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Treatment satisfaction across injectable, infusion, and oral disease-modifying therapies for multiple sclerosis

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ABSTRACT

Background: The recent approval of oral disease-modifying therapies (DMTs) for multiple sclerosis (MS) has provided patients with a new route of therapy administration. Little research has compared patients' experiences with and perceptions of injectable, infusion and oral MS therapies.

Methods: Three hundred fifty-seven treated MS patients enrolled in the CLIMB study completed the Treatment Satisfaction Questionnaire for Medication (TSQM). The TSQM provides information regarding perceived effectiveness, side effects, convenience and overall satisfaction. The patients were treated with either interferon beta-1a intramuscular (IFNβ−1a IM) (n = 40), interferon beta-1a subcutaneous (IFNβ−1a SC) (n = 45), glatiramer acetate (GA) (n = 118), natalizumab (NTZ) (n = 44), fingolimod (n = 66), or dimethyl fumarate (BG-12) (n = 44). Multivariable linear regression models were used to compare treatment satisfaction across all DMTs and between patients treated with injectable (n = 203), infusion (n = 44), and oral (n = 110) DMTs. All models were adjusted for sex, age, EDSS, and time on treatment.

Results: Patients taking oral DMTs reported significantly higher convenience scores compared to patients taking either injectable or infusion DMTs. The adjusted difference in the mean overall convenience score was 26.87 (95% CI: 21.4, 32.34) for the comparison of orals and injectables and 17.53 (95% CI: 11.15, 23.9) for the comparison of orals and infusion. In addition, the proportion of patients reporting a side effect was significantly lower for orals compared to injectables (adjusted OR = 0.35; 95% CI: 0.18, 0.68) and infusion compared to injectables (adjusted OR = 0.14; 95% CI: 0.05, 0.35).

Conclusion: Patients reported treatment with the oral medications as more convenient than the injectable and infusion DMTs.

1. Introduction

Multiple Sclerosis (MS) is a chronic immune-mediated disease of the central nervous system affecting more than 2.3 million people worldwide (Browne et al., 2014). Since the approval of the first disease modifying therapy (DMT), Betaseron, in 1993, a total of 15 medications have been approved by the Food and Drug Administration (FDA) for the treatment of MS. These medications have been shown to reduce the number of relapses and may also help to modify the disease course (Filippini et al., 2003. Kim et al., 2015; Ransohoff, 2007). Routes of administration include self-injection, infusion, and oral. Injectable medications were the first to be approved for MS, and remain among the most commonly prescribed therapies (Spessotto et al., 2016; Wilson et al., 2015; de Dios López et al., 2017). In the US, interferons are the most widely used injectable medications, but a third of patients are intolerant or unresponsive to this form of therapy (de Dios López et al., 2017. Guo et al., 2016; Bergvall et al., 2014). Interferons are associated with flu-like symptoms and injection site reactions, which are the most common reasons for discontinuation (O'Rourke and Hutchinson, 2005). Three oral medications have been approved by the FDA for MS since 2010, fingolimod (Gilenya), teriflunomide (Aubagio), and dimethyl fumarate (Tecfidera, BG-12). These three drugs along with natalizumab (NTZ), an infusion DMT approved in 2004, provide new routes of therapy administration for patients (Polman et al., 2006). By demonstrating a similar or improved relapse rate compared to that of injectable medications, oral therapies have emerged as a viable treatment alternative (Kim et al., 2015).

With the large number of drugs currently available to treat MS,

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patients are now able to consider lifestyle in addition to efficacy when making treatment decisions. When selecting DMTs, neurologists take into account the efficacy, safety, patient preference, convenience, and tolerability (Hanson et al., 2014). Patients, on the other hand, prefer drugs that can alleviate observable outcomes, and show preference for oral and infusion medications over injectables. [6] A 2016 study of 128 patients in Brazil found that the majority (72.7%) of patients who switched DMTs from interferons (IFNβ−1b, IFNβ−1a IM, IFNβ−1a SC), glatiramer acetate, or natalizumab, did so in favor of fingolimod (Spessotto et al., 2016). Lower rates of discontinuation as well as higher rates of adherence have been observed in patients treated with fingolimod (Agashivala et al., 2013). Physician recommendation was the most common reason for switching to and starting fingolimod in both treatment-experienced and treatment-naive patients (Hanson et al., 2013).

A small number of studies have examined patient satisfaction with newer oral therapies. Due to the relatively recent availability of oral medications for MS, the current literature has mostly looked at satisfaction with fingolimod, with little research being done on patient satisfaction with teriflunomide or dimethyl fumarate. The highest satisfaction scores have been found for fingolimod when compared against injectables and infusion (NTZ), with orals being rated as more convenient and preferred overall (Spessotto et al., 2016; Wilson et al., 2015). Injectable therapies still remain the most commonly prescribed DMTs, despite the preference observed for oral DMTs (Spessotto et al., 2016 de Dios López et al., 2017; Hanson et al., 2014).

Previous studies have shown a positive correlation between patient satisfaction with a medication and treatment adherence (Barbosa et al., 2012). Patients with chronic diseases such as MS tend to show low treatment adherence, which in turn can lead to worse disease outcomes. With lower convenience scores having been associated with lower adherence, there is a need for more convenient therapies that may provide a way for patients to be more treatment adherent (Glanz et al., 2014). In addition, patients with higher Expanded Disability Status Scale (EDSS) scores show greater preference for oral DMTs due to ease of use (Utz et al., 2014). This newer administration may better suit patients that struggle with correct handling of injectable DMTs.

The goal of this study was to compare patients' treatment satisfaction with oral, infusion, and injectable DMTs as well as differences among individual DMTs. Here we compare patients treated with either interferon beta-1a intramuscular (IFNβ−1a IM), interferon beta-1a subcutaneous (IFNβ−1a SC), glatiramer acetate (GA) natalizumab, fingolimod (FTY), or dimethyl fumarate (DMF). Our second goal was to compare satisfaction of patients who switched from injectable to oral medications to allow within patient comparisons of the treatments.

2. Methods

2.1. Subjects and measures

Subjects who completed a battery of patient reported outcomes (PROs) as part of the Comprehensive Longitudinal Investigation of Multiple Sclerosis at the Brigham and Women's Hospital, Partner's MS Center (CLIMB) were included in this study. CLIMB is an ongoing prospective observational cohort study that began enrolling subjects in 2000, and subjects who enrolled in CLIMB prior to 2009 complete PROs as part of their study activities. CLIMB is approved by the Partners Humans Research Committee at the Brigham and Women's Hospital in Boston MA. Subjects have clinical visits every six months that include complete neurological exams and EDSS ratings. Subjects who complete PROs completed the psychometrically validated Treatment Satisfaction Questionnaire for Medication (TSQM) annually from study entry until 2012, and then biennially from 2012 to 2016. The TSQM consists of 14 items scaled on a five to seven point bipolar scale (Atkinson et al., 2004). TSQM items are combined into four summary scores using the published scoring algorithm: effectiveness, side effects, convenience, and overall satisfaction. For all questions and summary scores, higher scores imply higher levels of satisfaction. Cronbach's alpha was calculated for the four TSQM scales in all subjects who contributed and found acceptable values for the Effectiveness (0.91), Side Effects (0.81), Convenience (0.91) and Overall Satisfaction (0.90) summary scales.

For this analysis, subjects were classified into groups based on the treatment at the time of the most recent TSQM measurement. To ensure that we had sufficient data to perform group comparisons, the six treatments with at least 40 subjects were chosen for further analyses, and these treatments were further grouped based on the routes of administration (injectable, infusion and oral). The three injectable treatments were interferon beta-1a intramuscular (IFNβ 1a IM, n = 40), interferon beta-1a subcutaneous (IFNβ 1a SC, n = 45), and glatiramer acetate (GA, n = 118). The infusion treatment was natalizumab (NTZ, n = 44). The oral treatments were fingolimod (FTY, n = 66) and dimethyl fumarate (DMF, n = 44).

2.2. Statistical analysis

The demographic and clinical characteristics of the treatment groups at the time of the questionnaire were compared using a one-way analysis of variance (ANOVA) for continuous variables, Kruskal-Wallis test for EDSS and Fisher's exact test for dichotomous variables. All comparisons were completed among the three routes of administration as well as among the six treatments. If significant group differences were found, pairwise group comparisons were completed. For the three group comparisons, no further correction for multiple comparisons is required (Bender and Lange, 2001). For the six group comparisons, a Bonferroni correction was used to account for multiple comparisons. For the comparison of treatment satisfaction among the routes of administration and individual treatments, both the summary scores and individual items for effectiveness, side effects, convenience and overall satisfaction were analyzed. Given the differences between groups in terms of demographic and clinical features, we also used a multivariable linear regression to estimate the group differences adjusting for potential confounders (EDSS, age, gender and time on treatment). For the comparison of the presence of side effects, multivariable logistic regression was used controlling for the same confounding factors. If the multiple group comparison was statistically significant, pairwise comparisons were completed.

In addition to the main group comparisons, two additional analyses were completed to confirm the results. First, we restricted attention to subjects who were on the treatment for at most 4 years to increase the comparability of the groups. All analyses from the primary analysis were completed in this subset of patients. Second, a group of subjects who were on an oral medication at the most recent visit with TSQM information had previously completed the TSQM while on an injectable medication (n = 42). For these subjects, both the summary scores and individual items were compared between the two modes of administration using a paired *t*-test. For the comparison of the presence of side effects, McNemar's test was used to compare the mode of administration. All statistical analyses were completed in the statistical package R (www.r-project.org).

3. Results

The demographic characteristics of the subjects are provided in Table 1 for the routes of administration and Supplementary Table 1 for the specific treatments. Subjects in the injectable group were older and had a lower EDSS compared to the infusion group, and subjects in the injectable group had longer treatment duration than both other groups. The treatment satisfaction outcomes are compared across the treatment groups in Table 2 for the routes of administration and Supplementary Table 2 for the specific treatments. For the statistically significant comparisons, the pairwise comparisons for the three routes of

Table 1
Demographic characteristics of study subjects.

	Injectable	Infusion	Oral	p-value
N	203	44	110	
Age (years, mean ± SD)	49.1 ± 11.0	42.8 ± 10.5	46.7 ± 11.9	0.003
Females (N (%))	145 (71.4)	31 (70.5)	79 (71.8)	0.986
Disease duration (years, mean ± SD)	14.1 ± 8.5	13.6 ± 7.8	15.7 ± 7.7	0.184
Race				0.328
Asian	1	1	0	
Black or African American	4	2	4	
More than one race	4	0	3	
Unknown or not reported	0	1	1	
White	194	40	102	
Ethnicity				
Hispanic or Latino	6	1	4	
Non-Hispanic or Latino	197	43	106	
EDSS (median, IQR)	1.5 (0, 2.5)	2 (1.5, 2.875)	1.5 (1,3)	0.009
Treatment duration	7.2 ± 3.6	2.5 ± 1.9	1.5 ± 1.1	< 0.001

EDSS = expanded disability status scale. Injectable medications were glatiramer acetate, interferon beta-1a intramuscular and interferon beta-1a subcutaneous, infusion medication was natalizumab, and oral medications were dimethyl fumarate and fingolimod.

administration are provided in Table 3. The most consistent differences among the groups were related to the convenience of the medication, with oral medications have the highest scores and infusion medications the second highest. All comparisons of oral medications vs. the other two groups were statistically significant. In addition, there were significant differences between all groups in terms of the presence of side effects, with the infusion medication having the lowest rate of side effects and the injectable medications having the highest. At the same time, the side effects of the injectable medications had a significantly smaller effect on mental function than the other two treatment groups among the subjects who had side effects. In terms of overall satisfaction subscale, the oral medication group reported significantly higher satisfaction compared to the injectable group in the total score, and the same relationship was seen in the question related to satisfaction with the medication. Both results were observed only in the adjusted analysis. Finally, subjects in the infusion medication group had significantly higher satisfaction compared with injectable medication groups with respect to the time it takes medication to start working in adjusted analyses.

When the specific treatment groups were compared, similar findings were observed. One interesting result was that subjects treated with fingolimod reported significantly higher convenience (summary score and individual items) compared to all other treatment groups including the other oral medication and significantly lower side effects compared to all treatment groups other than NTZ. No other significant differences between the oral medications were observed.

The results of the two additional analyses confirmed the primary findings. In particular, similar differences between the groups of medications were observed when only subjects with less than 4 years on treatment contributed (Supplementary Table 3). Further, similar differences between injectable and oral medications were observed in the group of subjects who completed the questionnaire while taking an injectable medication prior to an oral medication (Table 4).

4. Discussion

We examined treatment satisfaction in MS by comparing patients' satisfaction with oral, injectable and infusion therapies. Differences were found primarily for convenience, but other differences were observed in terms of side effects. Patients on oral therapies reported the

Table 2
Treatment satisfaction comparison based on mode of administration.

	Injectable	Infusion	Oral	p-value	Adjusted p-value^
Effectiveness	74.8 +/− 19.8	73.4 +/− 20.5	72.1 +/− 19.6	0.53	0.1011
Q1. Ability to treat or prevent condition	5.6 +/− 1.3	5.5 +/− 1.3	5.5 +/− 1.3	0.65	0.1992
Q2. Ability to relieve symptoms	5.4 +/− 1.3	5.2 +/− 1.5	5.1 +/− 1.3	0.24	0.2579
Q3. Time it takes medication to start working	5.4 +/− 1.2	5.5 +/− 1.2	5.3 +/− 1.2	0.79	0.0463
Number (%) who report side effects+	112 (55.2)	9 (20.5)	35 (31.8)	< 0.001	< 0.001
Side effects	80 +/− 15.8	72.9 +/− 15.6	74.7 +/− 20.6	0.16	0.3838
Q5. Bothersomeness of side effects	3.7 +/− 0.8	3.8 +/− 0.7	3.7 +/− 1.0	0.90	0.6367
Q6. Side effects interfere with physical function	4.4 +/− 0.8	3.7 +/− 0.9	4.0 +/− 1.0	0.017	0.0736
Q7. Side effects interfere with mental function	4.6 +/− 0.7	4.0 +/− 1.1	4.3 +/− 1.0	0.017	0.0241
Q8. Side effects impact overall satisfaction	4.2 +/− 0.9	4.2 +/− 0.8	4.0 +/− 0.9	0.53	0.6845
Convenience	68.4 +/− 17.8	70.7 +/− 20.6	88.1 +/− 16.8	< 0.001	< 0.001
Q9. Ease/difficulty to use	5.0 +/− 1.2	5.2 +/− 1.4	6.4 +/− 1.0	< 0.001	< 0.001
Q10. Ease/difficulty of planning to use	5.3 +/− 1.1	5.5 +/− 1.3	6.2 +/− 1.0	< 0.001	< 0.001
Q11. Convenience of taking as instructed	5.0 +/− 1.2	5.0 +/− 1.5	6.2 +/− 1.2	< 0.001	< 0.001
Overall satisfaction	76.5 +/− 20.8	74.1 +/− 20.2	75.5 +/− 23	0.78	0.0276
Q12. Confidence that taking medication is good	4.1 +/− 0.9	4.1 +/− 0.9	4.0 +/− 1.0	0.59	0.1137
Q13. Certainty that good things about medication outweigh bad	4.1 +/− 0.9	3.9 +/− 1	4.1 +/− 1	0.25	0.062
Q14. Satisfaction with medication	5.7 +/− 1.1	5.8 +/− 1	5.8 +/− 1.3	0.95	0.0033

Injectable medications were glatiramer acetate, interferon beta-1a intramuscular and interferon beta-1a subcutaneous, infusion medication was natalizumab, and oral medications were dimethyl fumarate and fingolimod.

^ : p-value for three group comparison controlling for age, gender, EDSS and time on treatment.

+ : For the comparison of the % who report side effects, multivariable logistic regression was used.

Table 3
Adjusted group differences and 95% confidence intervals.

	Infusion v injectable	Oral v injectable	Oral v infusion
Q3. Time it takes medication to start working	0.51; 95% CI: 0.07, 0.96; p = 0.024	0.37; 95% CI: 0, 0.74; p = 0.0507	−0.14; 95% CI: −0.57, 0.29; p = 0.5098
Presence of side effects[+]	0.14; 95% CI: 0.05, 0.35; p < 0.001	0.35; 95% CI: 0.18, 0.68; p = 0.0019	2.59; 95% CI: 1.03, 6.51; p = 0.0434
Q7. Side effects interfere with mental function	−0.73; 95% CI: −1.41, −0.05; p = 0.0348	−0.47; 95% CI: −0.87, −0.07; p = 0.0219	0.26; 95% CI: −0.42, 0.94; p = 0.4505
Convenience	9.35; 95% CI: 2.76, 15.93; p = 0.0056	26.87; 95% CI: 21.4, 32.34; p < 0.0001	17.53; 95% CI: 11.15, 23.9; p < 0.0001
Q9. Ease/difficulty to use	0.59; 95% CI: 0.15, 1.04; p = 0.0092	1.88; 95% CI: 1.51, 2.25; p < 0.0001	1.28; 95% CI: 0.85, 1.72; p < 0.0001
Q10. Ease/difficulty of planning to use	0.71; 95% CI: 0.29, 1.12; p = 9e−04	1.36; 95% CI: 1.01, 1.7; p < 0.0001	0.65; 95% CI: 0.25, 1.05; p = 0.0015
Q11. Convenience of taking as instructed	0.38; 95% CI: −0.08, 0.84; p = 0.1015	1.6; 95% CI: 1.22, 1.98; p < 0.0001	1.22; 95% CI: 0.78, 1.66; p < 0.0001
Overall satisfaction	6.37; 95% CI: −1.44, 14.17; p = 0.1097	8.75; 95% CI: 2.27, 15.23; p = 0.0083	2.38; 95% CI: −5.17, 9.94; p = 0.535
Q14. Satisfaction with medication	0.55; 95% CI: 0.14, 0.97; p = 0.0091	0.55; 95% CI: 0.2, 0.89; p = 0.0019	−0.01; 95% CI: −0.41, 0.4; p = 0.977

Injectable medications were glatiramer acetate, interferon beta-1a intramuscular and interferon beta-1a subcutaneous, infusion medication was natalizumab, and oral medications were dimethyl fumarate and fingolimod. The mean difference adjusted for age, gender, EDSS and time on treatment are reported along with the 95% confidence interval and p-value.
[+] : For the presence of side effects analysis, the adjusted odds ratio is reported.

highest scores for convenience confirming prior findings that orals are more convenient and preferred over other available treatments (Spessotto et al. 2016; Wilson et al., 2015).

In terms of specific comparisons, some of the greatest differences were seen when comparing oral treatments to injectable treatments. When patients taking an injectable treatment at the most recent visit were compared to patients on oral therapy, the injectable group had a significantly higher number who reported side effects, and the oral group reported significantly higher scores for convenience. A similar trend was observed in the subjects who had TSQM data while on both treatments. These patients reported significantly higher convenience and a significantly lower proportion of side effects on the oral medication compared to the injectable medication. Although these results confirm the group comparison, within patient comparisons must be interpreted cautiously because it is possible that patients who were highly satisfied with their injectable medication would be less likely to change to an oral medication.

Since the patients who remained on an injectable after the availability of orals may be more likely to be satisfied with the medication, the reported treatment satisfaction may be higher in this cohort compared to previous cohorts. In fact, previous work at our center found that patients treated with NTZ viewed it as more effective and convenient than injectable medications, but this finding does not replicate in the current analysis when adding satisfaction data for oral medications (Glanz et al., 2014). A potential explanation for the change in the difference between NTZ and injectables is related to the patients who are most satisfied with injectable therapies remaining on these treatments. In particular, the reported treatment satisfaction from previous work may be lower compared to the present analysis because patients who were most dissatisfied might have chosen to change treatment now that other medications are available. When we compare the treatment satisfaction scores while on the injectable among the subjects who switched to an oral to the treatment satisfaction while on an injectable among those who are on an injectable now, patients who remained on the injectable had higher scores on average on all questions. This result demonstrates that the subjects who remained on an injectable therapy are likely the subjects who were most satisfied with the treatment. A potential explanation for these results is that the large number of available treatment options allows patients to find a treatment that is well tolerated, which leads to greater satisfaction for individual patients and in the overall group.

Individual treatments were also compared across all of the TSQM items. The greatest number of patients were on GA, followed by FTY. DMF had the highest average age, while NTZ had the youngest age and highest EDSS. Despite its reported side effects, GA had the highest overall satisfaction, followed by FTY, although this was not a statistically significant difference. Interestingly, FTY-treated patients reported the greatest convenience score, even more so than DMF, which could be

Table 4
Comparison of oral and injectable treatments for subjects who took both treatment types.

	Injectable	Oral	p-value
Effectiveness	71.3 +/− 22.5	75.1 +/− 17.2	0.1917
Q1. Ability to treat or prevent condition	5.3 +/− 1.5	5.6 +/− 1.2	0.306
Q2. Ability to relieve symptoms	5.2 +/− 1.4	5.4 +/− 1.1	0.3026
Q3. Time it takes medication to start working	5.3 +/− 1.4	5.5 +/− 1.1	0.182
Number (%) who report side effects[+]	31 (68.9)	15 (33.3)	0.0022
Side effects	74.7 +/− 19.2	78.5 +/− 16.5	0.6178
Q5. Bothersomeness of side effects	3.6 +/− 0.8	3.8 +/− 0.9	0.7545
Q6. Side effects interfere with physical function	4.0 +/− 1.1	4.2 +/− 0.8	0.5035
Q7. Side effects interfere with mental function	4.3 +/− 0.8	4.6 +/− 0.7	0.0819
Q8. Side effects impact overall satisfaction	4.1 +/− 0.9	4.1 +/− 0.9	0.2199
Convenience	60.7 +/− 20.2	89 +/− 14.3	< 0.0001
Q9. Ease/difficulty to use	4.4 +/− 1.3	6.6 +/− 0.8	< 0.0001
Q10. Ease/difficulty of planning to use	5.0 +/− 1.3	6.3 +/− 0.9	< 0.0001
Q11. Convenience of taking as instructed	4.6 +/− 1.4	6.2 +/− 1.1	< 0.0001
Overall satisfaction	70.5 +/− 25.9	78.4 +/− 18.6	0.0453
Q12. Confidence that taking medication is good	3.9 +/− 1.2	4.1 +/− 0.9	0.1819
Q13. Certainty that good things about medication outweigh bad	4.0 +/− 1.1	4.1 +/− 0.8	0.5139
Q14. Satisfaction with medication	5.3 +/− 1.3	6.0 +/− 1.0	5.00E−04

Injectable medications were glatiramer acetate, interferon beta-1a intramuscular and interferon beta-1a subcutaneous, and oral medications were dimethyl fumarate and fingolimod. The p-value is from a paired *t*-test assessing the within person difference in each of the scores.
[+] : For the comparison of the % who report side effects, McNemar's test was used.

due to the DMF dosing of twice daily versus once daily for fingolimod. The two oral medications reported the two highest convenience scores, but differed in side effect profiles, with 59.1% of patients on DMF reporting side effects versus 13.6% of people on fingolimod. Sasane et al. found that patients on DMF were seven times more likely to report side effects than patients on fingolimod (Sasane et al., 2016).

While this study is limited by the inclusion of only one infusion therapy, satisfaction data for this method could prove relevant with the recent approval of ocrelizumab, a new humanized anti-CD20 monoclonal antibody infusion drug (Kappos et al., 2011). Our results show that patients on NTZ reported the fewest side effects of any of the three treatment types. Previous research has shown that patients on NTZ found it more convenient than IFNβ−1a IM and that infusion is preferred over other parenteral routes of administration (Wilson et al., 2015; Glanz et al., 2014). The present finding that orals are significantly more convenient than infusion may have an impact on patients considering starting treatment on ocrelizumab.

Evaluating treatment satisfaction is important because of its known association with medication adherence (Barbosa et al., 2012). It has been found that adherence in chronic diseases decreases over time, perhaps indicating a need for more discussion of adherence during neurologic exams (Saini et al., 2009). A study of treatment adherence in MS found that neurologists did not spend extensive time discussing the importance of treatment adherence when meeting with patients (Decoo and Vokaer, 2015). This is problematic because the benefits of adherence are numerous (Decoo and Vokaer, 2015; Steinberg et al., 2010; Tan et al., 2011). Lack of adherence has been shown to increase MS related medical costs, hospitalizations, and relapse rates Steinberg et al., 2010; Tan et al., 2011). Many factors contribute to treatment adherence: MS subtype, disability level, cognitive impairment due to MS, perceived lack of efficacy of medication, adverse events with DMT, and dosage frequency (Patti, 2010). The greater convenience scores found for oral medications could be beneficial for patients with higher levels of progression who have more difficulty with the administration of injectable medications and have been found to prefer oral therapies over injections (Utz et al., 2014). While some adherence data is available in our database, this data is not sufficient to assess the relationship between adherence and satisfaction in our sample. Future studies are needed to investigate the relationship between satisfaction and MS treatment modalities in terms of the effect on treatment adherence.

This study has several limitations. First, the CLIMB study sample has long disease duration and limited disability. These subjects may not be representative of MS patients as a whole due to exhibiting a mild form of the disease. Longer disease duration could influence patient opinions regarding treatment satisfaction in comparison to those of newly diagnosed patients. Second, the data collected were self-reported, which is subject to recall bias. Third, paired analysis should be interpreted with caution as people who were completely satisfied with an injectable medication are unlikely to switch to a new treatment. Fourth, an important aspect of treatment satisfaction is tolerability of treatment, but we did not specifically measure tolerability in our study.

Treatment satisfaction is an important aspect of disease management for people with MS. Differences were seen across the three routes of medication administration in terms of convenience and side effects. Overall, patients found oral medications to be significantly more convenient than infusion and injectable medications. These findings may be useful to patients and physicians when examining treatment options.

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Conflict of interest disclosure

Ms. Eagle, Ms. Stuart, Ms. Chua, Ms. LaRussa, Ms. LeClaire, and Ms. Cook have nothing to disclose.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.msard.2017.10.002.

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