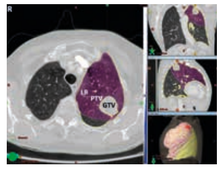
BY TUGBA AKINCI D'ANTONOLI

Hidden in plain sight: radiomics helps predict lung cancer prognosis on CT



Radiomics analysis in this study entailed for each patient with NSCLC three 3D regions of interest on CT images: gross tumoural volume (GTV), peritumoural volume (PTV), and lobe (LB), where tumour resided.

When in 1814 German physicist and optical lens manufacturer Joseph von Fraunhofer invented the spectroscope, he trained his instrument on the sun. He ended up identifying hundreds of fixed dark lines in the solar spectrum. It took 45 years and two other German scientists, Gustav Kirchoff and Robert Wilhelm Eberhard Bunsen, to explain the significance of the patterns of these dark lines: they were light absorbed by chemical elements such as iron, calcium, and sodium in the atmosphere of the sun. Fraunhofer had given astronomy a revolutionary tool, which disclosed the chemical composition of stars by their light but it was only after another 4 ½ decades of development that science was able to make sense of the information first acquired by Fraunhofer.

Starting from its inception in the early 1970s, CT has been capable of showing basic tissue characteristics on sectional images. Now, in the same way as Kirchoff and Bunsen were able to expand on Fraunhofer's technology, the processing capacity of computers has reached a level where it is now possible to glean much more detailed information about tissues imaged with CT. A new field of study, named 'radiomics' and aiming to extract large amounts of quantitative features from medical images, is now emerging. Radiomics has the potential to decipher disease characteristics that are impossible to be discerned by the naked eye alone.

During my 2016–2017 ESOR Fellowship year at the radiology department of Catholic University of the Sacred Heart in Rome, Italy, I worked as part of a team applying radiomics to a major clinical problem: lung cancer, which is the leading cause of cancer-related deaths. Non-small cell lung cancer (NSCLC) is the most common histologic type where surgery is the curative treatment for the early-stage (stages I and II) and also a palliative treatment for the locally advanced (stage IIIA) disease. Despite treatment, however, 30%–55% of patients develop a recurrence.

Conventional use of imaging modalities provides a relevant and valuable contribution to diagnosis, staging, and treatment planning, yet prognostic information remains mostly unrevealed. Radiomics features, on the other hand, offer novel information on tumour characteristics as well as the tumour's environment, which may be related to tumour behaviour and response to therapy. In our study our aims were two-fold: first, to design a recurrence prediction model by using the radiomics analysis of tumour and peritumoural regions on pre-surgical CT scans in NSCLC patients. Second, to establish a risk-scoring system with the combination of the patient's clinicopathological risk factors and radiomics signature.

We retrospectively enrolled 124 patients with pathologically confirmed NSCLC at TNM stages I to IIIA, who were surgically treated. We showed that radiomics analysis of tumour and peritumoural lung parenchyma on CT images helps predict NSCLC recurrence and stratify patients at risk, thereby enabling a personalised treatment. Further studies with a larger sample size, prospective in nature, and with multicentric collaboration are necessary to optimise radiomics for lung cancer patients before its routine clinical usage. We are on the threshold of an era where radiomics promises to help determine prognosis from a multitude of data hidden inside the images that until recently showed to our naked eyes lesions but did not necessarily tell about their outcomes.

Dr. Tugba Akinci D'Antonoli was ESOR Thoracic Radiology Research Fellow at the Catholic University of the Sacred Heart in Rome, Italy. She is a student at Harvard Medical School, Global Clinical Scholars Research Training Program now.

Scientific Session: Chest

Friday, March 2, 10:30–12:00, Room O
SS 1004 Artificial intelligence in chest imaging

Moderators: F. Doellinger; Berlin/DE
J. Jacob; London/UK

» **Keynote Lecture**
J. Jacob; London/UK

» **Radiomics signature for non-small cell lung cancer recurrence risk prediction after surgery: quantitative analysis of the tumour and peritumoural lung parenchyma on presurgical MDCT**
T. Akinci D'Antonoli, A. Farchione, J. Lenkowicz, M. Chiappetta, G. Cicchetti, A.R. Larici, V. Valentini, L. Bonomo, R. Manfredi; Rome/IT

BY JOHN DAMILAKIS

EUCLID: a European Commission project on clinical dose reference levels

EUCLID European Study on Clinical DRLs

Different image qualities are needed for different clinical indications of the same anatomical area. A kidney stone evaluation, for example, can be performed using a lower radiation dose than it would be required for an evaluation of appendicitis. This is because the detection of high-contrast structures is less affected by high image noise than low-contrast structures. Clinical indications dictate the main parameters that affect patient dose from CT such as scanning length, collimation and number of phases. Therefore, dose reference levels (DRLs) should be specified for a given clinical indication. The European Commission (EC) launched the 'European study on clinical diagnostic reference levels for x-ray medical imaging' (acronym: EUCLID) project to provide up-to-date clinical DRLs.

The EUCLID project is led by the European Society of Radiology (ESR). The ESR experts involved in the project are Prof. John Damilakis (project manager), Prof. Guy Frija (project co-manager), Prof. Werner Jaschke, Prof. Graciano Paulo, Dr. Jacques Repussard, Dr. Alexander Schegerer and Dr. Virginia Tsapaki. This project is also supported by the ESR Office.

The main objectives of this project are to: (a) conduct a European survey to collect the data needed to establish DRLs for the, from the radiation protection perspective, most important x-ray imaging tasks in Europe; and (b) to specify up-to-date DRLs for these clinical tasks. Moreover, a workshop will be organised to disseminate and discuss the results of this project with Member States and the relevant national, European and international stakeholders. The workshop will also identify the need for further national and local actions on establishing, updating and using DRLs.

To fulfil these objectives, this project will rely on:

1. An External Advisory Panel that has been set-up to be consulted on the main project activities and outcomes;
2. A Scientific Board that has been set-up to verify the used data sources;
3. Interaction with the Steering Group established by the European Commission's Directorate-General for Energy with other directorates concerned to review and approve the reports and the study;
4. A network of EuroSafe Imaging Stars hospitals and their experts.

The project is divided into five work packages (WPs). Each of these WPs covers specific tasks leading to the common objective to carry out a European study on clinical DRLs for x-ray medical imaging. WP1 covers the management and general coordination of the project, as well as communication and dissemination activities. WP2 is responsible for the identification of procedures and clinical indications for which DLRs will be established, as well as for review of existing DRLs. WP3 covers the implementation of a European DRL survey for CT and interventional radiology (IR) using a predefined methodology. WP4 is responsible for specifying up-to-date European clinical DRLs for the protocols/imaging tasks identified under WP2 and the stakeholder consultation/validation of these DRLs. WP5 covers the organisation of the workshop to disseminate and discuss the results of the project with stakeholders and to identify the need of further national and local actions on establishing, updating and using DRLs.

The EUCLID project started on August 1, 2017. During the first few months of the project, a comprehensive review was carried out to identify the status of existing clinical DRLs for CT, interventional radiology and radiography in Europe and beyond by analysing recent studies, standards and publications. Information about existing clinical DRLs was also collected from national competent authorities and other organisations involved in the project.

So far only a few national radiation protection authorities have defined a limited number of DRLs for different clinical indications. Although a large number of studies on doses from x-ray imaging are available, there is very limited information about clinical-indication specific DRLs. Therefore, the ESR developed a survey to collect the data needed to establish DRLs. Data will be collected for the CT clinical indications and fluoroscopically guided interventional procedures identified by WP2.

The project has received funding from the European Commission under Service Contract No° ENER/2017/NUCL/SI2.759174.

To learn more about clinical DRLs and the EUCLID project, participate in the EuroSafe Imaging session today at 14:00–15:30 in Room M1.

John Damilakis is full professor and chairman at the Department of Medical Physics, Faculty of Medicine, University of Crete, and director of the Department of Medical Physics of the University Hospital of Iraklion, Crete, Greece. He is president of EFOMP as well as the EURAMED research platform, chairman of the International Organization for Medical Physics (IOMP) Education and Training Committee and a member of the Board of Directors of International Medical Physics Certification Board (IMPCB).

EuroSafe Imaging Session

Friday, March 2, 14:00–15:30, Room M 1
EU 3 Clinical diagnostic reference levels for x-ray medical imaging

Chairpersons: J. Damilakis; Iraklion/GR
G. Frija; Paris/FR

» **Chairpersons' introduction and update on the project on clinical DRLs for x-ray medical imaging**
J. Damilakis; Iraklion/GR
G. Frija; Paris/FR

» **The concept of diagnostic reference levels (DRLs)**
E. Vaño; Madrid/ES

» **The concept of clinical diagnostic reference levels (DRLs)**
G. Frija; Paris/FR

» **An update on current European diagnostic reference levels (DRLs) in adult imaging**
J. Damilakis; Iraklion/GR

» **An update on current paediatric diagnostic reference levels (DRLs)**
C. Granata; Genoa/IT

» **The concept of local diagnostic reference levels (DRLs)**
N. Saltybaeva; Zurich/CH

» **Panel discussion**
J. Damilakis; Iraklion/GR
G. Frija; Paris/FR
E. Vaño; Madrid/ES
J.N. Vassileva; Vienna/AT
M.R. Perez; Geneva/CH

This session is part of the EuroSafe Imaging campaign.