Variability of Longitudinal Standard of Care Brain MRI Scans Ordered by a Single MS Center

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Introduction

- Magnetic Resonance Imaging (MRI) biomarkers such as new & enlarging lesions are the gold standard for detecting radiographic disease activity in Multiple Sclerosis (MS). Variability in image quality, acquisition protocol and equipment model within and across scanning sites makes it difficult to accurately assess changes in lesion burden. This significantly impacts the quality and accuracy of clinical interpretations.
- Leading MS consortiums have published MRI guidelines recommending patients with MS get longitudinal MRI scans at the same facility, at the same scanner, and with the same protocol to improve reliability and accuracy of measuring change in disease activity, yet adoption and adherence to these guidelines varies across institutions and over time.

Objective

- To identify variability of MRI imaging facilities and acquisition protocols obtained longitudinally for patients with MS when a standard of care brain MRI was ordered by a single MS Center with outpatient imaging.

Methods

- 230 patients with MS (PwMS) were consented as part of a standard of care study from July 2020 - July 2021.
- PwMS must have had scans performed at an imaging facility with the capability of performing a 3D T1-weighted acquisition.
- MRIs from the baseline scan and up to two years prior were obtained and de-identified. Institution information and scanner hardware features were extracted from DICOM tags.
- In order to track variability of MRI hardware and software within an institution, a unique identifier called ScannerIdentifier was created by concatenating the scanner's Facility, Field Strength, Manufacturer, Model, and Serial Number.

Results

- 173 unique PwMS with at least 2 MRIs were identified, resulting in 545 individual MRI scans covering a time span of 3 years (2018-2021). The number of scans per patient ranged from 2-7 (mean 3.12, SD= 1.04). [Table 1]
- DICOM tag analysis identified 21 facilities, 2 field strengths, 2 scanner manufacturers, 15 scanner models, and 40 serial numbers within the dataset.
- The number of unique ScannerIdentifiers per patient ranged from: 1 (N=72), 2 (N=59), 3 (N=31), to 4 (N=11).
- 458 scans were acquired on 1.5T (375 GE, 4 models; 83 Siemens, 4 models); 87 scans were acquired on 3T (76 GE, 3 models; 9 Siemens, 1 model; 1 unknown). [Figure 1]
- 118 patients were scanned at 1.5T only, 6 patients were scanned at 3T only, 49 patients were scanned on both 1.5T and 3T.
- 161 patients were scanned on a single scanner manufacturer, 12 patients were scanned on 2 different scanner manufacturers.
- 72 patients (42%) received the recommended consistency of longitudinal MRI imaging at the same facility and scanner. [Figure 2]
- 101 patients (58%) received longitudinal scans that varied across facility, field strength, scanner manufacturer, model, and serial number.
- One patient received MRI scans at 5 different facilities, across 2 field strengths, 2 scanner manufacturers, and 5 models.

Figures

Category	1	2	3	4	5	6	7
Number of subjects with ____ Scans	-	59	51	45	15	2	1
Number of subjects with ____ Magnetic Field Strength(s)	123	50	-	-	-	-	-
Number of subjects with ____ Manufacturer(s)	161	12	0	-	-	-	-
Number of subjects with ____ Manufacturer Model Name(s)	87	66	19	0	1	0	0
Number of subjects with ____ Unique Institution(s)	123	42	7	0	1	0	0
Number of subjects with ____ Unique ScannerIdentifier(s)	72	59	31	10	1	0	0

Table 1. The distribution of the number of patients within each combination of unique counts (columns) per MRI category (rows).

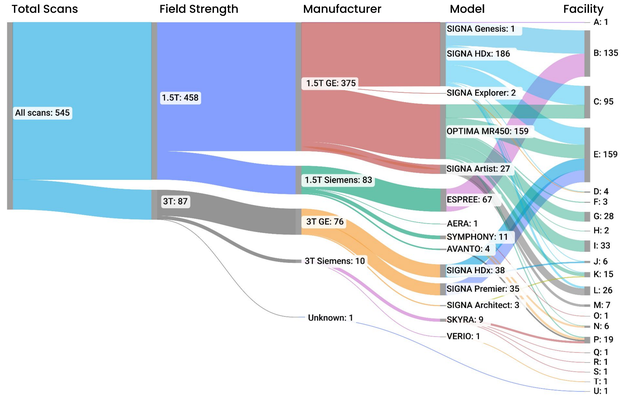

Figure 1. Sankey diagram depicting the combinations of scanner variables present at 21 institutions that provided 545 MRI scans.

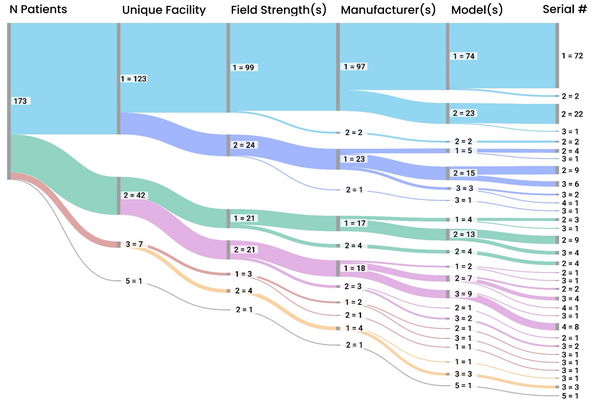

Figure 2. Various combinations of scanner variables patients experienced during 3 years of longitudinal standard of care imaging.

Conclusions

- Less than half of the patients in the study received longitudinal, comparable MRIs utilizing the same combination of major MRI parameters. There was demonstrated variability of scanner field strength, manufacturer and models across facilities. Facilities within larger institutions tended to have more longitudinal variability. The results show that even when a patient is scanned at the same facility over time, variations in the scanner's field strength, manufacturer, and model may vary, making the radiologists' comparisons to prior scans difficult. Image acquisition and reporting variability adds to the difficulties clinicians and patients face when interpreting MRI reports to make informed treatment decisions.

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