Standardized MR Imaging Protocol for Multiple Sclerosis: Consortium of MS Centers Consensus Guidelines


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CONSENSUS STATEMENT

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MR imaging has played an important role in contributing to our understanding of the natural history of multiple sclerosis (MS) in the brain and spinal cord, including its expression as both a focal (plaque) and more diffuse disease affecting normal-appearing white and gray matter, the latter detected by using quantitative MR techniques. A set of conventional measures (T2 burden of disease [BOD], T2 lesion, and T1 gadolinium-enhancing lesion counts) are routinely used in phase II and III MS clinical trials as primary and secondary outcome measures, respectively, and there is expanding use of enhancing lesion counts in phase I clinical trials as a “safety” measure. MR imaging activity (a new lesion) has recently been accepted by an International Panel (IP) of MS experts as a criterion that can be used to establish evidence of disease dissemination in time (DIT) after a clinically isolated syndrome (CIS) in lieu of a second clinical attack. This new MR imaging lesion allows a formal clinical diagnosis of MS, provided specific MR imaging-derived dissemination in space (DIS) criteria are also met. This use of MR imaging to establish the diagnosis of MS has the important effect of accelerating the diagnosis by months or even years. A positive MR imaging is also used as a factor for decision to treat, without additional evidence for DIT, by many neurologists, particularly in North America, when a patient presents with a classic CIS and characteristic lesions on MR imaging. Less formally, MR imaging is increasingly used in practice to measure subclinical disease, on the basis of its greater sensitivity compared with clinical measures. On average MR imaging is about 5–10-fold more sensitive to ongoing demyelination than clinical measures.

As MR imaging is used more and more for diagnosis and management decisions, limiting factors have been the lack of (1) a standardized protocol for how MR imaging should be used for patients with MS or suspected to have MS, (2) for when to use MR imaging, and (3) the minimum standard.

Recognizing the central role of MR imaging for diagnosis, in clinical trials, and to follow disease activity and injury, an international group of neurologists and radiologists met in Vancouver, British Columbia, on November 3–4, 2001. The meeting was sponsored by the Consortium of Multiple Sclerosis Centers (CMSC). The goal was to develop recommendations and guidelines for a standardized MR imaging protocol for the diagnosis and follow-up of MS patients. Formal follow-up meetings and discussion of the CMSC consensus guidelines criteria in 12 platform presentations at major neurology and radiology venues across 4 continents and more than 30 regional meetings have provided a forum for discussion and refinement of the original guidelines.

The purpose of this report is to present these recommendations and guidelines to the entire imaging community. Translation from population data (clinical trials and natural history studies) to the individual patient is not necessarily straightforward or without risk. The hope is that the imaging community will assume a leadership role in implementing these standardized guidelines into routine clinical practice, but also provide an opportunity for further discussions of future revisions particularly as the quantitative measures of normal-appearing central nervous system (CNS) tissues become feasible in a clinical environment, beyond the cornerstone of the conventional measures discussed here.

For this overview the CMSC consensus criteria for standardized MR imaging in MS are provided in bold text. Comments by the consensus panel and authors follow the recommendations as additional supporting information for the reader.
The subcallosal line joins the undersurface of the front (rostrum) and back (splenium) of the corpus callosum.

The diagnosis of MS is clinical and can be established without MR imaging. The subcallosal line joins the undersurface of the front (rostrum) and back (splenium).

When available, an MR imaging study that meets the standardized protocol should be acquired as part of the initial evaluation (Tables 1 and 2).

When acquired immediately following an enhanced brain MRI*

<table>
<thead>
<tr>
<th>Sequence</th>
<th>Recommendation</th>
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<tbody>
<tr>
<td>1</td>
<td>3 plane (or other scout) Recommended</td>
</tr>
<tr>
<td>2</td>
<td>Postcontrast sagittal T1 Recommended</td>
</tr>
<tr>
<td>3</td>
<td>Postcontrast sagittal FSE PD/T2t Recommended</td>
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<tr>
<td>4</td>
<td>Postcontrast axial T1 Through suspicious lesions</td>
</tr>
<tr>
<td>5</td>
<td>Postcontrast axial FSE PD/T2t Through suspicious lesions</td>
</tr>
<tr>
<td>6</td>
<td>Postcontrast 3D T1s Optional</td>
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</tbody>
</table>

When acquired without a preceding enhanced brain MRI

<table>
<thead>
<tr>
<th>Sequence</th>
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<tbody>
<tr>
<td>1</td>
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<td>Precontrast Axial FSE PD/T2t Through suspicious lesions</td>
</tr>
<tr>
<td>5</td>
<td>3D T1s Optional</td>
</tr>
<tr>
<td>6</td>
<td>Postcontrast-enhanced sagittal T1 Recommended</td>
</tr>
<tr>
<td>7</td>
<td>Postcontrast-enhanced axial T1 Through suspicious lesions</td>
</tr>
</tbody>
</table>

Note.—FSE indicates fast spin-echo (or turbo spin-echo); PD, proton density-weighted (long TR, short TE sequence); T2, T2-weighted (long TR, long TE sequence); T1, T1-weighted (short TR, short TE sequence). Section thickness for sequences 3–6 is ≤3 mm with no intersection gaps when feasible. Partition thickness for 3D sequence 6 is ≤1.5 mm. In-plane resolution is approximately ≤1.6 mm.

Details of the MR imaging component of the IP criteria are provided in Table 3. These criteria are based on counting lesions of specific types. In the early stages of MS, particularly at the time of a CIS, lesion counts are simple and can be performed rapidly with good reproducibility provided scan quality is adequate.

The phrase, when available, was introduced in recognition that MR imaging is not universally available in Third World nations. The diagnosis of MS is clinical and can be established without MR imaging.

Consensus

I. Initial Evaluation after a CIS or Based on Past History That Is Suspicious

When available, an MR imaging study that meets the standardized protocol should be acquired as part of the initial evaluation (Tables 1 and 2).

CIS is a common term in use today, though some prefer “monosymptomatic attack.” Most patients diagnosed with MS present with or retrospectively recall symptoms or signs consistent with an optic neuritis, usually acute and unilateral with loss of central vision, pain on eye movement, and an afferent pupil defect; a brain stem syndrome (eg, internuclear opthalmoplegia); or a spinal cord syndrome with partial transverse myelitis with ascending numbness and/or paresthesia, hyperreflexia, tight bandlike sensations localizing to the affected cord segment, with motor, bowel, or bladder involvement. Other suggestive features for MS include trigeminal neuralgia, Lhermitte phenomenon, spasticity, tremor, and ataxia.

The phrase, when available, was introduced in recognition that MR imaging is not universally available in Third World nations. The diagnosis of MS is clinical and can be established without MR imaging. However, early literature on which the DIS criteria were derived included variable section thickness (5–10 mm), intersection gaps, and low-field (<1T) imaging, several recent studies suggest that these quantitative (lesion count) criteria remain valid on the basis of more modern imaging technique.

The IP criteria (most often referred to as the McDonald criteria) are not the only documented MS predictive criteria in common use. For example, many MS neurologists, particularly in North America, will initiate immunomodulatory treatment based on a well-documented CIS accompanied by a positive MR imaging with 2 or more characteristic T2-lesions ≥3 mm in diameter, one of which is either periventricular or ovoid. These patients are at high risk for second clinical attack, or may accumulate additional subclinical MR imaging lesions suggestive of ongoing demyelination. For this set of individuals, standardized MR imaging is also important to minimize errors in interpretation of the MR imaging.
Cal length of lesion than the thoracic cord. Characteristic features include (verti-
axial sections. T2-hyperintense lesions do not develop in the
III. Baseline MR Imaging Evaluation
For a patient who already has a diagnosis of MS, it is ap-
propriate that the baseline evaluation include an MR imag-
ing that meets the standardized protocol. This is in addition
to a complete neurologic history and examination.
Misdiagnosis of MS is becoming less frequent with the use
of brain and spinal cord MR imaging to exclude MS mimick-
ers, such as neoplasm, spinal stenosis, or vascular malforma-
tion. More difficult and more clinically problematic is distin-
guishing MR imaging lesions due to overlapping pathology,
such as that caused by Sjögren syndrome, systemic lupus ery-
thematosus, Lyme disease, or sarcoidosis. The IP report dis-
cusses these pathologies and includes strong recommenda-
tions regarding exclusion of alternative diagnoses through
history, clinical evaluation, and appropriate laboratory stud-
ies.2 It is important that a diagnosis of MS not be made simply
on the basis of MR imaging findings without the appropriate
clinical signs and symptoms.

III. Indications for Spinal MR Imaging
A. If the main presenting symptoms are at the level of the
spinal cord, and have not resolved, spinal cord MR imaging
and brain MR imaging are required.
B. If the results of the brain MR imaging are equivocal
and the diagnosis of MS is still being entertained, spinal cord
imaging may be justified.

Recommendation (A) includes spinal cord MR imaging to
exclude mimicking or secondary pathology. Even when spinal
cord lesions are observed, the guidelines suggest baseline brain
MR imaging to demonstrate characteristic lesions.
With respect to (B), the lesions from MS in the spinal cord
have been well described in the literature; 50%–90% of cli-
cally definite MS patients will have lesions on spinal cord MR
imaging.11 These lesions are more common in the cervical
than the thoracic cord. Characteristic features include (verti-
cal) length of lesion ≤2 vertebral segments, and asymmetry on
axial sections.12 T2-hyperintense lesions do not develop in the
spinal cord from normal aging and are very uncommon from
small vessel disease such as that related to hypertension, dia-
abetes, and atherosclerotic risk factors.13 Nevertheless, some
cautions are justified in the interpretation of spinal cord findings
in isolation as brain MR imaging findings tend to be more
definitive and characteristic for MS and more likely to be
present than those in the spinal cord which represents a small
fraction of the total CNS tissue. Spinal cord evaluation may be
compromised by pulsation and other motion artifacts, and in
practice false-negative and false-positive interpretations are
not rare.

Recommendation (B) is provided with the understanding
that spinal cord imaging provides a relatively low but certainly
not zero yield at the time of a CIS when there is no clinical
evidence of myelopathy and the brain MR imaging is normal.
A positive cord MR imaging with characteristic lesions im-
proves confidence in the diagnosis or presumptive diagnosis
(which may lead to more careful follow-up). Spinal cord MR
imaging may establish additional lesions such that the IP cri-
teria for DIS are fulfilled, because they allow substitution of a
spinal cord lesion for a brain lesion.

IV. Follow-Up MR Imaging
A. In the absence of clinical indications, routine follow-up
MR imaging scans are not recommended, regardless of
whether the patient is being treated. Clinical indications for
follow-up MR imaging are (1) unexpected clinical worsening
or when the clinician has a concern about the patient’s course,
(2) reassessment of disease burden for the initiation of treat-
ment, and (3) suspicion of a secondary diagnosis.
Routine follow-up scans are defined as those requested on
a regular—for example, annual—basis in the absence of the
qualifying factors described below. The recommendations
provide flexibility in the use of MR imaging that are based on
current clinical practice patterns by many experienced MS
neurologists. Many members of the consensus panel expressed
hope that with increasing experience by using standardized
MR imaging, and its use in establishing baseline disease in
individuals (as opposed to populations), there will be a re-
evaluation of these relatively conservative recommendations
and consideration in the future for routine (perhaps annual)
follow-up MR imaging in MS.

The principal basis for this consensus finding was related to
the uncertainty in interpreting the results of new, routinely
scheduled MR imaging. For example, because all therapies are
only partially effective, an increase in MS lesion numbers in an
individual being treated with an immunomodulatory therapy
may reflect partially effective or completely ineffective therapy
but alternatively could be a smaller increase than might have
occurred had there been no therapy.

The approved therapies for MS—glatiramer acetate (Cop-
areas of relatively severe tissue injury, including axonal injury, moderate-severe. T1 black holes when truly chronic are focal
include (1) number of new or enlarging T2-hyperintense lesions
pared with previous studies.
performed according to the standardized protocol and com-
there were strong minority dissenting opinions expressed in
terminate (sensory) findings suggests therapy be re-evaluated.
ments of 5 minutes following injection. Although it is well docu-
20 mL maximum) are recommended with a minimum delay
of 5 minutes following injection. Although it is well docu-
brain barrier disruption can be rapidly reversed in some indi-
should be persistent for at least 6 months.17 In routine clinical
should be for at least 6 months.17 In routine clinical
practice, however, T1 black holes are assumed to be any lesions
are no practical and no established quantitative methodolo-
give rise to “good” (potentially reparative) versus “bad” (proinflam-
individuals. Volume loss can be transient related to hydration,
nutritional status, or use of corticosteroids.
Much has been learned about the disease from quantitative
analyses of T2-lesion volume (BOD), change in BOD, counts
of new or enlarging T2 lesions over time, and enhancing les-
ions evaluated monthly or annually in patients enrolled in
therapeutic trials. These simple measures have been instrument-
al in the approval process of the MS therapies by provid-
objective support for the clinical outcomes. T2-hyperin-
tense lesions predict MS (second clinical attack) over short
and long intervals, and change in T2 BOD predicts long-term
disability in populations.19
For the spinal cord, scan quality, lesion size, and lesion
(tissue) contrast typically make analysis of change in number
over time difficult or unreliable, unless change is dramatic.
V. Contrast-Enhanced MR Imaging
A. Regarding the use of gadolinium-chelate, enhanced MR
imaging is recommended for suspected MS for purposes of
diagnosis and initial diagnostic evaluation.
There are several factors contributing to this recommenda-
tion. Confounding diagnoses may be less well visualized, or
even missed, without contrast-enhanced MR imaging (lepto-
meningeal disease, meningioma, other mass lesions, vascular
malformation). More important, the identification of enhanc-
ing lesions is an important component of the IP criteria pro-
viding evidence for disease DIT and DIS. Enhancing lesions at
the time of a CIS are a strong independent predictor of future
clinical attacks and a diagnosis of MS,10,20,21 probably as iden-
tification of an enhancing lesion is more likely with more ac-
tive disease.
Conventional doses of gadolinium-chelate (0.1 mmol/kg,
20 mL maximum) are recommended with a minimum delay
of 5 minutes following injection. Although it is well docu-
documented that greater doses (and delayed imaging) will increase
lesion conspicuity and lesion number,22 for routine clinical
care in an individual there is no evidence that supports higher
doses at this time.
Although a greater dose of MR contrast may convert an
individual from not MS to MS, to date there have been no
formal tests of this strategy to predict MS. The cost of addi-
tional MR contrast is not inconsequential.
B. Enhanced MR imaging is considered optional for the
baseline evaluation (in individuals already diagnosed with
MS).
The standard of care is variable. Some MS neurologists
routinely use enhanced MR imaging in their baseline assess-
ment, but others do not. Enhancing lesions are a surrogate
marker for focal disruption of the blood-brain barrier associ-
ated with macroscopic inflammation, an early (though prob-
ably not the earliest) stage in focal MS lesions. New enhancing
lesions remain conspicuous from about 1 week through about
16 weeks, most <4 weeks.23 It is likely that inflammation is
also microscopic (below MR imaging resolution), but there
are no practical and no established quantitative methodolo-
gies for evaluating microscopic inflammation in vivo. There is
controversy regarding inflammation in MS—notably related to
“good” (potentially reparative) versus “bad” (proinflam-
atory, injurious) inflammation.24 Nevertheless, the current
at least partially effective MS therapies are thought to exert
much of their effect through anti-inflammatory mechanisms, and inflammation, dysfunction, and electrical disturbances are well correlated in functionally exquisite parts of the CNS, which suggests that much of the MR imaging–detected inflammation is undesirable. Inflammation is notably associated with axonal transection and other markers for axonal injury (amyloid precursor protein).25

C. Enhanced MR imaging is considered optional for the follow-up of MS.

Although the standard of care in many MS centers is to acquire routine enhanced MR imaging to aid in treatment decisions, there is insufficient evidence to conclude that enhancement alone should drive treatment decisions.

VI. Acquisition Standards

MR imaging of the brain or spinal cord should be performed (if possible) at \( \geq 1T \) to optimize image quality and tissue contrast.

A minority of participants were of the opinion there was insufficient evidence to support the superiority of \( \geq 1T \) over lower field strength (eg, 0.3T–0.5T) scanners for the clinical imaging of MS.26–28 The higher field strength systems do provide consistently higher image quality, by virtue of better signal intensity to noise for similar scan times and with thinner sections. This benefit would be most apparent for the evaluation of the spinal cord and for examining patients less able to cooperate with longer scanning times. Lower-field-strength magnets with an open configuration, however, may be the only option for examining extremely claustrophobic patients.

With the introduction of 3T MR imaging systems into clinical practice, several questions arise, including the comparability of 3T versus <3T imaging data (ie, whether 3T detects more pathology when routine imaging sequences are used, sensitivity of 3T MR imaging to contrast enhancement, and whether 3T imaging at the time of a CIS require change in DIS criteria).

VII. Referral Indications and Documentation

The referring physician should indicate on the request for the "standardized MR imaging" one of the following: (1) suspected MS; (2) baseline evaluation of MS; (3) follow-up of MS.

This simple classification is in keeping with the technical recommendations for standardized MR imaging as outlined in Tables 1 and 2 and helpful for the IP criteria as well (Table 3).

In practice, cases are not infrequently presented to radiology services with less-definitive, more-encompassing indications such as a clinical sign and/or symptom with MS listed in the differential among other potential etiologies. The decision to use the standardized (MS) protocol may not be an optimal or straightforward choice in all cases, though the protocol even when used in non-MS evaluations provides a fairly thorough evaluation for most first-time evaluations.

VIII. The Radiology Report

The radiology report should use everyday language and be consistent. The report should include (1) a description of the findings, (2) a comparison with previous MR imaging scans, and (3) interpretation and differential diagnosis.

Although no specific recommendations were generated, following from the discussion above, and based on the new IP criteria, a simple lesion characterization and terminology was discussed as likely to be helpful in patient care.

As discussed above, the report would include a count of the number of enhancing lesions when feasible, T2-hyperintense lesions, and consideration of T1-hypointense lesions and atrophy (eg, a scale of mild-moderate-severe). When feasible (in the earlier stages of MS before lesions become confluent), a count of the new T2-hyperintense lesions provides a metric of change over time.

A statement could be provided regarding T2-lesion volume: mild (few lesions); moderate (multiple lesions, early or near confluent); and severe (many, confluent lesions).

In view of the IP criteria, terminology for describing T2 lesions at diagnosis would include periventricular (touching ventricle surfaces), total T2 (all locations), juxtacortical-cortical (touching cortical gray matter), and infratentorial (cerebellum, medulla-pons-midbrain).

A quantitative measure of total lesion volume and brain and spinal cord atrophy was considered (optimistically) optional, with very few facilities capable at this time of providing these measures for clinical evaluation.

For future consideration, a reporting table, optional for use, would be developed. In most hospital and clinic environments, particularly as electronic data management and PACS are implemented, a reporting table may provide an opportunity to summarize data in individual patients over time, but this will require individual (center) efforts.

IX. Copy of the MR Imaging Studies

A. A copy of these MR imaging studies should be retained permanently and be available. In addition, it may be useful for patients to keep their own studies on portable electronic media.

Because of the chronic nature of MS, which spans several decades, it is expected that many patients may change location for their care or MR imaging. At many centers, film or digital data are destroyed after several years or difficult to retrieve in a timely fashion. Consequently, a personal MR imaging file that is always with the patient is beneficial and increasingly feasible with portable media such as recordable CD, DVD, and USB keys, to allow for comparison with previous studies.

B. Studies should be stored in a standard format (eg, digital imaging and communications in medicine [DICOM]).

Comparison of prior studies is feasible by using workstations or film. If standardized studies can be loaded on a workstation, in native format, comparison with prior studies is feasible and simplified.

Viewer software (programs included with CDs, for example), while common, may be more difficult to use for direct comparisons with prior studies.

Discussion in the Imaging and Neurology Community since the original Presentations of these Consensus Recommendations

Since the last consensus meeting, this work has been presented at North American, European, and Australian scientific sessions and in poster forums, as well as at less-formal venues sponsored by pharmaceutical companies, grand rounds, etc. In general, acceptance by the neurology community has been excellent, whereas anecdotal experience suggests the imaging
community has been more cautious in embracing these guidelines.

Strong concerns and questions have been raised regarding only a few issues.

1. Spinal cord imaging: The methodology for standard clinical imaging of the spinal cord for MS or myelopathy varies between practices, ranging from the gold-standard multiecho conventional spin-echo acquisition (though relatively rare today), fast spin-echo imaging (proton and T2-weighted), and fast-STIR sequences.29-32 The literature is not definitive in suggesting the best sequence, because there are few studies comparing pulse sequences and study design issues render the results difficult to interpret (determination of false-positive findings). In the end, what guides selection of a spinal cord sequence may be experience with a particular sequence, instrument limitations or advantages, and other nonquantifiable factors. The choice of fast spin-echo sequence by the consensus groups likely reflects the experience of the consensus group, but by no means suggests that other sequences (fast-STIR) may not have advantages as well.

It should be noted that, with the rare exception of border-line brain MR at the time of a CIS, the spinal cord examination is not used to provide a quantitative count of lesions. The accuracy and reproducibility of counting lesions in the spinal cord is not optimal, and the spinal cord represents only a small fraction of total CNS tissue. Qualitative assessment of the spinal cord (lesion size, shape, distribution, and change over time) are important in the evaluation of MS. The use of non-standardized sequences (fast-STIR) should provide comparable information to recommended sequences for these purposes.

2. Sagittal imaging of the brain. The recommendation for sagittal fast–fluid-attenuated inversion recovery (FLAIR) imaging of the brain was also based on practice patterns. Several experienced imagers have suggested alternative sequences (T1-weighted spin-echo or T2-weighted fast spin-echo) to achieve sharper margins between corpus callosum and surrounding tissues to evaluate midline structures and corpus callosum size. These potential advantages were weighed against the use of FLAIR contrast in providing greater conspicuity of early lesions33 and characteristic MS patterns. Some sites may elect to acquire a quick T1- or T2-weighted series in addition to the recommended sagittal fast-FLAIR series.

3. At the time of the initial consensus meeting, contiguous 3-mm-thick axial brain sections were recommended to increase the accuracy of lesion counting.34,35 Concern was raised regarding the increase in scan time necessary to do this, and the matter was reconsidered, ultimately resulting in rewording the recommendation of section thickness to “3 mm, or 5 mm if 3 mm imaging is not possible.”

4. FLAIR axial strategy. One strategy employed to decrease scan time is to acquire the fast-FLAIR axial series after injection of contrast, during the recommended interval (5 minutes) before acquiring the T1-weighted postcontrast-enhanced series. This makes efficient use of otherwise “dead” time.36 Although there may be some disadvantages (possibility of increasing blood-motion induced ghosting), the postcontrast FLAIR may be advantageous in increasing conspicuity of enhancing lesions (T1 and T2 effects), and some groups use this approach in routine imaging.

5. T1 precontrast. This sequence was not originally listed as required but is an option that many will elect to assist in determining enhancement.

6. Magnetization transfer (MT) postcontrast enhanced series. Although an appropriate MT pulse increases contrast-to-noise for enhanced lesions, optimal use requires a pre-MT pulse acquisition, and some sequences with MT are accompanied by increased noise from pulsation artifacts. This is not a commonly used option.

7. “Advanced” quantitative imaging. While the literature strongly underscores the importance in MS of abnormality of the normal-appearing white matter and gray matter1 detected by MT imaging, diffusion imaging (apparent diffusion coefficient or fractional anisotropy), T1 and T2 relaxation imaging, whole brain and regional atrophy measures, and proton (1H-) MR spectroscopy, these methods have not been shown as yet to be practical in the clinical environment in individual patients. Few doubt that these methods will become important in the future in clinical care as they are validated in formal studies and technique, standardization, and quality control issues are addressed.

8. These recommendations for MS are most valuable in diagnosis and follow-up of early MS in individuals characterized by a CIS and a relapsing course. After approximately 10 years, more than half of these patients (untreated) enter a secondary progressive stage with fewer relapses, fewer new or enhancing lesions, and yet progressive disability. In the secondary progressive stage of disease, the standardized criteria, based on focal lesions, may become less helpful in following individuals.

In primary progressive MS (progressive from onset), occurring in 10%–15% of the MS population, enhancing and new lesions do occur, but far less frequently than in relapsing MS. There is speculation that in many of these individuals, lesion burden increase is more so by lesion expansion than by addition of new lesions, but many individuals show patterns indistinguishable from relapsing MS. Severe spinal cord involvement is common. At this time, there are no specific alternative recommendations for imaging patients with a diagnosis of primary progressive MS.37

9. In some centers that use fast-FLAIR and heavily T2-weighted fast spin-echo imaging, proton-weighted imaging is no longer acquired for brain pathology indications. An advantage of the proton attenuation–density series, included in the standardized MS scan, is greater sensitivity to important lesions in the posterior fossa, an area where fast-FLAIR may not infrequently fail.38

10. These recommendations may not be applicable to evaluation of pediatric MS, though most characteristics will overlap. Further studies are required to address the issues of optimal imaging standardization in pediatric MS.39

Conclusions

The development of consensus guidelines is a challenging process that, when done well, balances advantages and disadvantages. In this case, the advantages of standardized indications and imaging are to allow diagnosis and follow-up within and between imaging centers and practices. Disadvantages include compromises in choosing methodology, removing choice, and in some cases asking practices to move from the
methodology in which they have the most experience. Ultimately, although initially slightly painful, the hope is that standardization will benefit the individual MS patient, which after all is the goal of any medical imaging. These recommendations are provided with the understanding that they will likely require modification as instrument capabilities change, new pulse sequences are developed, and more quantitative methodologies become validated in individuals and feasible in practice.

References

17. Richert ND. Glatiramer acetate reduces the proportion of new MS lesions evolving into “black holes.” Neurology 2002;58:1440–41; author reply 1441–42