<table>
<thead>
<tr>
<th>NAME AND TYPE OF DRUG</th>
<th>SIDE EFFECTS</th>
<th>HOW ADMINISTERED</th>
<th>ADDITIONAL NOTES</th>
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<tbody>
<tr>
<td>Avonex® (Interferon beta-1a) immune system modulator with antiviral properties</td>
<td>Flu-like symptoms and headache, blood count and liver test abnormalities</td>
<td>30 micrograms taken via weekly intramuscular injection</td>
<td>Side effects may be prevented and/or managed effectively through various treatment strategies; side effect problems are usually temporary. Blood tests may be given periodically to monitor liver enzymes, blood-cell counts, and neutralizing antibodies.</td>
</tr>
<tr>
<td>Betaseron® (Interferon beta-1b) immune system modulator with antiviral properties</td>
<td>Flu-like symptoms, injection-site skin reaction, blood count and liver test abnormalities</td>
<td>250 micrograms taken via subcutaneous injection every other day</td>
<td>Side effects may be prevented and/or managed effectively through various treatment strategies; side effect problems are usually temporary. Blood tests may be given periodically to monitor liver enzymes, blood-cell counts, and neutralizing antibodies.</td>
</tr>
<tr>
<td>Copaxone® (glatiram er acetate) Synthetic chain of four amino acids found in myelin (immune system modulator that blocks attacks on myelin)</td>
<td>Injection-site skin reaction as well as an occasional systemic reaction - occurring at least once in approximately 10 percent of those tested</td>
<td>20 (daily) or 40 (three times weekly) milligrams taken via subcutaneous injection</td>
<td>Systemic reactions occur about five to 15 minutes following an injection and may include anxiety, flushing, chest tightness, dizziness, palpitations, and/or shortness of breath. Usually lasting for only a few minutes, these symptoms do not require specific treatment and have no long-term negative effects. Copaxone was originally approved at a dose of 20 milligrams daily, but in January 2014, a new dose of 40 milligrams three times weekly was approved by the FDA. The original 20-milligram daily dose remains available, so patients and their doctors may now choose their preferred dosing regimen.</td>
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<tr>
<td>Extavia® (Interferon beta-1b) immune system modulator with antiviral properties</td>
<td>Flu-like symptoms, injection-site skin reaction, blood count and liver test abnormalities</td>
<td>250 micrograms taken via subcutaneous injection every other day</td>
<td>Side effects may be prevented and/or managed effectively through various treatment strategies; side effect problems are usually temporary. Blood tests may be given periodically to monitor liver enzymes, blood-cell counts, and neutralizing antibodies.</td>
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**SELF-INJECTED MEDICATIONS**

**APPROVED LONG-TERM TREATMENTS FOR MS**

**SIDE EFFECTS**

- Flu-like symptoms
- Headache
- Blood count abnormalities
- Liver test abnormalities

**HOW ADMINISTERED**

- 20 (daily) or 40 (three times weekly) milligrams taken via subcutaneous injection
- 125 micrograms taken via subcutaneous injection once every two weeks
- 44 micrograms taken via subcutaneous injection three times weekly

**ADDITIONAL NOTES**

- Using study results from trials with Copaxone, systemic reactions occur about five to 15 minutes following an injection and may include anxiety, flushing, chest tightness, dizziness, palpitations, and/or shortness of breath. Usually lasting for only a few minutes, these symptoms do not require specific treatment and have no long-term negative effects.
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### Infused Medications

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<td><strong>Lemtrada®</strong> <em>(alemtuzumab)</em> Humanized monoclonal antibody that rapidly depletes or suppresses immune system cells (T and B cells), which can damage the myelin and nerves of the central nervous system (CNS).</td>
<td>Common side effects include rash, itching, headache, pyrexia (increase in temperature), nasopharyngitis (inflammation of the nose and throat), nausea, diarrhoea and vomiting, insomnia, numbness/tingling, dizziness, pain, flushing, and infection.</td>
<td>Lemtrada is given for a course of five days via intravenous (IV) infusion and followed one year later by a second three-day course.</td>
<td>Adverse events from Lemtrada can include infusion reactions to the medication, an increased risk of infection, emergent autoimmune diseases, a potentially severe bleeding disorder called immune thrombocytopenic purpura (ITP), and an increased risk of malignancies including thyroid cancer, melanoma and lymphoproliferative disorders. For early detection and management of these risks, Lemtrada is only available through a restricted distribution program, the Lemtrada REMS (Risk Evaluation and Mitigation Strategy).</td>
</tr>
<tr>
<td><strong>Novantrone®</strong> <em>(mitoxantrone)</em> Antineoplastic agent (immune system modulator and suppressor)</td>
<td>Side effects include nausea, thinning hair, loss of menstrual periods, bladder infections, and mouth sores; additionally, urine and whites of the eyes may turn a bluish color temporarily</td>
<td>IV infusion once every three months (for two to three years maximum)</td>
<td>Novantrone carries the risk of cardiotoxicity (heart damage) and leukemia; it may not be given beyond two or three years. People undergoing treatment must have regular testing for cardiotoxicity, white blood cell counts, and liver function. Because of the potential risks, Novantrone is seldom prescribed for individuals with MS. Anyone taking Novantrone now or given Novantrone previously needs to have annual evaluations of his or her heart function, even if no longer receiving this medication.</td>
</tr>
<tr>
<td><strong>Ocrevus™</strong> <em>(ocrelizumab)</em> is a humanized monoclonal antibody designed to selectively target CD20-positive B cells. These are a specific type of immune cell that is an important contributor to the MS-disease process.</td>
<td>Side effects can include infusion reactions, which can be serious, as well as an increase in infections. Upper respiratory tract infection was the most common infection seen in studies with RMS and PPMS; skin infection and lower respiratory tract infection were also common infections seen in studies with PPMS.</td>
<td>A 600-milligram dose is given via IV every six months. For the initial dose, two 300-milligram doses are given, separated by two weeks.</td>
<td>Ocrevus should not be used in patients with hepatitis B infection or a history of life-threatening infusion-related reactions to Ocrevus. Other rare adverse events, including cancer and progressive multifocal leukoencephalopathy (PML), could potentially occur, but these risks are still being investigated.</td>
</tr>
<tr>
<td><strong>Tysabri®</strong> <em>(natalizumab)</em> Humanized monoclonal antibody (inhibits adhesion molecules; thought to prevent damaging immune cells from crossing the blood-brain barrier)</td>
<td>Headache, fatigue, depression, joint pain, abdominal discomfort, and infection</td>
<td>IV infusion every four weeks</td>
<td>Risk of infection (including pneumonia) was the most common serious adverse event during the studies (occurring in a small percentage of patients). The TOUCH Prescribing Program monitors patients for signs of PML, a potentially fatal viral infection of the brain. Risk factors for PML include: the presence of JC virus antibodies, previous treatment with immunosuppressive drugs, and taking Tysabri for more than two years.</td>
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### Oral Medications

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<td>Aubagio® (teriflunomide)</td>
<td>Headache, elevations in liver enzymes, hair thinning, diarrhea, nausea, neutropenia (a condition that reduces the number of certain white blood cells), and paresthesia (tingling, burning, or numbing sensation)</td>
<td>7- or 14-milligram tablet taken orally, once per day</td>
<td>More severe adverse events include the risk of severe liver injury and the risk of birth defects if used during pregnancy. A TB test and blood tests for liver function must be performed within six months prior to starting Aubagio, and liver function must be checked regularly. If liver damage is detected, or if someone becomes pregnant while taking this drug, accelerated elimination of the drug is prescribed.</td>
</tr>
<tr>
<td>Gilenya® (fingolimod, FTY720) S1P-receptor modulator (blocks potentially damaging T cells from leaving lymph nodes)</td>
<td>Headache, flu, diarrhea, back pain, abnormal liver tests and cough</td>
<td>0.5-milligram capsule taken orally once per day</td>
<td>Adverse events include: a reduction in heart rate (dose-related and transient); infrequent transient AV conduction block of the heart; a mild increase in blood pressure; macular edema (swelling behind the eye); reversible elevation of liver enzymes; and a slight increase in lung infections (primarily bronchitis). Other infections, and potentially PML; could also occur. A six-hour observation period is required immediately after the first dose, to monitor for cardiovascular changes.</td>
</tr>
<tr>
<td>Mavenclad® (cladribine)</td>
<td>The most common adverse reactions include upper respiratory tract infections, headache, and decreased lymphocyte counts</td>
<td>Two annual courses are given orally for a maximum of 20 days over two years. No treatment is needed for Years 3 and 4</td>
<td>Approved to treat adults with relapsing-remitting MS and active secondary-progressive MS. Potential adverse events include lymphopenia, a condition that causes abnormally low counts of white blood cells, and herpes zoster infection. Mavenclad has an increased risk of malignancy (cancer) and fetal harm. Mavenclad is not to be used in patients with an increased risk of cancer or who are pregnant; men and women of reproductive potential must use effective contraception.</td>
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*Progressive multifocal leukoencephalopathy (PML), a potentially fatal, viral infection of the brain, can develop in some individuals taking Tysabri. Risk factors include the presence of anti-JCV antibodies, taking Tysabri for two years or more, and prior immunosuppressant treatment. Currently, PML has occurred in a few patients taking Gilenya, Tecfidera, or OcREVOS; some of these cases are still under investigation.

In late 2019, the FDA approved three generic versions of Gilenya® (noted above) for the treatment of relapsing forms of multiple sclerosis (MS); however, these are not yet commercially available.

**Mayzent® (siponimod) it's primary actions are at the S1P1 and the S1P5 receptors, blocking the movement of lymph cells from lymph nodes; it has a relatively short half-life compared to similar medications, meaning that it does not stay in the body as long.**

**Tecfidera® (dimethyl fumarate) Immunomodulator with anti-inflammatory properties; may have neuroprotective effects, potentially protecting the nerves and myelin covering.**

**Vumery® (diroximel fumarate) Immunomodulator with anti-inflammatory properties; may have neuroprotective effects, potentially protecting the nerves and myelin covering.**

**Mavenclad® (cladribine) Selectively targets and depletes the immune system’s B cells and T cells, followed by a ‘reconstitution’, as new B cells and T cells are produced.**

**Aubagio® (teriflunomide) Immunomodulator (affecting the production of T and B cells; may also inhibit nerve degeneration)**

**Mayzent® (siponimod)**
- Headache, high blood pressure, and changes in liver function tests were the most common adverse reactions.
- After starting at a low dose, the recommended maintenance dosage is 2 mg taken orally once daily starting on Day 6.

**Tecfidera® (dimethyl fumarate)**
- Flushing and gastrointestinal events; reduced white-blood cell (lymphocyte) counts; elevated liver enzymes in small percentage of patients.
- 240-milligram tablet taken twice daily.

**Vumery® (diroximel fumarate)**
- Flushing and stomach problems are common, especially at the start of therapy, and may decrease over time; redness, itching, rash, or diarrhea may also occur.
- 231-milligram capsule taken twice daily.

**Vumery® is in the same class of MS therapy as Tecfidera® (noted above), but is believed to cause fewer gastrointestinal (GI) side effects. Warnings, side effects, and adverse events are similar to those listed for Tecfidera. The exact mechanism of action by which Vumery exerts therapeutic effect in MS is not completely understood. However, upon entering the body, the medication is rapidly converted into the molecule monomethyl fumarate, which is the same active component found in Tecfidera.**

**Tecfidera® (dimethyl fumarate)**
- Approved to treat individuals with clinically isolated syndrome, relapsing-remitting MS, and active secondary-progressive MS.
- Serious adverse events include a decrease in white blood cells, heart rate, and rhythm abnormalities, as well as hypertension, swelling of the macula of the eye; varicella zoster reactivation, and convulsions.
- Patients need to be monitored for changes in vision caused by macular edema, transient decreases in heart rate, decline in lung function, and changes in liver enzymes.
- Women who could become pregnant should use contraception to avoid potential risk of fetal harm.