Screening for Lung Cancer: Challenges and Obstacles THE I-ELCAP EXPERIENCE

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ICAHN SCHOOL OF MEDICINE AT MOUNTSINAI

NEW YORK, NY

2024 NOSCM JULY 20, 2024

THORACIC ONCOLOGY SESSION I

Today's Challenges and Obstacles
Same as we faced in 1992

- Recruitment
- Updating the protocol using latest innovations in scanners and AI, including criteria for enrollment
- Identification of appropriate staff and training
- Identification of bottlenecks or problems to be solved
- Communication of results
- Expansion of the screening program and pointers to new directions (i.e., identification of subgroups not well represented and how to reach them)

CRITICAL QUESTIONS in 1992

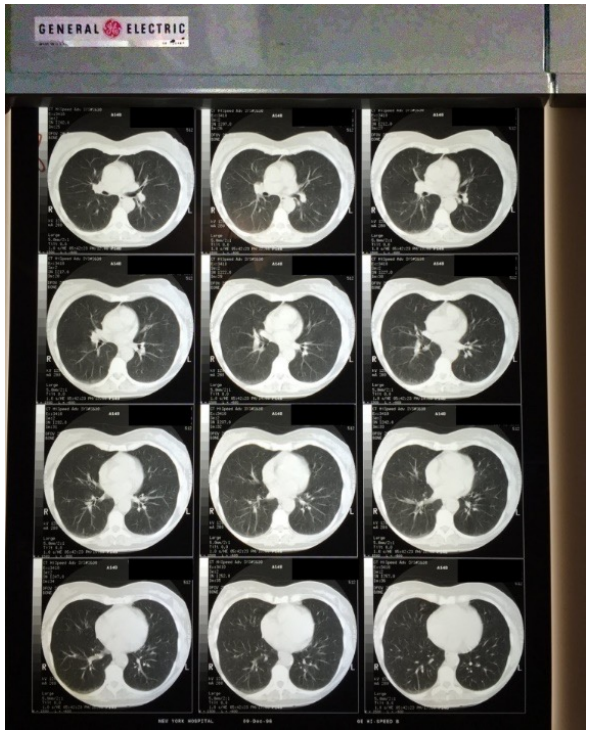
- How to reduce deaths from lung cancer?
  - When we find the lung cancer earlier we know that early treatment could result in a **cure**
  - We wanted to learn how early low-dose CT screening could find lung cancers compared to CXR
  - How to get funding for a preliminary study

- Morgan et al. What is the definition of cure in
- non-small cell lung cancer? Oncol Ther

2021; 9:365-371

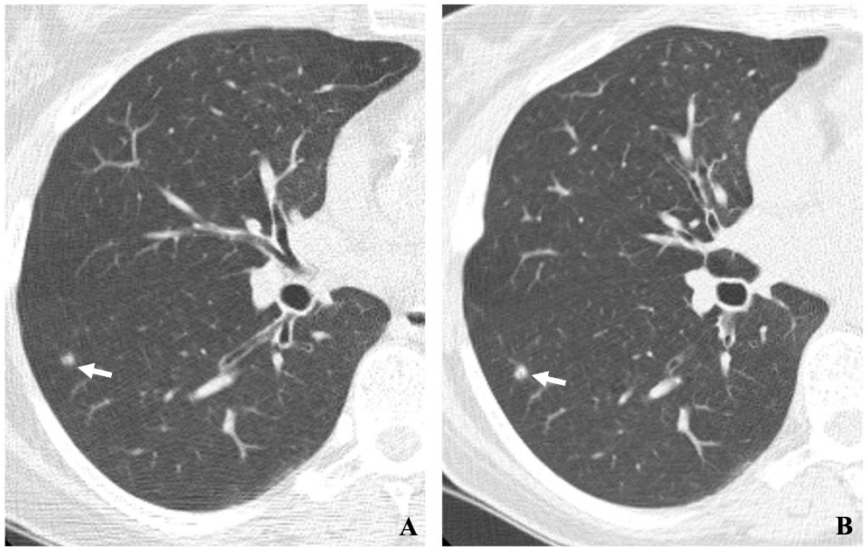
CT IMAGING IN 1992

12 tiny images on 1 x-ray film
Low dose acquisition just introduced
24-30 images on 2-3 x-ray films



12 images on 1 X-RAY

Today more than 1000 axial images
as well as coronal and sagittal images



Early Lung Cancer Action Project: 1990-1998

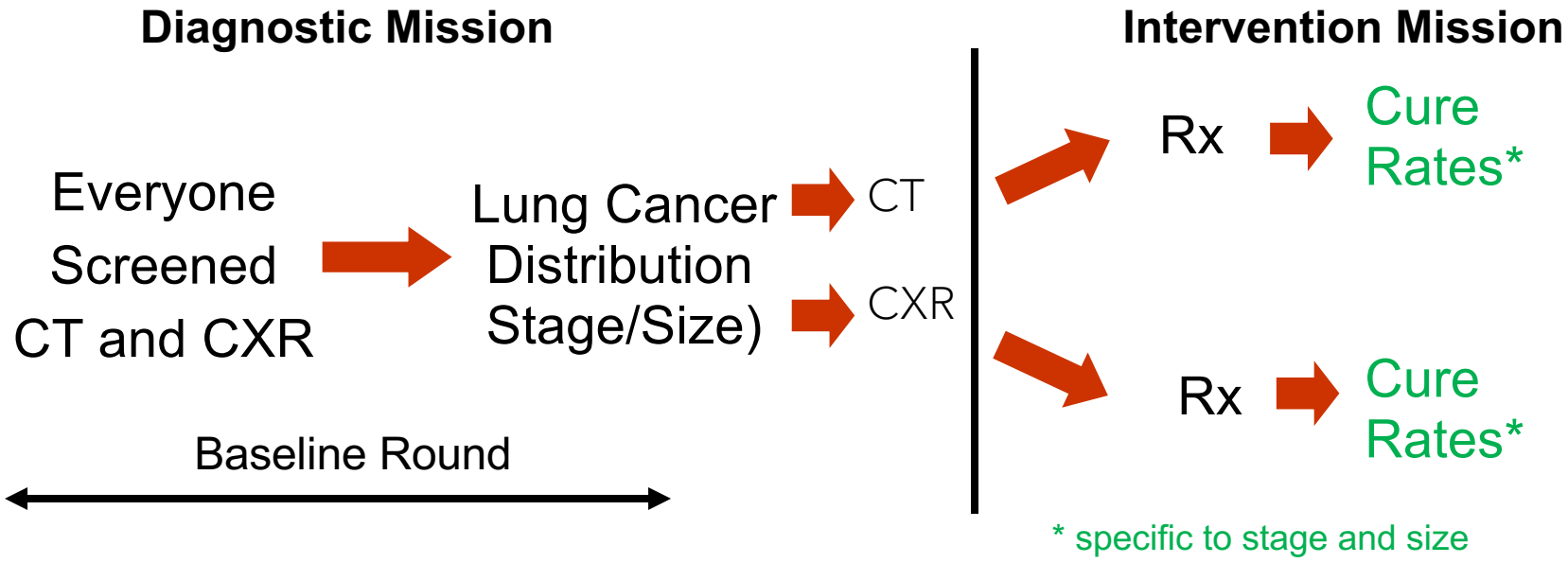
- Explored methods
  - AI: Article in **Business Week**. Searching for lung cancers instead of tanks: May 23, 1994
  - Henschke CI, Yankelevitz DF, Mateescu I, Brettle DW, Rainey TG, Weingard FS. Neural networks for the analysis of small pulmonary nodules. Clin Imaging 1997; 21:390-99 PMID:9391729
  - Volumetric assessment of growth of nodules
    - Reached out to engineers at Cornell University, Center of Excellence in Computing:
      - Started to work with Anthony Reeves PhD
    - Early Repeat CT Imaging for Evaluation of Solitary Lung Nodules. NCI R01-78905. 9/99-8/02
    - Yankelevitz DF, Reeves AP, Kostis WJ, Zhao B, Henschke CI. Small pulmonary nodules: volumetrically determined growth rates based on CT evaluation. **Radiology. 2000**; 217:251-6
- Programmed a management system using Statistical Analysis System (SAS)

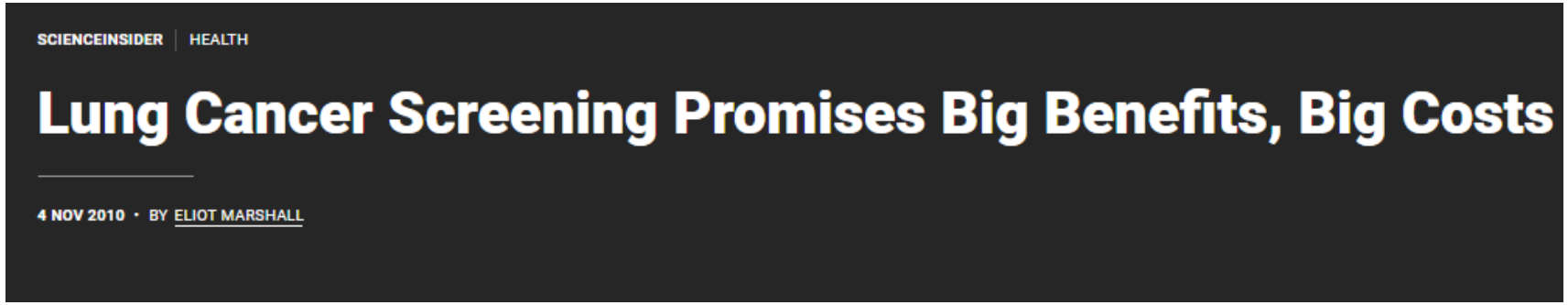
Grant from Rome Laboratories, Booz Allen, Hamilton. 1994-1996:
Neural Net Characterization of Small Pulmonary Nodules.
AND 2 NIH grants: R01: CA=63393 and CA-78905

The ELCAP Approach in 1992-1999

1000 participants, aged 60+ and at least 10 pack-years of smoking

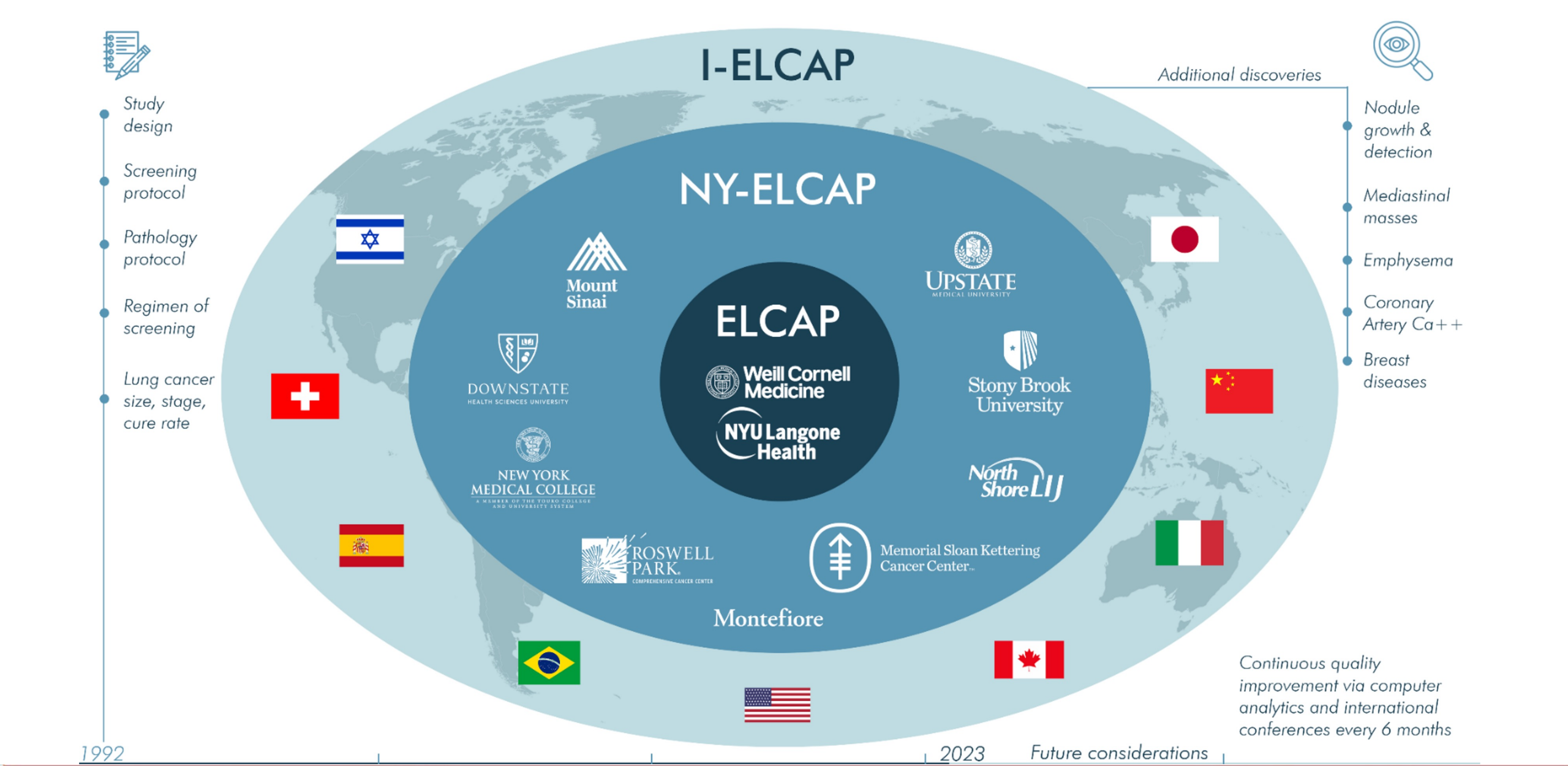
CT found 27 cancers of which 23 (85%) were Stage I
vs. CXR found 7 cancers of which 4 (57%) were Stage I





"the greatest single reduction of cancer mortality in the history of the war on cancer,“

says James Mulshine, vice president for research at Rush University Medical Center in Chicago, Illinois and cancer researcher associated with the pro-screening advocacy group, the Lung Cancer Alliance


I-ELCAP
NY-ELCAP
ELCAP
Weill Cornell Medicine
NYU Langone Health
Mount Sinai
UPSTATE MEDICAL UNIVERSITY
DOWNSTATE HEALTH SCIENCES UNIVERSITY
Stony Brook University
NEW YORK MEDICAL COLLEGE
North Shore LIJ
ROSWELL PARK COMPREHENSIVE CANCER CENTER
Memorial Sloan Kettering Cancer Center
Montefiore
Study design
Screening protocol
Pathology protocol
Regimen of screening
Lung cancer size, stage, cure rate
1992
Additional discoveries
Nodule growth & detection
Mediastinal masses
Emphysema
Coronary Artery Ca++
Breast diseases
2023
Future considerations
Continuous quality improvement via computer analytics and international conferences every 6 months

Key Components of Screening Program

- Screening intervals
- Separate the protocols for baseline and repeat screenings
- Nodule definitions
  - Solid, part-solid, nonsolid
  - Peri-fissural and costal pleural nodules
- Measurement of nodules
- Nodule growth assessment
- Thresholds for noninvasive and invasive diagnostic workup
- Management System for the entire screening process

Henschke et al. Lessons learned over 25 years.
J Thor Imag 2020;36(1): 6-23

ELCAP to NY-ELCAP to I-ELCAP: 1992-2024

Individualized CT screening depending on indicators of risk, e.g., current smokers, former smokers, never smokers

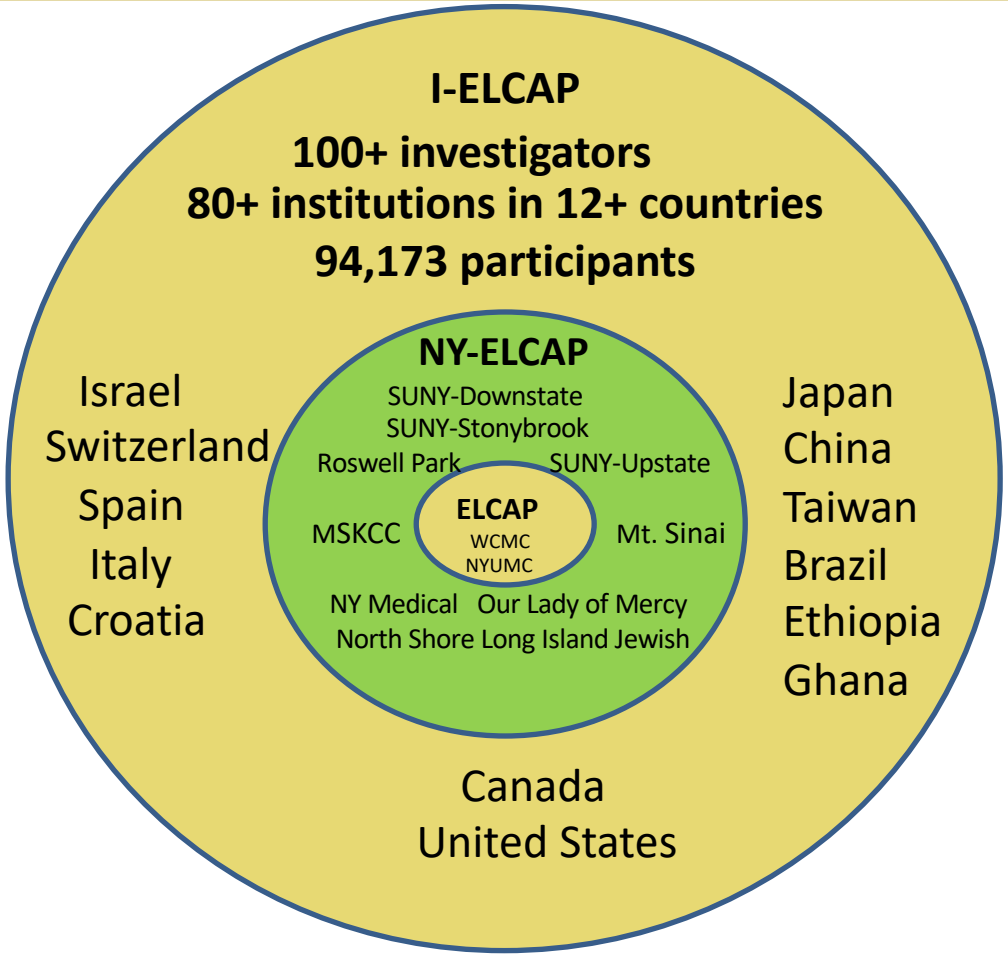
Study design

Screening protocol

Pathology protocol

Regimen of screening

Lung cancer size, stage, cure rate



Nodule growth and detection

Mediastinal masses

Emphysema

Coronary Artery Ca++

Breast Diseases

Computer Analytics

Conferences @ 6 months

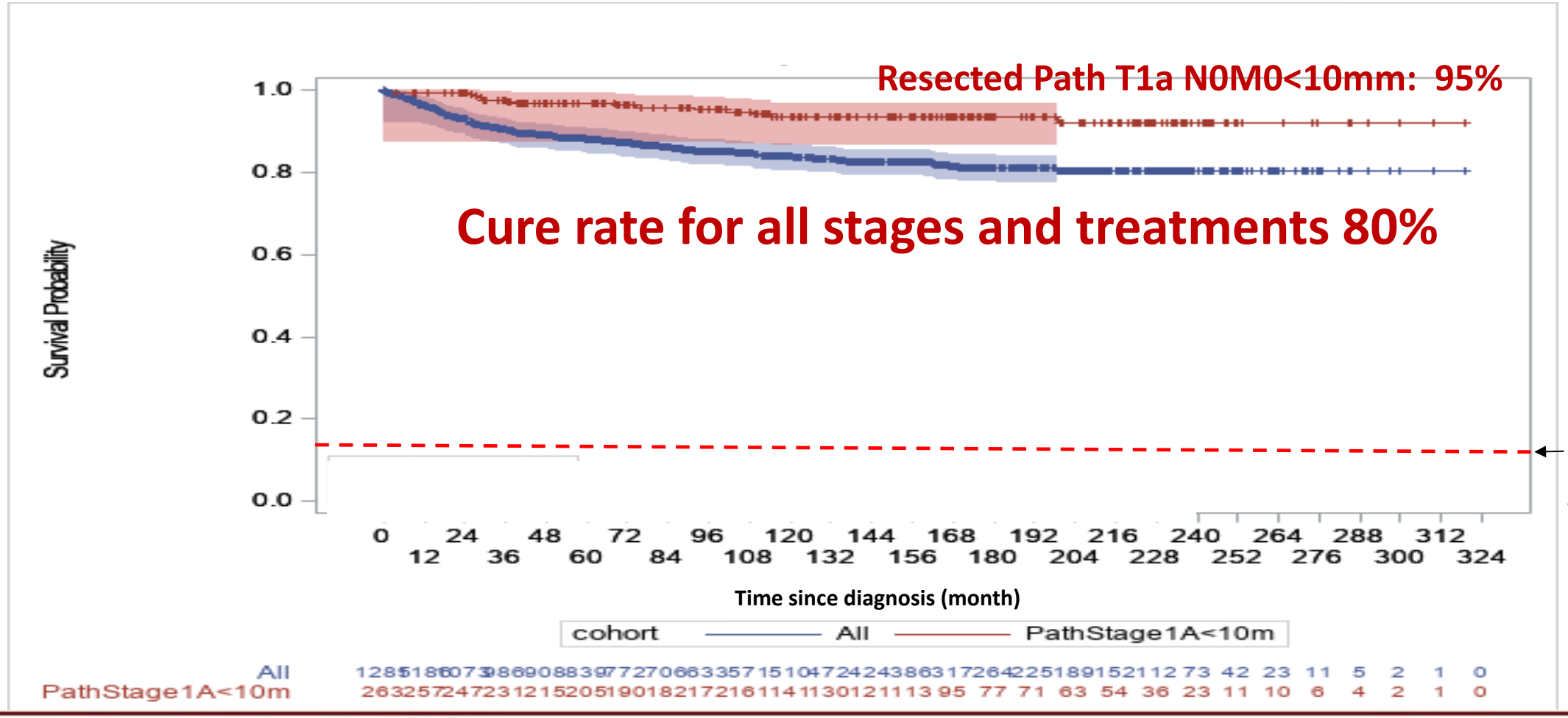
Continuous Quality Improvement

I-ELCAP International Early Lung Cancer Action Program

Lung Cancer 2002;35:143-8 & www.IELCAP.org

IELCART Initiative for Early Lung Cancer Research on Treatment

WE CAN INCREASE LUNG CANCER CURE RATE BY LDCT SCREENING (Radiology 2023)

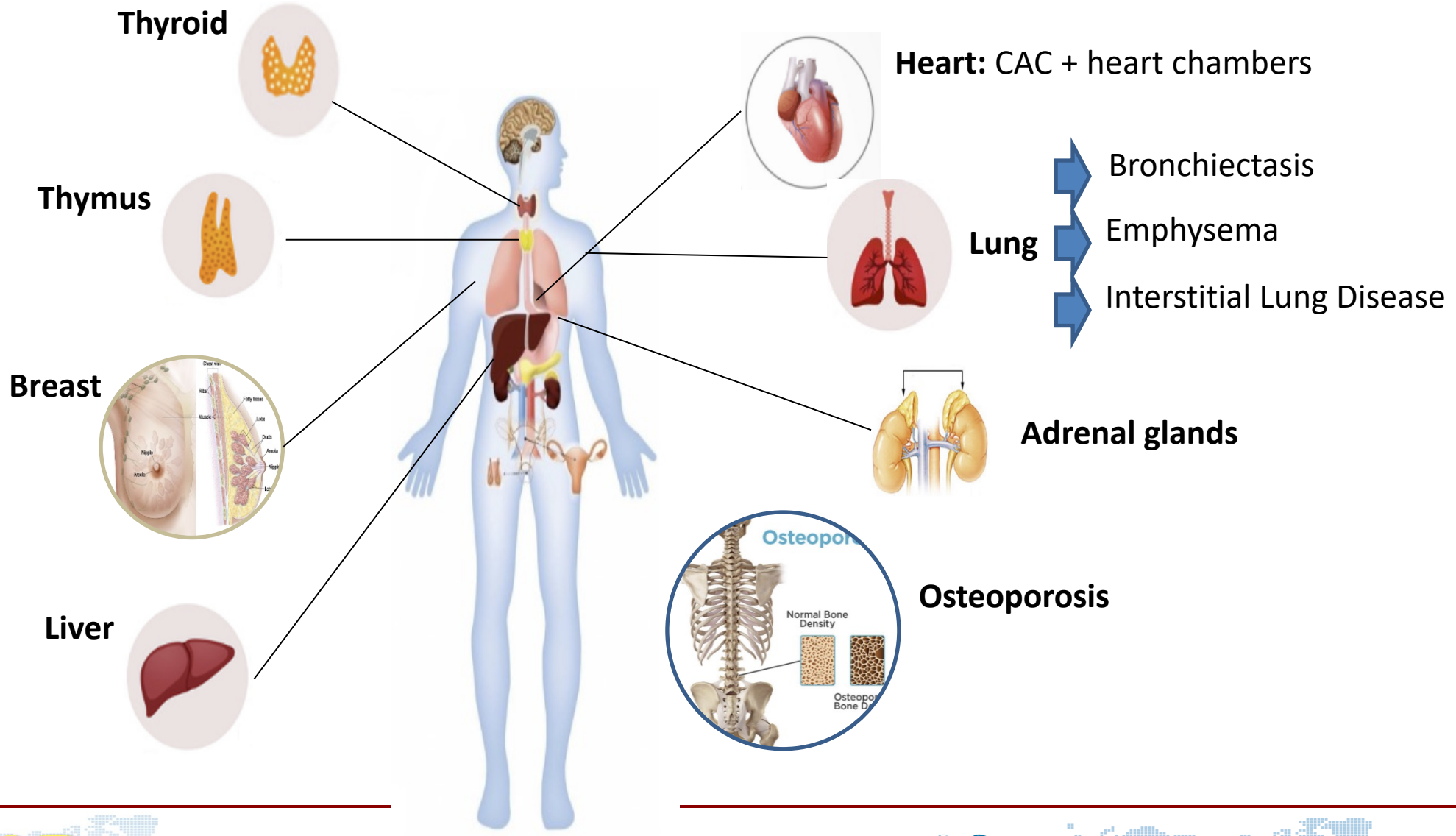


Cure rate <15% without screening

I-ELCAP International Early Lung Cancer Action Program

IELCART Initiative for Early Lung Cancer Research on Treatment

LDCT is an Annual Health Check

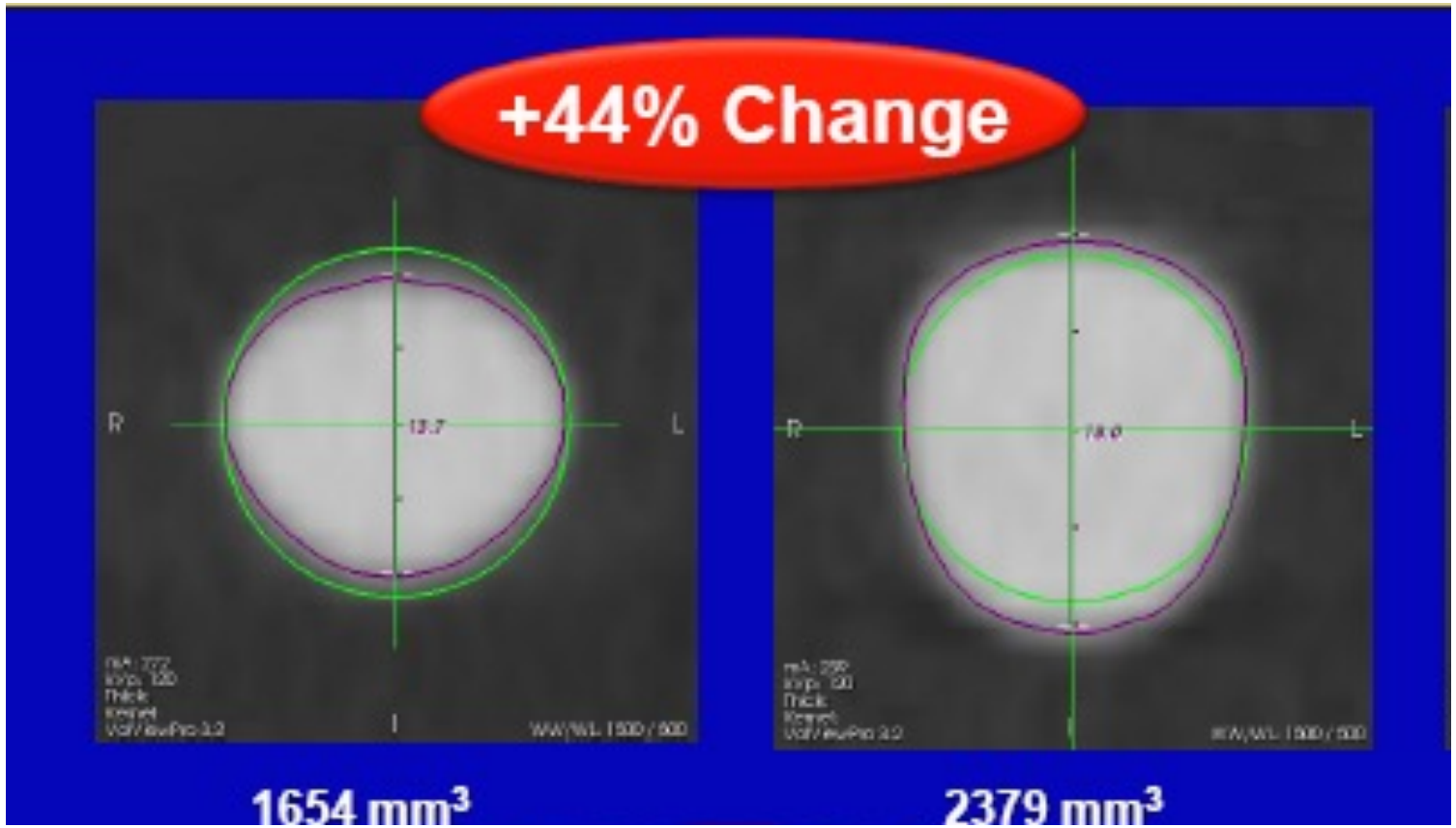


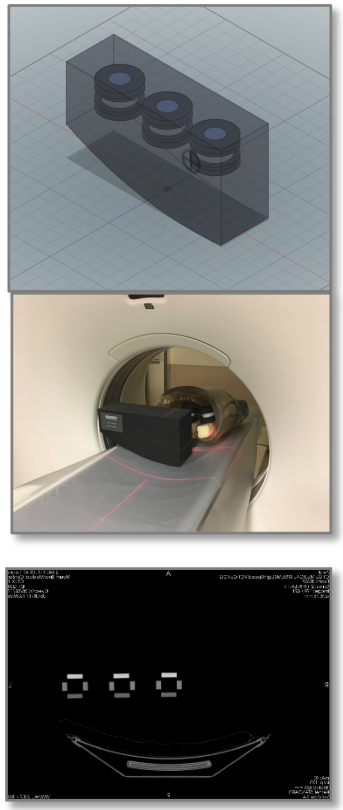
Global Lung Cancer Statistics in 2020

- 2.2 million people were diagnosed with lung cancer
- One fifth (1/5) of all deaths from cancer were due to lung cancer
  - Almost twice as many deaths as 2nd most (colorectal cancer) or 3rd most (liver cancer) cancer
- Lung cancer has a higher economic burden than any other cancer

- Without LDCT screening, the cure rate for lung cancer is low

Today Nodule Growth Assessment Still Limited by Measurement Accuracy





RSNA/QIBA Performance Certification

Check Each Time Scanner or Protocol Changes and Once Per Year

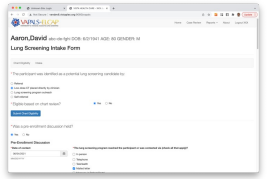
Within seconds of repeat CT, 44% change at a VDT rate of 172 days

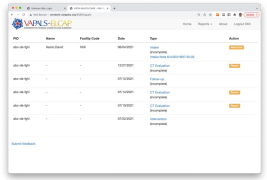
Henschke CI, Yankelevitz DF, Yip R, Archer V, Zahlmann G, Krishnan K, Helba B, Avila R. Tumor volume measurement error using computed tomography imaging in a phase II clinical trial in lung cancer. J Med Imag 2016; 3:035505

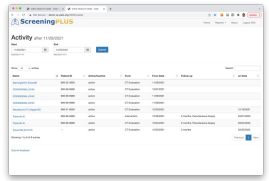
Updated I-ELCAP Management System Optimizes Screening Efficiency and Quali

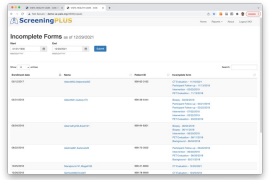
+ Screening Performance Reports For National & Local Administrators

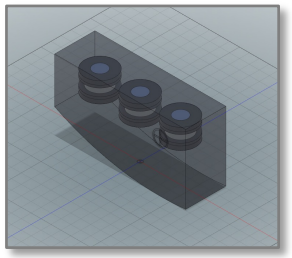
Nurse Navigator → CT Technologist → CT Scanner → Acquisition Protocol → Diagnostic Radiologist → Interventional Radiologist → Surgeon

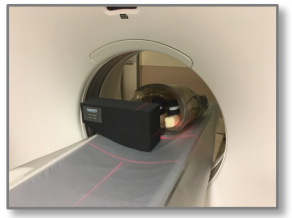


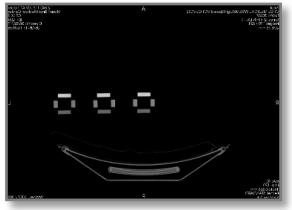


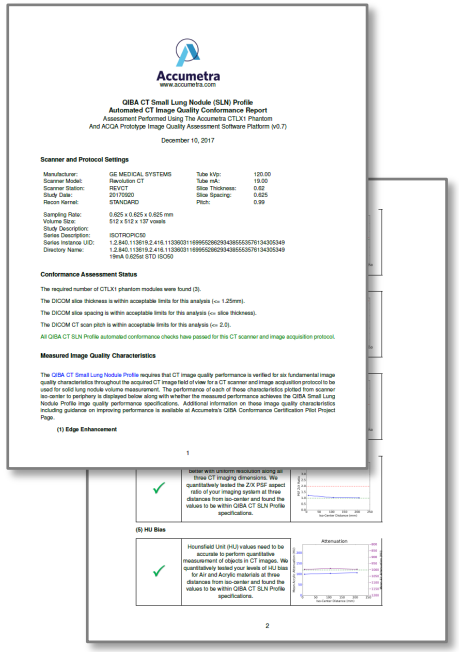






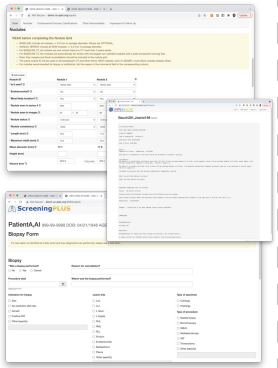






Pulmonologist

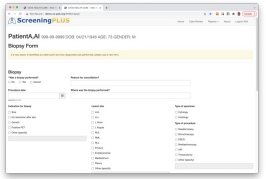
Teaching Files



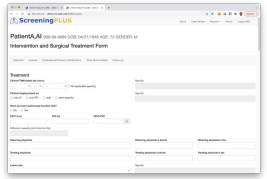
AI

Pathologist

Oncologist

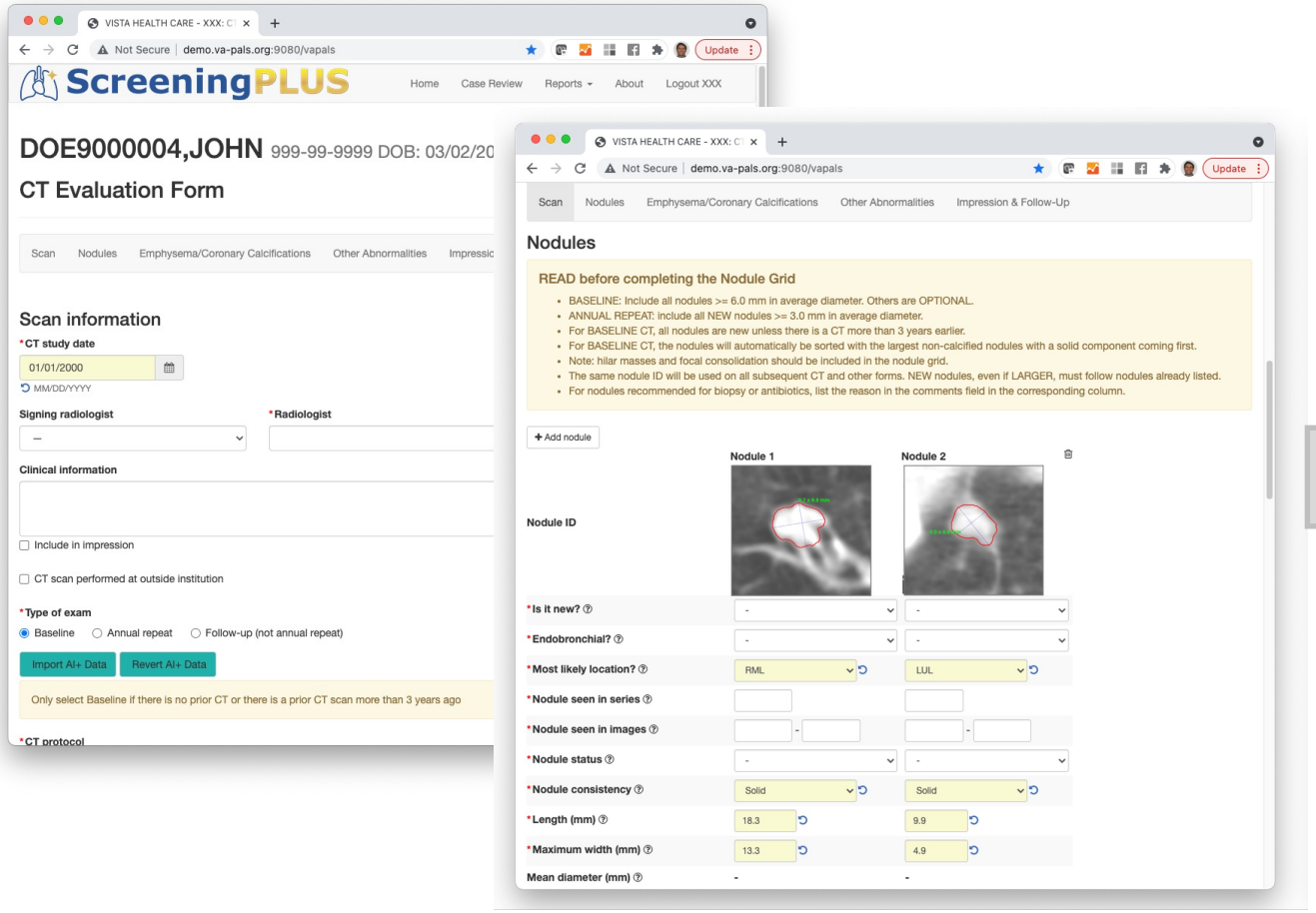


Radiation Oncologist



RSNA | American Lung Association

CT Evaluation Form

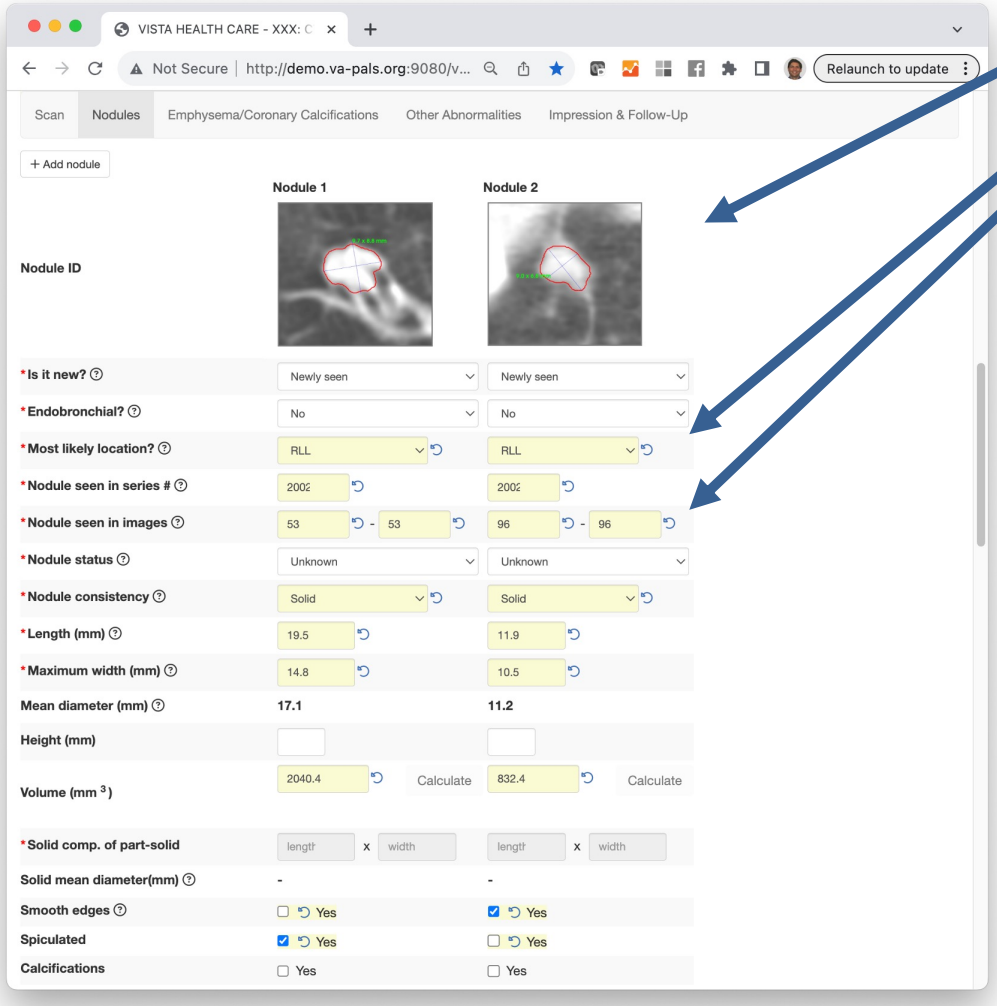


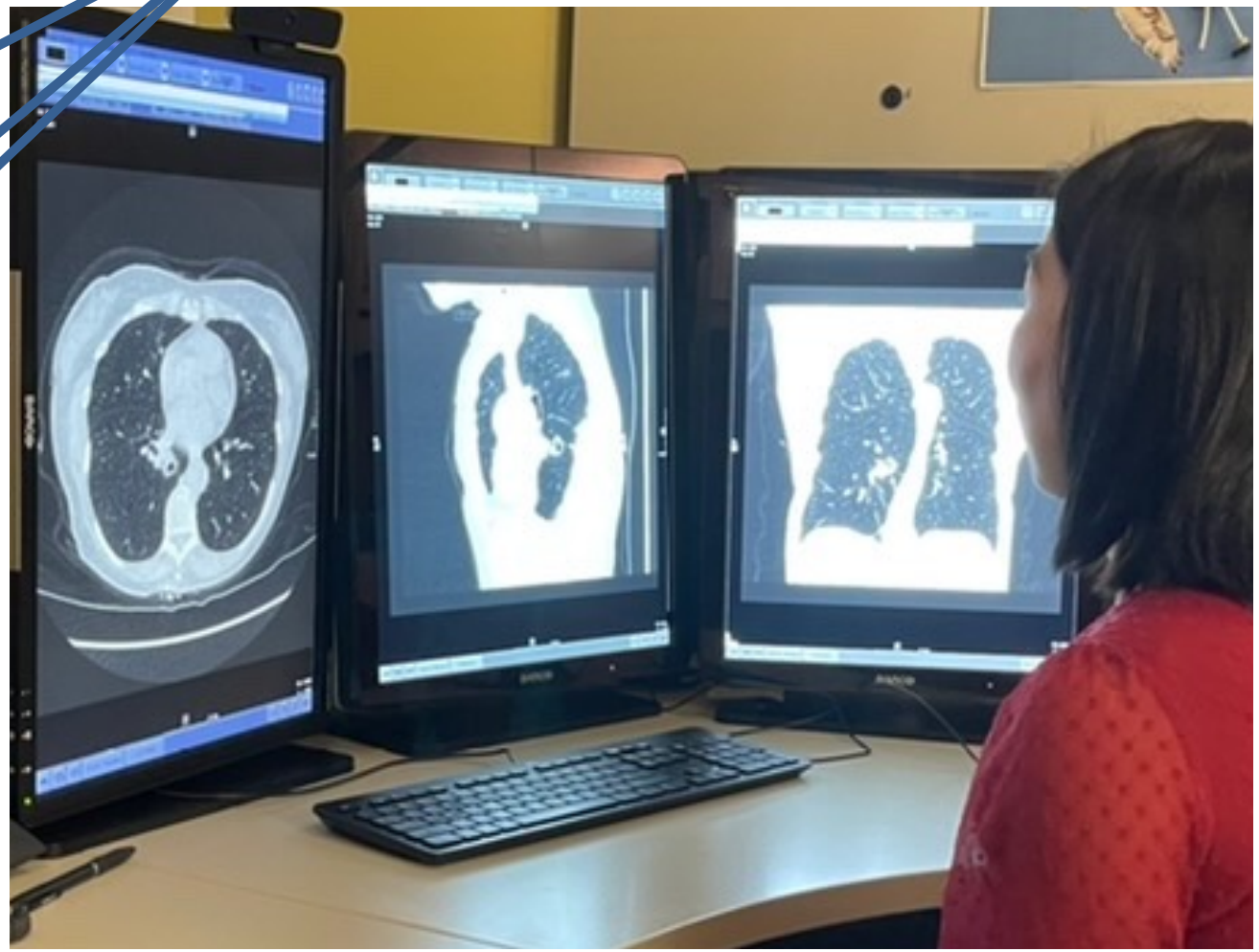
Structured Report Form Is Auto Filled In By A FDA Cleared CT Lung Nodule AI System

Translated into a Radiology Report

Editable Report That Is Automatically Sent To The EHR and PACS Via HL7

SCREENINGPLUS: updated I-ELCAP Mgt System
AI Results Now Auto-Fill The Nodule Grid





1st Conference on Integrating Early Detection of Heart and Lung Disease through Low-Dose CT

"Scientific Think-Tank Event Exploring New Frontiers in Averting Preventable Premature Deaths through AI-enabled Early Detection"

Together with

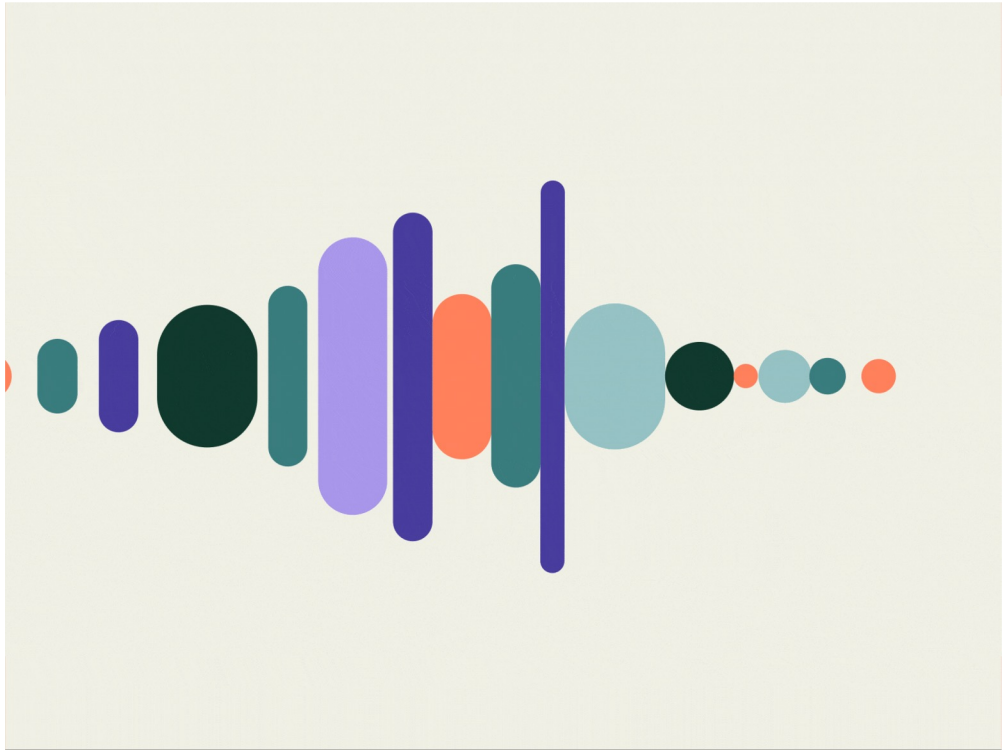
46th International Conference on Screening for Lung Cancer

14th Conference on Early Lung Cancer Research on Treatment

Integrating Cardiac and Lung Screening

September 19-21, 2024

New York Academy of Medicine in New York City



I-ELCAP AIRS:

Automated Image Reading System

An **Open Source automated image reading system (AIRS)** that determines **no clinical change has occurred** – **no new nodules** and **no nodule size change**

I-ELCAP AIRS Team

Claudia Henschke, PhD, MD

Director of Lung Screening at Mount Sinai

PI of I-ELCAP

PI of AIRS

David Yankelevitz, MD

Director of Biopsy Service at Mount Sinai

Co-PI of I-ELCAP

Co-PI AIRS

Kyle Myers, PhD

Puente Solutions LLC

Former FDA Director of Division of Imaging, Diagnostics, and Software Reliability

Consultant to AIRS

Ricardo Avila, MS

Founder/CEO Paraxial and Accumetra

Former head of CAD/AI for GE & Kitware

Founder of VTK and ITK imaging toolkits

AI Development Subcontract to AIRS

Artit Jirapatnakul, PhD

Associate Professor at Mount Sinai

I-ELCAP AI Computer Engineer

Lead Engineer to AIRS

Rowena Yip, MPH

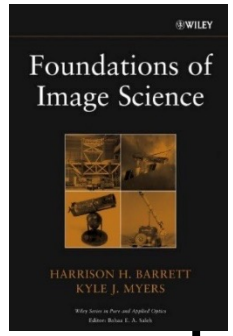
Senior Biostatistician at Mount Sinai

I-ELCAP Lead Statistician

Lead Statistician to AIRS

The I-ELCAP AIRS Team

- CH and DY developed automated nodule analysis in 1998
- This technology was licensed to GE in 2001, where RA was head of CAD/AI development at GE Research
- Nodule analysis (Lung VCAR) was brought by GE to FDA in 2004 where it was evaluated in the division headed by KM
- KM has extensive experience on image quality evaluation
- RY and AJ have worked with all members for many years
- In summary:
  - **The I-ELCAP AIRS Team has been working together on papers, conferences, and projects for many years**
  - **The I=ELCAP AIRS Team has been developing the AIRS concept for years**

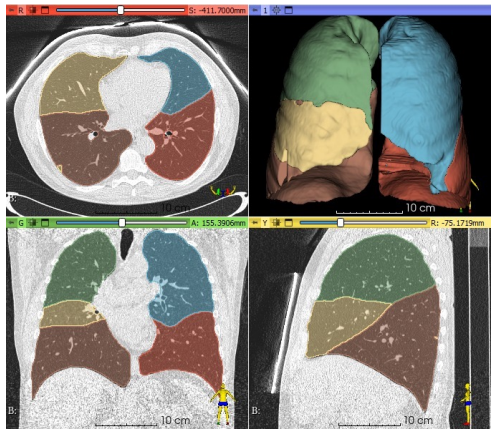


I-ELCAP AIRS will:

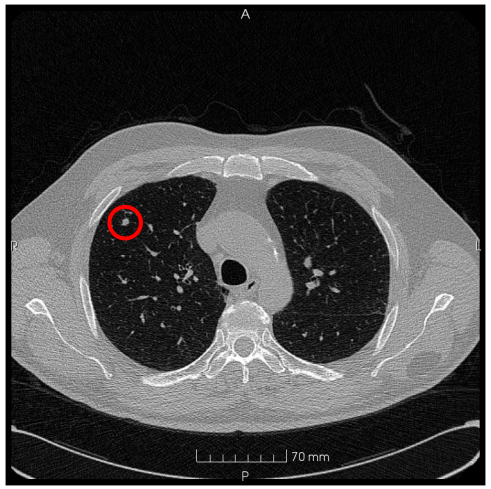
- Act as a **first-read** for **annual LDCT scans – radiologists would not need to spend time** reviewing these annual scans
- **Majority of scans** in an established screening program **will be annual LDCT scans**
- Will apply for FDA approval to facilitate clinical use

Imagine What Could be Accomplished

If sites around the world had access to this tool it would:



- Dramatically reduce the burden on radiologists, especially in low and moderate income countries
- Allow for automation of the entire screening process by connecting to a management system, such as the open source VAPALS-ELCAP/ScreeningPLUS system
- Standardize quality of scan interpretations



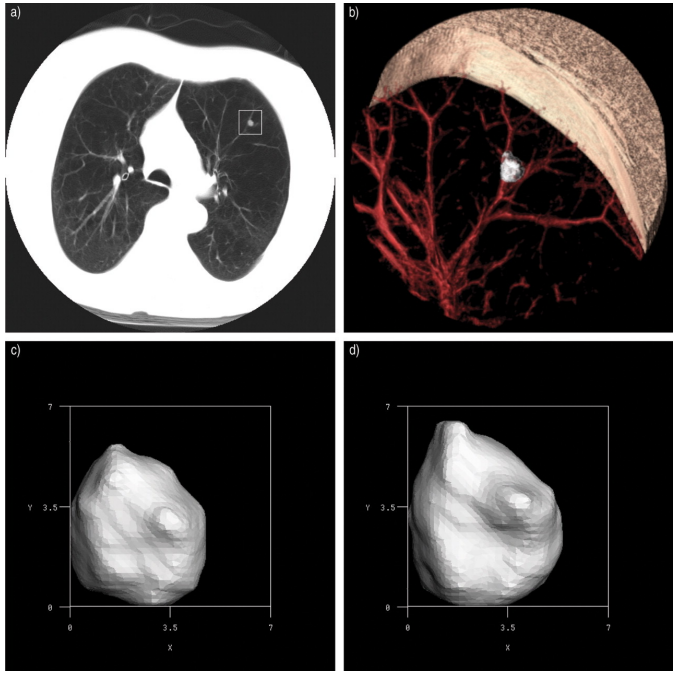
Why I-ELCAP Because…

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 OCTOBER 26, 2006 VOL. 355 NO. 17

Survival of Patients with Stage I Lung Cancer Detected on CT Screening

The International Early Lung Cancer Action Program Investigators*



We have the **largest database** of **lung screening CT scans: > 90k participants, 300k CT scans worldwide**

We are **leaders in lung screening**
(started in 1992!)

We are **leaders in automated medical imaging** – first patent on volumetric analysis of nodules

I-ELCAP
International Early Lung Cancer Action Program

I-ELCAP
AIRS
Automated Image Reading System

IELCART
Initiative for Early Lung Cancer Research on Treatment

Welcome New Members

- Croatia, first national screening program in European Union starting in 2019: Dr. Miroslav Samarzija
- Egypt: Dr. Ola Khorshid and HSW Mikhael
- Ethiopia: funded by BMSF: Dr. Wondo Bekele
- Ghana: Dr Alfred Yawson and Dr. Jane Afriyie-Mensah

The I-ELCAP Investigators Worldwide

I-ELCAP
International Early Lung Cancer Action Program

I-ELCAP
ARS
Automated Image Reading System

IELCART
Initiative for Early Lung Cancer Research on Treatment

Future Developments

Leveraging the infrastructure from the current program, we are seeking collaborations to develop:

- Enhanced automated accurate methods for determining growth rates of pulmonary nodules and their probability of malignancy
- Tools to easily link the comprehensive management system with institutional EMRs
- Comprehensive risk assessment tools
- New software tools for comprehensive health checks of cardiac illness, lung illness and personalized measures of health

Thanks and Acknowledgements

- **The efforts of all the I-ELCAP Investigators and their teams**

  We express our deepest gratitude to the many physicians, nurses, patient coordinators, academicians, and technical and administrative staffs whose dedicated and meticulous work over the past decades has provided the platform on which I-ELCAP research is built.

- **Our very, very special thanks to the thousands of screening participants** who have allowed us to follow their progress over the years so that others could benefit from the information gleaned from their experiences. We greatly appreciate their generosity of spirit.

I-ELCAP International Early Lung Cancer Action Program

I-ELCAP AIRS Automated Image Reading System

IELCART Initiative for Early Lung Cancer Research on Treatment

EARLY DIAGNOSIS AND EARLY TREATMENT

A new era in Preventive Health