mnda motor neurone disease association

Research

Stem cells and MND

Information Sheet F

Stem cell research has fuelled hope of a treatment for a variety of conditions. This information sheet explains what these cells are and includes details of the current development of them as treatments.

It also covers how they may be used to create new models of disease, to screen for potentially beneficial treatments and be used towards the goal of an effective treatment for motor neurone disease (MND).

The content is split into the following sections:

Disclaimer: *Please note that information provided in this information sheet is based on a review of the currently available literature. This information sheet was written by MND Association staff who are not clinicians, so any information provided in this sheet should not be considered clinical advice. You should always discuss potential treatments with your clinician.*

This symbol is used to highlight **our other publications**. To find out how to access these, see *Further information* at the end of this sheet.

1: What are stem cells?

Stem cells are cells that have not yet become specialised to perform a particular function. They can renew themselves and have the ability to give rise to various different cell types, for example blood, muscle or nerve cells.

Stem cells have generated much excitement and media attention because of the possibility that they could eventually be used as a therapy to repair or replace cells damaged by disease.

Scientists are also interested in using stem cells to generate motor neurones in the laboratory so that they can be used to learn more about MND.

2: Types of stem cells

The main types of stem cells are induced pluripotent stem cells (iPSCs), embryonic, adult and umbilical cord stem cells. Their uses in medicine include research to understand underlying causes of disease, such as MND, and the development of new therapies.

Induced pluripotent stem cell (iPSC)

Researchers can 'turn back the clock' on adult human skin and blood cells to reprogramme them into stem cells that have the same wide potential as other types of stem cells. These cells are known as induced pluripotent stem cells (iPSCs) and avoid the controversial use of embryos. Of all the types of stem cells, iPSCs are used most frequently in MND research funded by the MND Association.

Researchers funded by the Association have already used human skin cells to create iPSCs, which have then successfully been turned into motor neurones and their support cells. These skin cells are collected from people living with MND by means of a skin biopsy. Researchers then introduce a cocktail of chemicals to reprogramme the skin cells into stem cells.

When skin cells from people with an inherited form of MND are reprogrammed into nerve cells, these cells contain the genetic changes that cause MND and therefore display characteristics of the disease. These cells provide researchers with a model of MND, enabling them to study living human motor neurones in the lab.

As well as learning more about what kills motor neurones, researchers can use

these cells to screen potential drugs, before they go on to human clinical trials. By using human motor neurones in drug screening this could potentially increase the chance of successful clinical trials in humans.

Embryonic

Embryonic stem cells have the potential to develop into any type of cell in the body. They are found during the earliest stages of development, around 4-5 days after an egg has been fertilised.

Human embryonic stem cells present a number of ethical and religious concerns as well as technical challenges:

- Gathering embryonic stem cells results in the destruction of the embryo from which they came. Unwanted embryos from IVF procedures are sometimes used in research but the most controversy surrounds the use of embryos that have been created specifically for research.
- The wide potential of embryonic stem cells means that scientists must learn how to control their development to produce the right type of cell needed for research or treatments.
- Embryonic stem cells have the potential to generate tumours.

Adult and umbilical cord

After the very earliest stages of development, more specialised 'adult' stem cells develop that go on to form all the cells in a particular body system or tissue. For example, there are muscle stem cells (mesenchymal), blood stem cells (haematopoetic) and nerve (neural) stem cells.

Adult stem cells are often relatively easy to obtain and in some cases raise fewer ethical issues than embryonic stem cells. For example, blood stem cells found in umbilical cords and adult bone marrow are already used to treat diseases of the blood and immune systems, such as leukaemia.

The adult human nervous system contains some specialised stem cells, known as neural stem cells, which have the potential to develop into neurones and support cells known as glia. However, they are limited in the number that can be created and activities they can perform (such as self-renewal). They require manipulation by using nourishing factors (trophic factors) in order to get them to turn into a specific cell type such as neurones or glia cells.
The MND Association believes the use of stem cells in research is essential to understanding, preventing and ultimately finding a cure for

MND. Where stem cells are used, the majority of research we fund uses iPSCs.

3: Stem cells as a treatment

At present, there is no reliable evidence to suggest that stem cells can be used as an effective treatment for MND.

The gold standard for testing both the effectiveness and safety of a treatment is a series of carefully controlled clinical trials, which build on the conclusions reached in the laboratory. No stem cell treatment has yet completed such rigorous testing for MND.

There are two main approaches to the use of stem cells as a treatment for MND and other neurodegenerative diseases:

1) Using stem cells to 'replace and rebuild' lost neurones (e.g., growing a motor neurone from the spine to the foot). This approach faces substantial difficulties in that correct guidance and growth of the stem cell from the point of implant to the destination would need to be closely examined.
2) Using stem cells to produce 'healthy survival' (neurotrophic) factors that have the potential to promote survival of neurones and the cells around them. So far, this has only enabled short-term effects.

What about stem cell treatments advertised by clinics?

It is important to note that stem cell treatments offered by clinics at considerable cost have not undergone proper clinical trials to prove their efficacy and may carry the risk of serious side effects.

Claims by clinics that stem cells are a successful treatment are rarely backed up with sufficient clinical evidence. Comparisons of outcome measures such as ALSFRS-R scores before and after receiving treatment are not shared, making it hard to validate their claims of the treatment being effective.

For clinics that use stem cells to treat many illnesses, it is hard to know if their claims are specific or applicable to MND. Where stem cells are approved for use in other conditions it does not mean the same can be assumed for MND.

If you are considering pursuing stem cell treatment, please discuss it with your neurologist first.

For more information about unproven stem cell treatments, see Information Sheet C - *Unproven treatments*.

Stem cells as a potential future treatment

Researchers still do not fully understand how stem cells might exert their beneficial effects in diseases such as MND. Some of the possible ways in which stem cells might be used to treat MND are as follows:

- Replacement of damaged neurones
- Replacement of support cells (glia)
- Delivering treatments and nerve-nourishing substances
- Protection and nourishment
- Dampening down inflammation

Challenges to overcome

Stem cells that have been administered to repair damaged motor neurones in animal models have given promising results. These have suggested that stem cell transplants are more likely to be effective in protecting existing motor neurones than in actually replacing or repairing them. However, these studies generated many unanswered questions.

Safety

- What are the risks? (some stem cells have the potential to form tumours)

Feasibility / Practicalities

- What is the best source of stem cells for transplantation? (It might be that a combination of stem cells from different sources works best.)
- What is the best route for delivering stem cells to treat MND? (e.g., into the spinal cord or muscles)
- How many stem cells do you need to give to have an effect?
- How many doses of stem cells need to be given to maintain any beneficial effect?
- Do additional factors (such as nerve nourishing factors) need to be given in conjunction with stem cells?
- Can stem cells be transplanted at any stage of MND, or do they need to be given at a specific stage of the disease to see a beneficial effect?

Effectiveness: Short- and long-term

- If stem cells are transplanted what is to stop them from developing MND?
- Once transplanted, do stem cells function normally and if so for how long?

- How can we stop the patient's immune system from rejecting the transplanted stem cells? (Like patients sometimes reject other donor tissue such as after having a kidney transplant.)

4: Stem cells and clinical trials

There are currently several clinical trials, taking place around the world, that are assessing the safety and effectiveness of different stem cell therapies. You can find out more about these at **clinicaltrials.gov**.

For more information about clinical trials, see information sheet D - *Clinical trials*

5: Stem cells for MND research

Stem cells have a real potential to help drive MND research forward through the creation of new disease 'in a dish' models and as drug screening tools.

In order to find an effective treatment for MND, it is essential for scientists to understand what goes wrong in diseased motor neurones. Stem cells provide researchers with a unique platform for studying MND on a cellular level as they can be encouraged to develop into living motor neurones in a laboratory dish.

Of particular value for this type of research would be human motor neurones with MND. These provide a more efficient and, in some aspects, superior alternative to existing animal and cellular models for studying the disease process and testing potential
drugs. Motor neurones and their support cells can now be created from induced pluripotent stem cells (iPSCs).

6: MND Association funded stem cell research

As of September 2019, the Association is funding 13 research projects using iPSC technology to create human motor neurones grown in a laboratory dish from skin samples of people living with MND. These projects aim to develop iPSC derived motor neurones into new and better models of MND that can be used to further our understanding and test potential drugs.

For more information about the projects we fund, including those that include iPSCs, see Information Sheet E - *Research we fund*.

For the latest news on stem cell research and related issues visit www.mndassociation.org/stemcells.

MND Association statement on stem cells

There is an urgent need for ongoing research if we are to stop motor neurone disease killing six people every day in the UK. We believe the use of stem cells in research is essential to understanding, treating and ultimately finding a cure for MND.

There are many different types of stem cell, including induced pluripotent stem cells ('iPSCs'), adult stem cells (including blood stem cells) and embryonic stem cells.

Where stem cells are used, the majority of research we fund uses iPSCs - these are derived from human skin biopsies or from cells within the blood. These iPSCs can then be turned into motor neurones and other brain cells, enabling laboratory research into what kills motor neurones as well as screening potentially beneficial drugs.

As with all research we fund, there must be a clear potential benefit to people living with MND and the research must be conducted following robust, legal, ethical and regulatory frameworks.

January 2024

7: How do I find out more?

Further information

You may find these information sheets from the MND Association

helpful: C – *Unproven treatments*
D – *Clinical trials*
E – *Research we fund*

We also provide the following guides:

Living with motor neurone disease – our main guide to help you manage the impact of the disease

Caring and MND: support for you – comprehensive information for unpaid or family carers, who support someone living with MND

Caring and MND: quick guide – the summary version of our information for carers

You can download most of our publications from our website at www.mndassociation.org/publications or order in print from the MND Connect helpline, who can provide further information and support.

MND Connect can also help locate external services and providers, and introduce you to our available services, including your local branch, group, Association visitor or regional care development adviser.

MND Connect
Telephone: 0808 802 6262
Email: mndconnect@mndassociation.org

Research Development Team
Telephone: 01604 611 880
Email: research@mndassociation.org

MND Association website and online forum
Website: www.mndassociation.org
Online forum: forum.mndassociation.org or through the website

We welcome your views

Your feedback is really important to us, as it helps improve our information for the benefit of people living with MND and those who care for them. If you would like to provide feedback on any of our information sheets, you can access an online form at: www.surveymonkey.co.uk/r/infosheets_research

You can request a paper version of the form or provide direct feedback by email: research@mndassociation.org.

Last revised: December 2024