

# Patient-Reported Outcomes in Multiple Sclerosis: An Overview

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## ABSTRACT

**Background:** Patient-reported outcomes (PROs), including patient-reported outcome measures (PROMs) and patient-reported experience measures (PREMs), can be used to assess perceived health status, functioning, quality of life, and experience of care. Complex chronic illnesses such as multiple sclerosis (MS) affect multiple aspects of health, and PROs can be applied in assessment and decision-making in MS care as well as in research pertaining to MS.

**Objective:** To provide a general review of PROs, with a specific focus on implications for MS care.

**Methods:** Evidence synthesis of available literature on PROs in MS care.

**Results:** PROs (including PROMs and PREMs) have historically been utilized in research and are now being applied in clinical, improvement, and population health settings using learning health system approaches in many disease populations, including MS. Many challenges complicate the use of PROs in MS care, including reliability, validity, and interpretability of PROMs, as well as feasibility barriers due to time and financial constraints in clinical settings.

**Conclusion:** PROs have the potential to better inform clinical care, empower patient-centered care, inform health care improvement efforts, and create the conditions for coproduction of health care services.

**Keywords:** PRO; PROM; patient-reported outcome measure; patient-reported experience measure; quality of life; patient-centered care.

rupts signaling pathways.<sup>1</sup> It is most commonly diagnosed in young adults and affects 2.3 million people worldwide.<sup>2</sup> People with MS experience very different disease courses and a wide range of neurological symptoms, including visual, somatic, mental health, sensory, motor, and cognitive problems.<sup>1-3</sup> Relapsing-remitting MS, the most common form, affects 85% of those with MS and is characterized by periods of relapse (exacerbation) and remission.<sup>1</sup> Other forms of MS (primary progressive and secondary progressive MS) are characterized by progressive deterioration and worsening symptom severity without exacerbations. Disease-modifying therapies (DMTs) can reduce the frequency of exacerbations and disability progression, but unfortunately there is no cure for MS. Treatment is focused on increasing quality of life, minimizing disability, and maximizing wellness.

Patient-reported outcomes (PROs) describe the perceived health status, function, and/or experience of a person as obtained by direct self-report. Patient-reported outcome measures (PROMs) are validated PROs that can be used to inform clinical care,<sup>4</sup> and have demonstrated effectiveness in improving patient-provider communication and decision-making.<sup>5-7</sup> PROMs are currently used in some MS clinical trials to determine the impact of experimental interventions,<sup>8-10</sup> and are also being used to inform and improve clinical care in some settings. Especially for persons with MS, they can provide individualized perspectives about health experience and outcomes.<sup>11</sup> In more advanced applications, PROMs can

**M**ultiple sclerosis (MS) is a disabling, complex, chronic, immune-mediated disorder of the central nervous system (CNS). MS causes inflammatory and degenerative damage in the CNS, which dis-

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be used to improve face-to-face collaborations between clinicians and patients and to inform patient-centered systems of care.<sup>12-14</sup> PROMs can also be used to inform systems-level improvement for entire patient populations.<sup>15,16</sup>

In this article, we review current applications of PROs and PROMs in the care of persons with MS, as well as current limitations and barriers to their use.

### CASE STUDY

Marion is a 26-year-old woman who first developed MS symptoms at age 16, including increased sensitivity to heat, blurry vision, and numbness in her legs (note: this case was developed based on interviews with persons with MS, obtained with appropriate consents, and does not represent a specific patient). At that time, her clinician attributed her symptoms to a car accident she had been in a few months before. Later, at age 20, she developed abdominal paresthesia, which her clinician attributed to an episode of shingles. At age 23, she developed double vision. She was evaluated by a neurologist and was diagnosed with MS. Marion started care with an MS specialist, who worked with her towards her goals of having a family, working, and exercising. In addition to appropriate medical care, she started martial arts training and biking for exercise and transitioned to a consulting position with flexible hours and the ability to work from home. Her daughter was born a year later.

At a recent visit to her neurologist, Marion reviews her health diary, in which she has been tracking her fatigue levels throughout the day and when she has to visit the bathroom. The PRO diary also helps her remember details that she might not otherwise be able to recall at the time of her clinic visit. They review the diary entries together to develop a shared understanding of what Marion has been experiencing and identify trends in the PRO data. They discuss symptom management and use the PRO information from the diary to help guide adjustments to her physical therapy routine and medication regimen.

Part of Marion's "PRO package" includes the Center for Epidemiologic Studies Depression Scale (CES-D), a validated depression screening and symptom severity questionnaire that she completes every 3 months.

Although she denies being depressed, she has noticed that her CES-D scores in recent months have been consistently increasing. This prompts a discussion about mental health in MS and a referral to work on depression with the MS mental health specialist. Marion and the mental health specialist use CES-D measures at baseline and during treatment to set a remission target and to track progress during treatment. Marion finds this helpful because she says it is hard for her to "wrap my hands around depression... it's not something that there is a blood test or a MRI for." Marion is encouraged by being able to see her CES-D scores change as her depression severity decreases, and this helps motivate her to keep engaged in treatment.

### PROs and PROMs: General Applications

PROs are measures obtained directly from an individual without a priori interpretation by a clinician.<sup>9,17</sup> PROs capture individual perspectives on symptoms, capability, disability, and health-related quality of life.<sup>9</sup> With increasing emphasis on patient-centered care,<sup>18</sup> individual perspectives and preferences elicited using PROMs may be able to inform better quality of care and patient-centered disease treatment and management.<sup>19-21</sup>

PROMs are standardized, validated questionnaires used to assess PROs and can be generic or condition-specific. Generic PROMs can be used in any patient population. The SF-36<sup>22</sup> is a set of quality of life measures that assess perceived ability to complete physical tasks and routine activities, general health status, fatigue, social functioning, pain, and emotional and mental health.<sup>23</sup> Condition-specific PROMs can be used for particular patient populations and are helpful in identifying changes in health status for a specific disease, disability, or surgery. For example, the PDQ-39 assesses 8 dimensions of daily living, functioning, and well-being for people with Parkinson's disease.<sup>24</sup>

PROMs have been used in some MS clinical trials and research studies to determine the effectiveness of experimental treatments from the viewpoint of study participants.<sup>9,25,26</sup> PROs can also be utilized in clinical care to facilitate communication of needs and track health outcomes,<sup>27</sup> and can inform improvement in outcomes for health systems and populations. They can also be

used to assess experience of care,<sup>28</sup> encouraging a focus on high-quality outcomes through PRO-connected reimbursement mechanisms,<sup>29</sup> and provide aggregate data to evaluate clinical practice, population health outcomes, and the effectiveness of public policies.<sup>27</sup>

Patient-reported experience measures (PREMs) assess patient satisfaction and experience of health care.<sup>30,31</sup> CollaboRATE<sup>32</sup> is a PREM that assesses the degree of shared decision-making occurring between patients and clinicians during clinical care. PREMs are currently used for assessing self-efficacy and in shared decision-making and health care improvement applications. PREMs have yet to be developed specifically for persons with MS.

### PROMs in MS Care

Generic PROMs have shown that persons with MS are disproportionately burdened by poor quality of life.<sup>33-35</sup> Other generic PROMs, like the SF-36,<sup>36</sup> the Sickness Impact Profile,<sup>37</sup> and versions of the Health Utilities Index,<sup>38</sup> can be used to gather information on dysfunction and to determine quality and duration of life modified by MS-related dysfunction and disability. MS-specific PROMs are used to assess MS impairments, including pain, fatigue, cognition, sexual dysfunction, and depression.<sup>12,39-42</sup> PROMs have also been used in MS clinical trials, including the Multiple Sclerosis Impact Scale-29 (MSIS-29),<sup>43,44</sup> the Leeds MS QoL (LMSQoL),<sup>45,46</sup> the Functional Assessment of MS (FAMS),<sup>47</sup> the Hamburg Quality of Life Questionnaire in MS (HAQUAMS),<sup>48</sup> the MS Quality of Life-54 (MSQoL-54),<sup>49</sup> the MS International QoL (MUSIQoL),<sup>50</sup> and the Patient-Reported Indices for MS Activity Limitations Scale (PRIMUS).<sup>51</sup>

Condition-specific PROMs are more sensitive to changes in health status and functioning for persons with MS compared to generic PROMs. They are also more reliable during MS remission and relapse periods.<sup>44,52</sup> For example, the SF-36 has floor and ceiling effects in MS populations—a high proportion of persons with MS are scored at the maximum or minimum levels of the scale, limiting discriminant capability.<sup>22</sup> As a result, a “combined approach” using both generic and MS-specific measures is often recommended.<sup>53</sup> Some MS PROMs (eg, MSQoL-54) include generic questions

found in the SF-36 as well as additional MS-specific questions or scales.

The variety of PROMs available (see **Table** for a selected listing) introduces a significant challenge to using them—limited generalizability and difficulty comparing PROs across MS studies. Efforts to establish common PROMs have been undertaken to address this problem.<sup>54</sup> The National Institute of Neurological Disorders and Stroke (NINDS) sponsored the development of a neurological quality of life battery, the Neuro-QOL.<sup>55</sup> Neuro-QOL measures the physical, mental, and social effects of neurological conditions in adults and children with neurological disorders and has the capability to facilitate comparisons across different neurological conditions. Additionally, the Patient-Reported Outcomes Measure Information System (PROMIS) has been developed to assess physical, mental, and social effects of chronic disease. PROMIS has a hybrid design that includes generic and MS-specific measures (such as PROMIS FatigueMS).<sup>56</sup> PROMIS can be used to assess persons with MS as well as to compare the MS population with other populations with chronic illness.

PROMs have varying levels of reliability and validity. The Evaluating the Measure of Patient-Reported Outcomes<sup>57</sup> study evaluated the development process of MS PROMs,<sup>43</sup> and found that the MSIS-29 and LMSQoL had the highest overall reliability among the most common MS PROMs. However, both scored poorly on validity due to lack of patient involvement during development. This questions the overall capability of existing MS PROMs to accurately and consistently assess PROs in persons with MS.

### “Feed-Forward” PROMs

Oliver and colleagues<sup>16</sup> have described “feed-forward” PROM applications in MS care in a community hospital setting using a learning health system approach. This MS clinic uses feed-forward PROs to inform clinical care—PRO data are gathered before the clinic visit and analyzed ahead of or during the clinic visit by the clinician. Patients are asked to arrive early and complete a questionnaire comprised of PROMs measuring disability, functioning, quality of life, cognitive ability, pain, fatigue, sleep quality, anxi-

Table. **Selected PROMs and PREMs**

<b>PRO Instrument (PROM/PREM)</b>	<b>Description</b>
Functional Assessment of MS (FAMS)	MS-specific functional status PROM
Hamburg Quality of Life Questionnaire in MS (HAQUAMS)	MS-specific quality of life (QoL) PROM
Leeds MS QoL (LMSQoL)	MS-specific QoL PROM
MS Impact Scale 29 Item (MSIS-29)	MS-specific functional status and QoL PROM
MS International QoL (MUSIQoL)	MS-specific QoL PROM
MS Quality of Life-54 Item (MSQoL-54)	MS-specific QoL PROM
MS Quality of Life Inventory (MSQLI)	Collection of general QoL and MS-specific functional status PROMs. Includes the SF-36.
Neurological Quality of Life (Neuro-QoL)	Collection of neurologic functional status and QoL PROMs
Disease Steps (DS)	MS-specific functional status PROM
Patient-Reported Indices for MS Activity Limitations Scale (PRIMUS)	MS-specific functional status PROM
Patient-Reported Outcomes Measure Information System (PROMIS)	Collection of PROMs consisting of general functional status, QoL, and some MS-specific functional status PROMs
Short Form 36 Item (SF-36)	General health status and QoL PROM
Stanford Self-Efficacy Scale (7 Item)	General self-efficacy PROM
Treatment Satisfaction Questionnaire for Medication 9 Item (TSQM-9)	General medication satisfaction PREM
Wasson Confidence Scale (1 item)	General health confidence PREM
World Health Organization Disability Assessment Schedule II (WHO-DAS II)	General biopsychosocial disability PROM. Includes measures of QoL, functional capability and societal participation.
Work Productivity and Activity Impairment (WPAI)	General workplace functioning PROM

ety, and depression. Clinicians score the PROMs and input scores into the electronic health record before the clinical encounter. During the clinic visit, PROM data is visually displayed so that the clinician and patient can discuss results and use the data to better inform decision-making. The visual data display contains longitudinal information, displaying trends in health status across multiple domains, and includes specified thresholds for clinically active symptom levels (**Figure**).<sup>16</sup> Longitudinal monitoring of PROM data allows for real-time assessment of goal-related progress throughout treatment. As illustrated previously by Marion's case study, the use of real-time feed-forward PROM data can strengthen the partnership between patient and clinician as well as improve empowerment, engagement, self-monitoring, and adherence.

## PRO Dashboards

Performance dashboards are increasingly used in health care to visually display clinical and PRO data for individual patients, systems, and populations over time. Dashboards display a parsimonious group of critically important measures to give clinicians and patients a longitudinal view of PRO status. They can inform decision-making in clinical care, operations, health care improvement efforts, and population health initiatives.<sup>58</sup> Effective dashboards allow for user customization with meaningful measures, knowledge discovery for analysis of health problems, accessibility of health information, clear visualization, alerts for unexpected data values, and system connectivity.<sup>59,60</sup> Appropriate development of PRO dashboards requires meaningful patient and clinician involvement via focus groups and key informant interviews, Delphi process approaches to pri-

ortize and finalize selection of priority measures, iterative building of the interface with design input from key informants and stakeholders (co-design), and pilot testing to assess feasibility and acceptability of use.<sup>61-63</sup>

### Other Applications of PROs/PROMs in MS Learning Health Systems

The National Quality Forum (NQF) and the Centers for Medicaid and Medicare Services have adopted PROs for use in quality measurement.<sup>64-66</sup> This includes a movement towards the use of LHS, defined as a health system in which information from patients and clinicians is systematically collected and synthesized with external evidence to inform clinical care, improvement, and research.<sup>67-70</sup> Often a LHS is undertaken as a collaborative effort between multiple health care centers to improve quality and outcomes of care.<sup>70</sup> The MS Continuous Quality Improvement Collaborative (MS-CQI), the first multi-center systems-level health care improvement research collaborative for MS,<sup>71</sup> as well as IBD Qorus and the Cystic Fibrosis Care Center Network utilize LHS approaches.<sup>72-77</sup>

IBD Qorus is a LHS developed by the Crohn's and Colitis Foundation that uses performance dashboards to better inform clinical care for people with inflammatory bowel disease. It also employs system-level dashboards for performance benchmarking in quality improvement initiatives and aggregate-level dashboards to assess population health status.<sup>78,79</sup> MS-CQI uses a LHS approach to inform the improvement of MS care across multiple centers using a comprehensive dashboard, including PROMs, for benchmarking and to monitor system and population health status. MS-CQI collects PROMs using a secure online platform that can be accessed by persons with MS and their clinicians and also includes a journaling feature for collecting qualitative information and for reference and self-monitoring.<sup>71</sup>

### MS Research

PROMs are used in clinical and epidemiological research to evaluate many aspects of MS, including the FAMS, the PDSS, the Fatigue Impact Scale (FIS), and others.<sup>80-82</sup> For example, the PROMIS FatigueMS and the Fatigue Performance Scale have been used to assess the impact of MS-related fatigue on social participation.<sup>83</sup> Generic

and MS-specific PROMs have been used to assess pain levels for people with MS,<sup>84-87</sup> and multiple MS-specific PROMs, like PRIMUS and MSQoL-54,<sup>43</sup> as well as the SF-36<sup>39</sup> include pain assessment scales. PROMs have also been used to assess MS-related bladder, bowel, and sexual dysfunction. Urgency, frequency, and incontinence affect up to 75% of patients with MS,<sup>88</sup> and many PROMs, such as the LMSQoL, MUSIQoL, and the MSQoL-54, are able to evaluate bladder control and sexual functioning.<sup>43,89</sup>

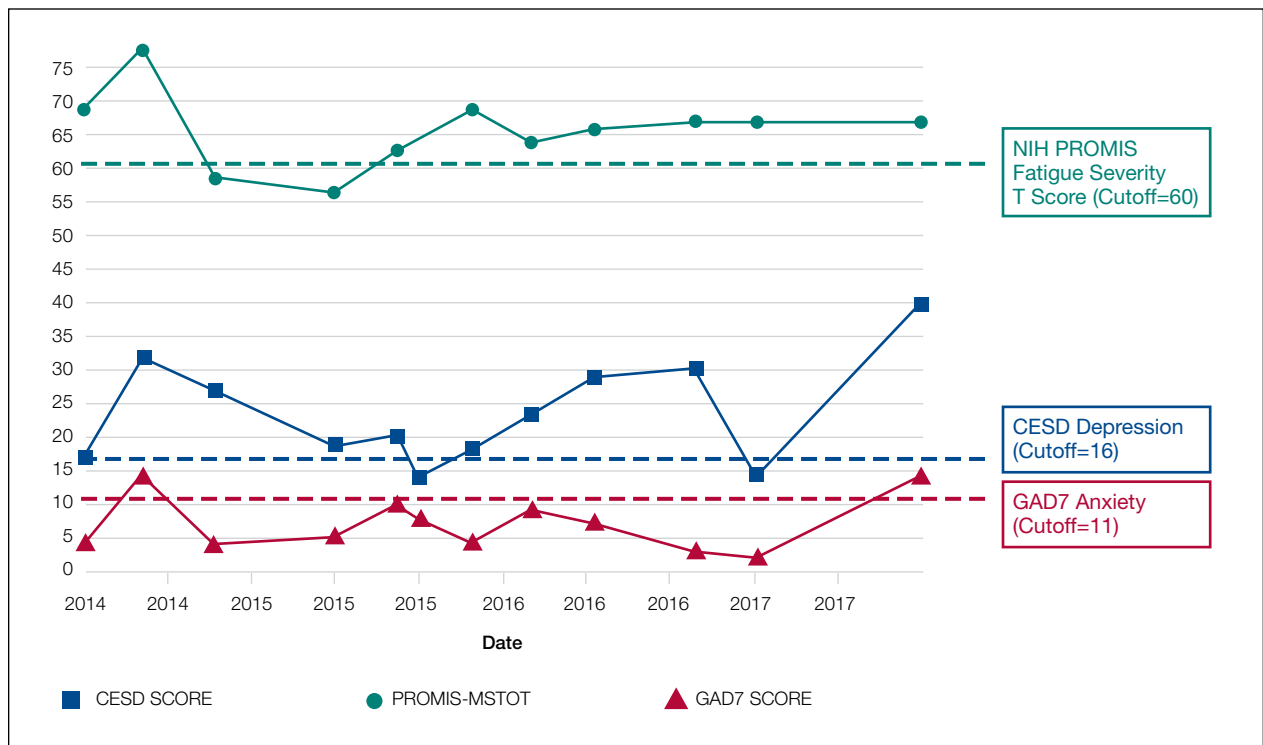
PROMs are employed in MS clinical trials to help assess the tolerability and effectiveness of DMTs.<sup>90,91</sup> PROs have been used as secondary endpoints to understand the global experience of a DMT from the patient perspective.<sup>92-94</sup> There are 15 FDA-approved DMTs for MS, and clinical trials for 6 of these have used PROMs as an effectiveness end point.<sup>54,91,95,96</sup> However, most DMT clinical trials are powered for MRI, relapse rate, or disease progression primary outcomes rather than PROMs, often resulting in underpowered PROM analyses.<sup>97</sup> In addition, many PROMs are not appropriate for use in DMT clinical trials.<sup>98,99</sup>

In order to bridge the gap between clinical research and practice, some industry entities are championing "patient-focused drug development" approaches. The Accelerated Cure Project for MS has launched iConquerMS, which collects PROMs from persons with MS to further PRO research in MS and follows 4700 individuals with MS worldwide.<sup>100</sup> In 2018, the American College of Physicians announced a collaboration with an industry partner to share data to inform DMT clinical trials and develop and validate PROMs specifically designed for DMT clinical trials.<sup>101</sup>

### Population Health

Registries following large cohorts of people with MS have the potential to develop knowledge about disease progression, treatment patterns, and outcomes.<sup>102</sup> The Swedish EIMS study has identified associations between pre-disease body mass index and MS prognosis,<sup>102</sup> alcohol and tobacco consumption affecting MS risk,<sup>103,104</sup> and exposure to shift work at a young age and increased MS risk.<sup>105</sup> The North American Research Committee on MS<sup>83,106,107</sup> and iConquerMS

## Patient-Reported Outcomes in MS



**Figure.** Visual display of patient-reported outcome measures in electronic health record. Dotted lines represent threshold levels selected for clinically significant symptom severity for each measure. CESD, Center for Epidemiologic Studies Depression Scale; PROMIS, Patient-Reported Outcomes Measure Information System; GAD7, Generalized Anxiety Disorder 7.

registries are “PROM-driven” and have been useful in identifying reductions in disease progression in people using DMTs.<sup>107,108</sup> The New York State MS Consortium has identified important demographic characteristics that influence MS progression.<sup>109,110</sup> PROs can also be used to determine risk of MS-related mortality<sup>111</sup> and decline in quality of life.<sup>112,113</sup> Limitations of these approaches include use of different PROMs, inconsistencies in data collection processes, and different follow-up intervals used across registries.<sup>102</sup>

### Patient-Centered Care

The Institute of Medicine defines patient-centeredness as “care that is respectful and responsive to individual patient preferences, needs, and values and ensures that patient values guide all clinical decisions.”<sup>114</sup> PROs are useful for identifying a patient’s individual health concerns and preferences, something that is needed when treating a highly variable chronic health condition like MS. The use

of PROs can help clinicians visualize the lived experience of persons with MS and identify personal preferences,<sup>115</sup> as well as improve self-monitoring, self-management, self-efficacy, adherence, wellness, and coping ability.<sup>116</sup> At the system level, PROs can inform improvement initiatives and patient-centered care design efforts.<sup>117-120</sup>

### Selecting PROMs

Initiatives from groups like the COnsensus-based Standards for the Selection of health Measurement INstruments (COSMIN)<sup>121</sup> and the International Society for Quality of Life Research (ISOQOL)<sup>108</sup> offer guidance on selecting PROs. The NINDS has promoted common data collection between clinical studies of the brain and nervous system.<sup>122</sup> General guidance from these sources recommends first considering the outcome and target population, selecting PROMs to measure the outcome through a synthesis of the available evidence, assessing validity and reliability of selected PROMs, and



using standard measures that can be compared across studies or populations.<sup>108,121</sup> Other factors include feasibility, acceptability, and burden of use for patients, clinicians, and systems, as well as literacy, cultural, and linguistic factors.<sup>123</sup>

The NQF recommends that consideration be given to individual patient needs, insurance factors, clinical setting constraints, and available resources when selecting PROMs.<sup>124</sup> To maximize response rate, PROMs that are sensitive, reliable, valid, and developed in a comparative demographic of patients are advised.<sup>125</sup> ISOQOL has released a User's Guide and several companion guides on implementing and utilizing PROMs.<sup>108,126,127</sup> Finally, PRO-Performance Measures (PRO-PMs) are sometimes used to assess whether PROMs are appropriately contributing to performance improvement and accountability.<sup>124</sup>

## The Cons of PROs

### *Time and Software Constraints*

PROs can disrupt busy clinical care environments and overextend clinical staff.<sup>125</sup> Online collection of PROs outside of clinical encounters can relieve PRO-related burden, but this requires finding and funding appropriate secure online networks to effectively collect PROs.<sup>128</sup> In 2015, only 60% of people seen for primary care visits could access or view their records online, and of those, only 57% used messaging for medical questions or concerns.<sup>129</sup> Ideally, online patient portal or mobile health apps could synchronize directly to electronic health records or virtual scribes to transfer patient communications into clinical documentation.<sup>130</sup> There has been limited success with this approach in European countries<sup>131</sup> and with some chronic illness conditions in the United States.<sup>74</sup>

Electronic health technologies, including mobile health (mHealth) solutions, have improved the self-monitoring and self-management capability of patients with MS via information sharing in patient networks, assistive technologies, smartphone applications, and wearable devices.<sup>132,133</sup> A recent study found that communication modes included secure online patient portal use (29%) and email use (21%), and among those who owned tablets or smartphones, 46% used mHealth apps.<sup>134</sup> Social media use has been associated with increased peer/social/emotional support

and increased access to health information, as well as clinical monitoring and behavior change.<sup>134,135</sup> Individuals using mHealth apps are younger, have comorbidities, and have higher socioeconomic and education levels,<sup>135,136</sup> suggesting that inequities in mHealth access exist.

### *Burden on People with MS*

Questionnaires can be time-consuming and cause mental distress if not appropriately facilitated.<sup>137</sup> Decreasing questionnaire length and providing the option for PROMs to be delivered and completed online or outside of the clinic context can reduce burden.<sup>138</sup> Additionally, while some people are consistent in sharing their PROs, others struggle with using computers, especially while experiencing severe symptoms, forget to complete PROMs, or simply do not have internet access due to financial or geographic constraints.<sup>139</sup> A group of disabled and elderly persons with MS reported barriers to internet use due to visual deficits, small website font sizes, and distracting color schemes.<sup>140</sup>

### *Interpretability*

Interpreting PROMs and displays of longitudinal PROM data can be a challenge for persons with MS and their clinicians. There is little standardization in how PROMs are scored and presented, and there is often confusion about thresholds for clinical significance and how PROM scores can be compared to other PROMs.<sup>141,142</sup> While guidelines exist for implementing PRO scores in clinical settings,<sup>126,143</sup> there are few that aid PROM interpretation. As a result, clinicians often seek research evidence for PROMs used in other similar patient populations as a benchmark,<sup>142-144</sup> or compare them to other patients seen in their clinical practice.

Longitudinal PRO data are usually displayed in simple line graphs.<sup>145,146</sup> Overall, line graphs have been found to have the highest ease of understanding by both patients and clinicians, but sometimes can be confusing.<sup>147</sup> For example, upward trending lines are usually viewed as improvement and downward trending lines as decline; however, upward trending scores on a PROM can indicate decline, such as increasing fatigue severity. Annotation of visual displays can help. Patients and clinicians find that employing thresholds and color coding

is useful, and better than “stoplight” red-yellow-green shading schemes or red-circle formats to indicate data that warrant attention.<sup>142</sup>

### **Error Risks**

PROs are not free of risk for error, especially if they are used independently of other information sources, such as clinical interview, examination, and diagnostic testing, or if they are utilized too frequently, too infrequently, or are duplicated in practice. If a PRO instrument is employed too frequently, score changes may reflect learning effects rather than actual clinical status. Conversely, if used too infrequently, PRO information will not be timely enough to inform real-time clinical practice. Duplication of PRO assessments (eg, multiple measures of the same PRO for the same patient on the same day) or use of multiple PRO measures to assess the same aspect (eg, 2 measures used to assess fatigue) could introduce unnecessary complexity and confusion to interpretation of PRO results.

PRO measures also can be biased or modified by clinical status and/or perceptions of people with MS at the time of assessment. For example, cognitive impairment, whether at baseline state or due to a cognitive MS relapse event, could impact patients' ability to understand and respond to PRO assessments, producing erroneous results. However, when used appropriately, PROs targeting cognitive dysfunction may be able to detect onset of cognitive events or help to measure recovery from them. Finally, PROs measure perceived (self-reported) status, which may not be an accurate depiction of actual status.

All of these potential pitfalls support the argument that PROs should be utilized to augment the clinical interview, examination, and diagnostic (objective) testing aspects of comprehensive MS care. In this way, PROs can be correlated with other information sources to deepen the shared understanding of health status between a person with MS and her clinician, increasing the potential to make better treatment decisions and care plans together in partnership.

### **Value and Cost**

National groups such as the Patient-Centered Outcomes Research Institute (PCORI) are working with regulatory

bodies, funding agencies, insurance providers, patient advocacy groups, researchers, providers, and specialty groups to investigate how PROMs can be implemented into value-based health care reforms, including value-based reimbursement.<sup>148</sup> However, practical PRO implementation requires considerable time and resources, and many methodological and operational questions must be addressed before widespread adoption and reimbursement for PROMs will be feasible.<sup>148,149</sup>

### **Summary**

PROs can generate valuable information about perceived health status, function, quality of life, and experience of care using self-reported sources. Validated PRO assessment tools include PROMs and PREMs. PROs are currently utilized in research settings (especially PROMs) but are also being used in clinical practice, quality improvement initiatives, and population health applications using LHS approaches. PROs have the advantages of empowering and informing persons with MS and clinicians to optimize patient-centered care, improve systems of care, and study population health outcomes. Barriers include PROM validity, reliability, comparability, specificity, interpretability, equity, time, and cost. Generic PROMs and PREMs, and some MS-specific PROMs, can be used for persons with MS. Unfortunately, no PREMs have been developed specifically for persons with MS, and this is an area for future research. With appropriate development and utilization in LHS applications, PROs can inform patient-centered clinical care, system-level improvement initiatives, and population health research, and have the potential to help facilitate coproduction of health care services.

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