].

1 in 6
2050 World Population
>65 Years Old[1]

[1] World Population Prospects 2019 (United Nations, 2019)
[2] World Health Organization Report -Communicating Radiation Risks in Pediatric Imaging

Pressure continues to build on Radiology Departments
Physically, mentally, and emotionally draining

>70% OF RADIOGRAPHERS EXPERIENCE WORK-RELATED INJURY[3]

REPEAT & REJECT RATES[4,5] CAN REACH **25%**

X-RAY EXAMS CONSTITUTE **60% OF IMAGING**[2]

Technologists confront the daily challenges of heavy lifting, repetitive motions, long hours, and uneasy patients that lead to a work-related musculoskeletal disorder rate that exceeds 70%

Radiologists and **Technologists** alike are frustrated by repeated and rejected x-rays (which can reach as high as 25%) and inconsistent image quality which is often caused by variability in patient positioning and exam setup.

Radiology Administrators struggle with the constant mandate to "do more with less". To accommodate more patients, more clinical applications, and more complex procedures amid staffing shortages, equipment breakdowns, and increased reporting and compliance requirements

[2] World Health Organization Report - Communicating Radiation Risks in Pediatric Imaging
[3] Work related musculoskeletal disorders among radiologists and radiographers Deepak SHARAN, Mathankumar MOHANDOSS, Rameshkumar RANGANATHAN, Jerrish JOSE, Joshua Samuel RAJKUMARHUMAN FACTORS IN ORGANIZATIONAL DESIGN AND MANAGEMENT – XI
[4] Emerg Med J 2001;18:263–269 - Diagnostic errors in an accident and emergency department
[5] Ann Emerg Med. 1984 Oct;13(10):900-904. Emerg Med J 2001;18(4):263-9

In-room Exam Workflow: Automation & Simplicity

Marathon it's just 40 km....

9.5 Average minutes per X-ray exam at high volume imaging departments in the US

13,000 The average number of exams per year a technologist would complete working a standard 40 hours per week.

Calculations are based a technologist working 40 hours per week, 5 days a week, 52 weeks a year.

498 The number of kilometers a technologist would walk a year to complete the exams

The distance walked per exam is calculated at 52 steps with each step being 2.4 ft.

New normal...New environment....New challenges... New balance...

Comfort

Image Quality

Medical staff

Ergonomy

Time

Dose

COVID 19

Safety

The multiplier effect
Every click, push, pull, step, and movement matters

Multiple actions are often required to accomplish a single step in a workflow.
Each additional workflow step therefore requires multiple additional actions.
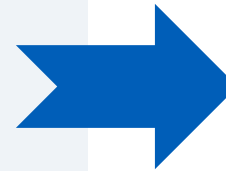These required actions multiply and negatively cascade upon each other producing negative results.

Cause

- Difficult workflow
- Additional workflow step
- Patient repositioning
- Equipment repositioning
- Image retake

Actions

- Mouse clicks
- Button pushes
- Walking steps
- Movement of equipment
- Movement of patient

Result

- Overall exam time increase
- More physical exertion
- More opportunity for error
- Less time for the patient
- More stress

Reducing a single step can save hundreds of thousands of actions when treating tens of thousands of patients a year.

What if you could walk 250 less kilometers per year?

Your personal assistant....Your in-room command center

The OTS console has all the functionality you need

- Worklist management and patient selection

- Protocol selection

- Technique modification

- Positioning setup

"stay close to patient"

Automated workflows
Skip the screens, skip the clicks

Exam start to patient positioning with zero clicks

STEP 1: Scan a barcode

Use the barcode scanner to scan the patient ID barcode, the system will automatically search and retrieve the patient information and exam procedure information from Modality Worklist .

STEP 2: Patient selection (Automated)

Skip the patient selection screen. The system will automatically select the patient and start the exam.

STEP 3: Procedure Selection (Automated)

Skip the protocol selection screen. Once the exam is started, Auto Protocol Assist (APA) will automatically establish the requested exam procedure according to the information from the Modality Worklist.

STEP 4: Initial Collimation (Automated)

Skip initial collimation. Auto Field of View sets the size and orientation of the collimation automatically based on the procedure and view that has been selected.

STEP 5: Position Patient and Equipment

System readiness

The system assists you by visually indicating when an exposure can be taken or if there is a problem

- A green light at the top of OTS console and at the top of tilting wall stands provides a clear indication the system is ready for exposure

- If something is inhibiting the system, warning buttons will be illuminated on both the OTS console screen and the acquisition workstation

- Clicking a warning button provides detailed information on the reason for the exposure inhibit or system issue and information on what correction information should be taken to resolve the issue.
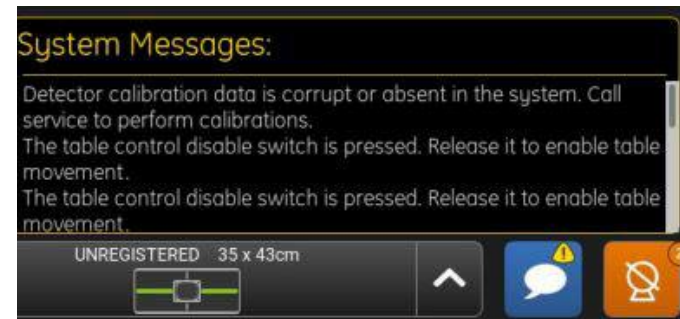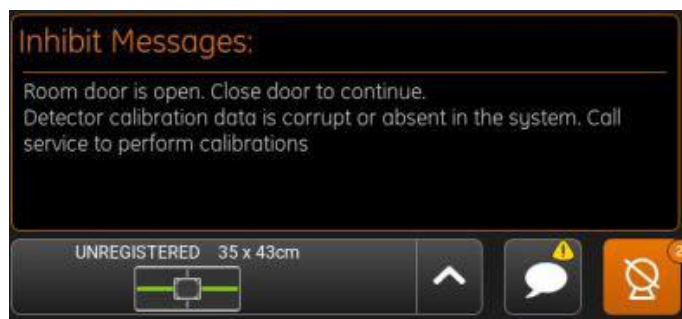
Out of Room Exam Workflow: Improve Consistency & Reduce Repeats

Variability and inconsistent images have huge impacts on clinical operations

Up to
25% of exams can be rejected or repeated.*

Up to
68% of repeat images are due to poor positioning.*

Up to 38%*
of rejected exams can be contributed to chest x-rays with a wide variability depending on the user.*

Automated workflows and automated positioning can help to lower variability in patient positioning and image quality.

But what if your x-ray system could assist you to do more?

*Little, Kevin J., et al. "Unified database for rejected image analysis across multiple vendors in radiography." Journal of the American College of Radiology 14.2 (2017): 208-216.

What if you could prevent exam errors before they occur?

Live Streaming Video

- Assists you in keeping your eyes on the patient when you can't be in the room.

- A camera, included with every system, situated on the x-ray tube head provides live streaming video of the patient imaging area onto the acquisition workstation console

- You can monitor the patient status, movement and orientation before an x-ray is taken

Live Streaming Video helps to:

- Stay connected to patients, monitor their safety, and intervene if necessary

- Clearly see patients' breathing patterns to better time exposures

- Potentially reduce rejects from patient motion or incorrect orientation

- Enable training while minimizing the number of people in the room

Help ensure that the first image counts
Intelligent Workflow Suite – Position Assist[†]

Avoid position related image retakes

Position Assist shows the detector boundaries, ion chamber locations and the active ion chambers

The overlays are available on any patient anatomy and view with real-time adjustments, so the placement is correct regardless of the patient size or parallax effects.

- See exactly where the ion chambers will align for confident patent positioning
- See which ion chambers are active for direct alignment to appropriate anatomy
- Includes ability to see ion chamber alignment for patients on the table

Wait to capture an image until the patient moves back into position or enter the room to reposition the patient

Position Assist helps ensure that the first image counts

Help create more consistent images for your patient population
Intelligent Workflow Suite – Technique Assist†

Produce consistent images, while increasing productivity

Optimized x-ray techniques exist for different patient sizes but are not always utilized.*

Technique Assist utilizes 3D cameras to measure the thickness of the patient and, using a database of programable sizes, suggest a patient size optimized to the specific patient.

- Improve x-ray technique based on patient size for improved image quality and dose.

- Displays measured thickness and automatic pop-up of suggested patient size to utilize.

Programmable for sizes according to your specific needs, Technique Assist will help create more consistent images for your patient population.
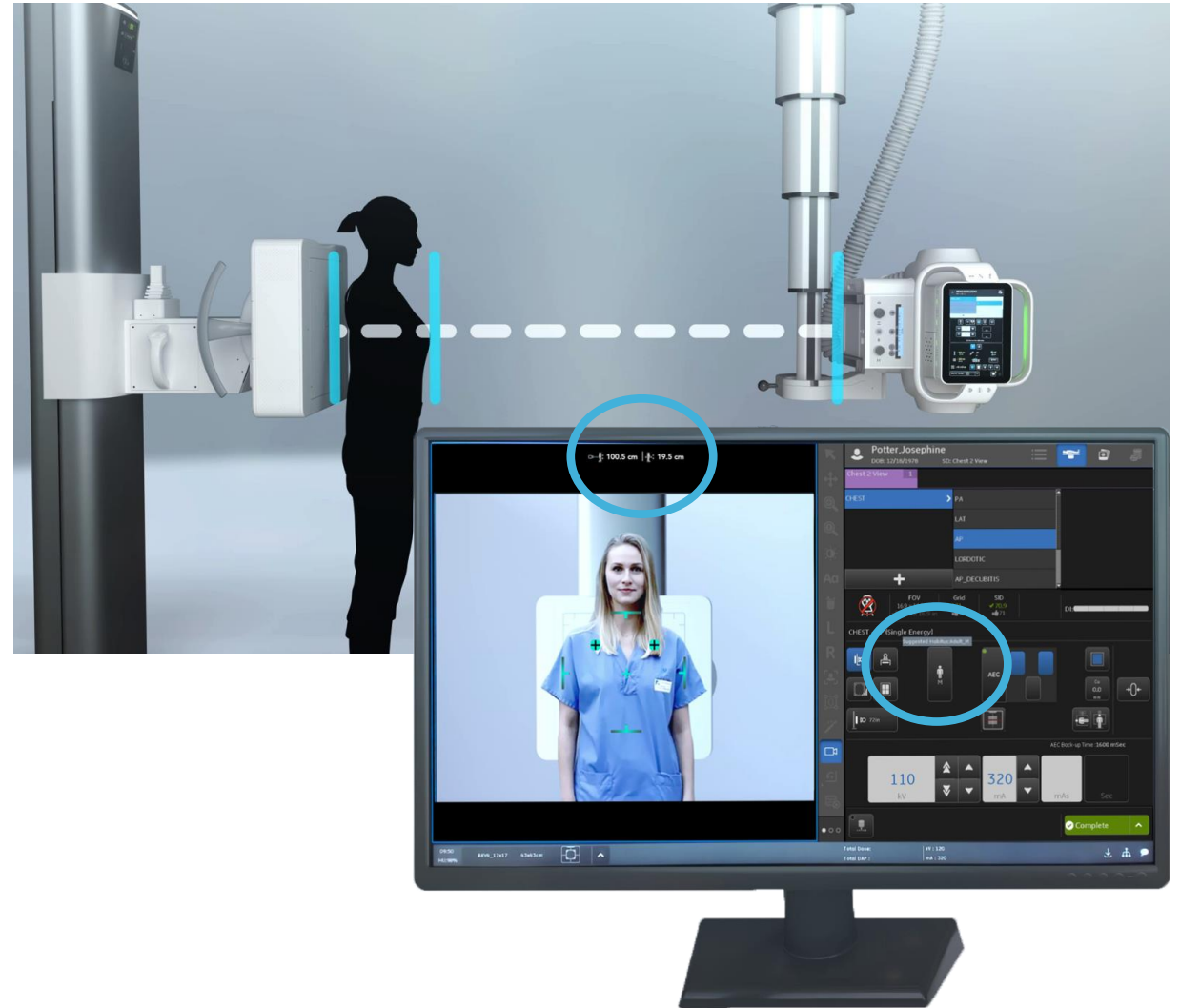
* Little, Kevin J., et al. "Unified database for rejected image analysis across multiple vendors in radiography." Journal of the American College of Radiology 14.2 (2017): 208-216.
†Denotes optional features

Improve clinical confidence
Intelligent Workflow Suite – Patient Snapshot[†]

Using optical images has been shown to increase the detection of wrong-patient radiographs from

13% to 64%*

Foreign objects and other unique imaging conditions can lead to questions from the Radiologist, slowing down diagnosis.

Patient Snapshot takes an optical picture at the same time as the x-ray exposure. The system then attaches the picture as a secondary DICOM capture when sent to the PACS, providing context to the radiologist such as:

- Presence of external objects, such as lines and clothing
- Positioning limitations and patient orientation
- Deviations from ideal imaging conditions
- Specifics of the x-ray acquisition parameters

Staying mindful of privacy concerns, you can block storing of the image during the exam as needed with one click.

Factory 3
R
MEW

FOV: 426 x 426 mm | Source to Patient Surface: 100.5 cm
Caliper Measurement: 19.5 cm | Suggested Range: 15.0 - 20.0 cm
Selected Habitus: Medium Adult | Suggested Habitus: Medium Adult
Operator Name: Wussow | Acquisition Time: 14:58:49 2021-07-12

Protocol: CHEST | View: AP
120 kV | 305 mA | 0.87 mAs | 3 ms
Grid: 130 cm | AEC: AUTOMATIC | Cu: 0.0 mm | Dose Index: 0.8

*Image for recorded patient position only, not for diagnostic purpose.

* Tridandapani, Srini, et al. "Increasing Rate of Detection of Wrong-Patient Radiographs: Use of Photographs Obtained at Time of Radiography" AJR (2013): W345-W352.
†Denotes optional features

Clinical Excellence:
Image Quality & Reconstruction

Hardware, software, and artificial intelligence (AI) combine to improve clinical decisions

Enhance Great Images

- **Helix Image Processing** with AI Brightness and Contrast, Local Contrast Enhancement. Detail Preserving Noise Filter, Real Time IP Looks, and IQ Compare

Make Great Images

- FlashPad HD Detectors
- High quality generator, tube and auto-collimator

Diagnostic Confidence

Make Advanced Images

- Angulated Image Pasting[†] with Auto Spine
- Dual Energy Subtraction
- Volume Rad with MAR

Obtain Decision Support

- Critical Care Suite [†]
- Thoracic Care Suite[†]

FlashPad HD: extraordinary anatomical detail at low dose

Quadruple Your Resolution

The FlashPad HD detectors pack four times more pixels per area for sharp x-ray images, with extraordinary anatomical detail, where it matters most.
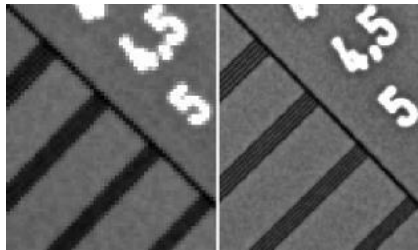
Resolution test pattern image. Left FlashPad, right FlashPad HD.

5 lp/mm resolution
100 micron pixel pitch

Helix™ 2.0 Advanced Image Processing
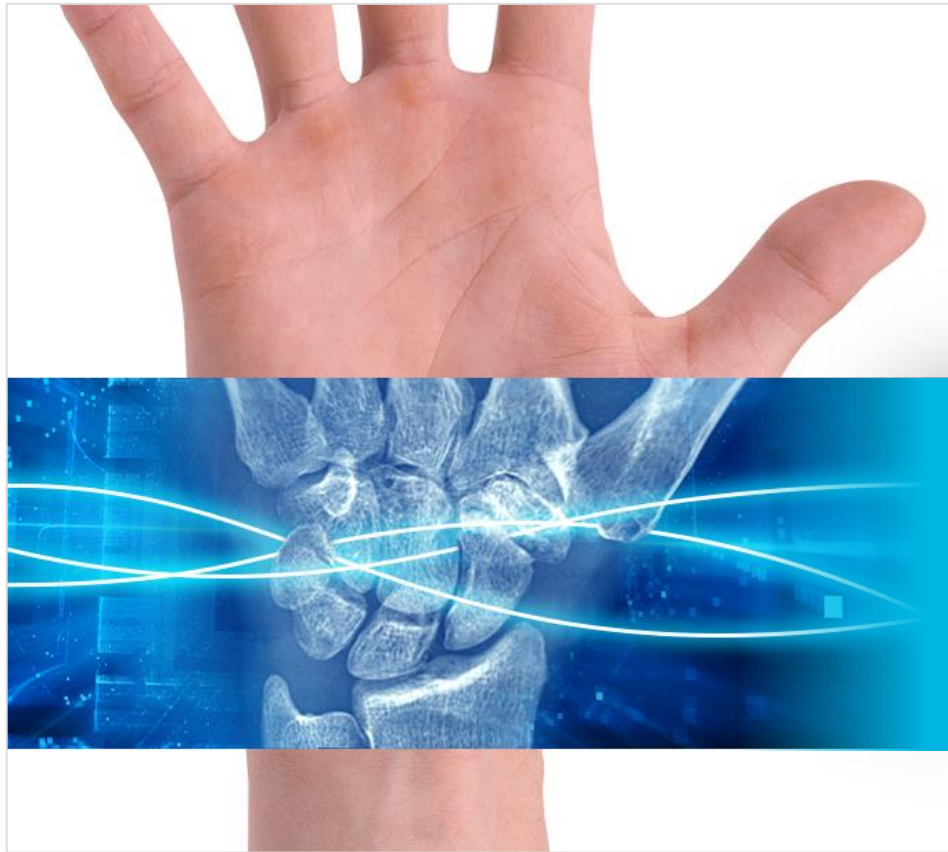
Helix™ 2.0 Advanced image processing delivers all of the benefits of Helix™ with improved noise reduction and with AI-driven automated brightness and contrast, delivering improved consistency **despite variations** in exposure technique and challenging exam conditions.

Extraordinary anatomical detail at low dose in every X-ray image.

Automated brightness and contrast
regardless of variations in dose, patient positioning, field of view and metal implants

Anatomy specific image enhancement for exquisite bone detail and clear delineation of soft tissue

Up to 40% increase in detectability* harnessing the ultra-high resolution and dose efficiency of FlashPad HD

Focus on what matters most ... your patient.

*Source: GE whitepaper: High resolution for improved visualization (DOC2045904)

Advanced Clinical Applications

Clinical diagnoses are complicated by overlapping anatomy

71 million

Chest X-ray studies are performed annually in the United States

26.4% & 43%

26.4% of the lung volume and 43.0% of the lung area are obscured by mediastinum, heart, and diaphragm on frontal chest radiographs[1]

90%

In 90% of the cases, errors in diagnosis of lung cancer occur on chest X-rays. It may be challenging for radiologists to distinguish a lung lesion from bones, pulmonary vessels, mediastinal structures, and other complex anatomical structures on chest X-rays.[2]

[1]Chotas HG1, Ravin CE. Chest radiography: estimated lung volume and projected area obscured by the heart, mediastinum, and diaphragm. Radiology. 1994 Nov;193(2):403-4.

[2]Missed lung cancer: when, where, and why? Annemilia del Ciello, Paola Franchi, Andrea Contegiacomo, Giuseppe Cicchetti, Lorenzo Bonomo, and Anna Rita Larici; 2017 Feb 16. doi: 10.5152/dir.2016.16187

Improve clinical outcomes with Dual Energy Subtraction†

Reduced opportunity for patient movement

Standard (High kV)

Reduce patient movement between images with the acquisition of two images taken in less than 160 milliseconds apart and generate three high-quality images

Improve the assessment of chest pathology

Soft Tissue (Low kV)

Enable physicians to remove the bones from a PA/AP chest image leading to the detection of abnormalities that may have been obscured by bones in a conventional radiograph.

See more than in a standard radiograph
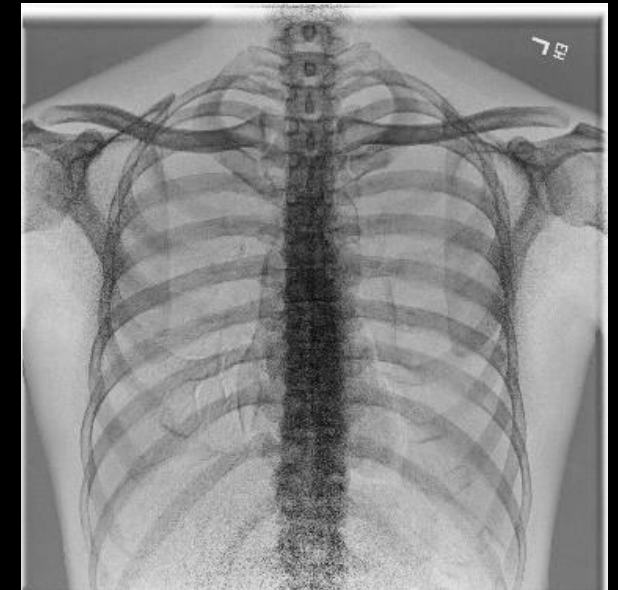
Bone (Subtracted)

The bone image is powerful on its own, enabling the radiologist to more clearly visualize calcified information for a given abnormality.

Discovery XR656 HD with VolumeRAD

VolumeRAD Digital Tomosynthesis delivers multi level image slices that provide similar data to CT at very low doses. VolumeRAD helps improve clinical diagnosis of doubtful findings seen on routine radiographs, by removing superimposition and overlying structures all while increasing diagnostic confidence with your Xray equipment.

VolumeRAD Slices

VolumeRAD image stack sequence

up to **95%**	approx. **79%**	up to **80%**
Sensitivity in the detection of wrist fractures.[1]	Detection of x-ray occult hip fractures[2]	Reduction in the need for additional CT imaging with an inconclusive chest X-ray. [3]

Sources:
1. Scaphoid imaging with digital tomosynthesis as an adjunct to Radiography: A Single Department's experience. Gibney et al., ECR 2016 / poster C-1036AJR Am J Roentgenol. 2010 Apr;194(4):1054-60. doi: 10.2214/AJR.09.3295. Radiographic detection of hip and pelvic fractures in the emergency department.
2. Initial clinical experience of the use of digital tomosynthesis in the assessment of suspected fracture neck of femur in the elderly. Al-Mokhtar N, Shah J, Marson B, Evans S, Nye K. Eur J Orthop Surg Traumatol. 2015 Jul;25(5):941-7. doi: 10.1007/s00590-015-1632-3. Epub 2015 Apr 17.
3. Cecilia Petersson, Magnus Båth, Jenny Vikgren, Åse Allansdotter Johnsson. An analysis of the potential role of chest tomosynthesis in optimizing imaging resources in thoracic radiology – Radiat Prot Dosimetry (2016)

Comparative difference of image with and without MAR

No MAR

MAR

37mm Slice Height
4mm thickness
Standard VolumeRAD

37mm Slice Height
4mm thickness
VolumeRAD w/MAR

Reduces undershoot and ripple, helping the radiologist more accurately determine placement of screws, cage or plate fusions.

Auto Image Paste[†] without Parallax

X-Ray tube angulated

No Parallax

1

2

Both acquisitions provide the same view, no image distortion.

Overlap
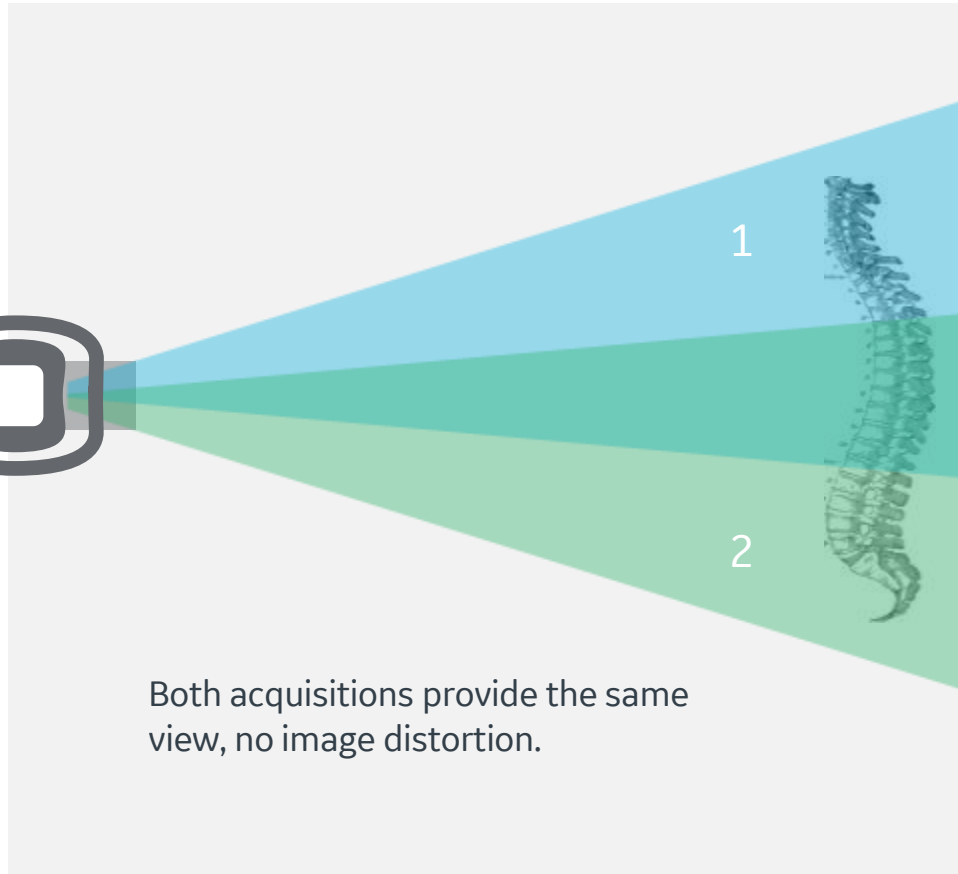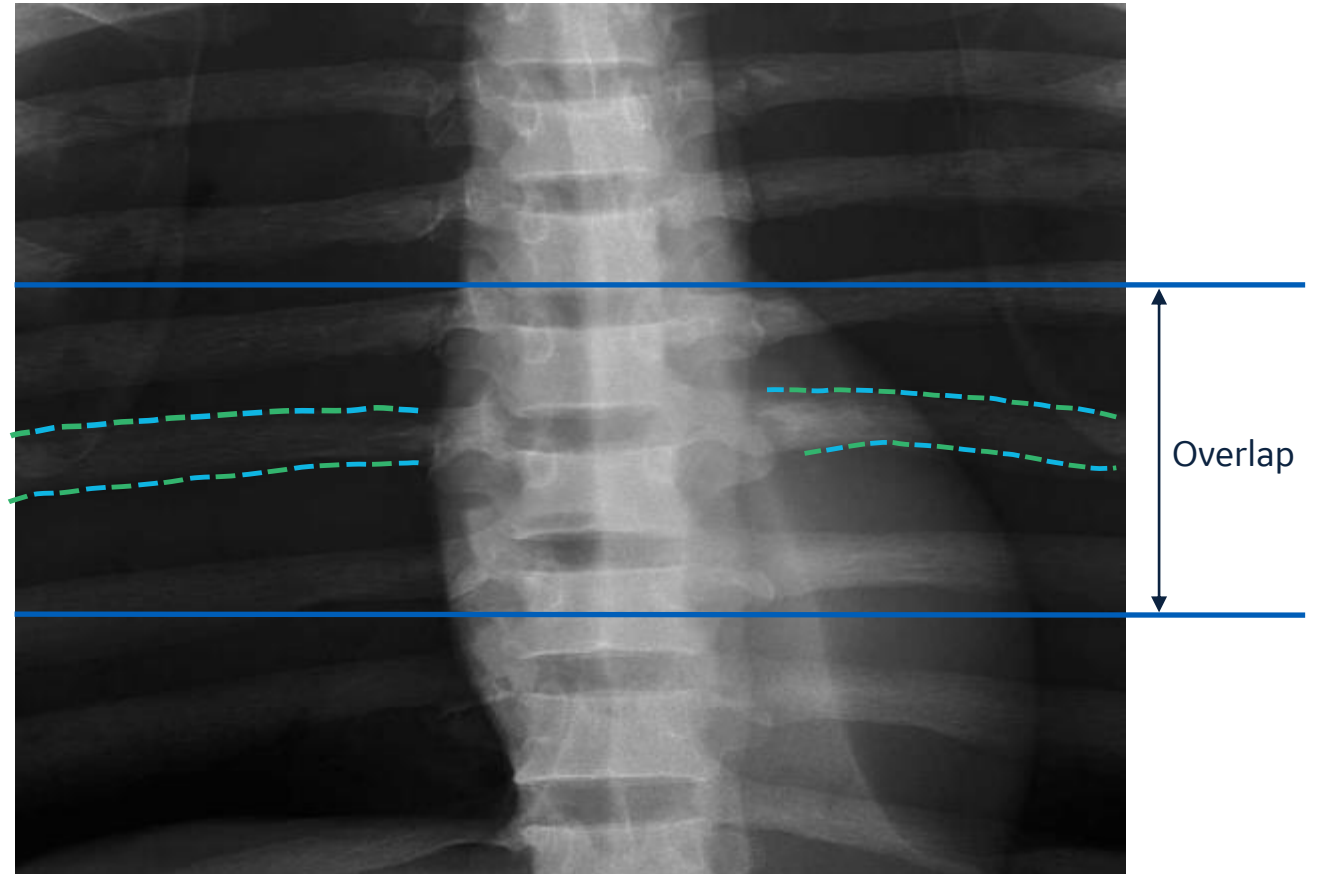
Angulated Auto Image Paste†

Fast, precise and highly automated long bone and spine exams at the wall stand

Auto Spine†

Auto Image Paste† is enhanced with Auto Spine

An intelligent algorithm follows the contour of the spine for vertical equalization enabling a natural balance of brightness and contrast along the patient body

Without Auto Spine
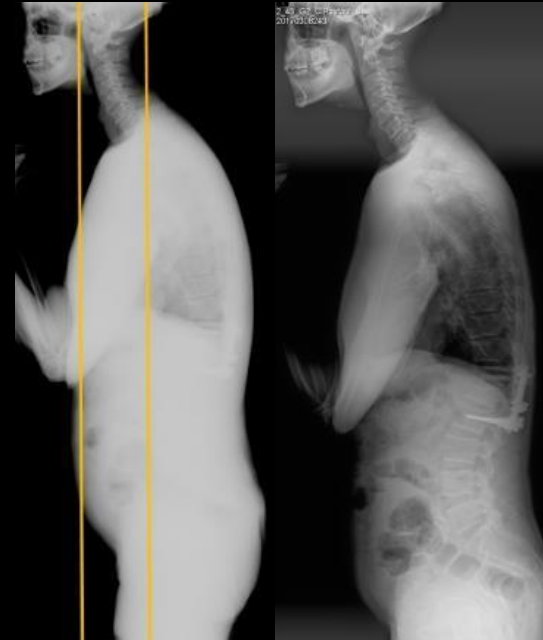
With Auto Spine

Clinical Decision Support

Critical Care Suite 2.0*

We developed a collection of on-device algorithms that integrate seamlessly with your existing X-ray workflow and assist you in delivering the highest quality care to patients

Clinical Decision Support

Endotracheal Tube Positioning
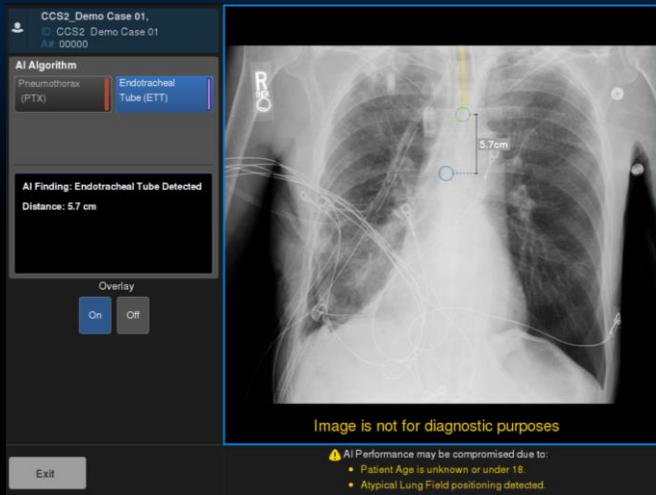
The first on-device AI solution that helps assess ET tube positioning

Pneumothorax Triage & Notification
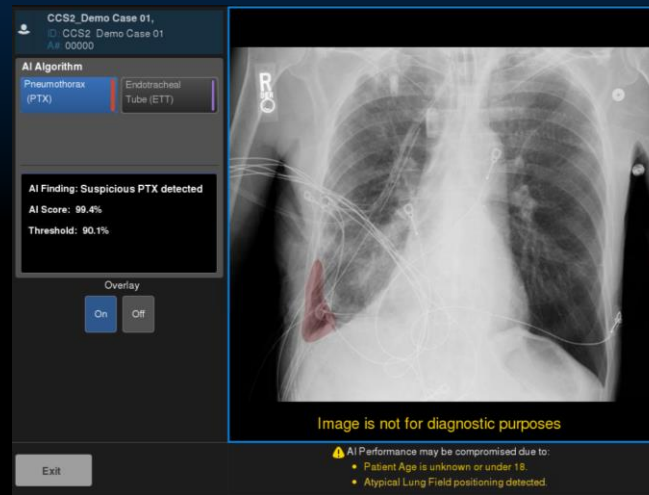
On-device AI algorithm that identifies and helps prioritize critical cases such as Pneumothorax

Quality Control & Efficiency

Quality Care Suite
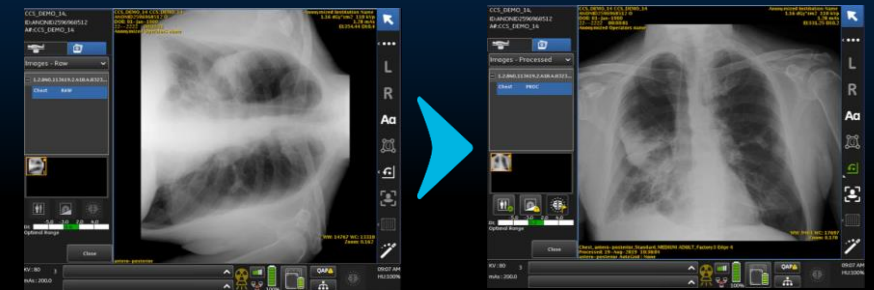
- **Intelligent Auto-Rotate**
- **Intelligent Protocol Check**
- **Intelligent Field of View**

AI algorithms that operate in parallel and help technologists reduce image quality errors and improve efficiency

Primary CCS 2.0 Features

1. Detection and highlighting of the Endotracheal Tube
2. Detection and Display of the ETT Tip and Carina
   - ETT Tip – Green Circle/Solid Black
   - Carina – Blue Circle/Dotted Black
3. Vertical Measurement between ETT Tip and Carina in cm only.
4. Export Secondary Capture to PACS in Color/Greyscale
5. An additional Icon (purple ruler) is displayed on the CCS Button to indicate that an ETT tube has been detected and a measurement is available.
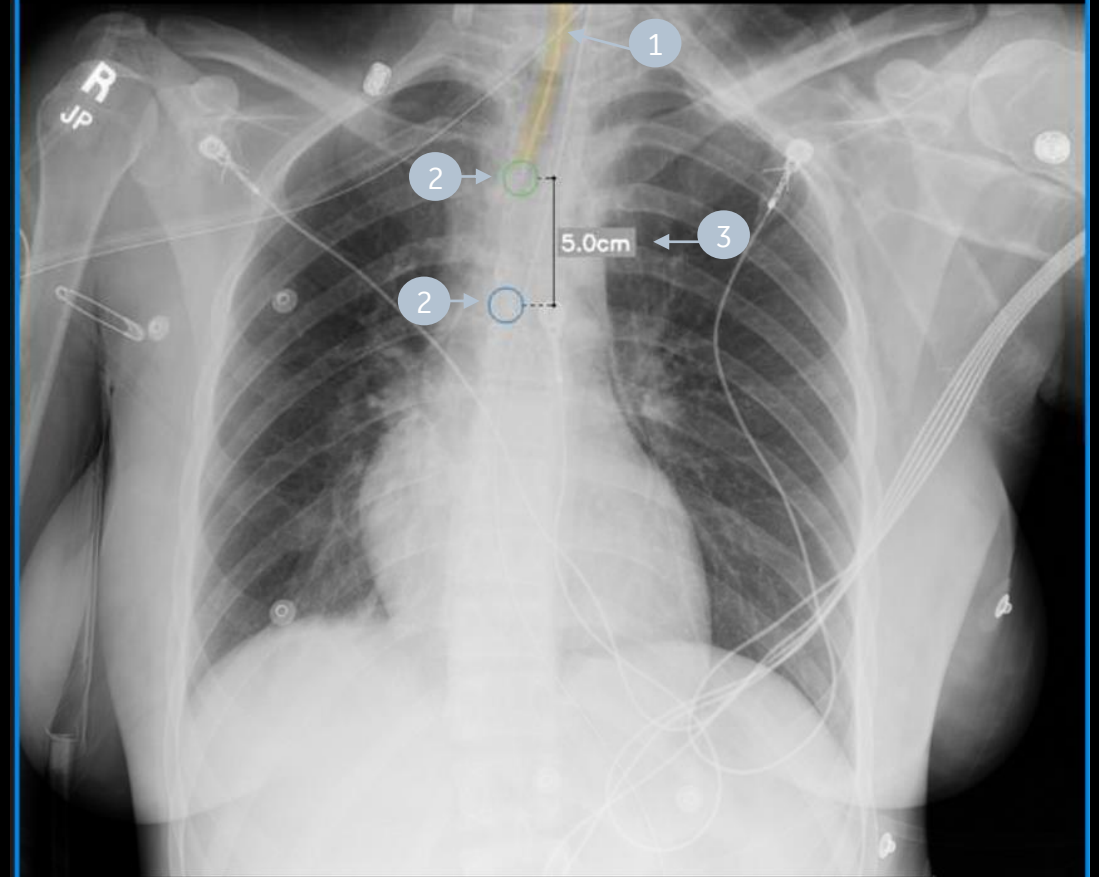
Image is not for diagnostic purposes

CCS2.0 Demo Case 01

ETT+ PTX+
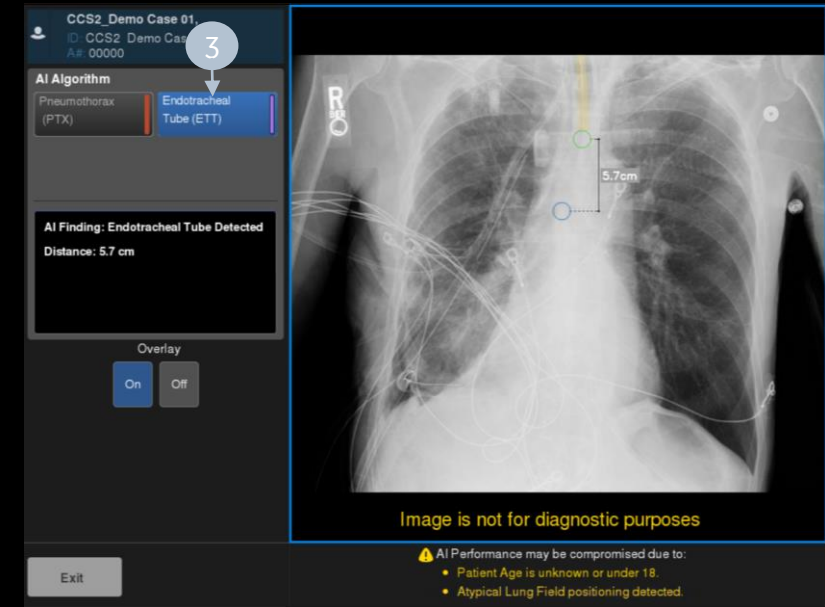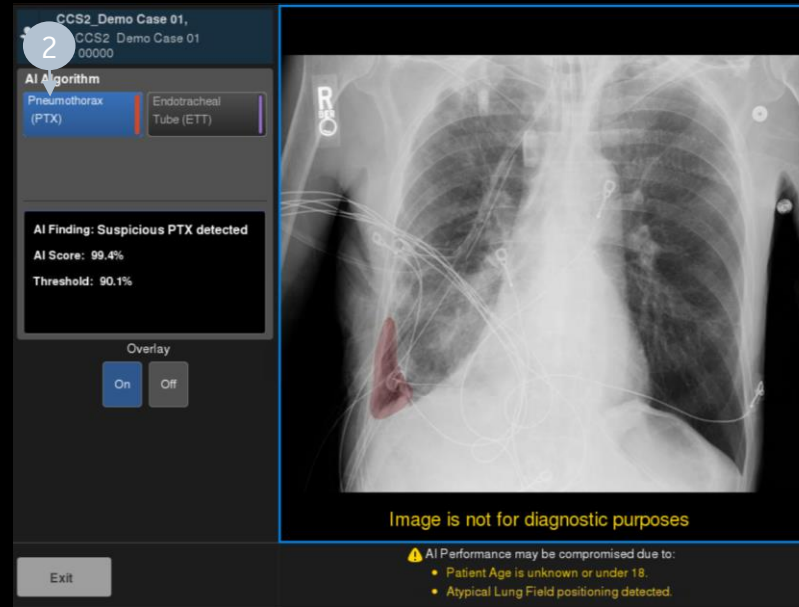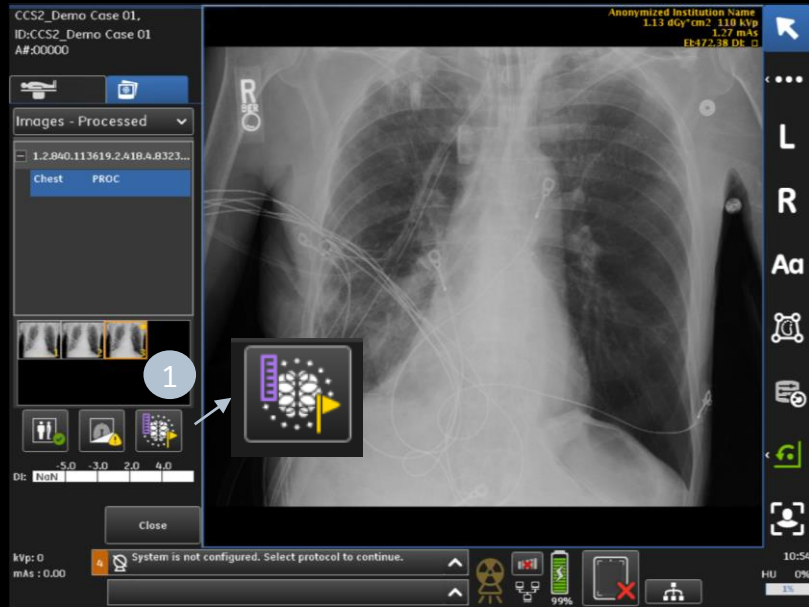
QCS/CCS Icons	AI Viewer – PTX	AI Viewer - ETT
• Yellow Flag = Suspicious of PTX • Purple Ruler = ETT has been detected and a measurement is available • Icon is green on QTB indicating image was rotated with QCS • FOV Notification	• **AI Viewer default view is PTX results** • Red bar on PTX Tab indicates image is suspicious of PTX	• Purple bar on ETT Tab indicates an ETT has been detected and measurement is available

CCS2.0 Demo Case 2
ETT- PTX+
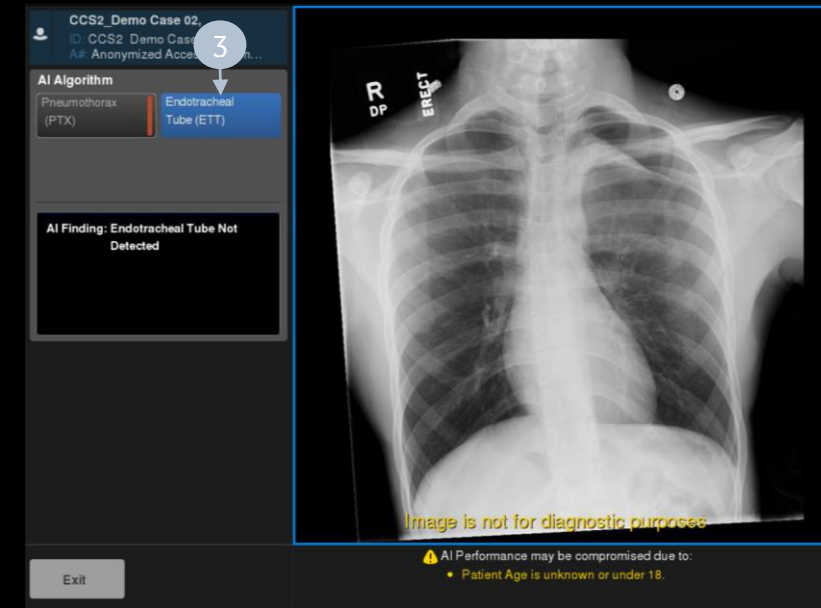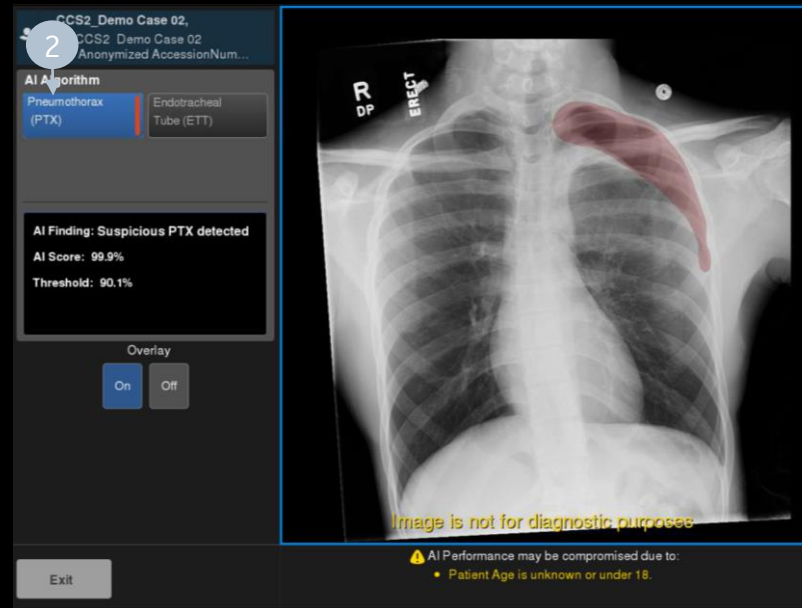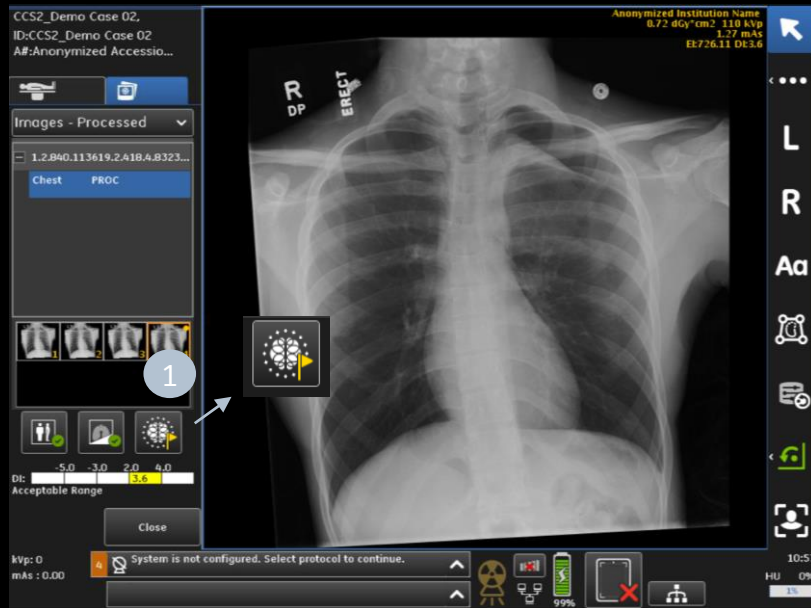
QCS/CCS Icons	AI Viewer – PTX	AI Viewer - ETT
• Yellow Flag = Suspicious of PTX • NO Purple Ruler = AN ETT has NOT been detected and a measurement is NOT available • Icon is green on QTB indicating image was rotated with QCS	• **AI Viewer default view is PTX results** • Red bar on PTX Tab indicates image is suspicious of PTX	• NO Purple bar on ETT Tab indicates an ETT has NOT been detected and measurement is NOT available

Thoracic Care Suite with Lunit INSIGHT CXR*†

Automatically analyzes images for the presence of eight abnormal radiologic findings

- Supports Tuberculosis detection and helps detect Pneumonia, which are indicative of COVID-19, via Consolidation findings

- Eight findings include: atelectasis, calcification, cardiomegaly, consolidation, fibrosis, mediastinal widening, nodule, and pleural effusion detection

- Artificial intelligence (AI) results can be viewed on secondary capture images supporting overlays and GSPS

Area Under the Curve (AUC) by Radiologic Finding *(N=3,671 cases from Korea)*			
Atelectasis	99.4%	Mediastinal Widening	98.5%
Calcification	97.7%	Nodule	97.6%
Cardiomegaly	98.9%	Pleural Effusion	99.7%
Consolidation	98.6%		
Fibrosis	98.8%		
Normal vs. Abnormal	97.2%		

Quickly help Radiologist identify diseases such as TB and COVID-19 pneumonia
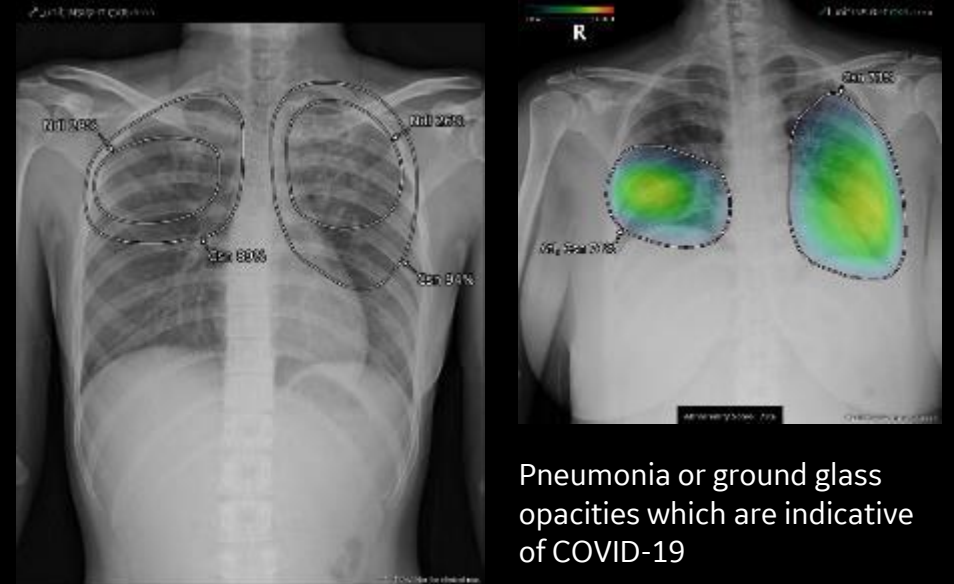
Pneumonia or ground glass opacities which are indicative of COVID-19

Clinical Cases – COVID-19

COVID-19 Patient

Abnormality Score: 73%
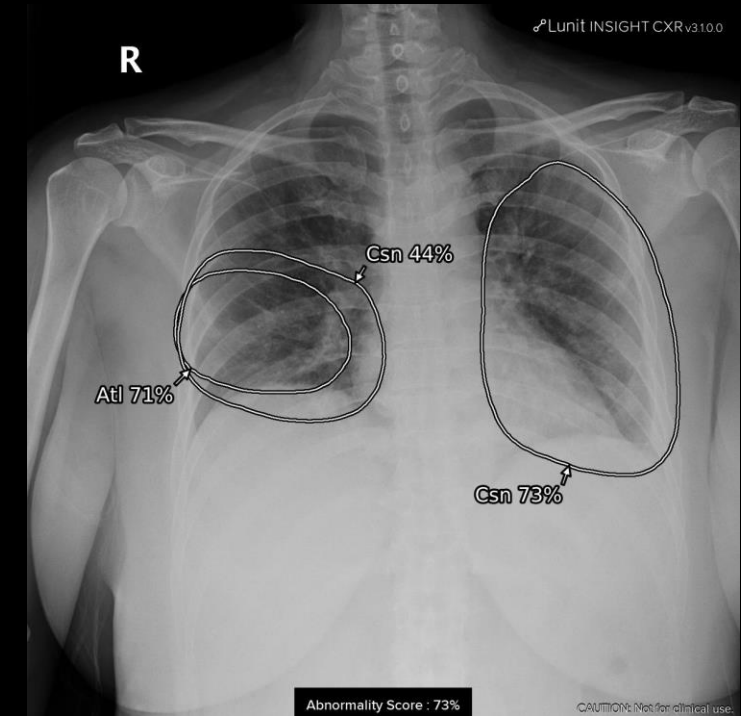
Clinical Cases – Tuberculosis

TB Patient

Abnormality Score: 94%

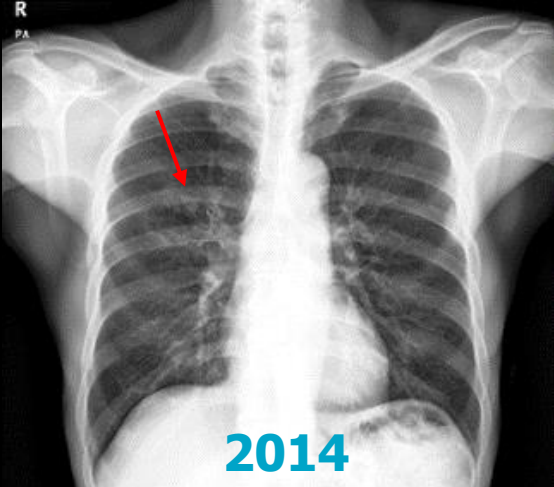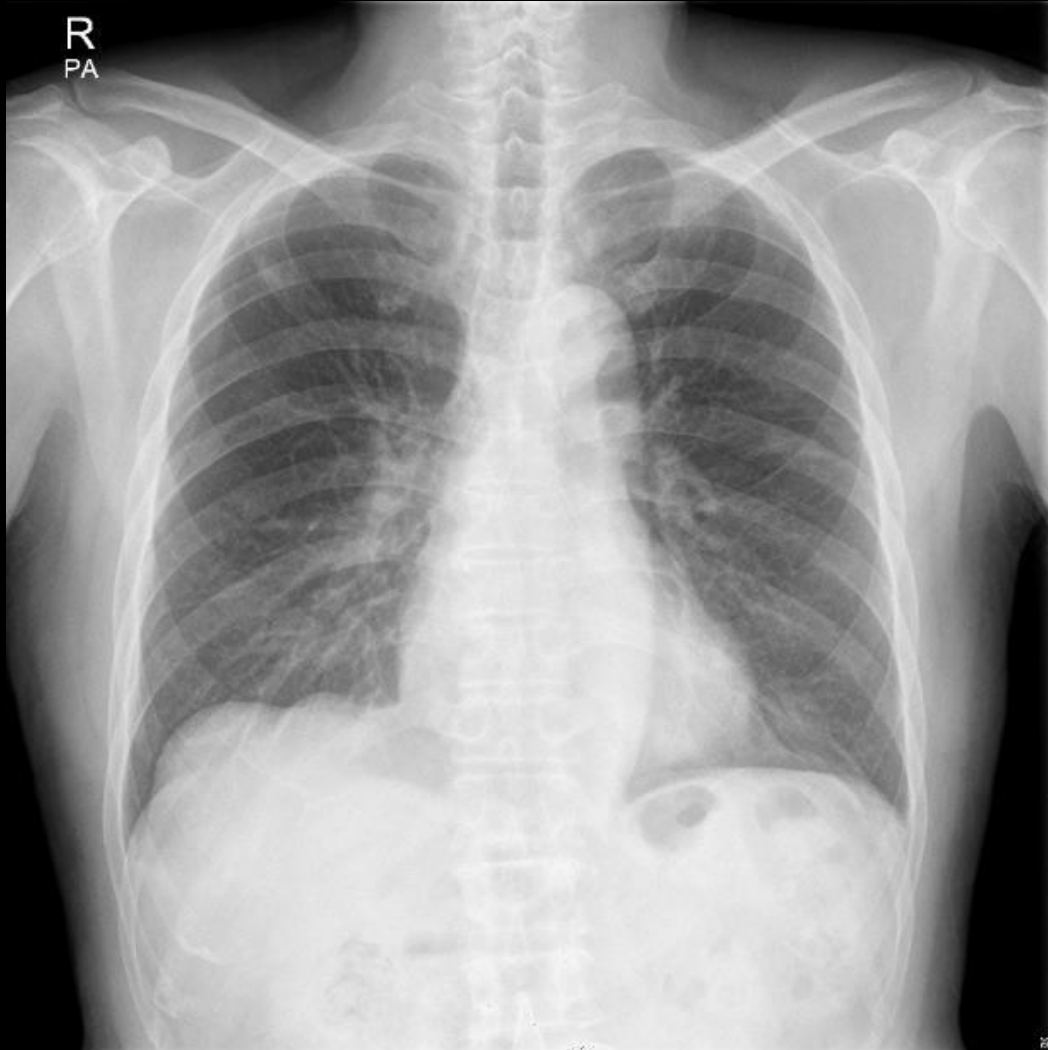# Clinical Cases – Early Diagnosis

54/M, Lung Cancer

Abnormality Score: 90%
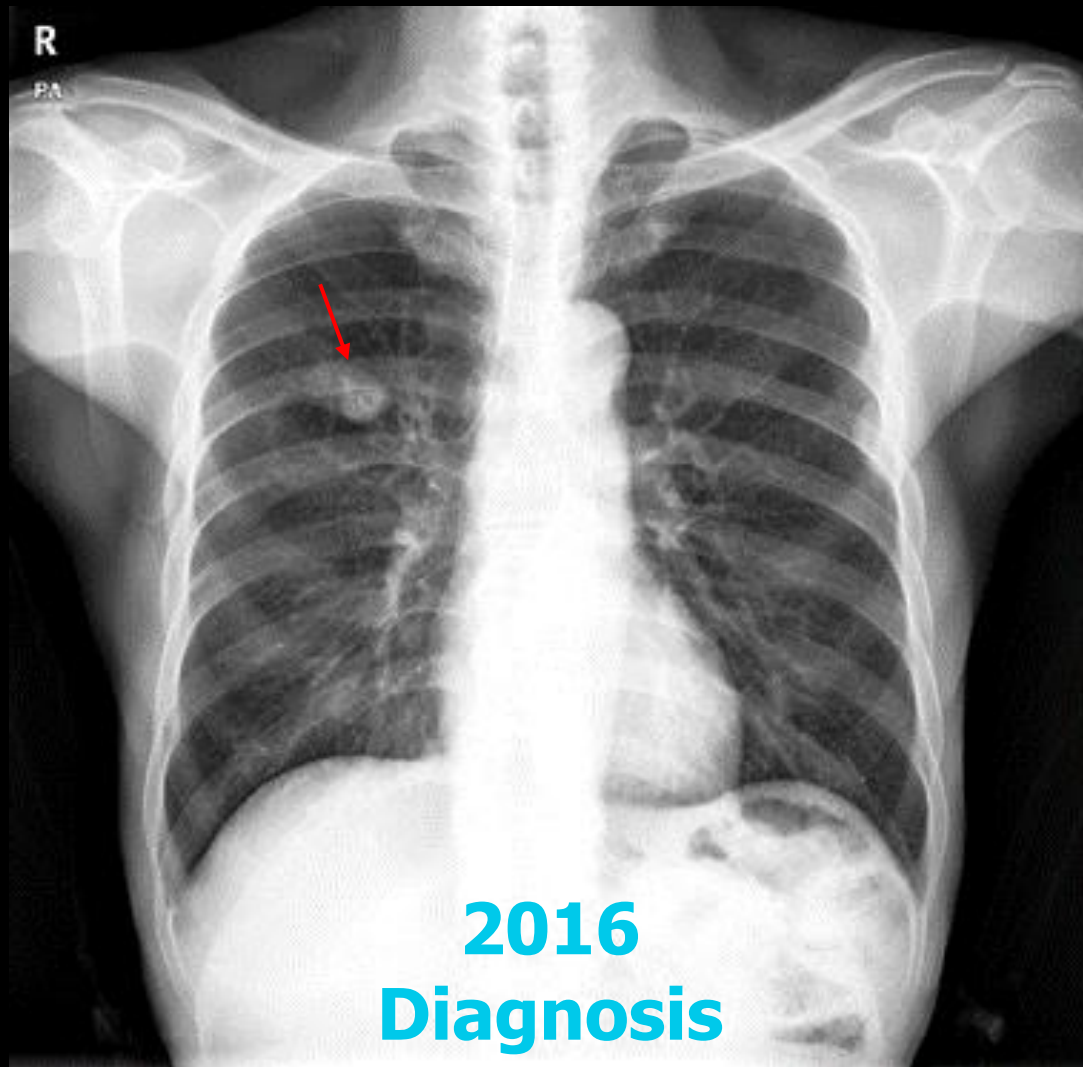
2016
Diagnosis

Clinical Cases – Early Diagnosis

2013

2014

2015

2016

Abnormality Score 16%

Abnormality Score 43%

Abnormality Score 61%

Abnormality Score 90%

Clinical cases – Missed Cancer
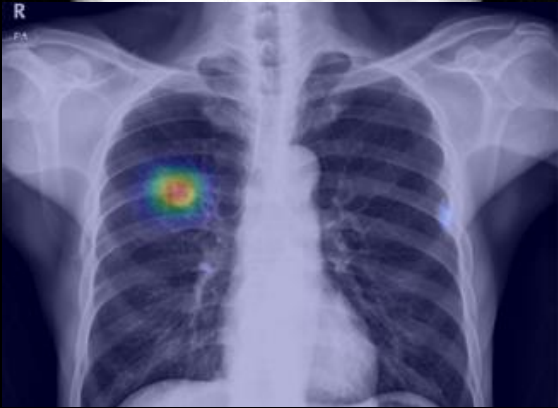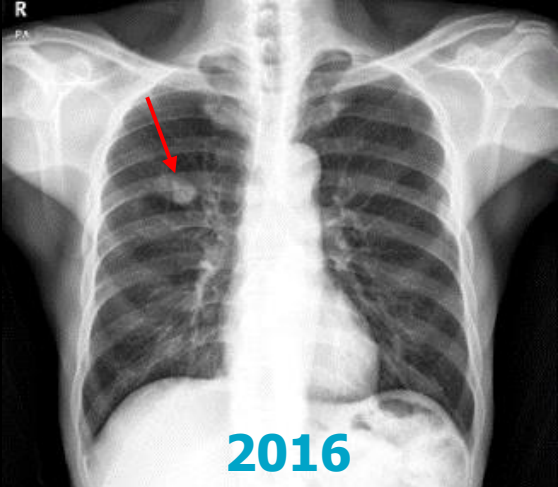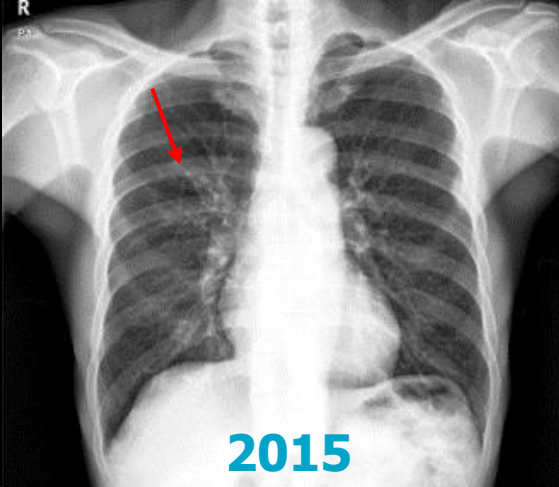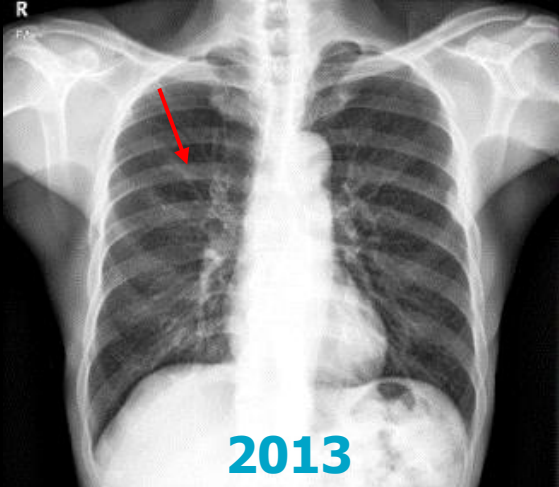
Small nodules overlaps with ribs

Clinical cases – Missed Cancer
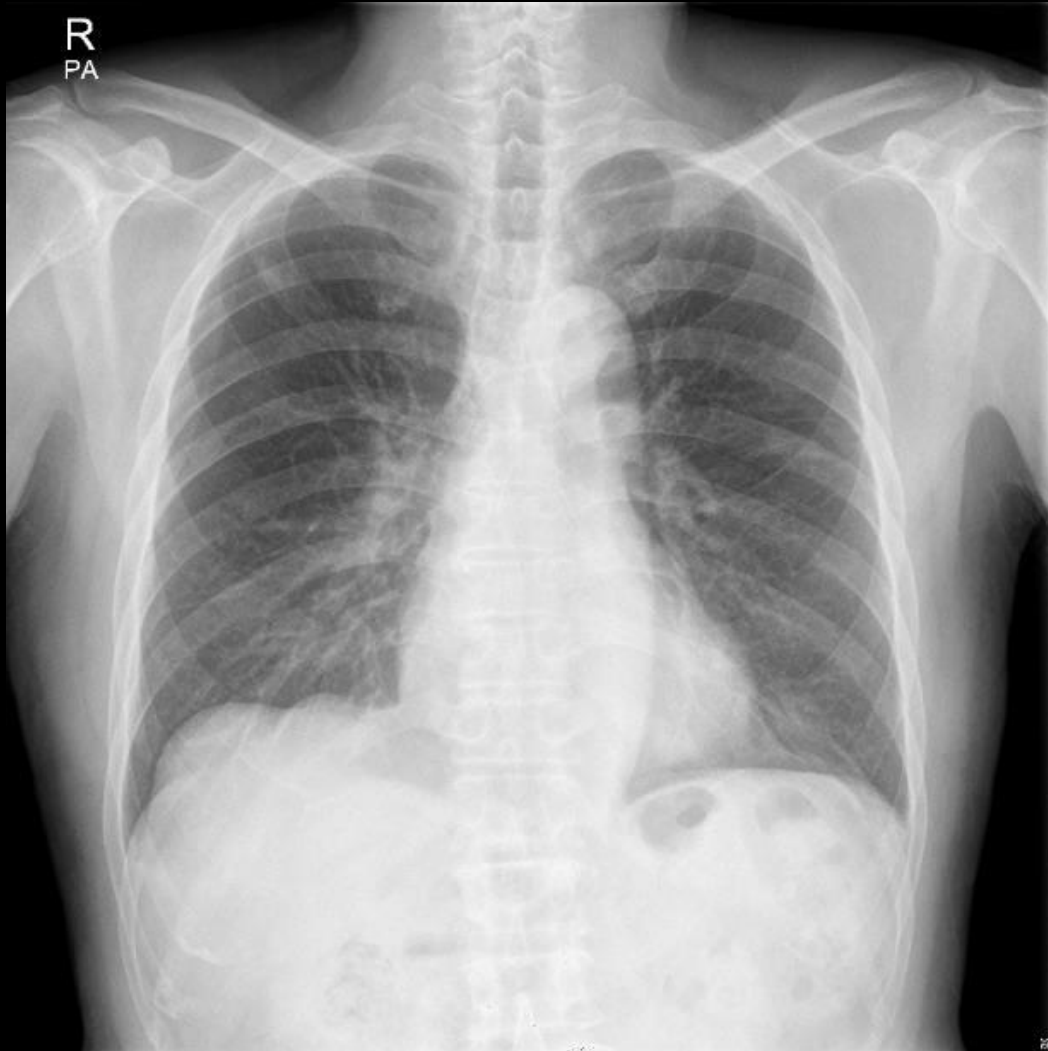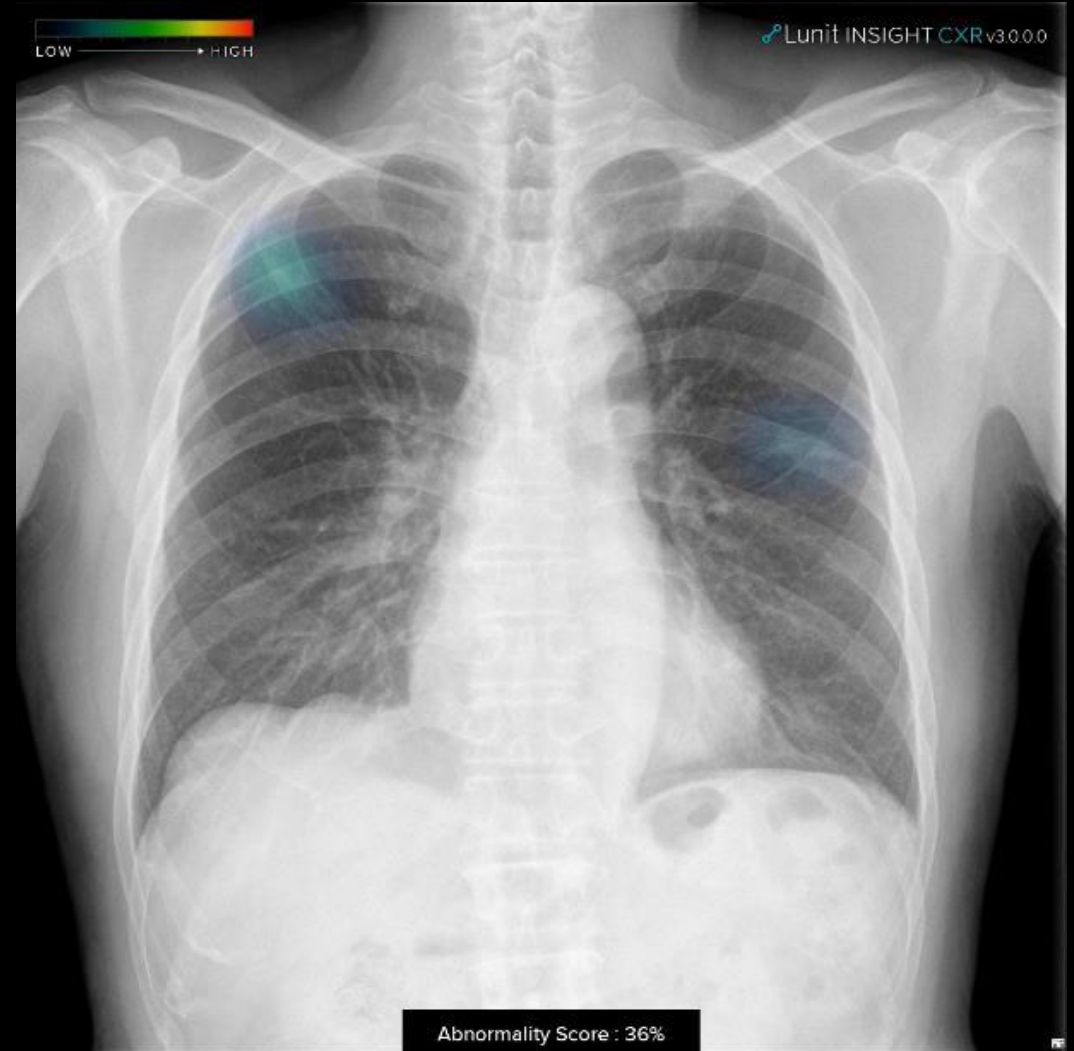
Small nodules overlaps with ribs

Abnormality Score: 36%

Clinical cases – Missed Cancer
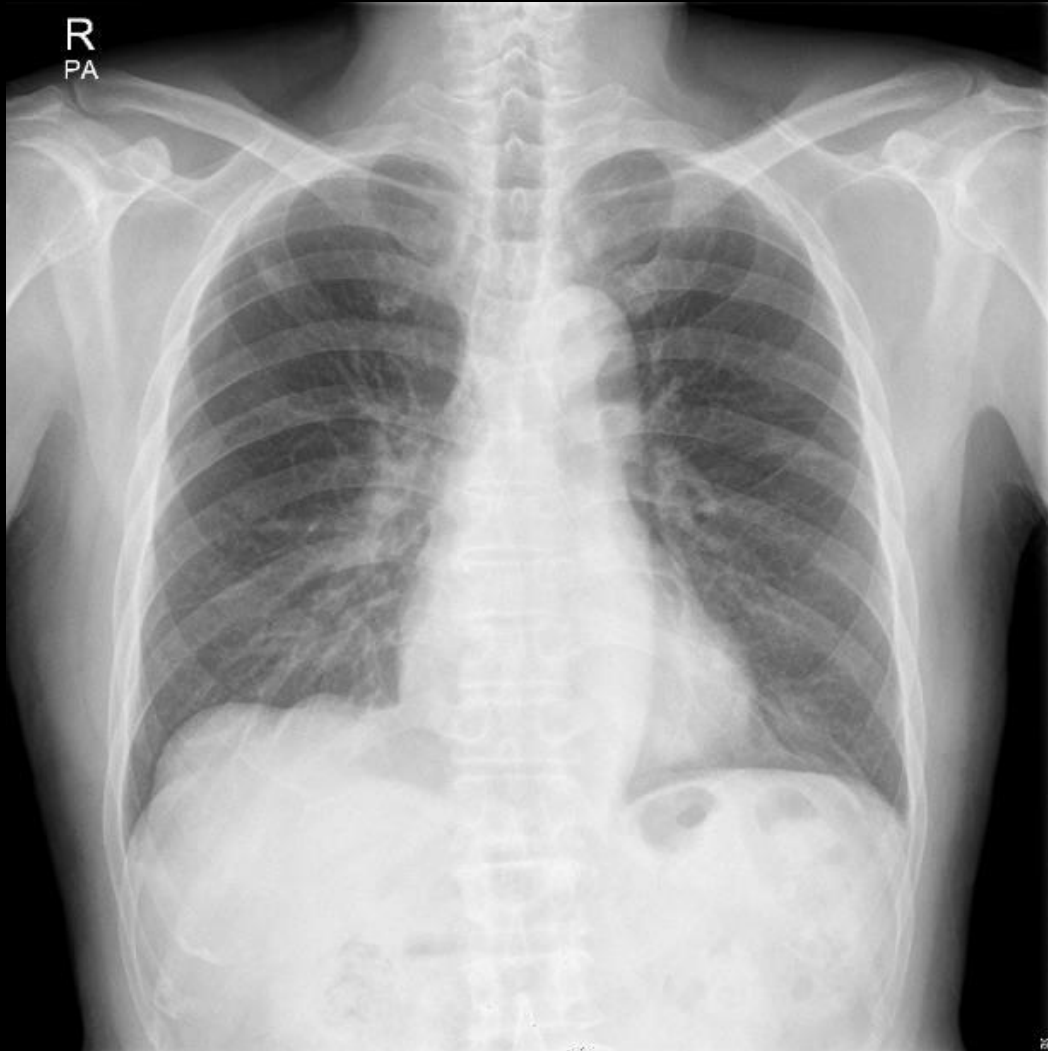
Small nodules overlaps with ribs

Abnormality Score: 36%
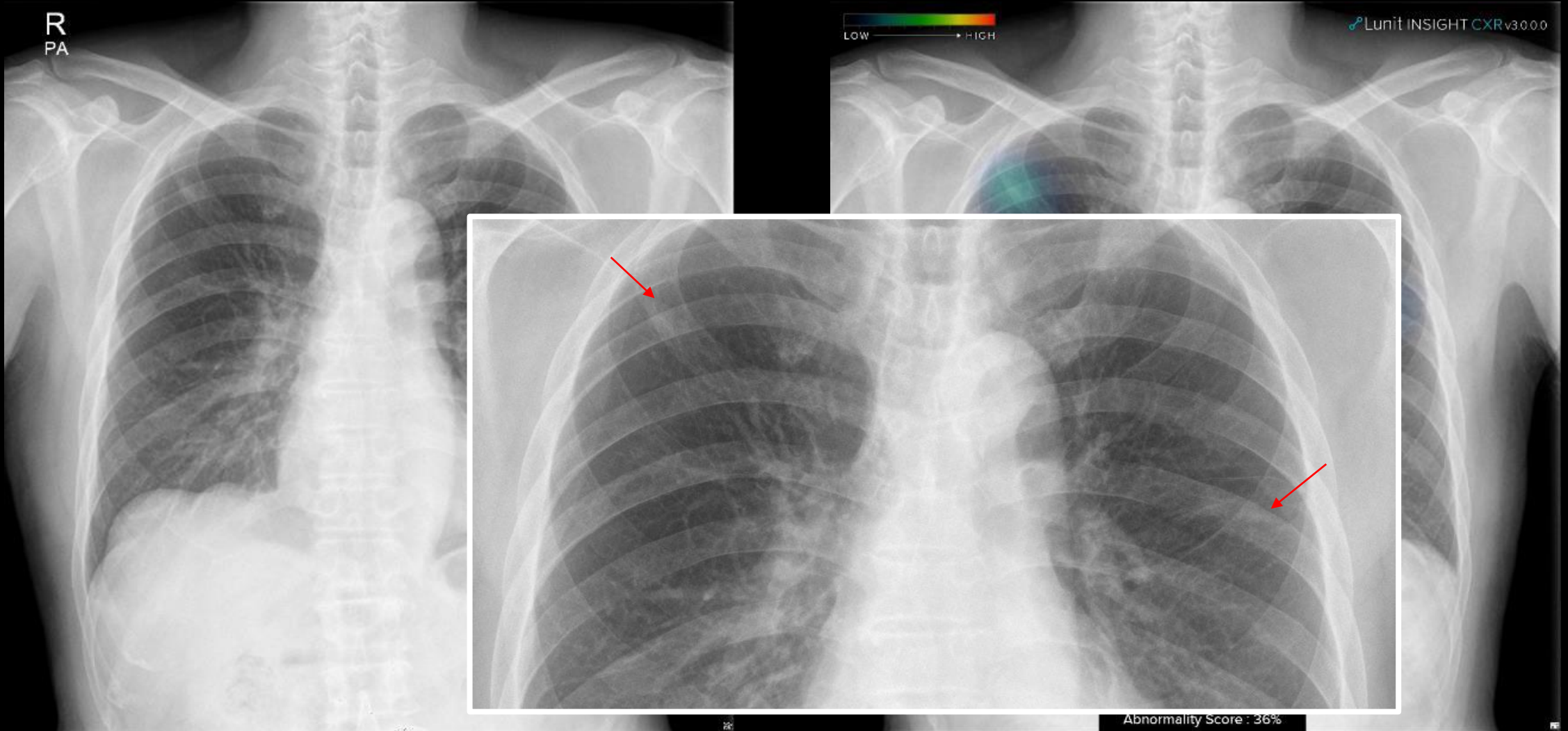
Clinical cases – Missed Cancer

Small nodules overlaps with vessels
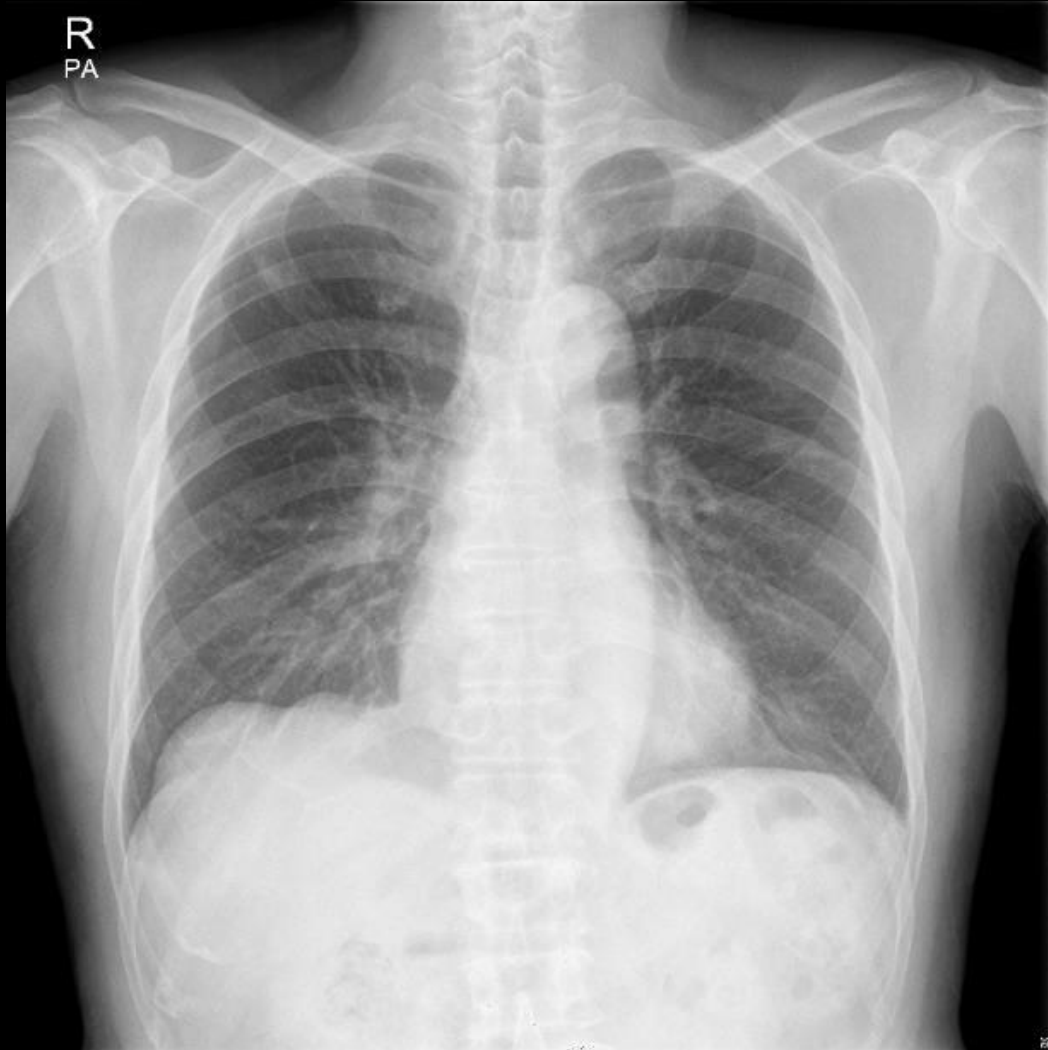
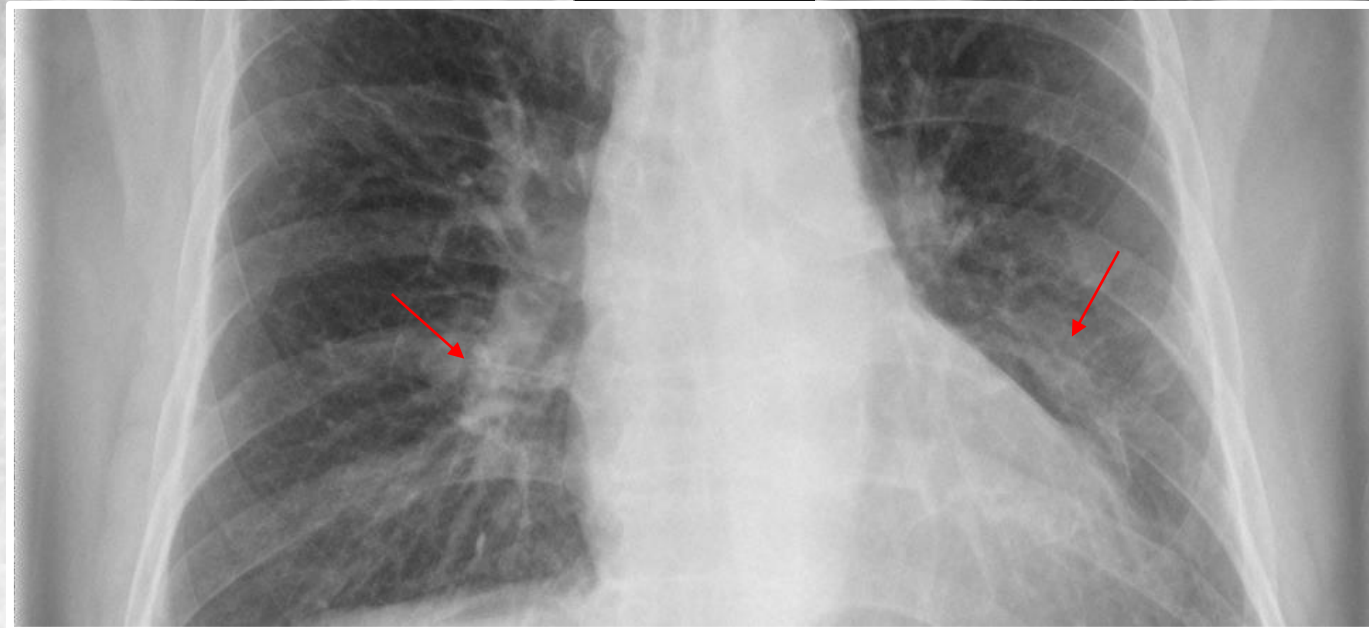# Clinical cases – Missed Cancer

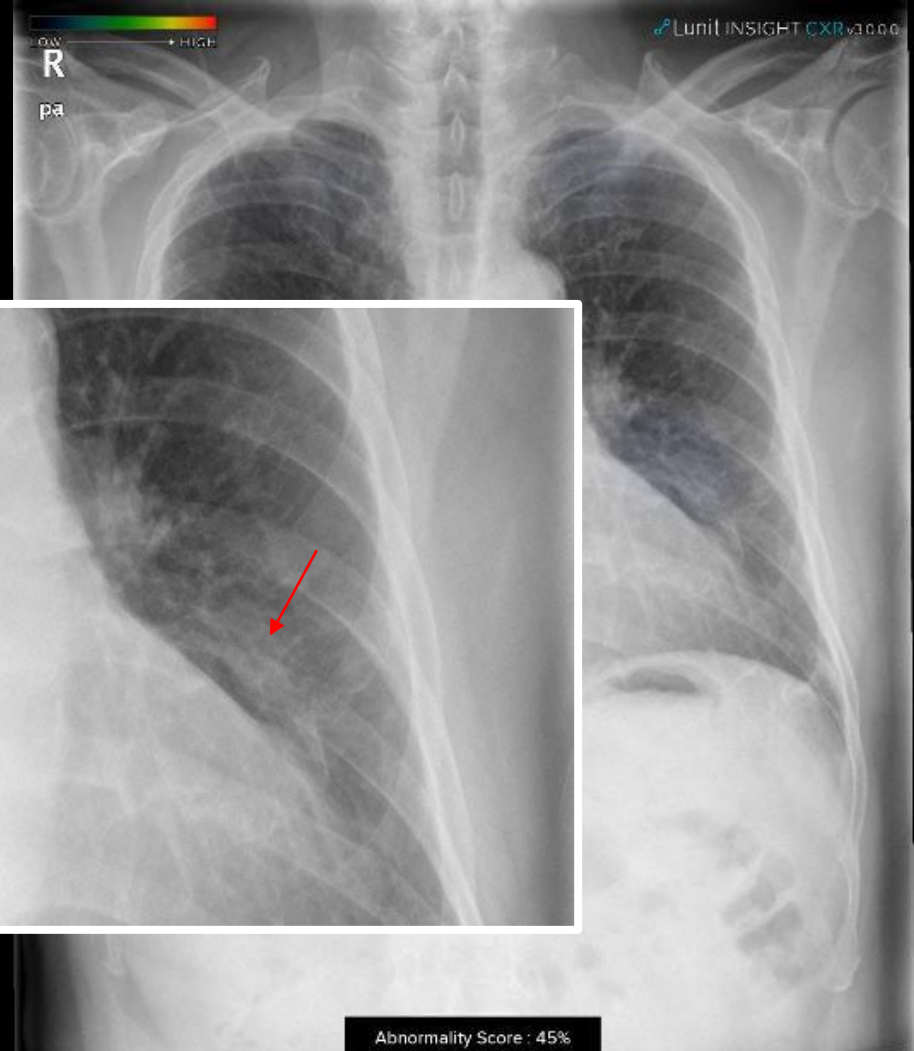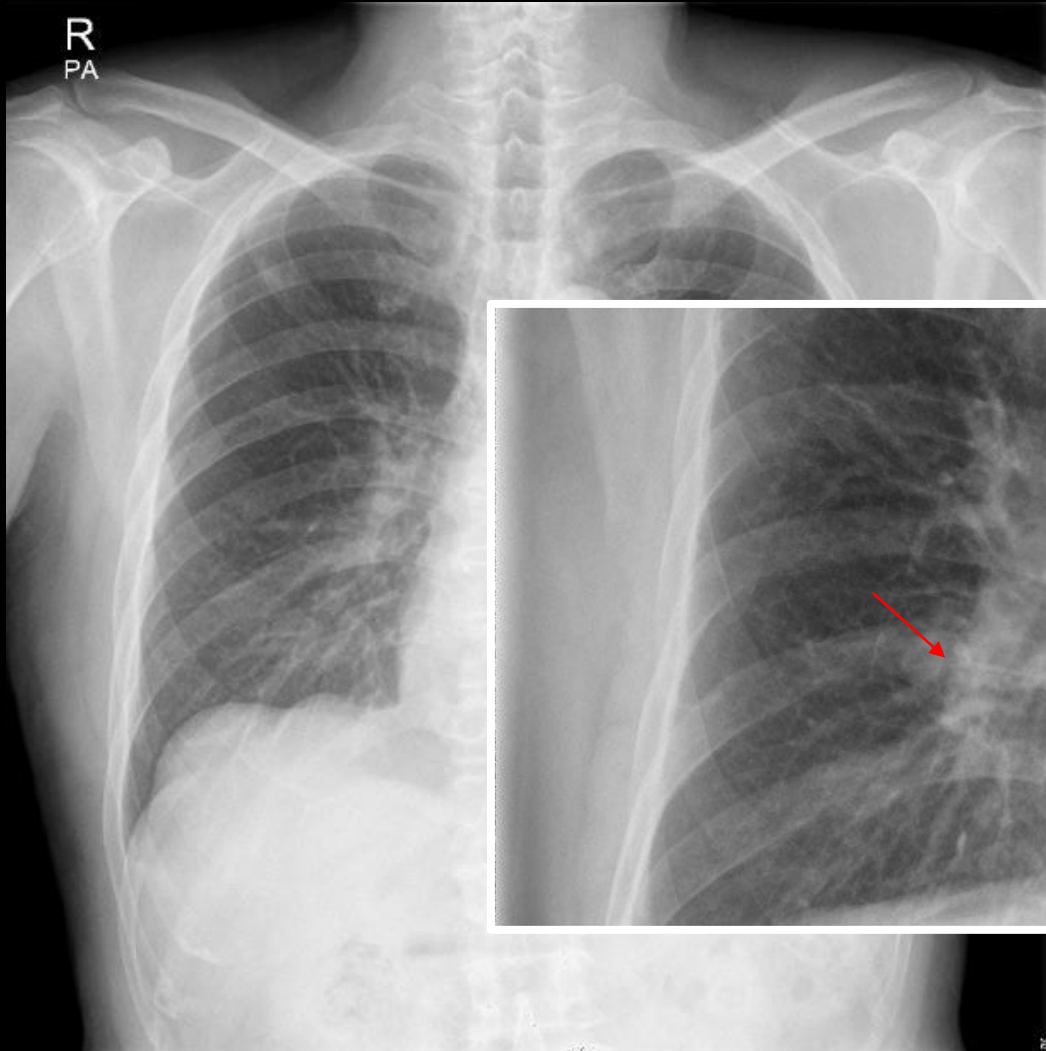Small nodules overlaps with vessels

Abnormality Score: 45%

Clinical cases – Missed Cancer

Small nodules overlaps with vessels

Abnormality Score: 45%

Building a world that works