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Team Shepherd Swimmers 4 MS are swimming together to promote wellness and raise funds and awareness for the MS community! So far, the team has raised $1400 and continues to increase their fundraising and team membership goals as they reach new milestones!
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Please send comments regarding *The Motivator* to editor@mymsaa.org
Another Successful Year in Improving Lives Today!

By Gina Ross Murdoch
MSAA President and CEO

With our previous fiscal year wrapping up in the summer, I am excited to share some of MSAA’s highlights that occurred. I am very happy to announce that we had another successful year in Improving Lives Today for the entire MS community, by providing a record number of programs and services. I’m also happy to note that our “Navigating MS” global shared decision-making initiative moved into phase two. This part of the project compiled and reviewed survey feedback from the United States, Europe, and Australia. We asked healthcare providers, nurses, and patients to discuss their experiences in having honest and open conversations about the progression of multiple sclerosis – conversations that are occurring between patients and healthcare providers. We also asked these healthcare professionals whom they feel the patients are the most comfortable with in having those conversations. In addition, we reviewed tools from all over the world for improving both sides of that conversation.

The next steps will be focused on creating tools to help foster more substantive, collaborative, and informed conversations about treatment decisions. The Navigating MS project will have a profound impact on conversations here in the United States and across the globe. MSAA is proud to be a proactive leader in the MS community in focusing on the importance of shared decision making.

In addition, we are excited to have the robust feedback from our needs assessment survey. This survey is a follow-up to our needs assessment conducted in 2012. Our true thanks and appreciation to everyone who completed the surveys. Your responses, comments, and perspectives are critical in how we approach and prioritize our upcoming strategic plan. This information is our guide to ensure we are doing all that we can to Improve Lives Today and plan for tomorrow.

Gina Ross Murdoch is a seasoned executive in non-profit management. Her career includes leadership positions with chapters of the Leukemia and Lymphoma Society as well as the American Diabetes Association. Earlier, she spent 14 years overseeing development activities at a large chapter of the National Multiple Sclerosis Society, leading explosive growth initiatives and ground-breaking strategic projects. An active member of the community, Ms. Murdoch has held several town positions and volunteers for her college alma mater, Drew University.
Another exciting announcement is with the expansion of our MSAA Board. We are honored to have Dr. Lilyana Amezcua and Mr. David Herzog join as our newest members. Dr. Amezcua is a multiple sclerosis specialist at the University of Southern California. Her research is focused on collaborating with basic researchers in the field of immunology, employing new imaging techniques to assess disease progression, as well as defining racial disparities that may exist within the multiple sclerosis population. Dr. Amezcua currently serves as co-investigator to several clinical trials within the MS department.

Mr. Herzog, who comes to us from St. Louis, retired from AIG in April 2016 after more than seven years as the Group Executive Vice President and Chief Financial Officer. Mr. Herzog serves on several national and international Boards of Directors, in the fields of finance and insurance. Welcome Lilyana and David!

As much as we are pleased and honored to welcome these new members to our MSAA family, I must also acknowledge our loss of Robert Rapp, former chief operating officer for MSAA, in July of this year. Bob was an integral part of MSAA for more than 16 years. Bob’s dedication to MSAA, his kindness toward everyone he worked with, and his passionate care for people affected by multiple sclerosis made him a unique individual that you would be honored to know. He cared deeply about our mission and infused all of our work with a sense of purpose. Bob’s passing is a true loss for the MS community, but his spirit and legacy are evident in every part of MSAA. We are thankful to have called him our friend.
Introduction

When someone presents with a symptom typical of multiple sclerosis (MS), such as optic neuritis, vertigo, or numbness and tingling, a clinician often orders magnetic resonance imaging (MRI). This technology reveals the inside of the brain, eye, and spinal cord in a painless, noninvasive method. The brain and spinal cord make up the central nervous system (CNS). While X-rays and computed tomography (CT) scans provide some detail about bones and some body tissues, an MRI reveals much more detail about tissue in the CNS, showing both the normal structure of the brain and spinal cord, as well as the presence of lesions, scars, or tumors.

When MS causes a specific symptom – vertigo, loss of vision, or numbness for example – sometimes a lesion can be seen on an MRI in a region of the brain that correlates to the symptom. A lesion is an area of inflammation or damage within the CNS. Finding such lesions helps with the diagnosis of multiple sclerosis and assists with ruling out other possible conditions, such as a tumor or stroke.

In addition to diagnosis, the MRI aids prognosis (predicting the likely course of one’s disease) and disease management in multiple sclerosis. The number of lesions on an MRI, their location, and their size can predict disease severity, even early in the course of MS. The overall burden of disease at diagnosis and the location of lesions impact treatment choices and whether the risks of a specific treatment outweigh the benefits.

Once someone with MS starts a disease-modifying therapy (DMT), a periodic MRI assesses whether the treatment is working.
If new lesions are detected after starting a therapy, then an MRI demonstrates that the individual may not be responding well to the treatment and a change may be considered. An MRI thus helps with diagnosis, prognosis, and monitoring the response to an MS treatment.

MRI can be useful when someone has an MS exacerbation – also known as a relapse or flare-up. With a relapse, an individual experiences new or worsening symptoms of MS. During relapses, the treating physician may order MRI to evaluate whether new inflammation is occurring in the brain or spinal cord.

Despite these advantages, an MRI poses challenges for individuals with MS. Many people feel claustrophobic in the small MRI tube and this makes it difficult for them to lie quietly for the length of an MRI, which can last up to an hour for multiple scans. Cost provides another barrier to obtaining an MRI, as many either do not have insurance or face an expensive co-pay. Sometimes insurance carriers will deny coverage of an MRI, even for individuals with MS where this monitoring is a standard of care.

This article presents an overview of MRI for individuals with MS – how MRI works, what it shows, how MRI techniques and machines differ, and challenges to getting an MRI. This article also explains how MRIs are used for monitoring disease activity and for evaluating treatment response. We hope to help reveal the mysteries behind magnetic resonance imaging, ultimately enabling members of the MS community to better understand why they are having an MRI and what the specific results will mean for them.

Author Dr. Jill Conway is a neurologist who currently serves as Director of the MS Center at Atrium Healthcare in Charlotte, North Carolina. She earned her medical degree from the University of Illinois and completed her neurology residency at the University of Pennsylvania. Dr. Conway completed a two-year multiple sclerosis fellowship, with a clinical research focus, at the University of Pennsylvania. This fellowship training was sponsored by the National Multiple Sclerosis Society. Dr. Conway has a longstanding interest in clinical ethics and clinical research ethics, and has served on Carolinas Medical Center’s Ethics Committee. Her research interests include cognitive function in multiple sclerosis, treatment of mood disorders in MS, new and emerging therapies, neuromyelitis optica, and issues related to women and multiple sclerosis.
What is an MRI and How Does it Work?

As noted earlier, “MRI” stands for “magnetic resonance imaging.” Because images are obtained by a magnetic field, no harmful radiation exposure occurs with an MRI scan. Provided that the patient has no metal on or embedded in his or her body, exposure to an MRI is safe. For additional details on the safety of using contrast dyes, please see page 16.

Generally, when the body’s tissues are exposed to a magnet, the protons (hydrogen atoms most commonly found in water) in the tissues orient themselves in the direction of the field, similar to how a compass needle lines up with the earth’s magnetic field. Turning the magnetic field on and off makes the protons line up and relax repeatedly, which releases energy that can be measured by a receiver in the MRI machine. Different tissues have varying amounts of protons, and thus, bone, fluid, and brain tissue all send different signals to the receiver. Computer software converts the received signals into a map of the tissue—based on the water content and response to the magnetic field.

As a person lies in the MRI tube, this process creates different pictures through different planes of the tissue being examined. These are different positions from which the computer takes its images. Some images will show the tissue in a cross-section, called an “axial plane.” Some images will show the tissue in slices from right to left, called a “sagittal image,” and others will show front-to-back images, called “coronal sections.”

What Does an MRI Show?

The MRI uses different pulsing techniques to create different images. The images that are created by each separate pulsing are called “sequences.” Each sequence of pulses has a different sound heard by the person lying in the tube.

T1, T2, FLAIR, and T1 with gadolinium refer to different MRI sequences. These different pulse sequences each show the fluid...
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and tissue differently on the brain and spinal cord images. Certain features and changes in the tissue appear more prominently, depending on the type of sequence used.

A normal brain has **gray matter** around the outside and **white matter** deeper in the brain. The gray matter contains the brain cells or neurons that generate impulses and thoughts. The white matter helps conduct the impulses generated to other parts of the brain or to the spinal cord, usually through **axons** (the nerve fibers of the CNS) surrounded by myelin (the protective covering). **T1 imaging** preserves this relationship in the images produced – the gray matter is darker than the white matter. T1 imaging shows normal structure extremely well, but seeing lesions on this kind of imaging can be difficult.

One kind of lesion that can be seen best on T1 images is a **black hole**. When an MS lesion forms and heals over time, sometimes the myelin partially repairs itself and the underlying structure remains. Other times, however, damaged axons and neurons cannot be repaired and brain tissue is lost. This process forms a black hole. A **chronic black hole**, present for more than six months, indicates the permanent loss of tissue. Black holes can be associated with more cognitive dysfunction and disability. Fortunately, some MS medications reduce the number of new lesions formed in MS, which can reduce the formation of black holes.

**T2 imaging** reverses the color of gray and white matter on MRI images. White matter looks darker and gray matter looks lighter. This sequence displays lesions as bright white spots or scars on the images. However, with T2 imaging, the **cerebrospinal fluid**, which is the normal fluid in and around the brain and spinal cord, also appears bright white. Seeing white spots next to an area of bright white fluid can be difficult. So although T2 imaging shows pathology or abnormal tissue well, it is limited by the confusion between the fluid and the spots.
**FLAIR images** resolve this difficulty. FLAIR stands for “fluid attenuated inversion recovery,” which basically means that the bright fluid on T2 imaging gets converted into black in the image. Thus FLAIR images show lesions as bright white spots and fluid as dark black; this helps make the lesions clearer and easier to see. On FLAIR and T2 images, old lesions and new lesions can be seen. Lesions are visible as they arise during the stage of acute inflammation, but they also tend to stay for many years afterward as a scar. Rarely, lesions will heal so well that they can no longer be seen on T2 or FLAIR images, but the majority will be visible on future MRIs.

**MRI with Contrast**

Often an MRI will be done with contrast. What does this mean? In a sequence with contrast, T1 images are created after a contrast dye has been injected into the patient’s vein. Once contrast is given, it travels through the bloodstream and into the blood vessels in the brain and spinal cord.

These vessels can be seen clearly on an MRI after the contrast has been injected. If active inflammation in the brain or spinal cord with a lesion is currently taking place at the time of the MRI, the blood vessels near the lesion will be “leaky.” This happens as part of the body’s basic response to injury and inflammation. Blood vessels become leaky so that white blood cells and other responses to injury can get into the damaged tissue.

In the brain and spinal cord with MS, a new lesion forming will have leaky local blood vessels. When the contrast dye is introduced, the dye leaks out and the area near the lesion shows up very brightly on this kind of image. These lesions are called “enhanced,” “bright with contrast,” or “active” on typical MRI reports.

Enhancing lesions have important meaning for clinicians as they indicate current disease not being adequately controlled by an MS treatment. A newly formed lesion usually enhances for a few weeks before blood vessels seal again and the blood-brain barrier (BBB) is restored. The BBB is a protective barrier that...
lines the blood vessels, designed to prevent damaging cells and other substances in the blood from entering the CNS. For additional details on the safety of using contrast dyes, please see page 16.

**How MRI Machines Differ**

Different MRI machines produce images of varying quality, partly depending on the strength of the magnet used, which is measured in teslas. Higher teslas indicate greater magnet strength. Many commercial MRIs use 3.0 tesla magnets, although 1.5 tesla magnets are frequently used as well. Magnets with a strength greater than 3.0 tesla can be used in research trials. Regardless of the specific tesla strength, because all MRIs use powerful magnets, having metal in the body or on the body as jewelry when having an MRI can be dangerous.

**Open MRIs** use lower tesla magnets (usually 0.3 to 0.7 tesla) and obtain lower-resolution images than traditional MRIs (at 1.5 and 3.0 tesla). For comparison, an average refrigerator magnet would have about 0.001 tesla strength. An open MRI, as the name implies, allows more open space around the individual, with the equipment above and to the side of the patient. Think of these lower-resolution images as being similar to having fewer pixels on a camera image, on a computer monitor, or on a TV screen. With fewer pixels, fewer details can be seen.

While valuable for those with severe claustrophobia (a fear of tight spaces), open MRIs create images with less clarity. For some purposes, such as seeing larger lesions in the brain hemispheres, reduced clarity works. For others, such as looking at tiny lesions in the spinal cord or optic nerve, higher resolution is needed to improve the accuracy and usefulness of the images.

Other options are available, including those with normal strength (1.5 and 3.0 tesla), but without the traditional “closed-bore” tube. Some facilities now offer MRIs with either a “wide-bore” or “short-bore” design, which can help to fit larger patients (up to 500 pounds in some cases), and can help individuals to feel less claustrophobic. Some MRIs allow for a person to be in a seated position, which can help those who have trouble lying down for an MRI.

A clinician orders an MRI with specific instructions, including the body part to be examined, specific additional sequences desired, and the use of contrast, if needed. Many MRIs are ordered with and without contrast, which means that the images are taken before contrast, and then T1 images are retaken after the patient has contrast injected.

When ordering MRIs, each specific part of the body will need a separate MRI. If the concern is for optic neuritis, a separate MRI of the eye and orbit around the eye may be ordered. If symptoms are present that may indicate spinal-cord disease, the spinal cord
may be included with the neck (cervical spine), or the spinal cord in the torso (thoracic spine). If someone has an acute symptom indicating potential relapse, contrast will usually be given to assess whether active inflammation is currently taking place.

**The Importance of Age, Context, and Location of Lesions**

The brain MRI of a young and healthy person should not have any lesions, spots, or plaques (scarred areas) visible on an MRI. The interior of the brain seen on an MRI appears symmetric. The brain appears to fill up the space inside the skull as no brain atrophy is present.

When an individual presents with a symptom typical of MS, the initial brain MRI helps to establish a diagnosis. As noted earlier, although some MS lesions heal so well that they are no longer visible on an MRI, most MS lesions remain present as “sclerosis” (which refers to hardening or scarring), and this can be seen even years later.

Not all lesions or spots indicate MS. As we age, the brain also ages. Bright spots on an MRI can develop due to conditions other than MS – including stroke, head trauma, migraine headache, or Vitamin B12 deficiency.

Certain infections, or other autoimmune diseases such as lupus or sarcoidosis, are associated with increased lesions in the brain. Cigarette smoking, diabetes, high cholesterol, and high blood pressure cause damage to the small blood vessels in the brain, which can also lead to bright spots on MRI.

To diagnose MS with an MRI, context matters. A healthy 17-year-old brain should have fewer scars than an 80-year-old with a history of smoking and diabetes. If the 17-year-old presents with blurry vision typical of optic neuritis and lesions in the brain, MS may be likely. In an 80-year-old person, brain changes may reflect aging and the probability of the scars being MS would be less likely.

The location of the lesions also matters for diagnosis. While lesions associated with multiple sclerosis can appear anywhere in the brain or spinal cord, they occur more frequently in specific locations, such as near the corpus callosum (a bundle of fibers connecting the two hemispheres of the brain), perpendicular to the fluid-filled ventricles, or in the brainstem.

Multiple sclerosis lesions arise from the white matter, with fewer lesions seen in the gray matter on commercial MRIs (those with standard tesla strength of 3.0 or below). This is in contrast to the MRIs used for research, which have stronger magnets and can more easily show lesions in the gray matter.

Lesion shape and size assist with diagnosis. MS lesions tend to be oval shaped and about a centimeter in diameter. Bright spots or lesions are commonly present in an aging brain, but spinal cord changes are rare. Spinal cord lesions typically indicate disease, although not necessarily MS.

Let’s imagine someone visiting a clinician, and he or she reports double vision when looking to the right. This is a classic symptom of multiple sclerosis, but it can also result from other conditions such as a stroke or tumor.
The clinician orders an MRI to evaluate the symptom. The MRI may show a brainstem lesion that enhances with contrast, demonstrating that the lesion developed recently – over the last few weeks – and likely caused the symptom.

Multiple sclerosis, however, implies that “multiple” lesions are present, and these occur over time. If the MRI shows many other scars, including older lesions that are not active, it demonstrates that the disease process is ongoing and not a single, isolated event. If these lesions exist in locations typical of MS – near the ventricles or in the spinal cord – and the person tests negative for other conditions associated with such lesions (these conditions are sometimes referred to as “MS mimickers”), then MS becomes a likely diagnosis, provided imaging features do not demonstrate signs of a stroke or tumor.

To summarize, at the time of diagnosis, the MRI helps with prognosis. Research suggests

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**CMSC’s Proposed 2018 Revised MRI Guidelines**

In February 2018, the Consortium of MS Centers (CMSC) published a booklet, *2018 Revised Guidelines of the Consortium of MS Centers MRI Protocol for the Diagnosis and Follow-up of MS*. This guide provides the recommended frequency and types of MRI to be performed depending on each patient’s specific situation. These recommendations were created by an international group of neurologists, radiologists, and imaging scientists with an expertise in MS, representing some of the most influential and respected neurological and radiological groups in North America and Europe.

*To follow is a simplified listing of some of their general recommendations:*

**For individuals with clinically isolated syndrome (CIS) or suspected MS**, but who have not yet been diagnosed, a brain MRI with gadolinium should be performed at baseline. A follow-up brain MRI with gadolinium should be performed six to 12 months later for individuals

with “high risk” CIS (those with two or more lesions on the first MRI) or 12 to 24 months later for “low risk” CIS (those who had normal findings on their first MRI).

**For individuals who have been diagnosed with MS**, a brain MRI is recommended at the following times with gadolinium-based contrast advised in most instances*:

- When no recent MRI imaging is available
- Following a pregnancy to establish a new baseline
- Before beginning or changing a disease-modifying therapy (DMT) and approximately six to 12 months later to establish a new baseline
- Every one to two years to assess sub-clinical activity (with inflammation occurring in the brain but without any outward symptoms) and every two to three years for individuals with stable disease
- With worsening symptoms or when the diagnosis needs to be reassessed
that individuals with more lesions on the initial MRI may have a more severe disease course. Lesions in the spinal cord are worrisome as those who have many spinal cord lesions tend to have worse disability in the future. The presence of brain atrophy and black holes predicts increased disease progression over time. Early recognition and effective treatment of MS lessens the chance of disease progression.

**A spinal cord MRI** is recommended for individuals who show symptoms that may be related to the spinal cord, such as myelitis or progressive myelopathy. An older age at MS onset is another consideration for a spinal cord MRI. In some instances, a spinal cord MRI may be used to help with establishing disease-activity dissemination in space and time, providing more support to an MS diagnosis.

When using a brain MRI for **surveillance of progressive multifocal leukoencephalopathy** (PML) for individuals taking Tysabri® (natalizumab), the following timeframes apply:

- For individuals who are **serum JC virus (JCV) antibody negative**, a brain MRI is recommended at least every 12 months
- For individuals who are **serum JC virus (JCV) antibody positive** and have been on Tysabri for more than 18 months, a brain MRI is recommended every three months if high index and every six months if low index

*The CMSC states that the use of **gadolinium-based contrast agents** is helpful but not essential for detecting subclinical disease activity. This is because new T2 lesions can be identified on well-performed standard MRIs. The exception is when a large T2 lesion burden obscures new T2 lesion activity.*

**Using MRI in Disease Management**

Although this surprises some individuals with MS, many MRI lesions in the brain are **clinically silent**, meaning that they cause no symptoms at all. A lesion in the optic nerve may lead to decreased vision, but small lesions in the brain rarely cause a symptom. For this reason, clinicians order **surveillance MRIs** to assess whether new lesions are present, even if no new symptoms have occurred. These surveillance MRIs help establish whether a
medication for MS is working adequately. After a certain amount of time has passed, if someone has new lesions while on medication, the clinician may consider whether another disease-modifying therapy (DMT) may provide better protection from breakthrough disease (this refers to continued disease activity despite treatment).

Evaluating breakthrough disease can be tricky, as it depends on timing. Most DMTs work within a few months of starting treatment, but not instantly. If someone has an MRI in January, leading to diagnosis in February, therapy may not begin until March or April, after all testing and insurance approvals are complete. If the therapy requires six months to reach its full effect, an MRI done in June may show active disease not yet suppressed by the DMT.

Concluding that a medication does not work when it hasn’t had enough time to take full effect would certainly be an unfair assessment. However, an MRI done six months after starting the DMT, in October for the example above, gives adequate time to suppress new disease activity. For this reason, clinicians commonly order MRI six-to-twelve months after beginning a new disease-modifying therapy. This MRI should not show any active or enhancing lesions, as ideally the DMT should prevent active disease.

When starting a new DMT, new lesions might appear before the new medication takes effect. Thus, the six-month MRI may show additional lesions not seen at diagnosis. These lesions likely occurred before the full benefit of therapy and do not necessarily indicate treatment failure. An MRI six-to-twelve months after starting a medication establishes a new baseline on therapy. Since the therapy should now be effective, future MRIs will hopefully show no changes from this new baseline.

Repeat imaging at the same imaging center should allow a radiologist to compare between MRIs and note any changes in the time between scans. Guidelines recommend repeating a brain MRI every year or two to assess for silent disease activity or progression of atrophy. For someone on the same therapy for many years whose disease activity is stable, less frequent imaging (every two-to-three years) may be adequate.

If someone is taking a DMT that increases the risk of certain infections such as progressive multifocal leukoencephalopathy (PML), annual imaging should be considered. PML is a potentially fatal brain infection that can occur in people with a weakened immune system, which can result from taking an immunosuppressant. For specifics on the latest MRI recommendations, please refer to pages 12 and 13.

Because MS can affect the entire central nervous system, initial MRIs may include the brain, cervical spine (neck), and thoracic spine (torso). These images help with choosing a DMT and illustrate the initial burden of disease and disease severity at onset. Subsequently, many clinicians order brain MRIs at regular intervals, but assess the spinal cord less frequently because fewer clinically silent lesions occur in the spinal cord. In addition, most new spinal cord lesions cause specific symptoms such as numbness in the
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The Safety of Contrast Agents

At the time of diagnosis and in the setting of possible breakthrough disease, MRIs done with contrast help distinguish new disease activity from old scars or healed lesions. Recently, the FDA investigated contrast dyes to assess whether they pose any danger to patients.

For many years, contrast agents for MRI based on gadolinium were believed to be safe for anyone with normal kidney function. The FDA has since found that contrast agents can be retained in the body for long periods of time, leading the FDA to include warnings on gadolinium agents. Whether retaining gadolinium in the body causes any specific harm, however, has yet to be determined. As noted in the previous sidebar on the CMSC’s 2018 Revised MRI Guidelines, gadolinium-based contrast agents “should be used judiciously, recognizing that gadolinium continues to play an invaluable role in specific circumstances related to the diagnosis and follow-up of individuals with MS.”

Although this information may appear contradictory, neurologists and radiologists must take many factors into consideration when deciding whether or not to use gadolinium-based contrast agents, based on benefits and risks. In some instances, when evaluating MS-disease activity in the brain and spinal cord, the benefits of using these contrast agents outweigh the undetermined risk of the agents being retained in the body for a longer period of time. Without contrast agents, evidence of current disease activity often cannot be viewed on the scans.

Certain gadolinium preparations appear to have a higher risk of being retained in the body than others. For the FDA’s report, please visit https://www.fda.gov/Drugs/DrugSafety/ucm589213.htm or go to www.fda.gov and search for “contrast agent safety.”

Another potential safety concern with having an MRI with gadolinium is the possibility of being allergic to this contrast agent. According to an article in the August 2012 issue of Radiology, “Immediate Hypersensitivity Reaction to Gadolinium-based MR Contrast Media” (Jung JW, et al. 264:2, 414-422), only a very small percentage of individuals experience an immediate reaction to gadolinium contrast agents for magnetic resonance. This was according to a study of nearly 85,000 patients where only 102 patients (0.121 percent) experienced a reaction. This figure is roughly 12 people out of every 10,000 receiving gadolinium as a contrast agent.

Of this small percentage of people, researchers found that having an initial reaction is more common in women and in those with allergies and asthma. Additionally, the recurrence of a reaction occurs in 30 percent of those who previously had a reaction. For this reason, appropriate premedication with an antihistamine or systemic corticosteroid should be considered for anyone who previously experienced a reaction. Hives were the most common reaction and occurred in 91.1 percent of those who experienced an allergic reaction. Anaphylaxis (severe allergic reaction) was less common and occurred in 9.8 percent of those having any allergic reaction to the contrast.
hands or feet, a band-like tightening around the rib cage known as the “MS hug,” or difficulty with walking or going to the bathroom. If these symptoms occur, spinal cord images may show whether new lesions and breakthrough disease are present. Without any symptoms that may be related to the spinal cord, new lesions are unlikely.

Radiologists or neurologists reading MRIs frequently comment on brain-volume loss or atrophy. Our brains change as we age. In a healthy young person, an MRI shows a brain without scars or evidence of loss of brain tissue. Just as our muscles decrease in size as we age, the brain also loses tissue over time. Brain shrinkage can be seen on MRI scans as an increase in the volume of fluid and a decrease in the brain substance.

Unfortunately, MS can accelerate this tissue loss. Black holes are associated with more atrophy. Exercise, along with taking a medication for MS to reduce new lesions on MRI and subsequent black holes, can help reduce the amount of atrophy.

MRI Results Relate to Age and Different Types of MS

Similar to fingerprints, MRIs from individuals with MS are unique. Lesion size, number, and location vary, but generally, new lesions arise more frequently in early MS. More early MRI lesions may lead to more disability later in the disease. As time passes, the immune system ages along with the brain. The older immune system attacks the brain less frequently, so fewer new lesions develop later in the MS disease course.

The three most common types of MS are:
• Relapsing MS with symptom flare-ups (relapses)
• Secondary-progressive MS (SPMS), which follows relapsing MS and has a more steady progression – with or without relapses
• Primary-progressive MS (PPMS), where individuals experience a steady worsening of symptoms from the start, usually without relapses

In relapsing forms of MS, active MRI lesions are more common. In progressive forms of MS, the MRI shows fewer new lesions and increasing atrophy. Although no specific characteristic on brain imaging determines whether an individual has relapsing or progressive disease, the presence of black holes, increased atrophy, and increased volume of lesions on an MRI make progression more likely. In primary-progressive disease, the spinal cord may be especially impacted, leading to more difficulty in mobility.

Early treatment can minimize the damage done in the early phase of MS. Because DMTs reduce the formation of new lesions, effective treatment minimizes brain changes over time. Fewer lesions lead to decreased atrophy and disability.

Areas of Function Corresponding to MRI Results

As mentioned earlier, MS can sometimes be “clinically silent,” where active lesions are not causing any symptoms. However, at other times, certain lesions observed through an MRI correspond specifically to some type of
dysfunction, depending on where the lesion is located. For instance, a lesion on the optic nerve may cause optic neuritis, while a lesion in the brainstem can cause vertigo and/or double vision.

**Lesions along the spinal cord** cause very specific symptoms depending on their location, but in general, these typically relate to either motor (movement) or sensory (sensation) problems. When lesions occur within the anterior (front) portion of the spinal cord, motor or movement functions are affected. Difficulty with coordination and strength with moving one’s arms or walking are examples of symptoms that may occur. When lesions occur within the posterior (back) portion of the spinal cord, sensory symptoms are more likely. These might include numbness, tingling, burning, and/or loss of feeling, among other sensory issues.

How high or how low the lesions occur along the spinal cord is also an important part of the equation. For instance, the part of the spinal cord that corresponds to the arms are in the cervical spine (upper portion), and lesions occurring below where these nerves come off the spinal cord may impact the legs, feet, and other function below the arms, but will not
The MSAA MRI Access Fund assists with the payment of cranial (brain) and cervical-spine (upper back) magnetic resonance imaging (MRI) scans for qualified individuals who have no medical insurance or cannot afford their insurance costs. The exam must be required to help determine a diagnosis of multiple sclerosis (MS) or evaluate current MS disease progression.

For people who have already had a brain and/or c-spine MRI for their MS, MSAA will reimburse the cost of their MRI(s) up to a certain amount for qualified candidates. Under the reimbursement option, MSAA will pay the billing facility directly, as we do not reimburse individual clients. Also, please know there is a 24-month wait period to reapply for MRI assistance for new or reimbursed MRIs.

To learn more and apply, please visit the MRI Access Fund page at mymsaa.org/mri or call (800) 532-7667, ext. 154.

Challenges to Obtaining an MRI

The useful information gained from an MRI can be challenging to obtain. Cost provides one barrier to surveillance imaging. The frequency of having an MRI may be dictated by the insurance company rather than provider and consumer. Even when insurance approves an annual MRI, high co-pays may hinder access.

Ordering a brain MRI, cervical spine MRI, and thoracic spine MRI generates three separate bills and three separate co-pays or coinsurance payments. An annual MRI may recur before the last MRI bill has been fully paid. Fortunately, financial assistance can help. For those without insurance or with high co-pays, MSAA’s MRI Access Fund may be able to assist. Please see the box below for more information.

MRI Funding Assistance Available

Impact the functioning of the arms or hands. Similarly, higher up on the spinal cord, lesions in the neck can cause problems anywhere at or below the neck. If lesions occur in the posterior spinal cord of the neck, changes in sensation can occur in the arms, legs, hands, or feet. This can mean pins and needles, numbness, burning, or tingling for the patient, but can also mean a decreased ability to feel the floor – resulting in decreased balance and concerns with mobility as well as the potential of falling.
How valuable is neuroimaging to the MS community?

MRI is a cornerstone of properly diagnosing MS. Patients would typically need to have an MRI scan performed before a diagnosis of MS can confidently be made. Once the diagnosis is confirmed, this technology serves as an integral part of standard patient care. MRI is an important tool to monitor disease activity and to learn if a patient is stable or doing worse. It also evaluates the effectiveness of a disease-modifying therapy to help the neurologist determine if a medication is working well or if the patient might be a candidate for a different treatment option.

Since its introduction in the 1980s, how dramatically has MRI technology improved over the past four decades, and how have these changes impacted the diagnosis and evaluation of MS disease activity?

MRI is far more sophisticated than it was 40 years ago. We’re now able to see the brain and spinal cord in much greater detail, enabling us to make more precise measurements and to view tissue damage resulting from MS in both the brain and spinal cord. In addition, we’re able to look at white matter fiber tracks of the brain, using MRI diffusion tensor imaging. Also known as “DTI,” this new technology is a research tool that became available within the...
Revealing the Mysteries behind Magnetic Resonance Imaging

in the closed space inside an MRI, even without having experienced claustrophobia previously. For those with anxiety during an MRI, anti-anxiety medications may help. Learning to practice deep breathing, relaxation techniques, or meditation may increase one’s tolerance of being in a small space.

Despite their limitations, open MRIs offer an alternative for people who cannot tolerate closed MRIs. As noted earlier, other options may be available, including those with either a “wide-bore” or “short-bore” design, which can help to fit larger patients (up to 500 pounds in some cases), and can help individuals to feel less claustrophobic.

As noted on page 16, regarding the safety of contrast agents, another physical challenge to having an MRI with gadolinium is the possibility past several years. Another relatively recent development is functional MRI, which allows us to see which areas of the brain are functioning normally. Through this technology, we can see which parts of the brain are “asleep” and which parts are “awake.”

What types of changes or improvements do you foresee with neuroimaging in the years ahead?

A new type of MRI scanner is 7.0 Tesla or “7T” MRI. This is a very sophisticated and powerful technology, showing us details of the brain that we’ve never seen before. For instance, the gray matter of the brain and gray matter lesions can’t be viewed well with traditional MRI. Also with 7T, we can see MS-related changes in the covering of the brain, known as the meninges. Here we can view inflammation and abnormal cells that may accumulate in the meninges of individuals with MS. At least 25 of these scanners are currently available in the United States, although most are only used for research. However, I expect to see more of this technology used for patient care in the not-too-distant future.

A different type of imaging is positron emission tomography or “PET” scanning. This technology continues to evolve and become more complex, giving us more detailed evaluative tools. These scans can show actual cells in the brain – and we can see those that are activated and those that are inactivated. For example, we can view microglia activity in MS, although we don’t yet know how changes in microglia activity relates to the disease. Microglia are a type of glial cell, a part of the immune system in the brain and spinal cord.

As new imaging techniques such as 7T MRI and PET are further developed and fine-tuned, the medical community should be able to learn more about diseases such as MS and the tissue changes that occur. This in turn enables researchers to understand each disease in more detail and ultimately may lead to important clues to develop more effective treatment strategies. I have much hope for the future of MS research and I know that advances in neuroimaging will play a vital role in this important initiative.
What is OCREVUS?
OCREVUS is a prescription medicine used to treat adults with relapsing or primary progressive forms of multiple sclerosis.

It is not known if OCREVUS is safe or effective in children.

Who should not receive OCREVUS?
Do not receive OCREVUS if you have an active hepatitis B virus (HBV) infection.

Do not receive OCREVUS if you have had a life threatening allergic reaction to OCREVUS. Tell your healthcare provider if you have had an allergic reaction to OCREVUS or any of its ingredients in the past.

What is the most important information I should know about OCREVUS?
OCREVUS can cause serious side effects, including:

• Infusion-related reactions: OCREVUS can cause infusion-related reactions that can be serious and require you to be hospitalized. You will be monitored during your infusion and for at least 1 hour after each infusion of OCREVUS for signs and symptoms of an infusion-related reaction. Tell your healthcare provider or nurse if you have any symptoms (see accompanying Patient Information).

These infusion-related reactions can happen for up to 24 hours after your infusion. It is important that you call your healthcare provider right away if you have any of the signs or symptoms listed in the accompanying Patient Information.

If you get infusion-related reactions, your healthcare provider may need to stop or slow down the rate of your infusion.

• Infection:
  - OCREVUS increases your risk of getting upper respiratory tract infections, lower respiratory tract infections, skin infections, and herpes infections. Tell your healthcare provider if you have an infection or have any signs of infection (see accompanying Patient Information). These signs can happen during treatment or after you have received your last dose of OCREVUS. If you have an active infection, your healthcare provider should delay your treatment with OCREVUS until your infection is gone.

  - Progressive Multifocal Leukoencephalopathy (PML): Although no cases have been seen with OCREVUS treatment in clinical trials, PML may happen with OCREVUS. PML is a rare brain infection that usually leads to death or severe disability. Tell your healthcare provider right away if you have any new or worsening
Have fewer maybes with OCREVUS.

In relapsing MS, OCREVUS was consistently proven superior to REBIF®, a commonly used treatment.

OCREVUS demonstrated:
- Reduction of relapses
- Slowing of disability progression
- Significant impact on brain lesions

In primary progressive MS, OCREVUS is the first and only treatment proven effective.

OCREVUS is given every 6 months.†

Ask your healthcare provider about OCREVUS.

These are not all the possible side effects of OCREVUS. Call your doctor for medical advice about side effects. You may report side effects to FDA at 1-800-FDA-1088.

For additional Important Safety Information, please see accompanying Patient Information.

OCREVUS®
ocrelizumab
30MG/1ML INJECTION FOR IV

Visit OCREVUS.com or call 1-844-627-3887 to learn more.

* In two 2-year clinical studies vs REBIF.
† REBIF® is a registered trademark of EMD Serono, Inc.
‡ First dose of OCREVUS is split—given as 2 separate infusions 2 weeks apart.

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neurologic signs or symptoms. These may include problems with thinking, balance, eyesight, weakness on 1 side of your body, strength, or using your arms or legs (see accompanying Patient Information).

- **Hepatitis B virus (HBV) reactivation**: Before starting treatment with OCREVUS, your healthcare provider will do blood tests to check for hepatitis B viral infection. If you have ever had hepatitis B virus infection, the hepatitis B virus may become active again during or after treatment with OCREVUS. Hepatitis B virus becoming active again (called reactivation) may cause serious liver problems including liver failure or death. Your healthcare provider will monitor you if you are at risk for hepatitis B virus reactivation during treatment and after you stop receiving OCREVUS.

- **Weakened immune system**: OCREVUS taken before or after other medicines that weaken the immune system could increase your risk of getting infections.

What are the possible side effects of OCREVUS?

OCREVUS may cause serious side effects, including:
- Risk of cancers (malignancies) including breast cancer. Follow your healthcare provider’s instructions about standard screening guidelines for breast cancer. Most common side effects include infusion-related reactions and infections.
What is the most important information I should know about OCREVUS?

OCREVUS can cause serious side effects, including:

- **Infusion reactions:** OCREVUS can cause infusion reactions that can be serious and require you to be hospitalized. You will be monitored during your infusion and for at least 1 hour after each infusion of OCREVUS for signs and symptoms of an infusion reaction. Tell your healthcare provider or nurse if you get any of these symptoms:
  - itchy skin
  - rash
  - hives
  - tiredness
  - coughing or wheezing
  - trouble breathing
  - throat irritation or pain
  - feeling faint
  - fever
  - redness on your face (flushing)
  - nausea
  - headache
  - swelling of the throat
  - dizziness
  - shortness of breath
  - fatigue
  - fast heartbeat

  These infusion reactions can happen for up to 24 hours after your infusion. It is important that you call your healthcare provider right away if you get any of the signs or symptoms listed above after each infusion. If you get infusion reactions, your healthcare provider may need to stop or slow down the rate of your infusion.

- **Infection:**
  - OCREVUS increases your risk of getting upper respiratory tract infections, lower respiratory tract infections, skin infections, and herpes infections. Tell your healthcare provider if you have an infection or have any of the following signs of infection including fever, chills, a cough that does not go away, or signs of herpes (such as cold sores, shingles, or genital sores). These signs can happen during treatment or after you have received your last dose of OCREVUS. If you have an active infection, your healthcare provider should delay your treatment with OCREVUS until your infection is gone.
  - Progressive Multifocal Leukoencephalopathy (PML): Although no cases have been seen with OCREVUS treatment in clinical trials, PML may happen with OCREVUS. PML is a rare brain infection that usually leads to death or severe disability. Tell your healthcare provider right away if you have any new or worsening neurologic signs or symptoms. These may include problems with thinking, balance, eyesight, weakness on 1 side of your body, strength, or using your arms or legs.
  - Hepatitis B virus (HBV) reactivation: Before starting treatment with OCREVUS, your healthcare provider will do blood tests to check for hepatitis B viral infection. If you have ever had hepatitis B virus infection, the hepatitis B virus may become active again during or after treatment with OCREVUS. Hepatitis B virus becoming active again (called reactivation) may cause serious liver problems including liver failure or death. Your healthcare provider will monitor you if you are at risk for hepatitis B virus reactivation during treatment and after you stop receiving OCREVUS.
  - Weakened immune system: OCREVUS taken before or after other medicines that weaken the immune system could increase your risk of getting infections.

What is OCREVUS?

OCREVUS is a prescription medicine used to treat adults with relapsing or primary progressive forms of multiple sclerosis.

It is not known if OCREVUS is safe or effective in children.

Who should not receive OCREVUS?

- Do not receive OCREVUS if you have an active hepatitis B virus (HBV) infection.
- Do not receive OCREVUS if you have had a life threatening allergic reaction to OCREVUS. Tell your healthcare provider if you have had an allergic reaction to OCREVUS or any of its ingredients in the past.

See "What are the ingredients in OCREVUS?" for a complete list of ingredients in OCREVUS.

Before receiving OCREVUS, tell your healthcare provider about all of your medical conditions, including if you:

- have or think you have an infection. See "What is the most important information I should know about OCREVUS?"
- have ever taken, take, or plan to take medicines that affect your immune system, or other treatments for MS. These medicines could increase your risk of getting an infection.
- have ever had hepatitis B or are a carrier of the hepatitis B virus.
- have had a recent vaccination or are scheduled to receive any vaccinations. You should receive any required vaccines at least 6 weeks before you start treatment with OCREVUS. You should not receive certain vaccines (called ‘live’ or ‘live attenuated’ vaccines) while you are being treated with OCREVUS and until your healthcare provider tells you that your immune system is no longer weakened.
- are pregnant, think that you might be pregnant, or plan to become pregnant. It is not known if OCREVUS will harm your unborn baby. You should use birth control (contraception) during treatment with OCREVUS and for 6 months after your last infusion of OCREVUS.
- are breastfeeding or plan to breastfeed. It is not known if OCREVUS passes into your breast milk. Talk to your healthcare provider about the best way to feed your baby if you take OCREVUS.

Tell your healthcare provider about all the medicines you take, including prescription and over-the-counter medicines, vitamins, and herbal supplements.

How will I receive OCREVUS?

- OCREVUS is given through a needle placed in your vein (intravenous infusion) in your arm.
- Before treatment with OCREVUS, your healthcare provider will give you a corticosteroid medicine and an antihistamine to help reduce infusion reactions (make them less frequent and less severe). You may also receive other medicines to help reduce infusion reactions. See "What is the most important information I should know about OCREVUS?"
- Your first full dose of OCREVUS will be given as 2 separate infusions, 2 weeks apart. Each infusion will last about 2 hours and 30 minutes.
- Your next doses of OCREVUS will be given as one infusion every 6 months. These infusions will last about 3 hours and 30 minutes.
What are the possible side effects of OCREVUS?
OCREVUS may cause serious side effects, including:
• See “What is the most important information I should know about OCREVUS?”
• Risk of cancers (malignancies) including breast cancer. Follow your healthcare provider’s instructions about standard screening guidelines for breast cancer.

Most common side effects include infusion reactions and infections.
See “What is the most important information I should know about OCREVUS?”

These are not all the possible side effects of OCREVUS.
Call your doctor for medical advice about side effects. You may report side effects to FDA at 1-800-FDA-1088.

General information about the safe and effective use of OCREVUS.
Medicines are sometimes prescribed for purposes other than those listed in a Medication Guide. Do not use OCREVUS for a condition for which it was not prescribed. Do not give OCREVUS to other people, even if they have the same symptoms that you have. It may harm them. You can ask your pharmacist or healthcare provider for information about OCREVUS that is written for health professionals.

What are the ingredients in OCREVUS?
Active ingredient: ocrelizumab
Inactive ingredients: glacial acetic acid, polysorbate 20, sodium acetate trihydrate, trehalose dihydrate.

Manufactured by: Genentech, Inc., A Member of the Roche Group,
1 DNA Way,
South San Francisco, CA 94080-4990
U.S. License No. 1048
For more information, go to www.OCREVUS.com or call 1-844-627-3887.
This Medication Guide has been approved by the U.S. Food and Drug Administration
Issued: 3/2017

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of being allergic to this contrast agent. However, this risk is very small. According to a large study, only about 12 people out of every 10,000 receiving gadolinium as a contrast agent have an allergic reaction.

Lastly, some individuals have trouble with the loud banging heard while undergoing an MRI. Fortunately, many MRI centers offer special headphones that allow the patient to listen to music during the procedure. Listening to music assists in blocking the banging noise, helps the patient to relax, and can also make the time seem to go by faster.

**GETTING THE RESULTS**

Waiting for MRI results can try anyone’s patience. Time is needed for the radiologist to read the MRI and generate a report, then more time to communicate the results to the ordering provider. Speaking with the physician who ordered the MRI is the best way to learn of one’s test results, however, the physician may not be immediately available. In the interim, some patients access results directly online or discuss results by phone with someone at the provider’s office.

Unfortunately, radiology reports use terminology such as “black holes” or “T2-lesion volume,” which can be difficult to interpret or cause unnecessary worry. Individuals should try to remember that extremely concerning findings on an MRI will usually lead to a direct phone call about results or may lead to an urgent appointment. Concerning findings are those that might indicate more rapid or more serious progression of the disease. More routine findings, or those that do not indicate any serious changes, can usually wait until the next appointment or be discussed with staff at the provider’s office. The ordering physician is the one to best determine whether results are concerning or routine.

Whether the results are received over the phone or online – writing down questions about the MRI report or any other specific questions about the MRI itself – ensure these are addressed at the next office visit. Once this visit has been scheduled, opportunities are available to review the scan with one’s provider at his or her medical office, allowing the time needed to ask these questions and address any concerns.

Most imaging locations will provide a CD with stored MRI images on request. These can be extremely useful to bring to any new neurologist or imaging location so older images can be compared to newer images. This is particularly helpful when someone with MS moves to a new location, changes providers, or switches insurance… and ends up seeing a new provider or has imaging at a different location. Maintaining a library of old images on CD can provide a comparison to the next MRI, which will ultimately be helpful to the treating physicians.

**Concluding Thoughts**

While challenges exist with the cost and inconvenience of getting MRI monitoring for individuals with MS, this technology provides enormous benefits. Clear images of changes in the brain and spinal cord – without any need for radiation or invasive procedures – offer the opportunity to see whether an MS medication is working effectively. MRI images can help
determine whether new symptoms reflect new disease activity or if they may have some other explanation.

In multiple sclerosis, because so many lesions do not cause specific symptoms, just feeling good is not enough. The MRI must also be free of new lesions, demonstrating that silent lesions are not occurring. Obtaining this information can provide reassurance that treatment has been effective or evidence that a change needs to be made.

Research into new techniques with MRI may increase the value of MRI in the future. Some imaging facilities now provide a specific quantification of the total-lesion volume and the extent of atrophy of the brain.

When images are compared over time, atrophy can be specifically measured and may indicate worsening disease even without any new lesions. Newer techniques may show disease activity in gray matter more effectively and illustrate information about pathology not well seen on conventional MRI. As these research techniques enter mainstream clinical medicine, MRI may have even more value in the future.

For the present, MRI allows for a window into the brain and spinal cord, with a clear view of disease progression, new inflammation, and treatment effect. This window into multiple sclerosis can help optimize treatment and help make effective disease-management decisions to limit the impact of multiple sclerosis.

Informative Publications from MSAA

About MS – Second Edition

Understanding Progression in MS

MS Relapse Toolkit

To download or order copies, please visit mymsaa.org/publications or call (800) 532-7667.
Is Stem-Cell Transplant an Option?

By Dr. Jack Burks
MSAA’s Chief Medical Consultant

Q: In July, MSAA posted an article on their website giving highlights from recent medical meetings. One of the topics covered was stem-cell transplant (SCT), where the treatment involved less-severe preparation for the transplant. In both of the studies mentioned, the individuals who were treated had highly active relapsing MS. Results were positive and study participants experienced improvements in their Expanded Disability Status Scale score.

With these types of results, why isn’t SCT an option for everyone with MS? If I can’t get SCT here in the United States, I have heard that some people are getting SCT in other countries.

A: Stem-cell transplant (SCT) is a complicated subject. In our 2018 edition of MSAA’s MS Research Update, we have a full section devoted to the different types of SCT and how each is performed. It also gives a good overview of recent and upcoming studies with SCT. Anyone interested in learning more may access this publication by going to mymsaa.org/publications and selecting the 2018 edition of this update.

While SCT is showing some remarkable results for individuals with MS, it is still in the early phases of study and is still considered experimental. SCT is not approved by the United States Food and Drug Administration (FDA) except in clinical trials. Studies so far have been at the Phase I and Phase II levels, and haven’t reached the larger Phase III level – such as those that have been conducted for the approved disease-modifying therapies.

Some may want to know what is taking so long and why they are potentially being deprived of an effective treatment for MS. These individuals need to know that patient safety is the top priority and that the protocol for SCT (referring to the safest procedures and dosages of medications) is still under investigation. Researchers still need to confirm – through clinical trials – the safest and most effective treatment procedures. As with experimental treatments for all conditions, investigators and the FDA must balance safety with effectiveness when evaluating and finalizing treatment protocol.

For FDA approval, the clinical trials must have approved protocols and show a favorable “risk-benefit ratio.” The science is encouraging but more work needs to be completed.
Additionally, until the FDA has approved SCT for the treatment of MS, insurance coverage is not available for this procedure.

As you mention in your question, without the approval of SCT for MS in this country, and without the possibility of insurance coverage, some patients are seeking SCT in other countries. This is a very risky endeavor and I can’t warn people enough about the dangers of considering SCT in a country where the medical procedures are not highly regulated. Risks can include treatments that are too severe as well as poor patient monitoring and care, all of which can lead to serious infections, long-term health problems, or worse. If you choose to go to another country for this procedure, make certain it is reputable and not just a commercial venture. Ask your neurologist or an MS center for advice before traveling to receive this procedure.

A safer alternative is to consider treatment with one of the 15 disease-modifying therapies that have been approved by the FDA for the treatment of most forms of MS – with additional possible treatments in the pipeline. The future of MS treatments is very bright. The SCT clinical trials are becoming safer and are encouraging. However, until the clinical trials have been completed and the ideal protocol has been determined, my advice is to work with your neurologist and healthcare team to make sure you are doing everything you can to stay healthy and reduce disease activity while waiting for additional clinical trial results and potential FDA approval of SCT.
Q: I was diagnosed with RRMS in 1994. I have rather significant cognitive fatigue issues from my MS. I began taking the ADHD medication Cylert (pemoline) for this, and it was like night and day for me. The fog burned off and life was now in “real time” again, as opposed to being two or three steps behind on everything. When Cylert came off the market in 2004, I switched to Ritalin® (methylphenidate), and about four years ago, I tried Adderall® (amphetamine and dextroamphetamine) twice per day. I do not know what I would do without this medication. My question is, why don’t we hear about the use of ADHD stimulants for the treatment of this very disabling symptom?

A: I am pleased that Adderall is helping your cognitive fatigue. As noted on mymsaa.org, approximately half of the MS population will experience some type of change in their cognitive abilities during the course of their disease. The most commonly affected cognitive processes in MS are speed-of-information processing, memory, and executive functions (such as organizing, planning, and problem-solving). Up to 80 percent of people with MS also experience the disabling effects of fatigue. With these two symptoms found so frequently, it comes as no surprise that cognitive fatigue might be an issue for someone with MS. Cognitive fatigue can cause an individual to experience reduced attention and slowed-thought processing.

Many MS neurologists prescribe ADHD medications for fatigue, including cognitive fatigue. Provigil® (modafinil) and Nuvigil® (armodafinil) are other options that many find to be helpful. Unfortunately, the problem with prescribing these medications for cognitive fatigue is often a lack of insurance coverage, since they are not approved by the FDA specifically for MS, although exceptions are possible with your neurologist’s persistence. For more information on symptoms and a full listing of medications prescribed, please visit mymsaa.org/symptoms.

Jack Burks, MD is the chief medical consultant for MSAA. He is an international MS neurologist, writer, lecturer, and researcher, who assists with the development of new MS therapies as well as new MS centers. He also advises patients, families, MS organizations, and healthcare groups. Dr. Burks is an adjunct professor at Nova Southeastern University and clinical professor of neurology at Florida International University. In addition, he has authored numerous textbooks, chapters, and articles on MS.
FDA Accepts Application for Cladribine Tablets

On July 30, 2018, EMD Serono, Inc. announced that the United States Food and Drug Administration (FDA) had accepted a New Drug Application (NDA) for Cladribine Tablets (an oral formulation of cladribine). This is an investigational treatment for relapsing forms of MS. Accepted by the European Commission in August 2017 and by Canada in December 2017, cladribine is currently approved for the treatment of relapsing MS in 38 countries under the trade name Mavenclad®.

In studies, cladribine has been shown to reduce disease activity in patients with relapsing MS, including disability progression, annualized relapse rate, and MRI activity. Potential adverse events include lymphopenia, a condition that causes abnormally low counts of white blood cells that play a role in fighting infection, and herpes zoster.

According to MSAA’s MS Research Update 2018, “Cladribine selectively targets the immune system’s B cells and T cells, leading to depletion of those cells. This is followed by a distinct pattern of ‘reconstitution,’ as new B cells and T cells are produced. The medication has an interesting dosing regimen, with two annual courses given for a maximum of 20 days over two years. Its developers note that this approach avoids continuous suppression of the immune system.” Following these first two years, no treatment is needed for Years 3 and 4.

FDA Accepts Gilenya for Pediatric MS

On May 11, 2018, Novartis announced that Gilenya® (fingolimod) was approved by the United States Food and Drug Administration (FDA) for the treatment of children and adolescents, ages 10 through 17, with relapsing multiple sclerosis (MS). This is the first disease-modifying therapy (DMT) to be approved for this form of the disease in this age group.

Known as “pediatric MS,” nearly all (98 percent) of those diagnosed have the relapsing form of the disease. Children experience approximately two-to-three times as many relapses as an individual with adult-onset MS. Prior to this approval, all 15 disease-modifying therapies (DMTs) for MS had only been approved for adults; no treatment had been approved specifically for children and adolescents with MS.

The FDA’s approval of Gilenya was based on the results from the Phase III PARADIGMS study. This clinical trial evaluated the safety
and effectiveness of Gilenya versus Avonex® (interferon beta-1a) in children and adolescents (ages 10 through 17) with relapsing MS. PARADIGMS is the first study to compare two MS therapies, approved for adults, in children and adolescents with MS. Enrolling 215 young individuals with MS, this study was conducted at 87 sites in more than 25 countries. PARADIGMS was a double-blind, randomized, multi-center Phase III study with a duration of up to two years, followed by a five-year, open-label extension phase.

Study participants were either given Avonex, a once-weekly intramuscular injection, or Gilenya, an oral pill taken once daily. Compared to the Avonex group, those taking Gilenya experienced an 82-percent reduction in their annualized relapse rate during a period of up to two years. Side effects and adverse events were similar to those seen in other clinical trials with adults.

For more information on Gilenya for treating pediatric MS, individuals may visit www.gilenya.com, or call 800-GILENYA (800-445-3692) to speak with a member of Novartis’ support team.

Research Highlights from the AAN and CMSC 2018 Annual Meetings

The results of numerous significant studies were reported at the Annual Meeting of the American Academy of Neurology (AAN), held in Los Angeles in April, and the Annual Meeting of the Consortium of Multiple Sclerosis Centers (CMSC), which took place in Nashville in May. Posted on July 6, 2018, MSAA provided a summary of some of the most interesting findings from those conferences.

Topics in this article include: updates on experimental disease-modifying therapies (DMTs); continuing studies on the effectiveness and safety of approved DMTs; comparative analysis of approved DMTs; new diagnostic testing; strategies for wellness; and hot topics in MS. This latter section includes information on stem cell transplant, gut microbiome, medical marijuana, and more. To read the full summary, please visit MSAA’s website at mymsaa.org and go to “Latest News”; then scroll down to select “Research Highlights from the AAN and CMSC 2018 Annual Meetings.” For individuals without internet access, please call MSAA at (800) 532-7667 to request a printed copy.

To read all of MSAA’s latest articles online, please visit our website at mymsaa.org and go to “Latest News.” For general information or to speak with a trained Client Services Specialist, please call MSAA’s Helpline at (800) 532-7667, extension 154. Questions to MSAA’s Client Services department may also be emailed to MSquestions@mymsaa.org.

Written by Susan Wells Courtney, MSAA Senior Writer

Reviewed by Dr. Jack Burks, MSAA Chief Medical Consultant
Through MSAA’s **Tribute Gift program**, a gift can be given as a lasting remembrance to memorialize a loved one, honor a friend or celebrate a birthday, holiday, anniversary, or unique accomplishment.

Your generous donation will help ensure more people get the assistance they are seeking – cooling vests, wheelchairs, informational resources, vital MRIs and much, much more.

To make a tribute gift, please visit [support.mymsaa.org/tribute](http://support.mymsaa.org/tribute)
MSAA’s Helpline and Educational Programs

By Peter Damiri
Vice President of Programs and Services

MSAA’s Helpline Offers More than Information and Resources

With the conclusion of our fiscal year on June 30th, MSAA is proud to announce that we have achieved a number of record-level accomplishments in serving more clients in more places than ever before! Most notably is the significant spike in Helpline calls and assistance throughout the year. With the goal of addressing 10,000 client inquiries for the fiscal year, MSAA’s Client Services staff surpassed this high-level mark by 26 percent, responding to more than 12,500 calls, emails, and online chats.

MSAA’s Helpline allows individuals with MS, care partners, family members, and friends to connect directly with a trained and dedicated social service professional and receive valuable information, guidance, and support. Topics commonly addressed by our specialists include: updates on MS research, treatments, and various symptoms; locating local neurologists and other healthcare professionals; identifying financial-assistance programs; providing resources on health insurance, employment issues, and vocational training; addressing housing and transportation needs; and explaining many of MSAA’s programs and services.

In addition to providing people with a wealth of resources and referrals, the Helpline staff offers a tremendous amount of encouragement, compassion, and empathy to our clients and their families. While our specialists are not medically licensed and cannot provide counseling or therapy, they do offer a very supportive environment where people can have meaningful, non-judgmental conversations about their MS journey. They can feel safe to express their feelings about personal relationships, coping with the uncertainty of the disease, and many other issues affecting everyday life with multiple sclerosis.

As a longtime member of MSAA, Florence D. from West Virginia utilizes the Helpline service for a variety of needs. Most recently she called to learn more about the products included in MSAA’s Equipment Program and was not only able to order a walker, but also a leg lift to help her safely transfer into her daughter’s pick-up truck.
“MSAA is wonderful and I am so grateful to be able to speak to the lovely Client Services Specialist staff when I have questions or concerns about my MS,” noted Florence. “They are all so kind, resourceful, and smart. I just love MSAA to pieces.”

As part of MSAA’s goal to engage with more clients all across the county, the Helpline hours were expanded earlier this year to include Wednesday evenings until 8:00 pm Eastern Time (ET) and the online chat feature was added to additional pages of the mymsaa.org website. To connect with an MSAA Client Services Specialist, please call our toll-free Helpline at (800) 532-7667, ext. 154 between 8:30 am and 5:00 pm ET, Monday through Friday, and until 8:00 pm ET on Wednesdays.

New Series of Educational Programs Launching This Fall

Organized and hosted by MSAA’s Directors of Education and Healthcare Relations, we are excited to announce a wealth of new, in-person educational programs occurring this fall and into 2019. These free dinner or lunch programs provide an excellent opportunity for individuals with MS and their care partners to learn about the latest advances in MS, coping strategies, and healthcare management from many of the country’s leading experts. Additionally, MSAA’s educational programs offer a terrific opportunity for people to connect, share common experiences among their peers, build friendships, and enjoy a nice day out.

Kicking off the fall slate of programs is our new series: “MS Journey: Managing Your MS Through the Years.” While MS is an unpredictable disease, many valuable tools and educational resources are available to help people navigate the MS journey. This series will focus on the following topics: early treatment and diagnosis; treatment considerations and health outcomes; symptom management and quality of life issues; changes in the understanding and treatment of primary-progressive MS; plus cognitive and emotional wellness. In conjunction with MSAA’s upcoming 50th anniversary, our goal is to include one program from this initiative in each of the 50 states.

Also new this fall will be a special focus on, “Women & MS.” Since multiple sclerosis is a disease that tends to affect women during the prime of their lives, many additional health issues should be considered and addressed outside of those directly connected to MS. This patient-education initiative seeks to address the overall health issues facing female MS patients by including the perspective of an OB/GYN specialist alongside an MS neurologist to provide a comprehensive overview of best practices in women’s health. These programs will enable female MS.
patients to make better decisions relating to their overall health and wellness, and better understand these issues within the context of having MS.

And, back by popular demand, MSAA is pleased to announce that it will expand its series on technology with a new round of presentations on: "What Have I Missed? The Newest Innovative Technologies, Tools & Strategies to Help Better Manage Your MS.” This initiative will educate participants about new ways to manage their MS and improve their overall wellness. Examples of the innovative tools to be presented include cognitive re-training tools, MS patient apps, breakthroughs in the delivery of MS disease-modifying therapies, fitness trackers, virtual MS comprehensive care centers, assistive walking devices, and virtual assistants.

While MSAA is pleased to spotlight these upcoming programs, please know that we are continuously planning new educational topics and initiatives, especially in the area of the African-American and Hispanic MS populations, as well as reaching more clients in rural locations across the United States. We encourage you to visit mymsaa.org/calendar to see the full listing of MSAA’s educational programs and to register to attend one or more of these insightful and informative events. If you have additional questions, please feel free to call MSAA’s Helpline at (800) 532-7667, ext. 154 or email questions to MSquestions@mymsaa.org.

The entire staff at the Multiple Sclerosis Association of America (MSAA), as well as many of MSAA’s corporate partners, are mourning the loss of our former Chief Operating Officer and treasured colleague, Robert “Bob” Rapp. Following a successful career in education and public service, Bob joined the staff of MSAA as Director of Services in August of 1999. He quickly advanced to Chief Program Officer, moving on to several Vice President positions, and ultimately earning the title of Chief Operating Officer in 2011.

Bob was known for his kind demeanor, good sense of humor, and unrelenting dedication to MSAA and the MS community. Retiring in mid-2016, Bob played an integral role in helping MSAA to significantly develop its programs and services during his 16 years of service to our organization.

Bob passed away on July 31, 2018, following an illness. He will be greatly missed by everyone who knew him. We extend our heartfelt condolences and sincere sympathy to his family members.
Submit Your Best Work for MSAA’s 2019 Art Showcases

MSAA is now accepting submissions for the MS Ability Showcase and Four Seasons Showcase!

MSAA welcomes paintings in oil, watercolor, and acrylic, as well as pastels and drawings in pencil and ink. MSAA also accepts digital artwork.

Artwork will only be accepted from individuals who have MS. Submitted pieces must be two-dimensional. Sculpture, pottery, fabric, and other types of three-dimensional works cannot be accepted to either showcase. The MS Ability Showcase is open to all themes; however, submitted artwork to the Four Seasons Showcase must depict a specific season or holiday. You may submit up to three (3) pieces of your artwork for each showcase.

Submissions will be featured on MSAA’s website beginning March 2019 in recognition of MS Awareness Month. Each month we will highlight one artist and his or her work.

Submissions will be accepted until December 14, 2018.

For submission guidelines, please visit support.mymsaa.org/artshowcase
Without Donations, MSAA Doesn’t Exist

by Erich Fasnacht, Vice President of Development
Fundraising profiles by Kaitlyn Gallagher

Imagine everything that MSAA is able to provide to people living with MS in a single day – a cooling vest for a mother in Ohio; a free MRI for a young man in Florida; a wheelchair for a woman in New Jersey; an educational program for 30 families in Chicago. MSAA helps people like this every day, not to mention our additional services such as our My MS Manager app, our online community, webinars, and publications. But absolutely NONE of this would be possible without donations.

MSAA doesn’t receive government funding. There is no multi-million dollar endowment. Each year, we rely on donations from individuals, corporations, and foundations to fund each one of our programs. An additional $250 donation means that we are that much closer to providing a free MRI to someone in need. A $10 online donation by 12 different people means that we can provide a transfer bench to someone with mobility issues. A $1,000 gift to MSAA can be a real, honest-to-goodness life-changer for someone who is struggling with multiple sclerosis.

Is it important to you that MSAA is able to continue providing these services to people living with MS?

We know that it is, because there’s something else that happens every single day – we receive donations: an online gift from a woman in Washington whose daughter has MS; a participant in our Ride to Montauk in New York gets a donation from a friend; a check in the mail from a father in Texas is received at our office. These generous and miraculous gifts make it possible to provide our free and urgently needed programs and services to the MS community.

If you would like to be part of this group of donors who support our work, or know someone who would, please reach out to MSAA at (800) 532-7667 or go to mymsaa.org.
Thank you!

STUDIOUS SWIMMERS

In July 2018, a group of National Honor Society students from Stafford, Texas embarked on their fourth Swim for MS challenge. Thanks to the hard work and dedication of this group of students, the Stafford team had their most successful year yet! The group collected two dollars for each lap they completed, and one dollar for each cannonball jump during their one-day swim event at the local pool. The Stafford NHS Twitter account also tweeted frequently in support of the team to encourage donations. As a result, the team collected more than $800 for MSAA’s free programs and services!
JOURNEY TO THE MARINE CORPS MARATHON

On October 28, 2018, Kari Albrecht Earll and her husband, Mike, will be racing alongside members of Team MSAA in support of the MS community for the 43rd Annual Marine Corps Marathon. Kari was diagnosed with multiple sclerosis in 2013 – however, this did not stop her from completing her first full marathon the following year. At a recent follow-up appointment with her neurologist, Kari mentioned her goal of completing a half marathon in every state. Her neurologist suggested that she join Team MSAA for the Marine Corps Marathon to help her get one step closer to her goal while supporting a cause she cares about. Now, Kari and her husband are training hard in preparation for the race!

continued on next page
Thoughts about Giving

“When I was diagnosed, I had no idea what MS really was,” said Kari. “I thought people with MS were all in wheelchairs and not able to walk. Here I am still running… MS does not define who I am, it is just something that I manage… I have days that are not as great, but with the support of my husband and my daughters I keep pushing on.” To date, Kari and Mike have raised more than $1,500 for MSAA’s free programs and services! We wish Kari and Mike the best of luck on their journey to the Marine Corps Marathon!

A Special Thank You To Our Supporters

Thanks to our generous supporters, MSAA continues to provide free, direct services and support such as cooling vests and mobility equipment; nationwide educational programs; a toll-free Helpline and Chat; MRI funding assistance; informational resources such as publications, videos, and webinars; and many more services to people with MS, their care partners, and loved ones.

We couldn’t do this work without you, and for that, we are forever grateful.

“We chose [to donate to] MSAA because your organization provides very practical items. Whether it is cooling vests and other physical aid items, or education for families and recently diagnosed persons, these items provide real and concrete help for people diagnosed with MS.”

– LR from California

“I have been diagnosed with multiple sclerosis for 10 years now. Thank you so much for the cooling vest. It has given me the opportunity to win one more battle over MS. When I saw the package I almost came to tears. It is wonderful for the resources you are giving MS patients.”

– MV from Florida

To support MSAA, please visit support.mymsaa.org/donate or call (800) 532-7667.
When Justeen first met Chris, they were little kindergarteners. He happened to be best friends with her cousin, who lived next door. The two grew up in the Salt Lake area of Utah, going to the same schools for elementary, junior high, and high school. As the two entered junior high, their friends would say, “You two should date each other! You’re both tall!” But both just smiled and shrugged it off. After high school graduation, the two went their separate ways: Chris attending Southern Utah University on a football scholarship, and Justeen staying in the Salt Lake area, earning her esthetician license.

After college, Justeen took a job in Salt Lake City, working at a hotel spa. Chris finished college and, unbeknownst to Justeen, joined another hotel in Salt Lake City – as a bellman. One afternoon, Justeen walked over to the other hotel (where Chris worked) for lunch and was shocked to run into Chris. Shortly after, the two started dating. After all, they were both tall! They had no idea how the next four years would shake out. As they began dating, a good friend of Justeen’s unexpectedly passed away. So did Chris’ grandmother, whom he was close to, as well as two of Justeen’s uncles. The two supported each other through these difficult times, and after a year and a half of casually dating, the two became more serious.

But as Justeen and Chris’ relationship grew closer, Chris noticed his body wasn’t its normal self. At an alumni basketball game, Chris could barely run the court and got a pounding headache. Always athletic, Chris found this fairly troubling. Over the next few days, he noticed exercise was extremely difficult and exhausting. And the headaches became more frequent.

At that point, Chris decided to visit a doctor. But he wasn’t sure what doctor to go to or what exactly he would say. It was difficult to
put into words the symptoms he was experiencing. But one thing he knew for sure, was that **something** was wrong. He visited several doctors trying to figure it out. At one doctor visit, the doctor checked his reflexes. Chris displayed no reflexes in his knees. Thinking it was a pinched nerve, the doctor ordered X-rays, but the X-rays showed nothing was pinched. As a next step, the doctor gave Chris an MRI, which showed lesions on his spine. Further examinations showed specific proteins in his cerebrospinal fluid. All of these together led the doctor to diagnose Chris with multiple sclerosis.

Chris was speechless. He’d known something wasn’t right, but his symptoms seemed milder than what you’d expect from someone with MS. And wasn’t he too young? He was only 27! Justeen made the call to Chris’ mother to confirm the diagnosis, who was devastated upon learning the news. Between sobs, she confessed to Justeen that Chris was soon planning to buy an engagement ring, and she wondered how this news would affect his plans.

And it did affect his plans. **Their** plans. Figuring out how to help Chris manage his disease was a journey for both of them, and not without its ups and downs. Finding the best doctors for him, as well as navigating through insurance issues, took a toll on their relationship. Getting engaged took a back seat. Finding quality time where they could simply focus on their relationship was a challenge. And while Chris realized he now wanted to pursue a career in the medical profession, having the time, energy, and money to pursue more college was now in question.

A year and a half later, after better learning how to manage his disease and work through insurance issues, Chris was able to think about getting married once again. Of course Justeen said yes, but because of insurance and medical costs, the two decided to make it a really simple, no-frills wedding.

That is, until Justeen – on a whim – entered a Utah-based Instagram “Wedding Giveaway,” with a prize valued at $20,000. By that evening, she’d forgotten she’d even entered the contest. A few days later as she was checking her Instagram feed, she was shocked to see her name listed as the winner of the giveaway.

After learning she really won, Justeen couldn’t help but shed tears of relief. Not only were they going to have a wedding, but they were going to enjoy a dream wedding!

Justeen explains, “I entered the giveaway as a shot in the dark. We were planning on having a simple wedding, and everything about the giveaway gave us what we wouldn’t have been able to afford. It allowed us to invite more people, all of whom had a big impact in our lives, and also gave us the chance to hire the band we both love.”

“All of these local companies [who contributed to the giveaway] are top-notch. We were excited to collaborate for this giveaway and to give one couple their dream wedding,” says Scott Porter, owner of San Diablo Churros and who helped orchestrate the giveaway. “We had no idea that such a deserving couple would end up winning. We are humbled by their story and were honored to help give them
Since Chris’s diagnosis, his symptoms come and go, and can last from one day to several weeks. He experiences numbness on the entire left side of his body, and some days the numbness is worse than other days. He struggles daily with balance and coordination, and closing his eyes can at times cause dizziness that is nauseating. Together, these symptoms prevent him from being the former athlete he was.

Chris also has Type 1 diabetes, and a round of steroids meant to correct numbness once caused his blood sugar to skyrocket for a week. Since then, Justeen and Chris work closely together with a nurse to ensure Chris eats a good diet and exercises to maintain his best health possible.

On June 30, 2018, Justeen and Chris were able to experience what it really means to live out a dream wedding, tying the knot in the rustic countryside of Kamas, Utah. “This miracle came at the perfect time for us, when we weren’t sure how everything was going to work out,” says Justeen. “This was an absolute dream come true.”

Don’t Miss Out on Important Email Updates from MSAA

Receive MS-related news, event details, and invitations for educational programs happening in your area.

To sign up for email updates, please visit mymsaa.org/signup
MSAA’s Lending Library Selections

The Inward Empire: Mapping the Wilds of Mortality and Fatherhood
by Christian Donlan
Little, Brown and Company
MSAA Book #433

This wonderful and heartfelt book provides fascinating insight into the symptoms and changes that occur with MS, as told by an award-winning journalist. The Inward Empire features “exquisite observations” of how the author’s world is evolving, the processes taking place within his body, and how his neurological decline contrasts with the neurological development of his young daughter, whom he cherishes. Described by reviewers as poetic and powerful… riveting and remarkable… this story is not only thought-provoking, but heartwarming, humorous, and meaningful.

But You Look So Good and Other Lies: A Memoir
by Cher Finver
Infinity Publishing | MSAA Book #431

In her debut book, author Cher Finver tells her personal story of abandonment, her family history of addictions and mental illness, as well as the realization that her life has been a lie. In spite of these virtually insurmountable challenges, not to mention the diagnosis of MS, Cher manages to land on her feet – becoming a devoted mother, loving wife, award-winning volunteer, and ultimately, a survivor. This book is both engaging and well-written. Please note that it does include adult themes and language.

Love Me Now
by Joanne T. Amoroso
Self-published
MSAA Book #432

In this profound story about caregiving, author Joanne Amoroso paints an inspirational picture of her daughter, Angela, through a collection of stories, letters, and cherished memories. At 16, Angela began traveling to several exotic countries, where she discovers that her true calling is in the field of art therapy. Although diagnosed with MS, Angela’s indomitable spirit, along with her family’s devotion and support, enabled her to live life to the fullest.

The Inward Empire: Mapping the Wilds of Mortality and Fatherhood
by Christian Donlan
Little, Brown and Company
MSAA Book #433

In her debut book, author Cher Finver tells her personal story of abandonment, her family history of addictions and mental illness, as well as the realization that her life has been a lie. In spite of these virtually insurmountable challenges, not to mention the diagnosis of MS, Cher manages to land on her feet – becoming a devoted mother, loving wife, award-winning volunteer, and ultimately, a survivor. This book is both engaging and well-written. Please note that it does include adult themes and language.

MSAA’s Lending Library
To borrow books featured in this column or any other book in MSAA’s Lending Library, please visit mymsaa.org/library to view a list of books available and to complete a form. When ordering a book, please reference the book number listed. Readers may also call MSAA at (800) 532-7667 for more information. MSAA and its clients greatly appreciate any donations made to help build the Lending Library. Please send your book donations to: MSAA Lending Library, 375 Kings Highway North, Cherry Hill, NJ 08034
Wherever You Go, Whatever You Do...

Keep Your Cool

Stylish, sized-to-fit cooling apparel from Polar Products has cooled the MS community for more than 30 years!

Add More to Your Special Day

Do you have an upcoming special occasion?

By making a donation to MSAA in place of conventional wedding or event favors, MSAA will provide you with personalized favors for your celebration to announce your generous gift!

To learn more about MSAA’s occasion favors, please visit support.mymsaa.org/favors
My MSAA Community

Join others who have similar experiences with multiple sclerosis in an online peer-to-peer forum.

- Get advice, support and connect with people affected by MS
- Communicate directly with others who have MS
- Feel more confident managing your own health and your family's health
- Solve day-to-day challenges
- Have your voice heard about important MS issues

"Some of us are newly diagnosed (me since May) and others have been dealing with it a long time. We have answers, advice, and questions...mostly questions. This is a great place to touch base when you need a question answered, want to vent, or just need the company of somebody who understands."

- My MSAA Community Member

Join My MSAA Community today:
healthunlocked.com/msaa