

#ECR2019: Imaging informatics management & performance



Professor [Luis Donoso-Bach](#), head of the department of medical imaging, Hospital Clinic of Barcelona, presented the keynote lecture “ *Artificial Intelligence and Machine Learning Informatics: management and performance analysis.*” It his poignant and informative presentation he emphasised “**the race is on**” as the roles in the healthcare continuum are shifting.

The way towards the future is through partnership with patients that perceive and value the radiologist's contribution to their care, consolidated equipment suppliers and physicians that value the contribution of Radiology. He said this partnering will replace patients who don't trust **radiologists** and physicians, general IT suppliers and physicians who do not value the contribution of radiology to the patient care team.

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Professor Donoso continued to highlight the objective to improving and moving forward in the practice of radiology with the help of diagnostic support tools as opposed to the theory of replacing radiologists by making diagnosis directly from the image and analysis of the patient's information.

“**10 years from now probably no medical imaging will be reviewed by a radiologist before it has been previously pre-analyzed by a “machine.” Artificial intelligence will replace most, if not all, of the quantification tasks currently performed by radiologists,**” Prof. Donoso said and concluded, “**the improvement of efficiency provided by AI will result in less need for radiologists.**”

[Oleg Pinykh](#), director of Medical Analytics, Department of Radiology at Massachusetts General Hospital presented their study to investigate whether they can predict ED examination volume surges several hours in advance, so that additional resources can be allocated to keep ED reporting on time.

Complex and unpredictable **ED workflow calls for advanced prediction tools**, therefore **machine learning** was chosen. ED department defined 7 unread CT cases as overload threshold, leading to stress and delays. “We **developed a logistic predictive model to forecast the probability** of overload several hours in advance” he said and added, “a full year of historical ED data was used to account for seasonal trends. **More than 100 predictive** features were derived from the HIS data, including current time and date, **number of active radiologists**, patient and examination counts and types, examination complexity scores, and more. Several machine-learning algorithms were evaluated to find the model with the optimal predictive quality.”

Random forest model provided the most accurate prediction, 79.5% accurate for 2-hour prediction. These results were found to be very satisfactory and sufficient for decision-making. **Large and noisy ED workflow data** presents **a perfect target** for machine-learning applications. Workflow overload predictions enable optimised resource management, help avoid stressful overloads, keep critical diagnostic time to the minimum.

Professor [Vidur Mahajan](#), Centre for Advanced Research in Imaging, Neuroscience and Genomics, Mahajan Imaging, New Delhi, presented a talk on the development and validation of **deep learning algorithms** for medical imaging and their requiring access to large organised datasets of images and their corresponding reports. **Currently, most medical imaging data in the world are unorganised and require images and text reports to be manually linked.** He presented an approach for linking medical images and reports of patients, where no unique identifier for linking them exists.

A **DICOM** image database of **311,694** studies and a separate **mySQL** database with **296,938** reports needed to be matched at study level. No unique identifier existed to link the two databases and not all reports had matching images, and there was only partial overlap between the databases. Additionally, patient names were inexactly entered with varied formats in the two databases making direct matching impossible. **Fuzzywuzzy Python library**, which incorporates **fuzzy string matching**, a technique based on **Levenshtein** distance between strings to estimate text similarity was used to match patient name in the two databases following date and modality-level filters. Four fuzzy matching techniques (simple, partial, token-set and token-sort ratios) were evaluated.

The results found simple, partial, **token-set** and **token-sort** ratios gave 4.56%, 46.45%, 57.37% and 7.97% matches of reports, respectively, with 95% match confidence. Token set ratio, which had the highest match percentage, matched 170,336 reports to their corresponding studies.

He concluded by stating that Fuzzy matching is a promising technique to merge independent datasets without unique identifiers, saving thousands of man-hours, critical for development and validation of DL algorithms.

Professor [Martin Mauer](#), Department of Diagnostic, Interventional and Pediatric Radiology Inselspital, University of Bern, talked about how to

analyse the **changes in radiologists' work profiles** and the reporting time after the implementation of a professional **subspecialisation** in the radiology department of a Swiss university hospital.

In a retrospective analysis, the overall number of different radiologic examinations performed in the department of radiology of a large Swiss university hospital were documented for 2014 and 2016 before and after the implementation of subspecialised reporting (subspecialities: abdominal, musculoskeletal, cardiothoracic, emergency, and paediatric imaging) in May 2015.

For six selected radiologists the number and types of reported examinations as well as the related radiology report turnaround times (RTATs) were analysed in detail and compared between the two 1-year periods.

Overall, there was a significant increase of 10.3% in the total number of examinations performed in the whole department in 2016 compared with 2014. For 4 of the 6 radiologists, the range of different types of examinations significantly decreased with the introduction of subspecialised reporting ($p < 0.05$). Furthermore, there was a significant change in the subset of the ten most commonly reported types of examinations reported by each of the 6 radiologists. Mean overall RTATs significantly increased for 5 of the 6 radiologists ($p < 0.05$).

Implementation of subspecialised reporting led to a change in the structure and a decrease in the range of different examination types reported by each radiologist. Mean RTAT increased for most radiologists. Subspecialised reporting allows the individual radiologist to focus on a special field of professional competence but can result in longer overall **RTAT**.

[Péter Szatmári](#), MRI Programme Manager [Affidea](#), talked about how to optimise operational performance using an advanced imaging analytics platform in combination with lean management concepts. Affidea is operating the public hospital of Walbrzych through a public-private partnership scheme, where the **MRI** scanner was connected to the MR Excellence Platform **to monitor in real-time** several key performance indicators including number of exams, examination time, non-scanning time and image resolution.

Several **interventions** in the operational level were done following the six sigma and Kaizen philosophy to eliminate waste. The main interventions included elimination of free slots in the daily schedule, continuity of exam bookings, **implementation of pre-built monthly scheduler** and grouping of similar exams in designated scheduling blocks. All relative inputs were extracted from the **MR Excellence Platform**.

There was a significant reduction in the waiting time to perform an exam from 8 days to 1.78 days after the implementation of the Operational Optimization project, while the average number of daily exams performed raised from 24.5 to 28.4 after the optimization of MRI protocols. All new sequences were evaluated in terms of diagnostic efficiency and image quality and approved by the local radiologists.

“Imaging analytics-powered operational optimization can result in significant improvement in operational efficiency of an MRI department maintaining high diagnostic standards” said Péter Szatmári.

Dr. [Yiftah Barash](#), Sheba Medical Center, Diagnostic Imaging Department, Sackler Faculty of Medicine, Tel Aviv University, discussed how **alerting on pathological findings** in imaging reports is a quality measure. He said they compared two NLP algorithms for flagging pathological head CT reports: the bag of words (BOW) algorithm and the long short-term memory (LSTM) deep learning algorithm.

Institutional review board approval was granted. The BOW model is used for text classification where the frequency of occurrence of each word is used as a feature for training a classifier. LSTM is a neural network that has some internal contextual cells that act as long-term or short-term memory cells. The output of the LSTM network is modulated by the state of these cells. This can be utilized in NLP as the sequence of words in a paragraph has contextual meaning.

They collected consecutive **head CT** non-English (Hebrew) reports performed in their **ER** during annual January and February (2013 - 2017). Each report was labeled as either normal or pathologic (e.g. haemorrhage, infarct, mass). All the words in the dataset were **tokenized**. The **BOW** algorithm used **unigrams** and **bigrams** as features. For the **LSTM** network, they embedded each word after **tokenization**, MLP over the last hidden layer and **cross-entropy** loss for training. The algorithms' performances were assessed using the accuracy metrics.

They retrieved 5,890 head CT reports. The incidence of pathological findings was 55%. The algorithm BOW algorithm showed an accuracy of 87.5% and the LSTM algorithm showed an accuracy of 89.1%.

The LSTM algorithm showed improved accuracy over the classic BOW algorithm on non-English reports.

Professor [Hiroshi Kondoh](#), Medical Informatics Division, Tottori University Hospital, Japan presented explained how their **EPR** and **PACS** sharing systems demanded interoperability and quick viewing even on the Internet. They developed that sharing system with IHE-XDS and XDS-I and cloud technology.

Global standard IHE-XDS and XDS-I was introduced on centre cloud server and thin-client infrastructure with one registry server. It was a connected EPR server and DICOM server of eighteen regional hospitals and gathered HL7 based data and DICOM images. It showed the data and images on thin client infrastructure and IP-sec VPN through the Internet. The image display time of the sharing system though the internet seemed to be faster than intra-hospital PACS with RAID disc and gigabit ethernet. The display times were measured by video data and compared the sharing system access from PC with iPhone tethering and from PC in Heidelberg conference through Internet with intra-hospital PACS.

The display times were 0.627 seconds (0.37-0.86) in intra-hospital PACS, 0.228 seconds (0.23-0.27) in the sharing system access with iPhone tethering, 0.250 seconds (0.198-0.297) access from PC in Heidelberg.

The thin client system was said to reduce the network load to 1/1000 and large flash memory dramatically reduced data access in the server. So even if Internet used, the display time seemed to be faster than intra-hospital PACS; because the thin client system is sending the subtraction image on same matrix size, there are no data reduction in black and white image.

Dr. [Adrien Vavasseur](#), Université Toulouse III - Paul Sabatier, talked about a **shift in student's behavior** that has been observed in medical schools. **Medical school students** (MSs) are **millennials** and part of a new 'YouTube' generation. Their purpose, he explained, is to measure the **impact of a combination of educational resources as a blended learning** (short video-based lecture (VBL), as part of the flipped classroom) among three promotions of MSs from our university hospital.

Dr. Vavasseur and his team conducted three consecutive promotions and performed a pre-test, based on abdominal imaging (respectively 102, 93 and 109 students). Then, the participants had access to 61 VBLs focused on abdominal imaging (total duration of 5h 11m). VBLs were available over a period of 5 months via a dedicated educational online platform. Finally, MSs performed a post-test and a face to face course to correct it.

The efficiency of this teaching format was measured quantitatively by a post-test and learner analytics, as well qualitatively (direct learner

feedback using student's satisfaction questionnaire).

The results found that blended learning combining VBLs and face to face final course significantly improved student results. The average post-test results was 77.2% and significantly higher than the pre-test (53.8%; Student t-test: $P < 0.001$). Satisfaction surveys about this format showed that 99% of students were satisfied or very satisfied by this e-learning training. The amount of videos views was 91 views per student (average) and a total of 27662 views. Moreover, students adherence to this medical education format increased across promotions.

“The flipped classroom based on short video based lecture attracts medical students, improves their performances in radiology and obtains their adherence” concluded Dr. Vavasour.

Dr. [Naglis Ramanauskas](#) , co-Founder, and Chief Medical Officer at Oxipit presented *“Deep learning based chest x-ray whole image search and retrieval.”*

“A typical hospital currently possesses more than a decade worth of digital radiological images with their radiological descriptions in the PACS/HIS system” he said, **“we aimed to create a radiological chest x-ray search system”** he said.

“In our solution, a deep learning neural network trained on a large set of radiographs with respective radiological findings is used in order to index the images.” This indexing process takes into account not only the pathology, but also the **localization** of the **pathology**, and the overall features of the **radiograph**. In order to quantify the quality of the search system, a radiology resident was presented with a set of 77 challenging chest x-ray images. Each of the reference images was subsequently indexed by the search system, and used to retrieve 10 radiographs from the hospital database of more than **200,000** images. A **radiology resident** was asked to evaluate and write reports for each of the images initially without assistance. After each report they were asked to review the returned search matches and modify the report if he found it necessary. They evaluated the initial and the modified reports and extracted statistics.

The report was modified after inspecting search matches for 56/77 cases. The impression was modified after inspecting search matches for 50/77 cases. The differential diagnosis was expanded for 28/77 cases. An image search solution for frontal chest x-ray images based on a Deep Learning model has been created.

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