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OP0058-PARE **MY SJÖGREN'S DIARY: AN ONLINE PATIENT PORTAL FOR PATIENT LED SJÖGREN'S SYNDROME RESEARCH**

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Background: Sjögren's Syndrome is a chronic autoimmune disease affecting the exocrine glands accompanied by variable extra-glandular manifestations. Symptom flares, including dry eyes, dry mouth, dry skin, fatigue, myalgia and arthralgia, are frequent. Many of these symptoms have a considerable impact on quality of life, but are variable, sensitive to external factors, and difficult to measure objectively.

Clinical research on Sjögren's Syndrome is advancing with the help of patient registries: an array of clinical data is collected and available for approved studies. However, many of these registries focus on collecting clinical information and often fail to capture the diverse patient experience adequately. Thus, there is an unmet need for an online 'patient portal', secure and encrypted with the capability of interacting with existing registries, while also patient-facing to encourage active involvement in research and personal healthcare. Patient demand for this resource was highlighted in 2017 when the Cambridgeshire regional support group of the British Sjögren's Syndrome Association (BSSA) contacted the Patient Led Research Hub (PLRH). The PLRH provides research expertise to co-produce research ideas with patient organisations¹; the PLRH and Cambridgeshire group have since secured funding and initiated work on this project with the Cambridge Clinical Trials Unit.

Objectives: Develop 'My Sjögren's Diary' a cross-platform patient portal to:

1. Act as an interactive tool to help patients manage their healthcare needs and aid communication with healthcare providers.
2. Function as a research platform, enabling patients to consent to contact, as well as support home-based data entry, allowing real-time capture of symptom scores and ensuring ease of participation for patients. Link with the UK Primary Sjögren's Syndrome Registry and NHS Digital to provide complementary clinical datasets.

Methods: The PLRH has coordinated a team of rheumatologists, database programmers, patients and family members to develop My Sjögren's Diary. Regular meetings, national surveys and correspondence with patients ensures the project remains relevant to patient needs, while collaborating with rheumatologists ensures the database is reliable, valid and of benefit to clinical care. Workshops hosted at key stages of database development have allowed both patients and rheumatologists to direct and refine My Sjögren's Diary. A prototype was presented at the 2019 BSSA Annual Conference before further improvements and beta release.

Results: A beta version of My Sjögren's Diary enabling BSSA members to track their medication and symptoms is now active. Feedback will be incorporated into the final version before it is publicly available to Sjögren's Syndrome patients. Further funding is required to develop the research platform.

Conclusion: My Sjögren's Diary encourages equal partnership between patients, clinicians and researchers. It presents a unique opportunity for comprehensive analysis of Sjögren's Syndrome and associated health utilities. Research participation is not mandatory, encouraging all patients to have an active role in personal healthcare management.

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Artificial intelligence and machine learning in imaging of rheumatology: Are we ready?

OP0059 **AUTOSCORA: DEEP LEARNING TO AUTOMATE SCORING OF RADIOGRAPHIC PROGRESSION IN RHEUMATOID ARTHRITIS**

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Background: The prevention of joint destruction is an important goal in the management of rheumatoid arthritis (RA) and a key endpoint in drug trials. To quantify structural damage in radiographs, standardized scoring systems¹, such as the Sharp/van der Heijde (SvdH) score², which separately assesses joint space narrowing (JSN) and erosions, have been developed. However, application of these scores is time-consuming, requires specially trained staff, and results are subject to considerable intra- and inter-reader variability¹. This makes their application poorly feasible in clinical practice and limits their reliability in clinical trials.

Objectives: We aim to develop a fully automated deep learning-based scoring system of radiographic progression in RA to facilitate the introduction of quantitative joint damage assessment into daily clinical practice and circumvent inter-reader variability in clinical trials.

Methods: 5191 hand radiographs and their corresponding SvdH JSN scores from 640 adult patients with RA without visible joint surgery were extracted from the picture archive of a large tertiary hospital. The dataset was split, on a patient level, into training (2207 images/270 patients), validation (1150/133), and test (1834/237) sets. Joints were automatically localized using a particular deep learning model³ which utilizes the local appearance of joints combined with information on the spatial relationship between joints. Small regions of interest (ROI) were automatically extracted around each joint. Finally, different deep learning architectures were trained on the extracted ROIs using the manually assigned SvdH JSN scores as ground truth (Fig. 1). The best models were chosen based on their performance on the validation set. Their ability to assign the correct SvdH JSN scores to ROIs was assessed using the unseen data of the test set.

Fig. 1. 3-step approach to automated scoring: joint localization, ROI extraction, JSN scoring.

Results: ROI extraction was successful in 96% of joints, meaning that all structures were visible and joints were not malrotated by more than 30 degrees. For JSN scoring, modifications of the VGG16⁴ architecture seemed to outperform adaptations of DenseNet⁵. The mean obtained accuracy (i.e., the percentage of

joints to which the human reader and our system assigned the same score) for MCP joints was 80.5 %, that for PIP joints was 72.3 %. In only 1.8 % (MCPs) and 1.7 % (PIPs) of cases did the predicted score differ by more than one point from the ground truth (Fig. 2).

Fig. 2. Confusion matrices of automatically assigned scores ('predicted score') vs. the human reader ground truth ('true score').

Conclusion: Although a number of previous efforts have been published, none have succeeded in replacing manual scoring systems at scale. To our knowledge, this is the first work that utilizes a dataset of adequate size to apply deep learning to automate JSN scoring. Our results are, even in this early version, in good agreement with human reader ground truth scores. In future versions, this system can be expanded to the detection of erosions and to all joints contained in the SvdH score.

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OP0060 MACHINE LEARNING BASED BERLIN SCORING OF MAGNETIC RESONANCE IMAGES OF THE SPINE IN PATIENTS WITH ANKYLOSING SPONDYLITIS FROM THE MEASURE 1 STUDY

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Background: Magnetic resonance imaging (MRI) offers a non-invasive and objective method of early diagnosis and classification, monitoring disease burden and treatment response for patients (pts) with axial spondyloarthritis (axSpA) including ankylosing spondylitis (AS).¹ Numerous scoring schemes such as the AS Spine MRI Activity (ASSpMRIa) score are available for the quantitative assessment of MRI, but are subject to intra- and inter-rater variability, labor intensive and costly. Nevertheless, quantification of MRI changes has become an important tool to demonstrate treatment success of biologic drugs in axSpA.

Objectives: To evaluate the performance of machine learning (ML) based software for automated Berlin grading of spinal MRI bone marrow oedema in pts with AS and compare with expert scoring.

Methods: Fully automated ML software (Figure) was developed to detect and label 23 vertebrae, define vertebral units (VU) as per the Berlin modification of the ASSpMRIa score, and score each VU as either 0 (score of 0) or 1 (score of 1, 2 or 3). The ML algorithm was based on the previously developed SpineNet software.² Analysis included 108 pts from the secukinumab MEASURE 1 study³, in which imaging was done using T1 and STIR sagittal MRI at baseline and Weeks 16, 52, 104, 156 and 208. Two expert readers, blinded to treatment and visit, evaluated all images by ASSpMRIa score. The scores from Reader 2 (R2) were binned into two groups: 0 vs 1, 2, or 3. As a result of multiple pt time points and expert reading sessions, the complete dataset comprised of 10,988 VU. Ten-way cross-validation at per-VU was used to train and validate the ML software. The dataset was split into 10 randomly selected subsets, ensuring that each pt appears in only one subset, after which 8 subsets were used for training the ML software, 1 was used to check for correct training and 1 was used for validation. The process was repeated ten times such that all 10 subsets were used for validation. Accuracy weighted for the frequency of each category, sensitivity and specificity were calculated using scores from R2 as reference. Intra-reader accuracy was also calculated.

Results: Accuracy of the software in relation to expert reader scores was 67% with a sensitivity of 0.63 and specificity of 0.70. The intra-reader accuracy was 71% and 77% for R1 and R2, respectively. Individual VU scoring of the Software vs. R2 are presented in the Table as a confusion matrix.

Conclusion: Automated scoring of MR images in AS pts provided moderate agreement to that of expert reader-based assessments. ML software has potential to provide an automated guided-reading approach to scoring MR images, which may enable further clinical insights.

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Figure. Processing pipeline of automated Berlin scoring software

Table. Confusion matrix between the software and R2

	Software Score = 0	Software Score = 1, 2 or 3	Total VU scored
R2 Score = 0	7199 (70%)	3068 (30%)	10,267
R2 Score = 1, 2 or 3	251 (35%)	475 (65%)	726
	7,450	3,543	10,993

Percentages calculated as a fraction over the total in each row. Overall accuracy is the average of the highlighted percentages.

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