Royal United Hospitals Bath
NHS Foundation Trust

Quantifying progressive fibrosis using artificial intelligence

BSTI Virtual Annual Meeting 19.11.2020

Dr. P Charters, Dr. G Robinson, Dr. J Suntharalingam,
Dr R Mackenzie Ross, Dr. J Rodrigues
Royal United Hospitals, Bath

Overview

Royal United Hospitals Bath
NHS Foundation Trust

- What is IMBIO?
- Lung Texture Analysis™
  - Example output
- Case presentation
- Discussion
- Summary

imbio

when average isn't good enough

NHS
Royal United Hospitals Bath
NHS Foundation Trust

"a leader in fully automated, biomarker-based solutions for quantitative Lung imaging"

The Problem

- 1 Billion imaging studies are requested in the U.S. and EU alone every year.
- This explosion of imaging hasn't come with the tools radiologists need to see and interpret all of the information
- 99% of imaging diagnosis remains a purely manual human process, one which is increasingly stressed by the demands of growing patient volume and the need to lower healthcare costs.

The Role of IMBIO

- Fully automated solution
- Preserve radiologists time
- Remove interobserver variability (longitudinal change)
- Providing data and visualisation to help make better personalized patient care decisions

imbio

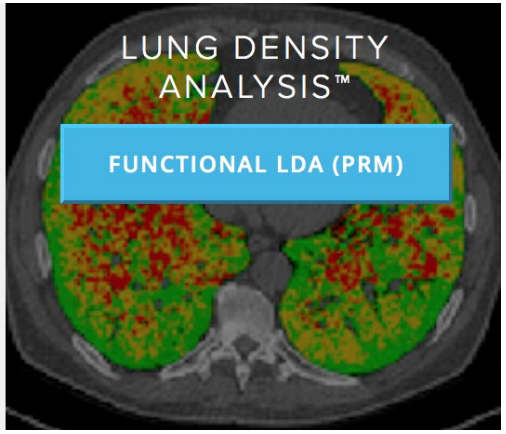
when average isn't good enough

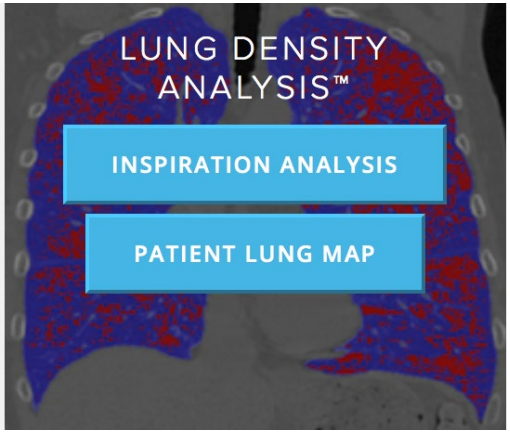
NHS

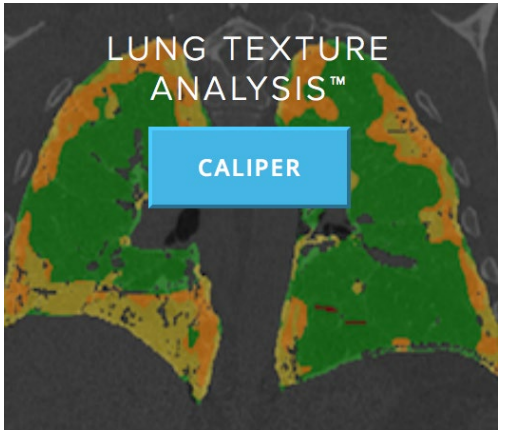
Royal United Hospitals Bath

NHS Foundation Trust

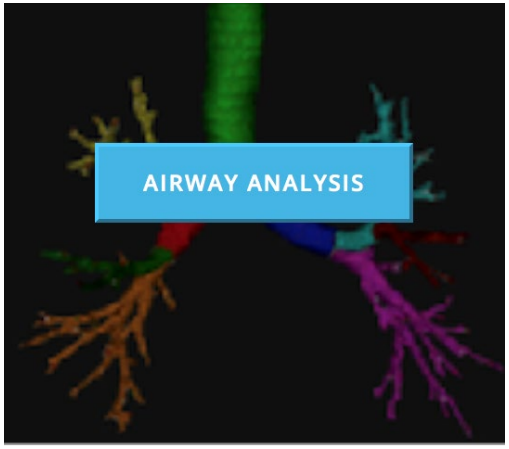
Commercial Algorithms

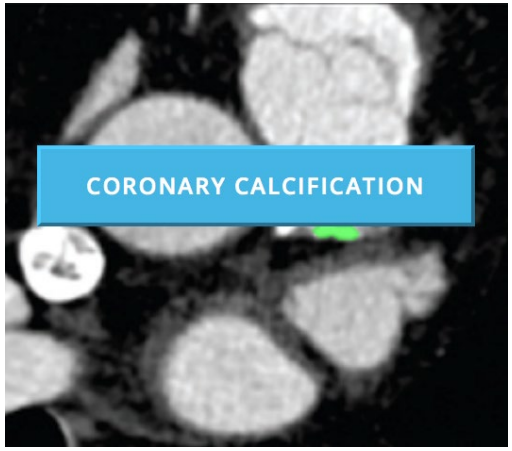


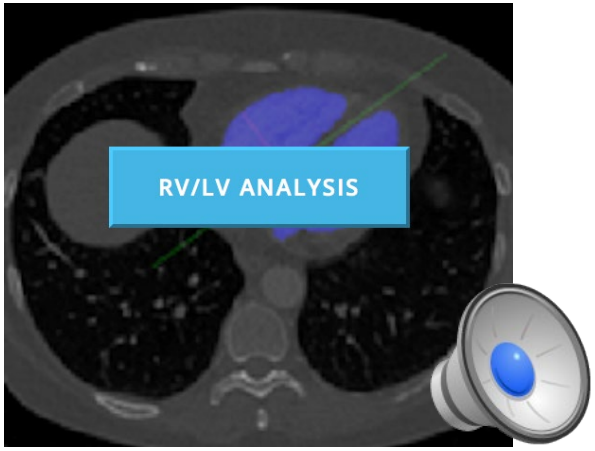




Research Algorithms







imbio

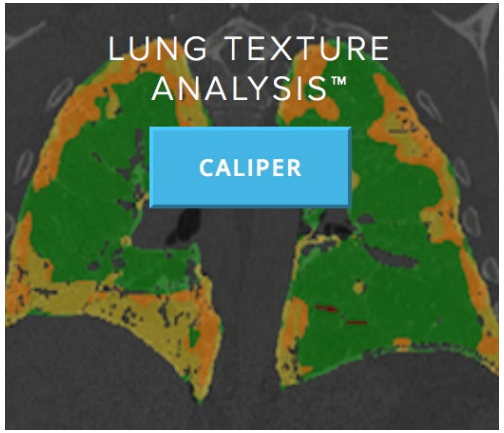
when average isn't good enough

NHS

Royal United Hospitals Bath

NHS Foundation Trust

Commercial Algorithms



Royal United Hospitals Bath
NHS Foundation Trust

Lung Texture Analysis ™

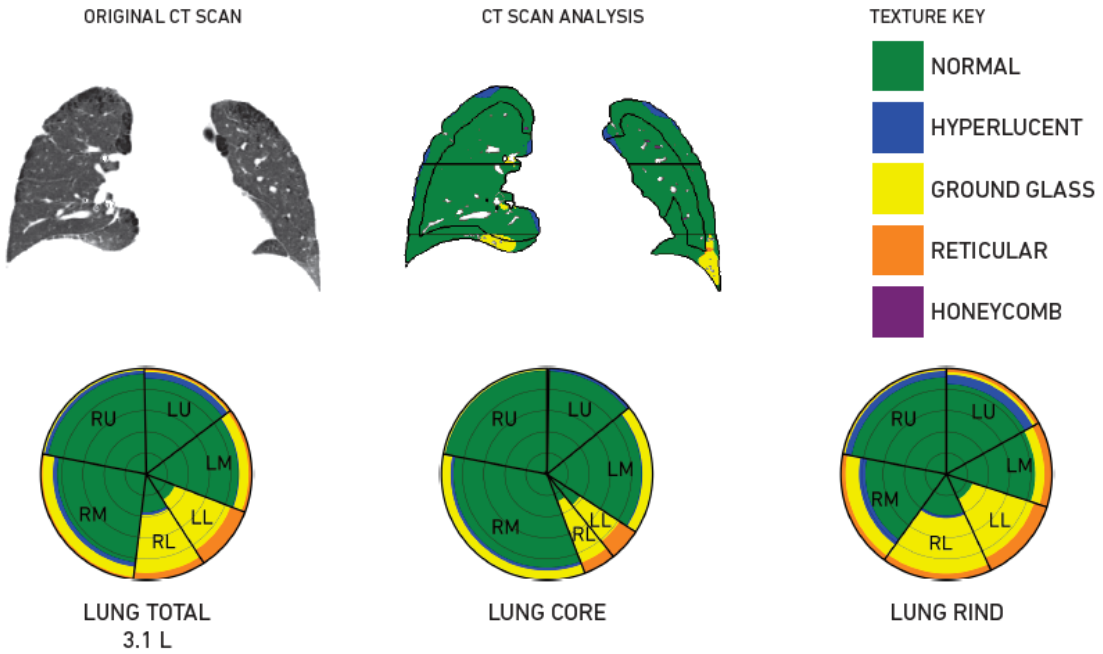
"Algorithms enable clinicians to quickly analyse a patient's lung density and texture. This includes using advanced computer vision to transform a standard chest CT into a detailed map of lung textures in order to identify cases of ILD and other fibrotic conditions."

- Lung Texture Analysis™ is based on CALIPER technology (Computer Aided Lung Informatics for Pathology Evaluation and Rating - Mayo Clinic).
- Post-processing algorithms characterise and quantify lung parenchymal patterns on HRCT
- Fully automated - no user input or intervention.
- LTA's DICOM image series provides an intuitive texture overlay on the patients HRCT
- Quantifies the lung textures that are key to identifying ILD's and other fibrotic conditions (normal, ground glass, reticular, honeycomb and hyperlucent).
- Physician summary report provides detailed quantification of the textures by lung region to help reduce reading variation, and enable data-based decisions for drug therapy, clinical procedures and other personalised patient care.

Example Case

Segmentation algorithm: automatically identify and separate the two lungs from the rest of the body.

Classification algorithm: identify each lung pixel as one of the five lung parenchymal pattern classifications.



SUMMARY

	NORMAL	HYPERLUCENT	GROUNDGLASS	RETICULAR	HONEYCOMB
TOTAL LUNG	77 %	3 %	16 %	4 %	0 %
Left Lung (1.3 L)	75 %	3 %	17 %	5 %	0 %
Left Upper (T/C/R)	90 % / 97 % / 85 %	6 % / 2 % / 9 %	2 % / 0 % / 2 %	2 % / 1 % / 4 %	0 % / 0 % / 0 %
Left Middle (T/C/R)	88 % / 90 % / 84 %	0 % / 1 % / 0 %	9 % / 9 % / 9 %	3 % / 0 % / 7 %	0 % / 0 % / 0 %
Left Lower (T/C/R)	29 % / 37 % / 26 %	0 % / 0 % / 0 %	57 % / 45 % / 61 %	14 % / 18 % / 12 %	0 % / 0 %
Right Lung (1.8 L)	79 %	3 %	15 %	3 %	
Right Upper (T/C/R)	94 % / 97 % / 92 %	3 % / 1 % / 6 %	2 % / 2 % / 1 %	1 % / 0 % / 1 %	0 %
Right Middle (T/C/R)	84 % / 88 % / 76 %	4 % / 3 % / 6 %	10 % / 8 % / 13 %	2 % / 1 % / 4 %	0
Right Lower (T/C/R)	36 % / 27 % / 39 %	2 % / 0 % / 3 %	55 % / 63 % / 52 %	7 % / 10 % / 6 %	0 % / 0 % / 0 %

T = total, C = core, R = rind, T = C + R

Case presentation

- 69 year-old male
- PMHx:
  - Pulmonary embolism 1989 (Rx 3-6/12 anticoagulation)
  - Myocardial infarction x 2 1985, NSTEMI 2019
  - NSIP ILD 2011
  - Diametes mellitus 2012
  - Syncopal episodes on exertion
- DHx: Aspirin, Atorvastastin, Candesartan, Ezetimibe, Lansoprazole, Metformin, Clopidogrel, Bisoprolol, Azithromycin, LTOT 2-3 L/min
- Never smoker, no pets. Occupation: food production industry

- HRCT in 2013: NSIP

Clinical deterioration 2018 - 2019

- Exercise tolerance reducing from half a mile to ~100m
- Lung function:

  Nov 2019: FEV1 1.40 (44%), FVC 1.77 (43%), FEV1/FVC ratio 79%, TLco 2.23 (24%), Kco 0.81 (63%).

  March 2014: FEV1 12.22, FVC 12.73, Kco 1.30.
- Echocardiogram: RV dilatation, septal flattening, RV pressure and volume overload
- CTPA 2019: New pulmonary hypertension. Progressive fibrotic interstitial lung disease.
- Repeat HRCT confirmed fibrotic ILD progressed since baseline.

HRCT 2013

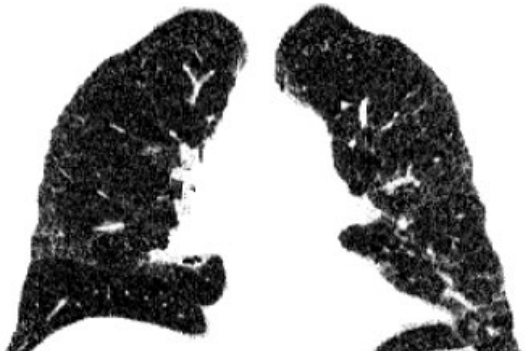
	NORMAL	HYPERLUCENT	GROUNDGLASS	RETICULAR	HONEYCOMB
TOTAL LUNG	85 %	3 %	3 %	9 %	0 %
Left Lung (2.0 L)	85 %	1 %	3 %	10 %	1 %
Left Upper (T/C/R)	95 % / 99 % / 92 %	3 % / 1 % / 5 %	1 % / 0 % / 1 %	1 % / 0 % / 2 %	0 % / 0 % / 0 %
Left Middle (T/C/R)	89 % / 98 % / 74 %	0 % / 0 % / 0 %	3 % / 1 % / 6 %	8 % / 1 % / 20 %	0 % / 0 % / 0 %
Left Lower (T/C/R)	63 % / 83 % / 50 %	0 % / 0 % / 1 %	8 % / 1 % / 12 %	26 % / 10 % / 35 %	3 % / 6 % / 2 %
Right Lung (2.3 L)	85 %	4 %	2 %	8 %	1 %
Right Upper (T/C/R)	97 % / 100 % / 94 %	2 % / 0 % / 4 %	0 % / 0 % / 0 %	1 % / 0 % / 2 %	0 % / 0 % / 0 %
Right Middle (T/C/R)	87 % / 95 % / 67 %	3 % / 3 % / 4 %	2 % / 0 % / 7 %	8 % / 2 % / 22 %	0 % / 0 % / 0 %
Right Lower (T/C/R)	68 % / 85 % / 60 %	8 % / 6 % / 9 %	5 % / 0 % / 7 %	18 % / 7 % / 23 %	1 % / 2 % / 1 %

HRCT 2019

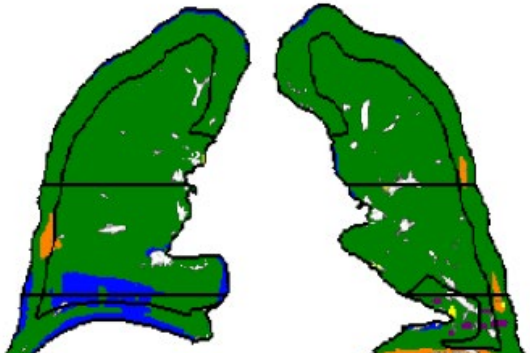
	NORMAL	HYPERLUCENT	GROUNDGLASS	RETICULAR	HONEYCOMB
TOTAL LUNG	66 %	1 %	8 %	25 %	0 %
Left Lung (1.4 L)	56 %	1 %	12 %	31 %	0 %
Left Upper (T/C/R)	89 % / 97 % / 83 %	1 % / 0 % / 1 %	2 % / 0 % / 3 %	8 % / 3 % / 13 %	0 % / 0 % / 0 %
Left Middle (T/C/R)	35 % / 50 % / 15 %	1 % / 2 % / 0 %	20 % / 13 % / 29 %	44 % / 35 % / 56 %	0 % / 0 % / 0 %
Left Lower (T/C/R)	15 % / 16 % / 14 %	0 % / 0 % / 0 %	22 % / 15 % / 25 %	63 % / 68 % / 61 %	0 % / 1 % / 0 %
Right Lung (1.7 L)	74 %	1 %	4 %	21 %	0 %
Right Upper (T/C/R)	94 % / 100 % / 89 %	1 % / 0 % / 1 %	0 % / 0 % / 1 %	5 % / 0 % / 9 %	0 % / 0 % / 0 %
Right Middle (T/C/R)	71 % / 85 % / 39 %	1 % / 1 % / 1 %	4 % / 2 % / 11 %	23 % / 12 % / 47 %	1 % / 0 % / 2 %
Right Lower (T/C/R)	39 % / 47 % / 36 %	0 % / 0 % / 0 %	13 % / 7 % / 15 %	48 % / 45 % / 49 %	0 % / 1 % / 0 %

T= total, C= core, R= rind, T= C & R

2013 HRCT



LTA^{TM} Analysis

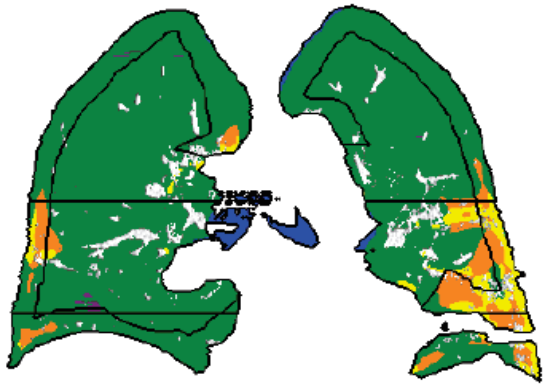


TEXTURE KEY

- NORMAL
- HYPERLUCENT
- GROUND GLASS
- RETICULAR
- HONEYCOMB

2019 HRCT

LTA^{TM} Analysis



Discussion

- LTA pattern = ILD diagnosis
- Radiological interpretation currently subjective.
- Clinical utility: Patient cannot reliably perform pumonary function test
  Pulmonary function testing is unsafe (aerosol generating procedure)
- LTA is quantitative and can plot longitudinal change (including treatment response)
- Potential Prognostic Value: Correlations to Lung Function & Survival
- Future: baseline and change in % fibrosis correlated with RVLV and PH outcome would be interesting.

Summary

- Quantitative Lung Texture Analysis™ aids diagnosis, removes subjective interobserver variability, may prognosticate outcome and more accurately assess treatment response.
- Lung Texture Analysis™ is invaluable when the patient cannot reliably perform pulmonary function tests and/or where pulmonary function tests are associated with the risk of COVID-19 transmission.

Royal United Hospitals Bath
NHS Foundation Trust

References & Acknowledgement

1. We would like to acknowledge the technical support provided by Imbio LLC during the quantitative analysis of chest CT scans
2. V Zavaletta, BJ Bartholmai, R Robb. High Resolution Multi-Detector CT Aided Tissue Analysis and Quantification of Lung Fibrosis. Acad Radiol. 2007 July ; 14(7): 772–787.
3. Maldonado, Moua, et al. Automated quantification of radiological patterns predicts survival in idiopathic pulmonary fibrosis. Eur Respir J 2014; 43: 204–21
4. Raghunath, Moua, et al. Correlation of Quantitative Lung Tissue Characterization as Assessed by CALIPER With Pulmonary Function and 6-Minute Walk Test. Chest. 2011;140(4_MeetingAbstracts):1040A
5. Guidelines for recommencing physiological services during the Coronavirus Disease 2019 (COVID-19) endemic phase [Internet]. Artp.org.uk. 2020 [cited 8 November 2020]. Available from: https://www.artp.org.uk/write/MediaUploads/Standards/COVID19/ARTP_COVID19_endemic__guidance_Vers_5.6_final.pdf