

Stem cell therapies in MS



Produced in partnership between





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Stem cell therapies in MS

There is a great deal of scientific and media interest in stem cells as a possible treatment for multiple sclerosis (MS). Some scientific reports do reveal encouraging clinical findings, but a lot of work still needs to be done to prove their effectiveness and safety for people with MS.

Stem cells in MS are still experimental. There is no proven stem cell therapy available for MS anywhere in the world.

About this booklet

This booklet has been written for and with people affected by MS. In it, we aim to explain the key issues around stem cells and MS.

We look at what benefits someone might expect from a stem cell therapy and the different types of stem cells which are being researched for MS. We highlight why it is important to have properly controlled trials in this area also emphasising that we strongly discourage people with MS from approaching 'stem cell clinics' that are offering 'stem cell therapies' outside of an official clinical trial.

The role of MS charities in stem cell research

In May 2009, the MS societies of the UK and US held an international meeting in London to reach a consensus on stem cell therapies in MS.

The event was supported by the national MS societies of Italy, France, Canada and Australia, and the MS International Federation (MSIF).

Twenty-seven experts in stem cells and MS, as well as 17 charity representatives, attended. This included many people affected by MS.

As a result of this meeting we now have:

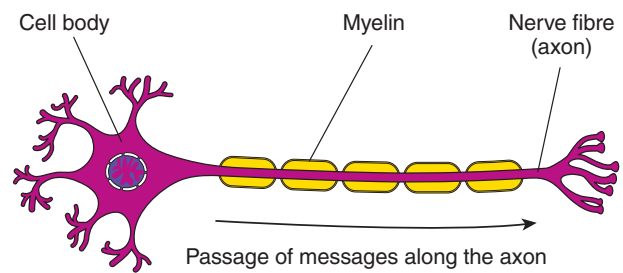
- An agreed statement ('consensus statement') and guidelines for researchers and clinicians. These should encourage consistency between studies and speed up the development of potential therapies.
- This information booklet, for people affected by MS.

What is MS?

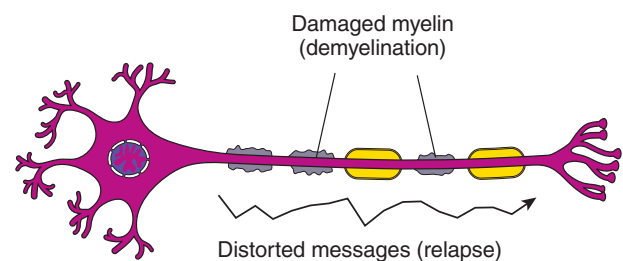
Multiple sclerosis (MS) is widely believed to be an autoimmune condition – the body's immune system mistakenly attacks, and subsequently damages, the 'myelin sheath' protecting nerve cells in the brain and spinal cord. This damage causes messages to and from the brain to be slowed, distorted or stopped altogether. This is what leads to the symptoms of MS.

Damage to the myelin sheath is believed to cause 'relapses', or MS attacks. In these attacks, symptoms flare up and last for anything from 24 hours to several months. Over time, if nerve fibres themselves become damaged, or destroyed completely, this can lead to 'progression' of the MS and an increase in disability.

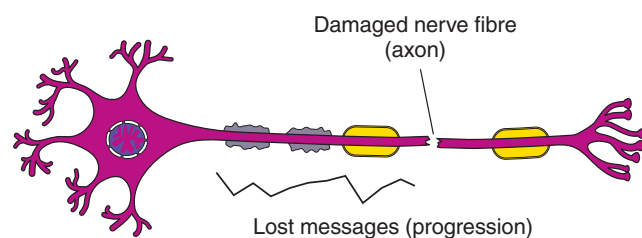
Normal neuron



Demyelination in MS



Damage of nerve fibre in MS



There are three main types of MS

Relapsing remitting MS (RRMS):

- Periods of acute attacks with worsening of symptoms followed by complete or partial recovery (remission)
- Around 85 per cent of people with MS are diagnosed with RRMS.

Secondary progressive MS (SPMS):

- Following an initial period of relapsing remitting MS, many people develop secondary progressive MS. This is characterised by a gradual accumulation of disability, either with or without relapses (relapsing SPMS or non-relapsing SPMS).

Primary progressive MS (PPMS):

- A gradual accumulation of disability from the beginning, with no distinct periods of relapse and remission.
- Around 10-15 per cent of people diagnosed have this form of MS.

Stem cell therapies in MS

What are stem cells?

Two things define stem cells:

- 1 They can 'self renew' – this means they can multiply and produce greater numbers of themselves
- 2 They can 'differentiate' – this means they can develop and change into at least two different types of specialist cell that carry out a specific function

There are a number of different types of stem cell that can be collected (or 'harvested'), from a variety of sources. They can all self renew. The difference between them is in what types of specialist cells they can become – how much they can 'differentiate'.

Five different types of stem cell are described below

Stem cell	Source	Description
Adult Stem Cells	Parts of the adult human	Found in parts of the body such as bone marrow and the brain. Can produce a limited number of different types of specialised cell. This depends on the part of the body from which they were harvested (for example, adult stem cells taken from the brain will produce brain cells).
Embryonic Stem Cells	Donated embryos	Can produce most types of cell in the body.
Foetal Stem Cells	Donated aborted fetuses	Have developed further than embryonic stem cells and are a little more specialised – their options are slightly more limited. However, they can still produce most types of cell in the body.
Cord Blood Stem Cells	Donated umbilical cord blood	Are stem cells similar to that found in the bone marrow. Can produce a limited number of cells that can be found in the blood, for example immune system cells.
Induced Pluripotent Stem Cells (iPSCs)	Some parts of the human body	These stem cells are engineered from older, fully specialised cells – for example, skin cells, which are limited naturally to being only skin cells. Scientists encourage these limited cells to act like embryonic stem cells again, with the ability to become any type of human cell. This is a complex technique that has only recently been developed and is the subject of much ongoing research.

What is a stem cell therapy?

Stem cell therapy is any treatment that uses or targets stem cells. This is usually to help replace or repair damaged cells or tissues, but can also be used to prevent damage from happening in the first place. Stem cell therapy might either involve transplanting stem cells or giving drugs that target stem cells already in the body.

There are very few approved stem cell treatments available. The most commonly used stem cell therapy is a bone marrow stem cell transplant to treat leukaemia, lymphoma and several inherited blood disorders.

There are no proven stem cell therapies for MS.

How could stem cells help in MS?

Treatments

From what we know so far about stem cells and MS, there are two main ways that potential treatments for MS might be developed:

- 1 immunomodulation** – preventing immune damage to the nervous system
- 2 remyelination** – repairing the myelin sheath that has already been damaged

These are both considered ‘neuroprotective’ therapies because they aim to protect the nerve fibres inside the myelin sheath.

It is also hoped that eventually stem cells might assist in rebuilding lost nerve fibres. This could repair the damage caused in the progressive stages of MS that results in the accumulation of permanent disability. However, at the moment there is not enough scientific evidence to show stem cells working in this way. Scientists around the world agree that more research is much needed in this complicated and challenging area before embarking on clinical trials aimed at rebuilding nerve fibres.

Research in the laboratory

In addition to having the potential to be a treatment for MS themselves, stem cells can also be used to help identify and develop other new treatments for MS. Stem cells are useful because they can mimic aspects of MS in the laboratory so that potential drugs can be tested more quickly.

Stem cell therapies in MS

What types of stem cell might be used for MS?

There are several different types of stem cell that have shown potential benefit. They have all been extensively studied in animals. Some of these are already in the early stages of clinical trials (trials involving people). Until the trials are completed we can't be certain that they are effective or safe.

HSCs (haematopoietic stem cells)

These are adult stem cells, found in bone marrow and blood. They are capable of producing all of the cells that make the blood and the immune system.

They are already used to treat leukaemia, lymphoma and several inherited blood disorders. HSCs are being trialled in highly active forms of MS, where it is thought they may help prevent damage to myelin by altering how the immune system functions ('immunomodulation').

MSCs (mesenchymal stem cells)

These are adult stem cells, found in several places in the body including the bone marrow, skin and fat tissue. They produce cells which help other stem cells function properly.

MSCs are being trialled for MS. It is thought they may have a positive effect through 'immunomodulation' and might also promote the nervous system's own repair mechanisms to repair damaged myelin ('remyelination').

NSCs (neural stem cells)

These are the cells responsible for repairing myelin in the brain, but when someone has MS, their NSCs don't seem to function properly – they don't 'turn on' to repair the damage that has occurred.

There are two approaches that might be able to correct this. One is to give drugs that make the NSCs already present work more effectively. The other is to transplant new cells that will repair the damage that the resident brain stem cells cannot.

NSCs are likely to be trialled for MS soon. It is believed that NSCs can have an effect through immunomodulation and a direct effect on remyelination. NSCs occur naturally in the brain, but because of the difficulty in harvesting cells from the brain, foetal stem cells are used in clinical trials.

ESCs (embryonic stem cells) and iPSCs (induced pluripotent stem cells)

ESCs can naturally produce every type of cell in the body. iPSCs are engineered to do the same.

This is still a controversial and uncertain area of research as both ESCs and iPSCs have the potential to develop into tumours.

However, it is widely accepted that in the short to medium term, ESCs and iPSCs will be extremely useful in the laboratory – to identify and test potential drugs before they are tested in clinical trials. More safety testing in laboratories is required before they can begin to be tested as a possible therapy for MS in people.

What type of stem cell for which type of MS?

Without first conducting clinical trials it is difficult to predict which type of MS will benefit from a particular type of stem cell transplantation. At first, stem cells will be trialed in a small number of people with the type of MS that is most likely to respond positively – this is so it can be shown that, in principle, stem cells work. It is also likely that the first to receive stem cells will be people for whom existing therapies have not worked. Only after these early trials will stem cell treatments be tested for benefits in other types of MS.



How are stem cells injected?

When stem cells are tested as potential treatments for MS, there are three ways they can be injected:

- intravenous – injected into the vein
- intrathecal – injected into the space around the spinal cord
- intraparenchymal – injected directly into the brain

Where stem cells are injected is likely to influence how they work. The intravenous and intrathecal methods are so far the only ones used to test treatments for MS, but all might have a role to play as we learn more about stem cells.

Stem cell therapies in MS

Taking into account the available scientific evidence, the following tables summarise the likely potential of different stem cells for each type of MS and highlight what is currently being done.

Relapsing remitting MS

HSCs - haematopoietic stem cells

HSCs injected intravenously is an experimental treatment sometimes used for MS. The HSCs are taken from the person themselves – they are known as ‘autologous’ stem cells. This is still an unproven therapy and is a risky procedure (with a one to two per cent death rate). It is therefore only used for highly active forms of relapsing remitting MS that do not respond to available therapies.

Clinical trials (phase I, phase II and phase III) are underway. These are aimed at assessing how effective HSC are as a therapy for MS and at identifying ways to reduce the death rate and other associated side effects.

The main aim is immunomodulation – to prevent immune damage to the nervous system.

MSCs - mesenchymal stem cells

Autologous MSCs injected intravenously and intrathecally are being investigated in clinical trials (phase I). However, these trials are likely to focus on people with early secondary progressive MS. People with relapsing remitting MS may benefit from these and this might be trialled at a later date.

The main aim is immunomodulation, but it is possible that MSCs could indirectly help with remyelination – repairing damaged myelin.

NSCs - Neural stem cells

NSCs injected intrathecally will be investigated in a clinical trial (phase I) underway soon. This trial will use NSCs from the foetus – they are known as ‘allogenic’ stem cells. The trial is likely to focus on people with early secondary progressive MS, but people with relapsing remitting MS may benefit from these and this might be trialled at a later date.

The main aim of intrathecal NSCs is remyelination. In future, there may be trials with NSCs given intravenously, where immunomodulation would be the main aim.

Secondary progressive MS

HSCs - haematopoietic stem cells

HSCs injected intravenously is an experimental treatment sometimes used for MS. The HSCs are taken from the person themselves – they are known as ‘autologous’ stem cells. This is still an unproven therapy and is a risky procedure (with a one to two per cent death rate). It is therefore only used for highly active forms of secondary progressive MS that do not respond to available therapies.

Clinical trials (phase I, phase II and phase III) are underway. These are aimed at assessing how effective HSC are as a therapy for MS and at identifying ways to reduce the death rate and other associated side effects.

The main aim is immunomodulation – to prevent immune damage to the nervous system.

MSCs - mesenchymal stem cells

Autologous MSCs injected intravenously and intrathecally are being investigated in clinical trials (phase I). These trials are likely to focus on people with early secondary progressive MS.

The main aim is immunomodulation, but it is possible that MSCs could indirectly help with remyelination – repairing damaged myelin.

NSCs - neural stem cells

NSCs injected intrathecally will be investigated in a clinical trial (phase I) underway soon. This trial will use NSCs from the foetus – they are known as ‘allogenic’ stem cells. The trial is likely to focus on people with early secondary progressive MS.

The main aim of intrathecal NSCs is remyelination. In future, there may be trials with NSCs given intravenously, where immunomodulation would be the main aim.

ESCs - Embryonic stem cells and iPSCs - induced pluripotent stem cells

In the long term, these stem cells may be able to help rebuild nerve fibres that are lost with progressive MS. However, currently there are no clinical trials underway using ESCs or iPSCs for MS. More research is needed to help assess the potential benefits and safety of these cells.

Primary progressive MS

HSCs - haematopoietic stem cells

There are no clinical trials underway using HSCs for primary progressive MS as there is no scientific evidence to suggest that people with primary progressive MS will benefit from this treatment.

MSCs - mesenchymal stem cells

It is not yet known whether people with primary progressive MS could benefit from MSCs – more research is needed before clinical trials can begin.

NSCs - neural stem cells

NSCs injected intrathecally will be investigated in a clinical trial (phase I) underway soon. This trial will use NSCs from the foetus – they are known as ‘allogenic’ stem cells. Although this trial is likely to focus on people with early secondary progressive MS, it might lead to future trials for primary progressive MS.

The main aim of intrathecal NSCs is remyelination. In future, there may be trials with NSCs given intravenously, where immunomodulation would be the main aim.

ESCs - Embryonic stem cells (ESCs) and iPSCs - induced pluripotent stem cells

In the long term, these stem cells may be able to help rebuild nerve fibres that are lost with progressive MS. However, currently there are no clinical trials underway using ESCs or iPSCs for MS. More research is needed to help assess the potential benefits and safety of these cells.

Frequently asked questions

Should we be researching stem cells?

Yes. Scientists around the world believe there is enough evidence to suggest that stem cells hold real potential as a therapy for MS. This evidence comes from research in animals and from a handful of early clinical trials. They believe that it is now time for a concerted effort in stem cell research and an international effort to support clinical trials of stem cells for MS.

Are stem cells an approved clinical treatment for MS?

No. There are currently no approved stem cell therapies for MS. All stem cell therapies for MS are currently 'unproven', 'experimental' therapies. This means that doctors do not know whether stem cells are effective for people with MS, and more importantly, whether they are safe. The only way a legitimate experimental stem cell therapy can be given is through a properly conducted clinical trial.

How effective might stem cells be?

We need to be realistic about our expectations for stem cells, and understand what a particular stem cell therapy might be able to achieve. For example, does it have the potential for immunomodulation, or remyelination, or both?

Before stem cells could be become a viable option for people with MS, tests will also need to show that their safety and effectiveness is better than other therapies already available.

If I received a stem cell transplant, how long would it take to work?

After stem cells have been transplanted into someone's body they have to make their way to the correct place (e.g. area of damage) and then have their desired effect. This process takes time and although it is difficult to predict exactly how long, it is likely that it will take several weeks or months. Any immediate positive effect following transplantation will not be due to the stem cells.

Could a stem cell therapy be repeated?

This is a possibility. For some stem cells it may be beneficial to repeat the transplantation. At the moment, there is no long-term evidence from clinical trials, so it's difficult to say whether repeating would be necessary or safe. Future clinical trials will study this in detail.

Could a stem cell therapy be used at the same time as other therapies?

We don't know yet. This will not be studied in early clinical trials, as this would make it very difficult to measure the true effects of the stem cell therapy. However, a combination therapy may be effective for MS and is likely to be studied in the future.

Stem cell therapies in MS

What about clinics offering stem cell treatments?

Stem cell treatments are already being presented by some people as a cure for MS. This is not the case. As mentioned previously, there is currently no proven stem cell therapy available for MS.

All legitimate stem cell therapies for MS are being tested in official clinical trials. They are unproven, experimental therapies, still being tested to see if they are safe and if they are effective.

We would strongly discourage people with MS from approaching ‘stem cell clinics’ that are offering ‘stem cell therapies’ outside of an official clinical trial.

The marketing of these ‘therapies’ by clinics can be sophisticated and persuasive, but in reality:

- they cost a significant amount of money
- there is no evidence to show that they are effective
- they hold considerable risks to safety

For more information, contact your national MS Society or see the International Society for Stem Cell Research (ISSCR) guidelines www.isscr.org/clinical_trans/pdfs/ISSCRPatientHandbook.pdf

For more information on the importance of evidence-based claims see www.senseaboutscience.org.uk/index.php/site/project/267/

How are stem cell therapies given?

Initially the stem cells will be collected (or harvested) either from the person with MS themselves or from a donor source (foetal stem cells, for example). They will then usually be prepared for transplantation in a laboratory, according to strict regulations following the Good Manufacturing Process – (GMP)

Once the stem cells are ready, they can be transplanted into the body. There are several different ways stem cells can be transplanted, each quite likely to end up with a different result:

- intravenous – injected into the vein
- intrathecal – injected into the space around the spinal cord
- intraparenchymal – injected directly into the brain

If stem cells come from a donor (‘allogenic’ stem cells) the recipient’s own body may reject the stem cells. To reduce the risk of this occurring, powerful drugs are often used to dampen down the immune system for a while after the transplantation.

Do stem cells always need to be injected to make a difference?

This information booklet mainly relates to the issues surrounding the transplantation of stem cells – where stem cells have been collected and are then injected into the body. However, it may be possible, to activate stem cells that are already present in the body through the use of drugs. This might help to promote neuroprotection. There are no clinical trials currently testing this, but it is likely that this will happen in the future.

When will stem cells be available as an approved clinical treatment for MS?

It is extremely difficult to predict, but it is unlikely to be in the next few years. However, stem cells are now being trialled for MS in several countries. The findings from these trials will help inform future clinical trials and offer some guidance as to how beneficial stem cells may be for people with MS.

How is a new medical treatment developed?

This usually begins with many years of laboratory science (pre-clinical studies) to show the potential of a particular therapy in laboratory models (including animals). Safety is also assessed at this stage.

Once a potential therapy looks promising in laboratory models of MS it has to be tested in several phases of clinical trials (phases I, II and III). Each of these phases provide further evidence for its effectiveness and safety. This is a rigorous and necessary process to ensure all new medicines are effective and that all safety issues have been identified.

If a therapy completes all phases of clinical trial (phases I, II and III) and is shown to be effective and reasonably safe then it must be approved by a national or regional regulatory agency – for example, the US Food and Drug Administration (FDA) or the European Medicines Agency (EMA).”

Only after all this testing and checking can a therapy be deemed safe and effective and made widely available.

Why does it take so long to develop a new medical treatment?

Laboratory science can take many years before it identifies a potential therapy. Then, once a potential therapy is identified, each phase of clinical trial can take up to five years to complete. Although this process takes a considerable amount of time, it is essential to properly show that therapies are safe and effective. There are also significant financial costs involved in all these stages of development, which can only be met through investment from a number of funding sources such as government, medical research charities and industry.

Development Timeline

Phase I

Purpose: To find a safe dosage.

To decide how the drug/treatment should be given.
To observe how the drug/treatment affects the human body and measure side effects.

Length of time: Typically about a year

Status: Unproven

Phase II

Purpose: To determine if the drug/treatment or intervention has a positive effect on MS.

To see how the drug/treatment or intervention affects the human body and measure side effects.

Length of time: Typically one to three years.

Status: Unproven

Phase III

Purpose: To compare the new drug/treatment or intervention with a current standard if available.

Length of time: Typically two to three years.

Status: Unproven

Stem cell therapies in MS

How do I know if a clinical trial is official?

For a clinical trial to be official it must be approved and registered by the national regulatory agency of the country where the trial is being held. In the majority of cases registered trials will feature on a database which can be found at clinicaltrials.gov

Here are some warning signs which might suggest a clinical trial is NOT official. This is just a guide – you might notice other tell-tale signs of an unofficial trial:

- *Treatment is available for multiple conditions or diseases*
A clinical trial for MS usually focuses on testing a treatment for MS only. On rare occasions a treatment can be tested for MS and a couple of other related conditions in the same trial (for example, other autoimmune conditions such as Crohn's disease), but MS is unlikely to be tested alongside unrelated conditions, such as heart disease.
- *Lack of details about the treatment itself*
If a clinical trial is official, anyone taking part will be given an 'participant information sheet' which will include specific details about where the stem cells come from, how they are prepared in the laboratory and what participants can expect to happen. This form will explain these details clearly and participants will be invited to raise any queries or concerns before signing an informed consent form.'
- *Claims that there are no risks*
Clinical trials test potential therapies for safety as well as effectiveness. There will always be potential risks involved in a stem cell trial for MS and these should be clearly explained to those taking part in the participant

information sheet and from the doctor leading the trial.

- *Cost for the treatment*
Clinical trials do not usually involve costs for the people taking part, other than possibly travel and personal expenses. The participant should also be made aware of the arrangements, and whether there is any cost, for emergency medical care if anything goes wrong with the treatment.
- *No or few restrictions on the eligibility to receive the treatment*
A clinical trial will usually have a list of strict criteria, stating exactly who can be accepted onto the trial. These criteria will include aspects such as age, history of previous treatments, history of previous conditions or diseases, current conditions or diseases, type of MS and level of disability (EDSS score).

Should I take part in a clinical trial?

This is a decision that each person has to make for themselves. Without people taking part in clinical trials, new therapies will not be developed, but every clinical trial comes with risks. A decision should only be made after considering all of the safety and ethical issues. Most of these will be explained in the 'participant information sheet' provided by the people running the trial. It is also sensible to discuss things with relevant health care professionals. People also find it helpful to speak to family and friends before making a decision like this, which could affect those close to them. Taking part in a clinical trial is not suited to everyone and nobody should ever feel pressured into taking part in a clinical trial.

What are the risks involved in taking part in a stem cell clinical trial?

Any clinical trial carries a certain amount of risk for the participant. The trial will be designed to reduce the risks as far as possible, but risks cannot be eliminated completely.

It is difficult to list potential risks for each type of stem cell. Risks will vary according to the specific clinical trial, depending on: the stem cell used; the number of stem cells transplanted; the type of MS the participant has; and the way the stem cells are transplanted.

The risks involved will be explained in the 'participant information sheet' from the trial organisers. They will also be explained to the participant by the health care professional leading the trial.

If I agree to take part in a clinical trial can I then withdraw from it if I have doubts?

Yes. It is possible to withdraw from a clinical trial if you do not feel comfortable with continuing. Signing the 'informed consent form' given by the trial organisers, or even beginning the clinical trial does not mean you are committed to completing the trial – withdrawal can take place at any stage in the process. If you do withdraw, it is important to speak first to the health care professional involved in the trial – there may be safety precautions to take.

How can I find out about and get involved in a clinical trial?

Your neurologist, GP or other health care professional should be able to advise you on clinical trials in your area, which trials may be suitable and how to get involved. There

are also a number of other resources which can help you find a suitable clinical trial, including:

clinicaltrials.gov

For most registered clinical trials taking place around the world

www.mssociety.org.uk/research/get_involved_in_research/clinical_trials

For UK-based phase II and phase III trials seeking participants

www.nationalmssociety.org/research/clinical-trials

For a current list of ongoing, planned and recently completed clinical trials

Stem cell therapies in MS

Other useful resources

International Society for Stem Cell Research patient handbook on stem cell therapies

www.isscr.org/clinical_trans/pdfs/ISSCRPatientHandbook.pdf

Information regarding the importance of evidence-based claims for treatments

www.senseaboutscience.org.uk/index.php/site/project/267/

MS Society (UK)

www.mssociety.org.uk

National MS Society (US)

www.nationalMSSociety.org

Associazione Italiana Sclerosi Multipla (Italy)

www.aism.it

Association Recherche Sclerosi En Plaque (France)

www.arsep.org

MS Research Australia

www.msaustralia.org.au/msra

MS Society (Canada)

www.mssociety.ca

MS International Federation (International)

www.msif.org/en

We would like to thank the following contributor:



Participants to the stems consensus group

Gabby Ansems	MS Society, UK
Roberta Amadeo	FISM, Italy
Jack Antel	McGills University, Montreal, Canada
Annick Baron Van Evercooren	INSERM, Paris, France
Mario Alberto Battaglia	FISM, Italy
Matt Brookes	Research Network, MS Society, UK
Doug Brown	MS Society, UK
Paul Bull	Research Network, MS Society, UK
Tamir Ben Hur	Hadassah Hospital, Jerusalem, Israel
Dhia Chandraratna	MSIF
Siddharthan Chandran	University of Cambridge, Cambridge, UK
Michel Clanet	Purpan Hospital, Department of Neurology, Toulouse, France
Tim Coetzee	Fast Forward, USA
Giancarlo Comi	San Raffaele University Hospital, Milan, Italy
Alastair Compston	University of Cambridge, Cambridge, UK
Ian Duncan	University of Wisconsin, Madison, USA
Lee Duster	MS Society, UK
Charles ffrench-Constant	University of Edinburgh, Edinburgh, UK
Robin Franklin	University of Cambridge, Cambridge, UK
Francesco Frassoni	University of Genoa, Genoa, Italy
Mark Freedman	Ottawa University, Ottawa, Canada
Robin Gill	University of Kent, UK
Dimitrios Karussis	Hadassah Hospital, Jerusalem, Israel
Sarv Kaur	Research Network, MS Society, UK
Doug Kerr	Johns Hopkins, Baltimore, USA
Jeffrey Kocsis	Yale University, USA
Susan Kohlhaas	MS Society, UK
Catherine Lubetzki	Salpêtrière Hospital, Department of Neurology, Paris, France
Luigi Mancardi	University of Genoa, Genoa, Italy
Roland Martin	Hamburg University, Hamburg, Germany
Gianvito Martino	San Raffaele University Hospital, Milan, Italy
Patricia O'Looney	National MS Society, USA
Emmanuelle Plassart-Scheiss	ARSEP, France
Stefano Pluchino	San Raffaele University Hospital, Milan, Italy
Christine Remediakis	MS Research Australia
John Richert	National MS Society, USA
Riccardo Saccardi	University of Florence, Florence, Italy
Sven Schippling	Hamburg University, Hamburg, Germany
Neil Scolding	University of Bristol, Bristol, UK
Jayne Spink	MS Society, UK
Alan Thompson	Institute of Neurology, Queen Square, London, UK
Antonio Uccelli	University of Genoa, Genoa, Italy
Lesley Weiner	University of Southern California, Los Angeles, USA
David Welch	Invitrogen, UK
Boris Zalc	INSERM, Paris, France

MS Society

MS National Centre
372 Edgware Road
London NW2 6ND
020 8438 0700

MS Society Scotland

Ratho Park
88 Glasgow Road
Ratho Station
Newbridge EH28 8PP
0131 335 4050

MS Society Cymru

Cwrt y Deml/Temple Court
Heol y Gadeirlan/Cathedral Road
Caerdydd/Cardiff CF11 9HA
029 2078 6676

MS Society Northern Ireland

The Resource Centre
34 Annadale Avenue
Belfast BT7 3JJ
028 9080 2802

www.mssociety.org.uk
Helpline 0808 800 8000

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