Overview: Opportunities to Leverage Quantitative Thoracic CT Imaging to Improve Health Outcomes
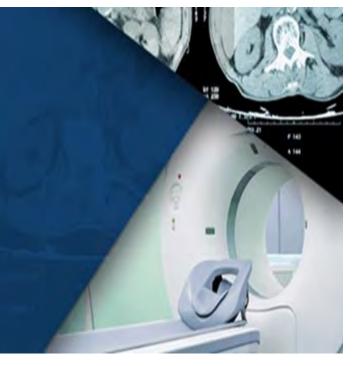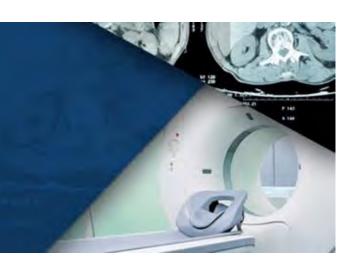
QUANTITATIVE IMAGING WORKSHOP XVIII:
Optimizing Thoracic Imaging to Detect and Manage Early Lung Cancer/COPD

November 4-5, 2021 | Virtual

Goals of the 18th PCF Annual QI Workshops are to convene relevant stakeholders :

1. To review the status of detecting/managing early tobacco-related disease with thoracic CT screening implementation
2. Explore how the social determinants of disease can help morph cancer screening from early cancer detection into a more personal-centric "health check" with physical activity as an example of a health intervention
3. Define strategies for sustained screening uptake with population health
4. Develop reliable/accessible imaging and related computational tools for early thoracic diseases using well characterized image data
5. Define process for analysis and reporting tools to guide management of CT-detected early thoracic disease especially in regard to the intersection of lung CA and COPD
6. Define the technical approach for precise measurements of relevant imaging signatures

Lung Cancer Screening Context

- *National screening going forward with growing acceptance, but uptake of screening just over 6%

- Reevaluation of LDCT by USPSTF affirms recommendation and expands eligibility (begins at 50 yrs. with 20+ pk/yrs.)

- Most screening centers are adapting existing general tools to support their specific screening efforts often on generic spreadsheets

- New CISNET modeling shows expanded screening eligibility will still be cost effective

- Techniques to extract more medically relevant information from thoracic CT (i.e. COPD/CAD) are emerging but not widely available

*Mulshine JL, Pyenson B. The Long, Slow Road to Lung Cancer Cure
JAMA Oncol. Published online October 21, 2021. doi:10.1001/jamaoncol.2021.4711

Obstacles to Lung Cancer Screening Implementation

- Acceptance of Screening Benefit with primary care and other healthcare professionals as well as the public, improving with additional & maturing RCT data
- Safety concerns sideline screening during COVID-19 Pandemic
- Impediments to rapid screening access
  - ➤ *Unintended consequences of formal Shared Decision-Making process
  - ➤ Logistics sorting through financial and eligibility issues at screening sites
  - ➤ **Issues with Structural Barriers to Equitable Screening Access

*Mulshine JL, Yankelevitz DF, Pyenson BS. Concerns Related to Benefits and Harms of Real-World Shared Decision-Making for Lung Cancer Screening. American Health and Drug Benefits. June 2021
https://www.ahdbonline.com/online-first/3148
**Oyer RA , Smeltzer MP, Kramer A et al. Equity-Driven Approaches to Optimizing Cancer Care Coordination and Reducing Care Delivery Disparities in Underserved Patient Populations in the United States. JCO Oncol Practice DOI: 10.1200/OP.20.00895 JCO Oncology Practice - published online before print April 9, 2021PMID: 33974823

What is the Value-Proposition with QI

"I can do very well using Lung-RADS to guide the management of my lung cancer screening cases, why should I incur the potential cost and additional effort in using quantitative analysis?"

Potential Benefits of QI in LDCT screening:

Lower false positive rate while preserving high sensitivity

Assessment of clinical aggressiveness and /or disease status using growth rate

Quantitative measurement of other imaging biomarker features

Requires/enables more precise quality control potentially improves analysis for additional informative imaging signatures using computational analysis

Extract Additional Medical Information from Thoracic CT

- *Reanalysis of 52,726 baseline screening CT scans revealed a 23.8% occurrence of COPD emphysema which was usually (75%) without clinical prior symptoms

- COPD is the fourth leading cause of premature death in the US

- Robust efforts to develop targeted therapy to intercept progression of lung diseases especially including COPD are ongoing

- **Lung cancer & COPD are co-morbid diseases routinely occurring in tobacco-exposed individuals, so additional information enhances screening yield

*Steiger D, Siddiqi MF, Yip R et al. The importance of low-dose CT screening to identify emphysema in asymptomatic participants with and without a prior diagnosis of COPD. Clin Imaging. 2021 .78:136-141.
**Rizzo A, Mulshine JL. Thoracic CT screening: using routinely detectable COPD information. Clinical Imaging. 2021. 78: 310-12

Implications of COPD Detection and Characterization

- *COPD is now defined by airflow obstruction, which may be associated with chronic bronchitis, bronchiolitis, or emphysema
- Quantitating the extent of bronchitis or emphysema may involve more than one imaging approach and it is likely that these imaging biomarkers involve different techniques than those used for measuring nodule volume
- Need to flexibly optimize image acquisition and analysis for both diseases without compromising image quality for either
- **COPD has complex biology involving inflammatory dysregulation which is an active area of targeted therapy effort

*American Thoracic Society. Standards for the diagnosis and care of patients with chronic obstructive pulmonary disease. Am J Respir Crit Care Med. 1995;152:S77–S120

**Seijo LM and Zulueta JJ. Understanding the links between lung cancer, COPD and emphysema: A key to more effective treatment and screening. Oncology 2017; 31: 93-100

Quantitative Imaging Biomarker Alliance Profiles for LC/COPD adapted for COVID Detection

- Members of two QIBA profile groups (COPD and LDCT screening) integrated their profiles to optimize the quality of CT imaging of COVID-19*

- This effort laid the foundation for harmonizing their work to enable optimal quantitative assessment of COPD from images acquired for lung cancer screening

- With new USPSTF guidelines an additional 50% more individuals with tobacco-exposure will be eligible for annual screening (eligibility from 9-14M)

- Efficient yet rigorous, standardized approach to image processing key to scalable early disease management quality, which is an ideal setting for pragmatic trials and rapid learning strategies to refine management

Options to Improve Preventive Outcomes with Current Early COPD/Lung Cancer Interventions

- Enhanced measures to encourage smoking cessation

- *Life style modification i.e. increased physical activity

- **Adapting existing COPD management strategies

- Targeted drug therapy research (anti-inflammatory strategies) for disease pre-emption or prevention

*Minihan AK, Patel AV, Flanders WD, Sauer AG, Jemal A, Islami F. Proportion of Cancer
 Cases Attributable to Physical Inactivity by US State, 2013-2016. Med Sci Sports Exerc. 2021 Oct 4.
doi: 10.1249/MSS.0000000000002801. Epub ahead of print. PMID: 34628449.
**Diaz AA, Colangelo LA, Okajima Y et al., Association between Cardiorespiratory Fitness and
Bronchiectasis at CT: A Long-term Population-based Study of Healthy Young Adults Aged 18–30 Years In
the CARDIA Study. Radiology Published Online: Apr 27 2021https://doi.org/10.1148/radiol.2021203874

Why finding fingerprints of pre-symptomatic disease matters?

- *Value of "general health-check" currently modest with potential for harms

- **Lung cancer screening entails annual thoracic CT imaging in a large tobacco-exposed cohort from age 50 onward at-risk for lung CA, CAD, COPD including individuals with social risks & other structural determinants of disease

- The analysis of change in early imaging signatures over time may elucidate other aggressive emerging disease from artifact within an actionable time window

- Systematic analysis of this longitudinal imaging experience with computational tools can elucidate key drivers of major chronic diseases, which can <u>objectively</u> inform the health check conversation

- **Objective evidence of screening benefit in communities with social risk issues may help address "hesitancy" issues with initial screening participation and annual sustained participation to reduce health inequities

*Liss DT, Uchida T, Wilkes CL, et al. General Health Checks in Adult Primary Care. JAMA. 2021;325:2294-2306. doi:10.1001/jama.2021.6524

**Davidson KW, Krist AH, Tseng C-W. Incorporation of Social Risk in USPSTF Recommendations and Identification of Key Challenges for Primary Care JAMA. 2021: 326:1410-1415. doi:10.1001/jama.202112833

Pre-empting Bias in Artificial Intelligence Applied for Thoracic Screening Management –Problem vs. Solution?

- Artificial Intelligence is being applied to improve disease diagnosis and to facilitate complex clinical decisions

- AI tools could introduce bias if tool training data does not represent full relevant features of minority subgroups

- Possibility of incurring bias may be increased by "hesitancy" to share validation data in subgroups unfamiliar with potential AI benefit

Parikh RB, Teeple S, Navathe AS. Addressing Bias in AI in Health Care. JAMA 322: 2377-8, 2019

Developing and Validating Tools to Assist in More Comprehensive Analysis of Thoracic CT (Nodules & COPD)

- Need images with data to allow evaluation that tools work in all settings

- *Complex tool development/validation will involve commercial firms

- **Medical literature describes hesitancy in many individuals with sharing medical data with commercial entities

- Imaging of the thorax may reveal evidence of other chronic diseases: CAD, aneurysms, osteoporosis, breast cancer, metabolic syndrome, NASH…

- Additional imaging targets result in additional work for radiologists, but it is not clear that there are enough radiologists to do just lung cancer screening—how do we expedite comprehensive imaging of the thorax?

*Roberts M, Driggs D, Thorpe M, et al. Common pitfalls and recommendations for using machine learning to detect and prognosticate for COVID-19 using chest radiographs and CT scans. Nat Mach Intell. 3:199-216, 2021
**Baird A, Schuller B. Considerations for a More Ethical Approach to Data in AI: On Data Representation and Infrastructure. Front. Big Data: doi: 10.3389/fdata.2020.00025, 2020

Thoracic CT Detects Coronary Calcium Frequently
-Which Will Not Be a Focus of This Year's Workshop-

*Multi-Ethnic Study of Atherosclerosis (MESA) – validated the value of CT-detected coronary calcium as an informative biomarker for risk of major coronary events

McClelland RL et al. 10-Year Coronary Heart Disease Risk Prediction Using Coronary Artery Calcium and Traditional Risk Factors: Derivation in the MESA With Validation in the Heinz Nixdorf Recall Study and the Dallas Heart Study. J Am Coll Cardiol. 2015 Oct 13;66(15):1643-53.

**SCAPIS evaluated 25,182 randomly selected, asymptomatic 50-64 yr. old individuals with Coronary Computed Tomography Angiography (CCTA) found Coronary Disease in 42%-with 5% significant (stenosis >50%) or severe in 2% (L main stem, LAD, or across 3 vessels)

**Bergström G, Persson M, Adiels M, Björnson E, Bonander C, Ahlström H, et al.. Prevalence of subclinical coronary artery atherosclerosis in the general population. Circulation. 2021; 144:916–929. doi: 10.1161/CIRCULATIONAHA.121.055340

QIW 18 BLOCK TOPIC SESSIONS:

DAY 1

WHAT IS NEEDED FOR THORACIC HEALTH TO FIT INTO POPULATION HEALTH?

How Measurement Drives Population Health Models

TRANSFORMING THORACIC HEALTH FOR EVERYONE – WHAT DOES THE FIELD NEED AND WHAT DO PEOPLE NEED?

Big Data and Vulnerable Populations – Addressing the Gap

Simultaneous Breakout Sessions

Session - 1 *Data Use in the Time of Screening and AI: Defining Consensus, Value, Context and Responsibilities*

Session - 2 *Optimizing Image Quality and Acquisition Parameters to Enable Optimal Lung Cancer Screening with Assessment of COPD and Related Lung Injuries*

QIW 18 BLOCK TOPIC SESSIONS:

DAY 2
ELUCIDATING THE EVOLUTION OF THORACIC DISEASE AS THE
BASIS FOR RATIONAL CLINICAL MANAGEMENT

LUNG CANCER & COPD IMAGING – TECHNICAL IMAGING
GUIDANCE

Closing Breakout Session

Summary, Action Items and Group Discussion

Potential Action Items From this Workshop

- Benefits/harms relationship for LDCT screening could be improved if early detection of asymptomatic COPD embraced

- Endorse early detection of COPD within LDCT screening to allow enhanced intervention efforts for smoking cessation and for increased physical activity to mitigate progression of COPD and Lung Cancer

- Write a radiology editorial on need to separate the compact CT image data optimized for radiologists' visual review from the larger, non-processed CT imaging data needed for optimal computer quantitative analysis review

- Report on technical CT requirements including image quality processes and standardized report structure for the intersection of lung CA and COPD

- Report on the possibility of rapid progress in developing advanced computational tools, such as with artificial intelligence that could improve the reliability, accuracy, efficiency and economy of thoracic CT screening

Thanks to attendees for advancing this discussion

2016 Leadership Award Ceremony with Laurie Fenton Ambrose, Honoree