Impact of MS Imaging Analytics on MRI Report Findings

P226

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Introduction

MRI reports guide neurologist management of multiple sclerosis (MS) patient care. The addition of quantitative MRI data such as brain volumetrics, lesion counts & volumes, change analyses and corresponding visualization tools may improve the ability to detect and report clinically significant insights derived from MRI. To understand whether these metrics affect clinical decision making, research is needed to evaluate if integrating these tools & data significantly affect the content and quality of MRI reports in patients with MS (PwMS).

Objectives

To investigate whether a Neuroradiologist's (NR) interpretation of a MS brain MRI changes when presented with brain volumes and percentiles, lesion counts and volumes, longitudinal analyses, and region of interest visualization tools from a commercial FDA-cleared brain and lesion segmentation algorithm.

Methods

3 NRs with 2-9 years of clinical experience interpreted brain MRIs for 90 PwMS who had 2 MRI scans (average 1 year apart) with 3D T1 pre-contrast, 3D T1 post-contrast, and 3D T2 FLAIR. In Round 1 (R1), NRs wrote a structured, standard of care report based on visual interpretation only. In Round 2 (R2), scans were processed using an FDA cleared software for automated lesion & brain structure segmentation and manually reviewed by a trained specialist. After an extended washout period (>1 year) the original scans, color-coded segmentations, and corresponding quantitative MRI metrics were randomized, renamed, and presented to the 3 NRs to complete a 2nd MRI report using a structured, quantitative template specifically designed for MS. Results from R1 and R2 PwMS reports were compared using a paired T-test.

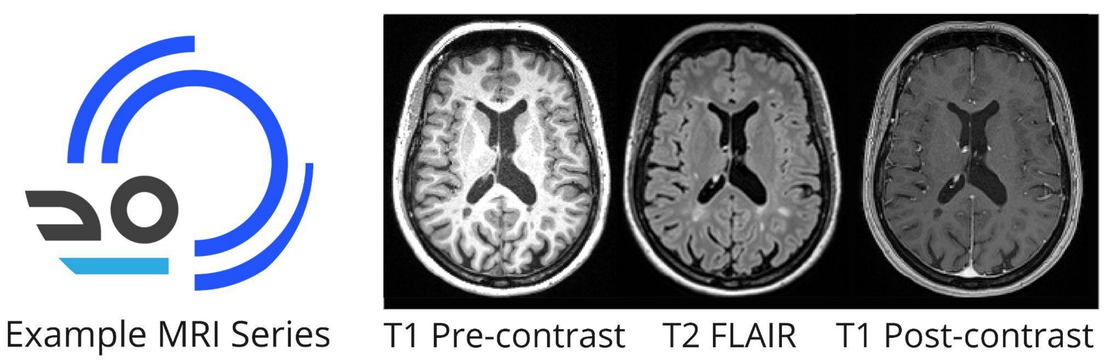

Figure 1: Example MS MRI Series used in NR interpretation. 3D T1 pre-contrast, 3D T2 FLAIR, and 3D T1 post-contrast series were provided to NRs in dicom standard format.

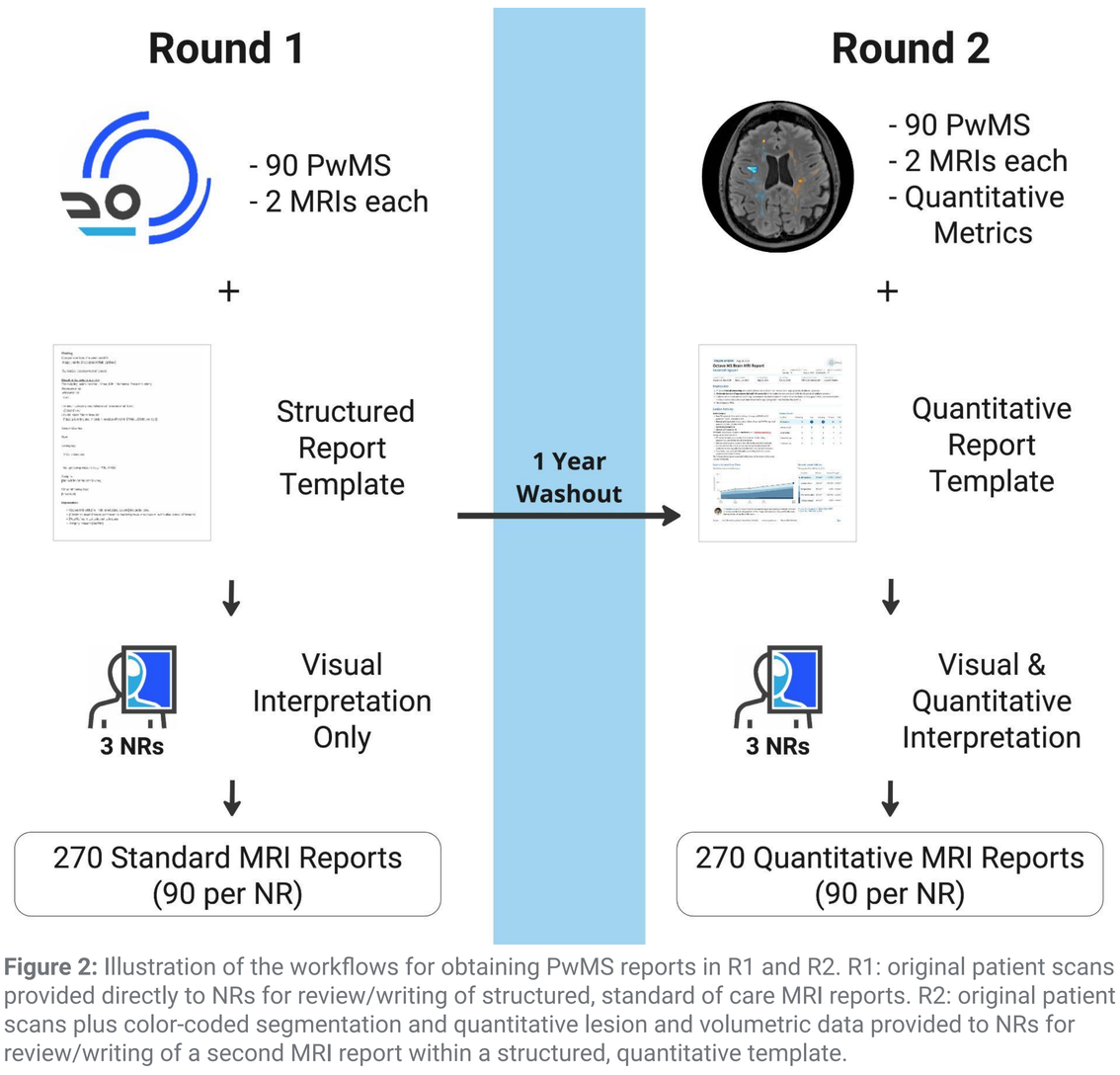

Figure 2: Illustration of the workflows for obtaining PwMS reports in R1 and R2. R1: original patient scans provided directly to NRs for review/writing of structured, standard of care MRI reports. R2: original patient scans plus color-coded segmentation and quantitative lesion and volumetric data provided to NRs for review/writing of a second MRI report within a structured, quantitative template.

Results

Results for each imaging measure are reported below in the following format: Measure: (R1: category count. R2: category count. # Changed = Number of reports whose value changed between R1 and R2, p value from a paired T-test).

- **Change in Disease Activity** | (R1: 77 Changed since prior scan, 181 Stable. R2: 62 Changed since prior scan, 196 Stable. # Changed=71, p=0.075) [Fig 3].
- **Lesion Burden** | (R1: 100 Mild, 101 Moderate, 57 Severe. R2: 140 Mild, 87 Moderate, 31 Severe. # Changed=94, p<0.001) [Fig 4].
- **Atrophy** | (R1: 108 None, 115 Mild, 30 Moderate, 4 Severe. R2: 105 None, 107 Mild, 43 Moderate, 2 Severe. # Changed=65, p=0.152).
- **Enlarging Lesions** | (R1: 253 Absent, 5 Present. R2: 216 Absent, 42 Present. # Changed=43, p<0.001) [Fig 5].
- **New Lesions** | (R1: 217 Absent, 41 Present. R2: 218 Absent, 40 Present. # Changed=70, p=0.910).

Results (Continued)

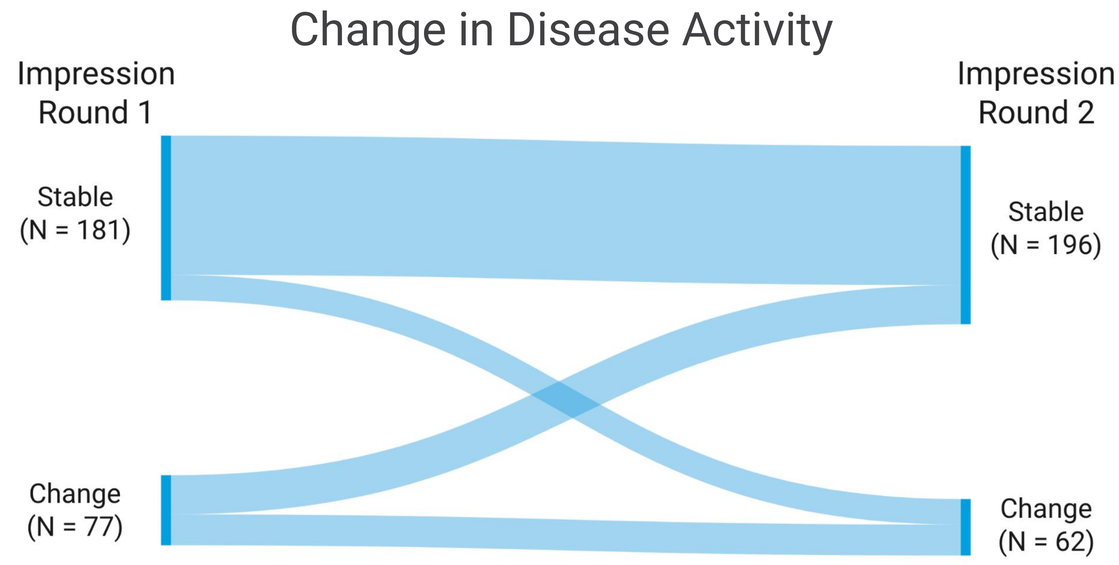

Figure 3: NR impression of changing in disease activity from R1 to R2. The same impression was reported in both rounds for 196 reports (76.0%). 62 reports (24.0%) showed different impressions of change in disease activity in R1 than in R2 (28 Stable → Change; 43 Change → Stable).

Figure 4: Qualitative interpretation of MS lesion burden from R1 to R2. 164 reports (63.6%) showed no difference. 15 reports (5.8%) showed an increase in severity of lesion burden (11 Mild → Moderate, 4 Moderate → Severe), while 79 PwMS reports (30.6%) showed a decrease in severity (28 Severe → Moderate, 2 Severe → Mild, and 49 Moderate → Mild).

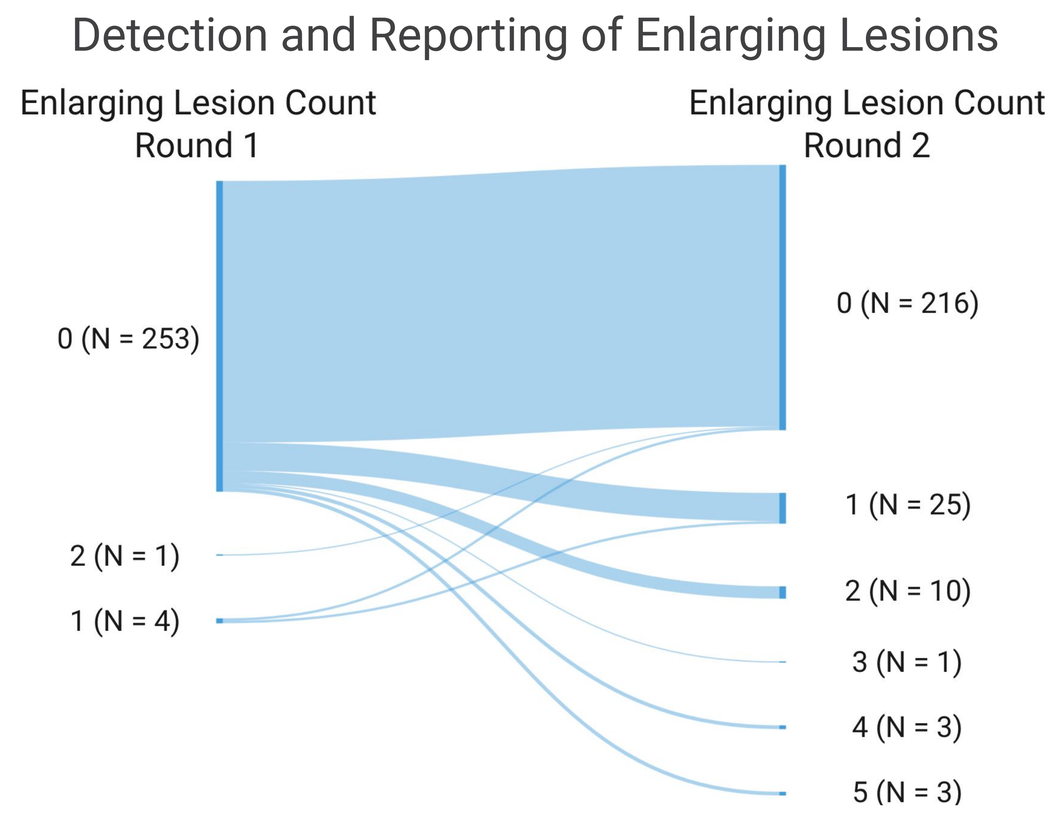

Figure 5: Interpretation of the number of enlarging lesions from R1 to R2. 202 PwMS reports showed no change in number of enlarging lesions (78.3%). When interpreted with quantitative data and lesion change maps in R2, NRs noted enlarging lesions in 32 reports that did not have enlarging lesions in R1 (12.5%), while 3 reports with enlarging lesions in R1 did not report enlarging lesions in R2 (1.2%).

Conclusions

The inclusion of quantitative brain and lesion volumetrics, and resulting longitudinal analyses and color-coded segmentation maps clearly affects NR interpretation in pwMS MRI reporting. These additional MS insights yield a significant increase in the reporting of enlarging lesions, as well as a significant difference in the NR impression of lesion burden. While not statistically significant, the NR impression of change from a prior scan was also heavily impacted. These changes in clinical interpretation may significantly impact individual patient care.

Future analyses will examine the intra- and inter-rater variability among the NRs. Additional analysis is needed to clarify the driving factors of these changes within each PwMS' clinical context. This research is a step towards demonstrating the clinical utility of quantitative brain and lesion measures to enhance MS MRI reporting.

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