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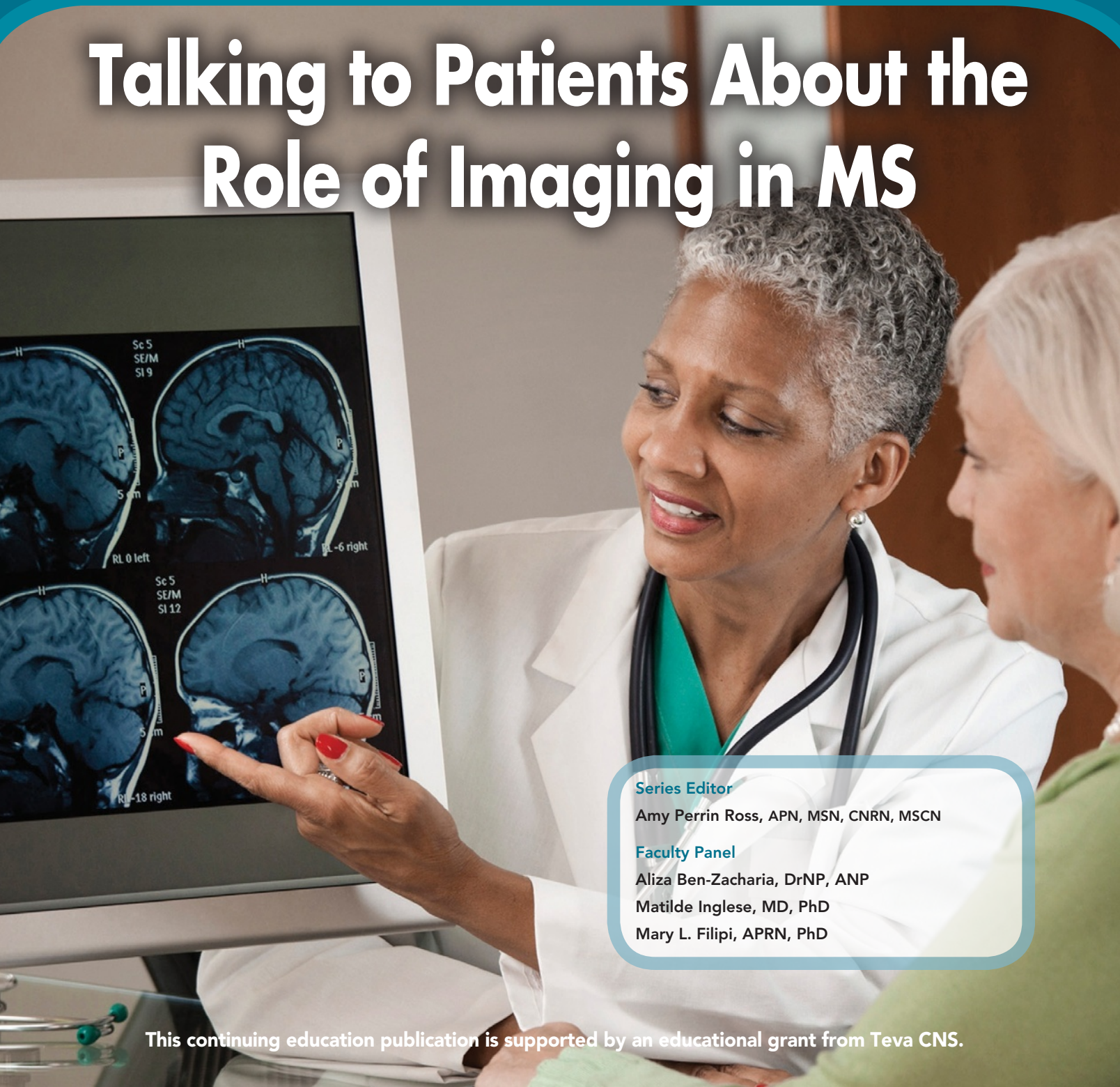
Counseling Points™

Enhancing Patient Communication for the MS Nurse

Talking to Patients About the Role of Imaging in MS



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Counseling Points™

Talking to Patients About the Role of Imaging in MS

Continuing Education Information

Target Audience

This educational activity is designed to meet the needs of nurses who treat or who have an interest in patients with multiple sclerosis (MS).

Purpose

To provide nurses with up-to-date information and strategies for counseling patients about the role of magnetic resonance imaging (MRI) in MS.

Learning Objectives

Upon completion of this educational activity, the participant should be able to:

- Assess the role of imaging studies in the evaluation of MS status and disease progression
- Analyze how new knowledge about imaging technologies relates to mechanisms of existing and newer therapies for MS
- Discuss issues pertaining to safety and accessibility of MS imaging technologies
- Describe methods for counseling patients about when and how often imaging studies should be performed

Continuing Education Credit

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In order to earn credit, please read the entire activity and complete the post-test and evaluation at the end. Approximate time to complete this activity is 60 minutes.

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welcome

Dear Colleague,

Most people with multiple sclerosis (MS) are all too familiar with the inside of a magnetic resonance imaging (MRI) scanner and the sensation of gadolinium being injected into a vein. With earlier diagnoses and a greater variety of treatments available, MRI is an especially crucial tool to guide MS clinicians in making decisions about when and how to treat and whether the disease is progressing.

MRI—how it works, what it shows in the brain—is a bewilderingly complex area for patient education. It is difficult to explain to patients exactly what a lesion shows, whether it is benign or indicative of inflammation or axonal damage, and why MRI results may vary from scan to scan. This is hardly surprising, given the highly technical nature of this material.

It is important for MS nurses to help patients feel they are part of the process. MRI scans can be uncomfortable and frightening for anyone, and may be especially difficult for someone who experiences pain or spasticity. Patients should understand why they are having this test and why repeat studies may be necessary. In addition, patients should have realistic expectations about what an MRI is *not*. There remain many unanswered questions about MRI in MS. Much of the damage from the disease remains hidden in gray matter and other areas that are not well visualized via standard MRI of the brain or spinal cord.

This review takes us back to the basics to guide MS nurses in educating patients about MRI. It also addresses some of the more difficult questions about MRI and other imaging techniques based on the latest research findings.

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Talking to Patients About the Role of Imaging in MS

Every person who has a diagnosis of multiple sclerosis (MS) or who is going through the diagnostic process usually undergoes magnetic resonance imaging (MRI) testing, and many will have these tests annually or even more frequently. Still, there is little MS-specific information available about how to support and educate patients undergoing an MRI. The interpretation of an MRI scan and what the results mean to the individual are among the most difficult aspects of MS to explain clearly. Patients' attitudes about MRI are also largely unexplored.[1] Patients may have fears or misunderstandings about the MRI testing process, its safety, and what the results may reveal about their condition. MS nurses can offer patients support, guidance, and valuable education about MRI. This article contains many of the tools to help nurses with this process.

Explaining MRI Technology to the Patient with MS

MRI technology was first applied in MS in the early 1980s.[2] MRI is a noninvasive procedure that uses powerful magnets and pulses of radio wave energy to create a computerized image of the soft tissues of the body.[3-5] As with a computed tomography (CT) scan, MRI creates images that appear as multiple "slices" of an organ or body area.

During an MRI scan, a large magnet causes the spinning of hydrogen atoms (located mostly in the water within a person's body) to change direction and align with the magnetic field. The MRI equipment turns smaller magnets on and off and emits radio pulses at specific frequencies to change the direction of the hydrogen atoms' spin. These changes release energy, which is detected by a computer and converted mathematically into a detailed image of the tissue. Because atoms in normal tissues and altered tissues respond differently to the magnetic fields, abnormalities in an area can be visualized. The use of a contrast agent, gadolinium, alters the local magnetic field in an area being scanned and enhances the difference between abnormal and normal tissue.[5]

The amount of detail given to patients about how MRI tests work can be tailored to each patient's level of understanding and desire to know. For those who are interested, a good tutorial can be found on howstuffworks.com (http://www.howstuffworks.com/mri.htm).[6]

MRI Scanning and Patient Safety

Unlike x-rays and CT scans, MRI does not use ionizing radiation that can potentially trigger long-term or permanent changes in human cell behavior. There are no known hazards to exposure to the magnetic field at the strengths used in clinical MRI settings for most patients.[7] When the magnetic field is turned off, the hydrogen atoms in the body immediately return to their normal state.

According to the Safety Committee of the International Society for Magnetic Resonance in

Medicine, MRI is performed on more than 10 million patients each year with no risk of short- or long-term health hazards.[8] The magnet strengths used for MRIs in most MS examinations are either 1.5 Tesla or 3 Tesla. Much higher magnet strengths (up to 7 or 9 Tesla) have been used in experimental studies on tissue samples.[9-11] Less is known about the safety of these higher magnet strengths.

Gadolinium is approved by the Food and Drug Administration (FDA) for use with MRI as a contrast agent to provide an improved image of body organs and tissues.[12] Gadolinium is cleared from the body via the kidneys and has a half-life of approximately 1.5 hours in people with normal renal function.[13] Use of gadolinium is not recommended in pregnant women or nursing mothers because of the unknown effect on the fetus or infant.[14] Women who are pregnant should not have MRI, and those who are breastfeeding should discard breast milk for 24 to 48 hours after receiving gadolinium before resuming nursing. Reactions resembling an allergic response are extremely rare (0.004% to 0.7%) and may present as rash, hives, urticaria and, uncommonly, bronchospasm.[15]

The primary risk from use of gadolinium is in patients with severe renal impairment, including:

- severe acute or chronic renal insufficiency (glomerular filtration rate <30 mL/min/1.73m^2);
- hepatorenal syndrome;
- during the perioperative liver transplantation period.[12]

Indwelling metal devices or objects present the primary safety hazard during MRI tests. Because ferromagnetic items are rapidly attracted to the magnet, great care is taken to prevent any external metal objects (e.g., credit cards, jewelry, watches) from entering the room where the scanner is located.[16] But what about metal within a person's body? Today the odds are increased that a person may harbor such an object. Indwelling, ferromagnetic metals that may prohibit MRI testing are listed in **Table 1**.[17] Non-ferromagnetic metals (such as braces or fillings on the teeth) do not contraindicate an MRI but may potentially affect the quality of the image.[18] There have been a number of reports of cutaneous burns during MRI in patients with tattoos. Tattoos with black pigment derived from iron oxide and applied in a loop pattern are considered to pose the greatest risk for a cutaneous reaction.[19] In addition, some pigments, including facial tattooing for "permanent" eyeliner or eyebrows, may lead to artifacts on the MRI image.[20]

Table 1. Metals That May Contraindicate MRI Testing[17]

- Implantable defibrillators
- Some pacemakers (some models are "MRI-friendly")
- Aneurysm clips
- Artificial heart valves or vascular stents
- Cochlear implants
- Recently placed artificial joints
- Potential metal fragments in the eye (e.g., in sheet metal workers)
- Shrapnel/bullet fragments
- Some dental implants or dentures with magnetic keepers
- Other implants that involve magnets

People with MS may be concerned about the safety of having an MRI if they have an intrathecal baclofen pump. The presence of a baclofen

pump is not a contraindication to MRI testing, but it is important that the technologist be aware of the device.[21] For most devices, the pump's rotor will automatically turn off during the MRI and will normally restart again after the MRI is complete. Patients are advised to have the pump checked within 2 hours of the MRI exam to ensure that it has restarted and its settings are correct.[22]

Types of MRI Platforms Used in MS

The terms used to describe MRI in the context of MS can be confusing for all but the most scientifically informed patients. There are three basic types of brain MRI scans used in MS diagnosis and monitoring: T1-weighted scans, T1-weighted scans with gadolinium (also called enhancing or gadolinium-enhancing scans), and T2-weighted scans **(Table 2)**.[23] "T" refers to relaxation time, or the time that it takes for a substance to become magnetized after exposure to a magnet, with T1 representing longitudinal relaxation time and T2 representing transverse relaxation time.[5]

Table 2. Brain MRI Platforms in MS[23]

MRI Platform	MS Signs Visualized	Appearance on Image
T1-weighted scans	Tissue damage, atrophy	Hypointense spots ("black holes")
T1 gadolinium-enhancing scans	Break in the BBB, active disease	Pronounced hyperintense spots
T2-weighted scans	New and scarred lesions	White or hyperintense spots
T2 FLAIR sequence	Hyperintense contrasted lesions	White lesions on black background

BBB=blood-brain barrier; FLAIR=fluid-attenuated inversion recovery.

On brain MRI images in a person with MS, T2-weighted scans show the presence of scarred lesions, which appear as white (hyperintense) areas. T1-weighted scans depict areas of nerve damage and atrophy, and appear as less-dense (hypointense) spots, or "black holes."[3,23,24] When gadolinium is used in conjunction with a T1-weighted scan, the contrast agent leaks into the brain tissue at breaks in the blood-brain barrier to identify areas of active disease (inflammation), which appear as hyperintense or "gadolinium-enhancing" T1 images.[25]

MRI of the spinal cord is recommended in the Consortium of Multiple Sclerosis Centers' (CMSC) MRI guidelines as an aid to diagnosis in patients with clinically isolated syndrome (CIS), if there is "persisting uncertainty about the diagnosis or if presenting signs and symptoms are at the level of the spinal cord."[26] Spinal cord lesions have the same degree of importance as brain lesions for the diagnosis of MS. Imaging the spinal cord is a challenge, in part because movement by the patient as well as natural movement of the heart and respiratory system create "noise" that affect image quality.[27] A technique known as dual fast spin-echo (FSE) is one of most commonly used for spinal cord imaging in MS, allowing for visualization of focal (localized) and diffuse areas of damage on the cord.[28] Other spinal MRI sequences may include short inversion time inversion recovery (STIR; shown to be particularly sensitive for detecting diffuse lesions) and T1-weighted inversion recovery.[28]

Interpretation of MRI Findings

MRI is an invaluable tool for diagnosing and monitoring disease progression in MS, but the images are subject to interpretation and must be evaluated by someone who has expertise in the field of MS.[29] "Spots" on a brain or cervical spine MRI are not necessarily MS lesions, but may be

signs of other types of pathology, including some associated with aging.[30] Some patients may consult an MS specialist only to find that the "spots" seen on their MRI were not indicative of MS. Others may be misdiagnosed because MRI changes did not appear in a typical pattern for MS.

The interpreter of the MRI must take into consideration the location of the lesions in the brain and the number of lesions present, their shape, and how they appear in the presence of gadolinium.

For an MS diagnosis to be confirmed by McDonald criteria, MRI lesions must be demonstrated to have "dissemination in time," and "dissemination in space."[31] Patients may find these terms difficult to understand, especially those diagnosed with CIS who are unclear about how this differs from MS. Dissemination in time usually means that two or more MRIs show different lesions. Dissemination in space involves a single MRI showing lesions in different parts of the brain or the spinal cord.[31]

The quality of an MRI study in a patient with MS may be dependent on a number of factors, including the settings used on the scan, the magnet strength used (see the box "How Important Is Tesla Strength?"), and any movement of the patient during the scan.[33] The latter can produce "artifacts" that make interpretation difficult.[32] When a person with MS is sent for a scan, it is important that the facility follow MRI protocols for MS recommended by the CMSC **(Table 3)**.[26] It is also advisable for patients to receive subsequent scans at the same facility, which allows for a more accurate comparison among the findings.

In addition to the protocols, there are specific aspects of the MRI report that can help the clinician make decisions about MS care, including:

- lesion number, location, size, shape, and character;
- whether MRI dissemination in space and dissemination in time criteria are met;
- qualitative assessment of brain atrophy and overall T2 and T1 hypointense lesion burden severity; and
- comparison with previous studies for new lesion activity and atrophy.[21]

How Important Is Tesla Strength?

The strength of the magnet used in a magnetic resonance imaging (MRI) scan is usually designated as a Tesla (T). In some geographic areas, 1.5T MRI is the main technology available for people with MS in clinical settings, while in other areas, 3T scans are standard procedure.[33] A study comparing MRI findings using 1.5T and 3T platforms in patients with MS and normal controls showed that the 3T platform provided:

- higher visibility of overall cerebral lesion load;
- significant correlation of MRI lesion load with Expanded Disability Status Scale (EDSS) scores; and
- stronger and more frequent associations between lesions in cognitive domains.[25]

Current MRI guidelines in MS do not specify magnet strength. Future recommendations may call for use of 3T or higher MRI when evaluating patients with MS.[9,33]

What Can MRI Tell About Disease Status in MS?

MRI is very useful in detecting inflammatory changes in MS, especially in the earliest stages of the disease. Gadolinium-enhanced MRI is a more sensitive predictor of inflammatory disease activity in MS than either clinical disease or the occurrence of relapses.[34] However, the number and size of lesions (overall lesion volume) do not always correspond well with clinical disability in MS. For example, cognitive dysfunction in MS

Table 3. CMSC-recommended MRI Protocols for MS[26]

Field strength	No specific recommendations on magnet size or strength Scans should be of good quality, with adequate signal noise ratio (SNR) and resolution (in slice pixel resolution of ≤1mm x 1mm)
Slice thickness and gap	≤3mm, no gap for brain and spinal cord, except ≤4mm, no gap for axial spinal cord
Core brain MRI sequences	Sagittal FLAIR Axial FLAIR Axial T2 Axial T1 pre- and post-gadolinium injection
Gadolinium	Single dose 0.1 mmol/kg given over 30 seconds Minimum 5-minute delay before obtaining post-gadolinium T1 One of the other sequences (e.g., FLAIR, T2) can be acquired during the 5-minute post-gadolinium delay
Options for brain MRI	Axial proton density (PD) 3D IR prepared T1 gradient echo (1.0–1.5mm thickness)
Brain MRI scan prescription and coverage	Whole brain coverage Use subcallosal plane on sagittal localizer to prescribe the axial slices
Core spinal cord MRI sequences	Cervical cord coverage Sagittal T2 Sagittal PD or STIR (Short Tau Inversion Recovery) Sagittal T1
Options for spinal cord MRI	Post-gadolinium T1 3D IR prepared T1 gradient echo (1.0–1.5mm thickness) Thoracic cord and conus coverage Gadolinium does not need to be given for a spinal cord MRI if it follows a contrast brain MRI study

CMSC=Consortium of Multiple Sclerosis Centers; FLAIR=FLuid-Attenuated Inversion Recovery; MRI=magnetic resonance imaging.
Adapted with permission from the Consortium of Multiple Sclerosis Centers. MRI Protocol for the Diagnosis and Follow-up of MS, 2009 Revised Guidelines. Available at: http://c.ymcdn.com/sites/www.mscare.org/resource/collection/9C5F19B9-3489-48B0-A54B-623A1ECEE07B/mriprotocol2009.pdf.

has not been shown to correlate well with lesion placement on conventional MRI, although there is correlation with the degree of brain atrophy.[35,36]

In terms of providing prognostic information about MS, MRI is most useful in the early stages of the disease.[23] In cases of CIS, the number of cerebral T2 lesions has been shown to predict the development of clinically definite MS, especially in patients who also have oligoclonal bands present in their cerebrospinal fluid.[37]

Conventional MRI provides excellent contrast between intact and demyelinated white matter in the brain, but the standard technology cannot distinguish the exact makeup of a lesion or the degree of injury present.[38] The lesion visible on MRI reflects an abnormal area of tissue that may indicate any combination of inflammation, demyelination/remyelination, and neuroaxonal loss.[39]

The lack of correlation between MRI findings and clinical presentation in MS (sometimes termed the "clinical-MRI paradox") has long frustrated MS clinicians.[40] This paradox may be mainly due to the fact that MS pathology is not limited to white matter lesions visible on conventional MRI. Microscopic changes in areas such as gray matter, normal-appearing white matter (NAWM),

and diffusely abnormal white matter (DAWM, also called "dirty-appearing white matter") may contribute to MS pathology in ways that are not well understood.[41,42] Many of the key pathologic processes of MS have been shown to occur in gray matter, especially the cerebral cortex.[43,44] In addition, conventional MRI is less likely to show inflammatory changes in the later stages of the disease and in progressive forms of MS.[45]

Advanced types of MRI and other imaging technologies can delineate significantly more detail about MS pathology in areas of the brain that are difficult to view, such as NAWM. These technologies can provide information about whether a lesion has demyelination or remyelination present, or the chemical makeup of brain tissues. Advanced imagining technologies are used mainly in research settings, where they are contributing significantly to our knowledge of the disease and the effect of MS therapies **(Table 4)**.[23]

Table 4. Advanced Imaging Platforms Used in MS[23]

Imaging Platform	Benefits in MS
Magnetization transfer imaging (MTI)	• Measures and quantifies changes in myelin content • Correlates with demyelination and remyelination in pathologic studies
Magnetic resonance spectroscopy (MRS)	• Measures and quantifies biomarkers such as glutamate and NAA involved in MS pathology • Determines changes in biomarkers in relation to MS treatments • Quantifies axonal loss
Diffusion tensor imaging (DTI)	• Identifies pathology in NAWM • Differentiates among lesion types
Functional MRI (fMRI)	• Shows effects of brain pathology on clinical disability and compensatory processes

MS=multiple sclerosis; NAA=N-acetylaspartate; NAWM= normal-appearing white matter.

When Should Patients Have Follow-up MRI Studies?

The frequency with which MRI studies should be performed in a person with MS may be a subject of great concern to the patient. A baseline MRI is essential, and many MS experts now recommend an MRI after a patient has had an acute relapse.[46,47] The frequency of MRI studies in patients with stable disease is highly individual. The practitioner may consider factors such as clinical signs, the behavior of lesions on the last MRI, changes in drug therapy, and insurance coverage allowances in making the decision of when to do repeat studies. The CMSC MRI guidelines provide general recommendations for follow-up **(Table 5)**.[26]

Table 5. CMSC Guidelines for Follow Up of Patients with Established MS[26]

Brain MRI with gadolinium is recommended for the follow up of patients with MS:

- To evaluate an unexpected clinical worsening or potential secondary diagnosis
- For the re-assessment of the original diagnosis
- For re-assessment before starting or modifying therapy
- To assess subclinical disease activity (*Consider* every 1-2 years; the exact frequency may vary depending on the patient's clinical course and other clinical features)

Spinal cord MRI with gadolinium recommended for the follow-up in:

- Patients with clinical evidence of disease activity referable to the spinal cord who do not have MRI evidence of disease activity in the brain

CMSC=Consortium of Multiple Sclerosis Centers; MRI=magnetic resonance imaging.

Adapted with permission from the Consortium of Multiple Sclerosis Centers. MRI Protocol for the Diagnosis and Follow-up of MS, 2009 Revised Guidelines. Available at: http://c.ymcdn.com/sites/www.mscare.org/resource/collection/9C5F19B9-3489-48B0-A54B-623A1ECEE07B/mriprotocol2009.pdf.

Can MRI Determine How Well an MS Therapy Is Working?

Along with relapse rates and disability scores, MRI findings such as new T2 lesions and overall lesion volume have become standard outcomes to evaluate the effects of MS disease-modifying therapies (DMTs). However, the FDA still does not recognize these "surrogate" markers as primary outcomes when evaluating the potential for an agent to be approved for MS. Pivotal trials of MS drugs are using a greater variety of imaging outcomes to look at the effects of an agent, including changes in brain volume and indicators of brain atrophy due to MS. Khan and colleagues recently compared changes in brain volume among patients with MS who received either low-dose interferon beta (IFNβ), high-dose IFNβ, or glatiramer acetate (GA) continuously for 5 years.[48] All patient groups had significant reductions in brain volume loss compared to an untreated group of patients with MS ($P<0.0001$), with the GA group experiencing the least amount of brain volume loss.[48]

A recent meta-analysis by Sormani and colleagues compared conventional MRI markers from 12 randomized controlled trials of IFNβ or GA with relapse rates from those trials.[49] The meta-analysis showed a strong correlation between conventional MRI markers and reduced relapse rates associated with treatment. According to the authors, these findings "substantiate the strong association between the effect of a treatment on MRI lesions and its effect on relapse rate."[49]

It is important for patients to be informed that the findings of these studies apply to broad populations of people with MS and do not predict response to a drug in an individual patient. There is no magic formula for an MRI result that will say, "This drug is working well for this individual." That determination must be made based on a combination of factors including clinical findings, radiologic findings, tolerability, and adherence.

Guiding the Patient

We may take for granted patients' willingness to endure "the tube," but remaining perfectly still for extended periods of time in the MRI scanner is a particular challenge for some people with MS due to problems with spasticity, pain, or poor motor control. MRI testing can also be a highly anxiety-provoking experience that may or may not get easier with time. MS nurses who are supportive and understanding of this experience can help make the MRI process easier for the patient and increase the likelihood that the study will be performed successfully.

Before an MRI, the MS nurse and patient should discuss his or her feelings about the process. Claustrophobia—or the anticipation of having claustrophobia during the exam—is one of the key factors contributing to anxiety about the test. Open MRI is sometimes not considered an option for people with MS because of the need to visualize the brain with a higher-field magnet. Closed MRI is necessary for imaging of the spinal cord. If indicated, use of a short-acting anxiolytic agent is often an effective way to calm a person who is fearful and claustrophobic. Many people rely on premedication for a successful MRI, but the nurse should be aware that it may not work for all patients or may be contraindicated. If an anxiolytic agent is used, it is important that the patient does not drive after the procedure, and

preferable that someone accompanies the person home. Some other tips to discuss with the patient include:

- Bring music or a relaxation tape, if the MRI facility allows it. Many facilities allow patients to bring their own music in the form of a CD or electronic file.
- Have the patient ask the technologist if the MRI equipment contains a call button that the patient can use to notify the technologist if there is a problem during the exam.
- Advise the patient to ask the technologist to explain ahead of time how often he or she will be able to communicate with the tech during the exam.

Conclusion

Much of a patient's anxiety about the MRI procedure may be related to fears about MS itself and potential confirmation of worsening disease. It is important for MS nurses to acknowledge and validate these feelings when discussing MRI testing with the patient. Patients should be assured that the test is noninvasive, that techniques for interpreting MRI are advancing, and that damage to brain tissues can often be prevented with DMTs, especially when used early in the course of the disease. People with MS can help to streamline the process by keeping track of the dates on which they've had MRIs performed and the reports from those tests to prevent unnecessary repeat exams and to help ensure continuity of reporting between exams.

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Counseling Points™

Talking to Patients About the Role of Imaging in MS

- Magnetic resonance imaging (MRI) is a noninvasive procedure that uses powerful magnets and pulses of radio wave energy to create a computerized image of the soft tissues of the body. MRI does not use ionizing radiation.
- Patients may have fears or misunderstandings about the MRI testing process, its safety, and what the results may reveal about their condition. MS nurses can offer support, guidance, and education.
- The magnet strengths used for MRIs in most MS examinations are either 1.5 Tesla or 3 Tesla. Gadolinium is used as a contrast agent to provide an improved image of body organs and tissues.
- Indwelling metal devices or objects present the primary safety hazard during MRI tests. Most intrathecal baclofen pumps are MRI-safe, and some newer pacemaker models are also MRI-safe.
- Three basic types of MRI scans used in MS are T1-weighted scans, T1-weighted scans with gadolinium contrast, and T2-weighted scans. Gadolinium leaks into the brain tissue at breaks in the blood-brain barrier to identify areas of active disease.
- MRI is most useful in detecting inflammatory changes in MS in the earliest stages of disease. MRI images are subject to interpretation and should be evaluated by someone with expertise in the field of MS.
- Lack of correlation between MRI findings and clinical presentation in MS may be due in part to the fact that MS is not purely a white matter disease. Advanced forms of imaging can delineate a great deal more detail about MS pathology, but are mainly used in research settings.
- MRI findings are key aspects of clinical trials but are not recognized by the FDA as primary outcomes to demonstrate efficacy of a disease-modifying therapy in MS. Clinical trials in MS are required to have clinical outcomes as primary endpoints and MRI findings as secondary endpoints due to their supportive role in identifying disease activity.
- MS nurses should explore patient attitudes about MRI testing, including the potential for claustrophobia during the exam, to determine if premedication or other steps may be advisable.

Counseling Points™

Talking to Patients About the Role of Imaging in MS

Continuing Education Post-test

To receive contact hours, please read the program in its entirety, answer the following post-test questions, and complete the program evaluation. A certificate will be awarded for a score of 80% (9 correct) or better. A certificate will be mailed within 4 to 6 weeks. There is no charge for the CNE credit.

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Via the Web: Applicants can access this program at the International Organization of MS Nurses' website, www.IOMSN.org. Click on *Counseling Points* and follow the instructions to complete the online posttest and application forms.

PLEASE SELECT THE BEST ANSWER

1. **Magnetic resonance imaging (MRI) technology is based on the behavior of _____ atoms in the body when exposed to a magnetic field.**
   A) hydrogen
   B) oxygen
   C) carbon
   D) nitrogen

2. **Which of the following is TRUE about MRI safety?**
   A) MRI uses only trace amounts of ionizing radiation, relative to conventional x-rays.
   B) MRI may be harmful to patients with regular, long-term exposure.
   C) MRI technology uses no ionizing radiation.
   D) The radiation in MRI technology has been found to be harmful to humans.

3. **The primary safety concern associated with gadolinium use in MRI relates to:**
   A) a high rate of allergic reactions to gadolinium
   B) long-term buildup of gadolinium following multiple MRIs
   C) patients with mild kidney disease
   D) patients with severe forms of kidney disease

4. **Magnet strengths used in clinical MRI testing in multiple sclerosis (MS) are usually:**
   A) 1T and 0.2T
   B) 1.5T and 3T
   C) 3T and 5T
   D) 7T and 9T

5. **Patients with MS who have an intrathecal baclofen pump should be advised to:**
   A) have the pump checked after an MRI to make sure it has restarted and its settings are correct
   B) check with the manufacturer before the scan to ensure the pump is MRI-safe
   C) not have an MRI
   D) none of the above

6. **MRI has been shown to be safe for women who are pregnant.**
   A) True
   B) False

7. **Which of the following statements is true with respect to spinal cord imaging in MS?**
   A) patients with MS may have difficulty remaining still during an MRI
   B) compared to brain lesions, spinal cord lesions do not show up as clearly on MRI
   C) small movements in the cord can affect image quality
   D) all of the above

8. **Use of 1.5T MRI in patients with MS provides similar visibility of cerebral lesions as compared with 3T, so there is little benefit to use of the stronger magnet in a clinical setting.**
   A) True
   B) False

9. **MRI may be useful for providing prognostic information about MS especially in:**
   A) people who have had the disease for many years
   B) patients who have progressive forms of MS
   C) people in the early stages of MS
   D) all of the above

10. **According to the Consortium of Multiple Sclerosis Centers (CMSC) MRI guidelines for MS, brain MRI is recommended for follow-up:**
    A) to evaluate unexpected clinical worsening
    B) to reassess the diagnosis
    C) before starting or modifying a therapy
    D) all of the above

11. **A meta-analysis by Sormani based on controlled trials of interferon beta and glatiramer acetate in MS showed correlations between MRI findings and:**
    A) relapse rates
    B) cognitive dysfunction
    C) Expanded Disability Status Scale (EDSS) scores
    D) all of the above

12. **People with MS who are anxious about MRI or concerned about claustrophobia should:**
    A) find a center that will use an open MRI
    B) try to forget about it and endure the test as best they can
    C) premedicate at home with anything that will make them sleepy
    D) discuss concerns with a health professional and the MRI technologist ahead of time

Counseling Points™: Program Evaluation Form

Talking to Patients About the Role of Imaging in MS

Using the scale provided (Strongly Agree = 5 and Strongly Disagree = 1) please complete the program evaluation so that we may continue to provide you with high-quality educational programming. Please fax this form to **(201) 612-8282** or complete it online as instructed below.

5 = Strongly Agree 4 = Agree 3 = Neutral 2 = Disagree 1 = Strongly Disagree

At the end of this program, I was able to: *(Please circle the appropriate number on the scale.)*

1) Assess the role of imaging studies in the evaluation of MS status and disease progression 5 4 3 2 1
2) Analyze how new knowledge about imaging technologies relates to mechanisms of existing and newer therapies for MS 5 4 3 2 1
3) Discuss issues pertaining to safety and accessibility of MS imaging technologies 5 4 3 2 1
4) Describe methods for counseling patients about when and how often imaging studies should be performed 5 4 3 2 1

To what extent was the content:

5) Well-organized and clearly presented 5 4 3 2 1
6) Current and relevant to your area of professional interest 5 4 3 2 1
7) Free of commercial bias 5 4 3 2 1
8) Clear in providing disclosure information 5 4 3 2 1

General Comments

9) As a result of this continuing education activity (check only one):

❒ I will modify my practice. (If you checked this box, how do you plan to modify your practice?)_____

_____

❒ I will wait for more information before modifying my practice.

❒ The program reinforces my current practice.

10) Please indicate any barriers you perceive in implementing these changes.

❒ Cost
❒ Lack of administrative support
❒ Lack of experience
❒ Lack of opportunity (patients)
❒ Reimbursement/insurance
❒ Lack of time to assess/counsel patients
❒ Patient adherence issues
❒ Lack of professional guidelines
❒ No barriers
❒ Other (please specify)_____

_____

_____

11) Will you attempt to address these barriers in order to implement changes in your knowledge, skills, and/or patients' outcomes?

❒ Yes. How? _____

❒ Not applicable

❒ No. Why not?_____

Suggestions for future topics/additional comments: _____

_____

Follow-up

As part of our continuous quality-improvement effort, we conduct postactivity follow-up surveys to assess the impact of our educational interventions on professional practice. Please check one:

❒ Yes, I would be interested in participating in a follow-up survey.

❒ No, I would not be interested in participating in a follow-up survey.

There is no fee for this educational activity.

Post-test Answer Key	1	2	3	4	5	6	7	8	9	10	11	12

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