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Assessment of automatic decision-support systems for detecting active t2 lesions in multiple sclerosis patients

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Background: New T2 lesions count is routinely used for assessing disease activity in multiple sclerosis (MS), although their visual detection is challenging (low sensitivity, high variability).
Objectives: We assessed two different automatic decision-support systems to detect new T2 lesions in longitudinal brain MRIs of patients with MS.

Methods: The study included 100 MS patients with two MRI exams (median interval 12 months [range 3-27 months]; relapse free 85%). MRI scans were acquired on a 3T magnet following a standardized protocol (3D-FLAIR, 3D- MPRAGE, and 2D dual-echo T2-weighted sequences). Two different automated methods were used: M1, based on an unsupervised approach that used intensity-derived features from the subtraction images together with deformation fields information obtained from the non-rigid registration between the two scans; and M2, a supervised approach based on the application of convolutional neural networks (CNN) trained to detect the presence of new T2 lesions in the follow-up scan. The outcomes of these automated tools were compared to the results of two operator-related methods based on visual analysis: the standard radiological report (O1); and revision of the MRIs by an expert observer non-blinded to the radiological report (O2). A "Gold Standard Outcome" (GOS) was created by consensus of two expert observers based on combined visual assessment of all the MRI images, the radiological reports, and the outcomes of the automated methods.

Results: GOS identified 104 new T2 lesions in 38 patients. Automated tools doubled the number of new T2 lesions (125 for M1; and 119 for M2) compared to operator-related methods (59 for O1 and 73 for O2). Specificity for detecting patients with at least one new T2 lesion was 100% for operator related methods while for automatic tools was 83% for M1 and 87% for M2. Sensitivity was higher with both automated tools (92.1% for M1; 97.4% for M2) compared to operator related methods (76.3% for O1, and 89.5% for O2).

Conclusions: The CNN model was more sensitive for detecting new T2 lesions and active patients, compared to standard and expert visual analysis, and to an unsupervised automated tool. However, visual supervision of the CNN model outcomes is still required due to its suboptimal specificity. Automatic tools, based on the application of CNN models are promising for detecting MRI disease activity, and shows potential to be used as an aid to the neuroradiological visual assessment in clinical practice.