

Using advanced MRI to explore metabolism and tissue structure in multiple sclerosis (MISSION MIMS)

Submission date 16/11/2023	Recruitment status Recruiting	<input type="checkbox"/> Prospectively registered <input checked="" type="checkbox"/> Protocol
Registration date 21/11/2023	Overall study status Ongoing	<input type="checkbox"/> Statistical analysis plan <input checked="" type="checkbox"/> Results
Last Edited 06/03/2026	Condition category Nervous System Diseases	<input type="checkbox"/> Individual participant data

Plain English summary of protocol

Background and study aims

Multiple sclerosis (MS) is a brain degenerative condition caused by immune system changes. Magnetic Resonance Imaging (MRI) with contrast injection is the current standard for detection. In our study, we aim to use two new MRI techniques, 'Sodium MRI' and 'Carbon MRI,' to assess biological changes in MS-affected brains. Evidence suggests a buildup of 'lactate' in MS areas visible with 'Carbon MRI,' while 'Sodium MRI' images salt level changes. Another aspect of the study involves imaging glucose activity in the brain using Hyperpolarized Carbon and Deuterium MRI techniques. This substudy aims to compare the advantages of each method in measuring fast and slow glucose metabolism in MS patients.

We plan to compare brain images of both MS patients and healthy volunteers to understand normal versus abnormal brain patterns. The goal is to better understand MS-related brain changes, predicting treatment outcomes based on tissue lactate and glucose levels and blood vessel structure.

Who can participate?

Patients aged 18 years or older, with Multiple sclerosis. Healthy volunteers aged 18 years or older.

What does the study involve?

The MRI procedure involves a cylindrical machine with a plastic case over your head. 'Sodium MRI' is like a standard MRI, 'Carbon MRI' includes an injection of a natural sugar compound and 'Deuterium MRI' includes an administration of a sweet drink. You might be offered an optional scan within 14 days to test the technique's repeatability. Other procedures may include basic health checks, blood tests, and pregnancy tests, conducted with your well-being in mind. Fasting for up to six hours before a scan may be required.

What are the possible benefits and risks of participating?

Taking part in this study may not directly help you, but it could help doctors find better ways to

check for and keep track of brain tumours without using invasive methods. You will not be paid for taking part, we can cover your travel and parking costs.

MRI Scans: MRI scans are safe and do not involve X-rays or radioactivity. Some people might feel a bit closed-in (claustrophobic) or bothered by the noise, but you will be given earplugs and a squeeze-ball to help you feel more comfortable. The imaging software and hardware used are for research and not yet approved for routine diagnosis.

Incidental Findings: Although the scans are not part of your medical record, if we notice anything unusual, we will consult a specialist who may need to discuss it with you and your doctor.

Cannulation (inserting a small tube into a vein): This is a common procedure and is generally safe, but it might cause some discomfort or bruising at the insertion site. The cannula will be removed immediately after the scan.

Injection containing a substance called pyruvate: The injection is generally safe, with only mild and short-lasting side effects like flushing, feeling hot, dizziness or a metallic taste. Allergic reactions are highly unlikely, but we are prepared to manage any issues that may arise.

Sweet drink containing a substance called deuterated glucose: Glucose is a natural sugar that our body uses for energy, and deuterium is a safe form of hydrogen that is also found naturally in small amounts in our body. Scientists have previously studied water and glucose containing deuterium in people, and they did not find safety concerns. Any potential side effects will be managed by our team.

Where is the study run from?

Cambridge University Hospitals NHS Foundation Trust (UK).

When is the study starting and how long is it expected to run for?

July 2015 to December 2026

Who is funding the study?

Multiple Sclerosis Society (UK)

Who is the main contact?

cuh.radiologyresearch@nhs.net

Contact information

Type(s)

Public, Scientific

Contact name

Dr Marta Wylot

Contact details

Department of Radiology, Level 5, Box 218

Addenbrooke's Hospital, Hills Road

Cambridge

United Kingdom

CB2 0QQ

+44(0)1223767926

marta.wylot@nhs.net

Type(s)

Principal investigator

Contact name

Prof Ferdia Gallagher

ORCID ID

<https://orcid.org/0000-0003-4784-5230>

Contact details

Department of Radiology, Level 5, Box 218
Addenbrooke's Hospital, Hills Road
Cambridge
United Kingdom
CB2 0QQ
+44 (0)1223 767062
ferdia.gallagher@nhs.net

Type(s)

Scientific

Contact name

Ms Maria Zamora

Contact details

Box 218, Department of Radiology, Level 5
University of Cambridge School of Clinical Medicine
Cambridge Biomedical Campus
Cambridge
United Kingdom
CB2 0QQ
-
maria.zamoramorales@nhs.net

Additional identifiers**Integrated Research Application System (IRAS)**

166097

Central Portfolio Management System (CPMS)

19436

Study information**Scientific Title**

Molecular Imaging and Spectroscopy with Stable Isotopes in Oncology and Neurology: Imaging metabolism and tissue structure in Multiple Sclerosis with MRI (MISSION: MIMS)

Acronym

MISSION: MIMS

Study objectives

The distribution of tissue sodium and the physiological metabolism of a glucose breakdown product, pyruvate can be assessed by hyperpolarised ¹³C-pyruvate MRI and sodium MRI.

Ethics approval required

Ethics approval required

Ethics approval(s)

approved 08/09/2015, NRES Committee East of England - Cambridge South (The Old Chapel, Royal Standard Place, Nottingham, NG1 6FS, United Kingdom; +44 (0)115 883 9428; nrescommittee.eastofengland-cambridgesouth@nhs.net), ref: 15/EE/0255

Study design

Observational physiological imaging study

Primary study design

Observational

Study type(s)

Diagnostic

Health condition(s) or problem(s) studied

Multiple sclerosis

Interventions

Current methodology as of 27/02/2026:

Up to 15 patients with MS will be successfully imaged following injection with ¹³C pyruvate.

Up to 40 healthy volunteers will be successfully imaged following injection with ¹³C pyruvate.

Up to 40 healthy volunteers will be recruited as part of the deuterium metabolic imaging (DMI) sub-study.

Up to 35 patients with MS will be recruited as part of the deuterium metabolic imaging (DMI) sub-study.

An optional second imaging study up to 14 days (HV) or 7 days (MS patients) later will be offered. Some of the participants will be asked to fast for 6 hours prior to the scan taking place.

Previous methodology:

Up to 15 patients with MS will be successfully imaged following injection with ¹³C pyruvate.

Up to 40 healthy volunteers will be successfully imaged following injection with ¹³C pyruvate.

An optional second imaging study up to 14 days later will be offered. Some of these volunteers will be asked to fast for 6 hours prior to the scan taking place.

Up to 30 healthy volunteers will be recruited as part of the deuterium metabolic imaging (DMI) sub-study.

Up to 15 patients with MS will be recruited as part of the deuterium metabolic imaging (DMI) sub-study.

Intervention Type

Other

Primary outcome(s)

Using MRI imaging:

1. ¹³C. Spatial maps of area under the curve (AUC) timecourse sums of signals from

hyperpolarized pyruvate, lactate, and any other metabolites detected, and ratios between these metabolite AUCs. Also estimates of the kinetic rate constants of conversion between injected tracer pyruvate and the metabolites formed (lactate, other). The timecourse typically covers approximately 1 minute beginning approximately 16 seconds after the start of injection.

2. DMI. Spectral peak intensity ratios between deuterated water, glucose, glutamate (brain only), lactate and lipids. These will be either in spatial maps derived from 3D spectroscopic imaging, or in unlocalized spectra from the whole sensitive volume of the coil.

Key secondary outcome(s)

Sensitivity and spatial resolution of carbon-13 imaging of pyruvate and lactate in the human brain as measured by computing the signal-to-noise ratio in images of the area-under-the-curve of the timecourse signals of pyruvate, lactate and bicarbonate.

Completion date

31/12/2026

Eligibility

Key inclusion criteria

MS patients (for C13 and DMI)

1. Be aged 18 years or older.
2. Have a confirmed diagnosis of MS.
3. Be aware of and understand their diagnosis.
4. Be able to provide written informed consent according to ICH/GCP, national and local regulations.
5. Be willing and able to comply with scheduled visits, laboratory tests, imaging and other study procedures.

Healthy volunteers (C13 and DMI)

1. Be aged 18 years or older
2. Be able to provide written informed consent according to ICH/GCP, national and local regulations
3. Be willing and able to comply with scheduled visits, laboratory tests, imaging and other study procedures

Participant type(s)

Healthy volunteer, Patient

Healthy volunteers allowed

Yes

Age group

Mixed

Lower age limit

18 years

Upper age limit

100 years

Sex

All

Total final enrolment

0

Key exclusion criteria

MS patients (for C13 and DMI)

1. Have uncontrolled diabetes or glucose deranging conditions, or treatment that would cause such effects.
2. Have any medical condition that may increase the risk associated with study participation or in the judgement of the investigators make it unsuitable for the patient to enter the study.
3. Have a known allergy, adverse reaction or contraindication to any of the injected contrast agents used in this study including gadolinium contrast agents or pyruvate.
4. Be otherwise unsuitable for MRI e.g. having a permanent pacemaker, severe obesity or inability to lie still.
5. Be pregnant or breastfeeding

Healthy volunteers (for C13 and DMI)

1. Have uncontrolled diabetes or glucose deranging conditions, or treatment that would cause such effects. The significance of this will be determined by the research team.
2. Have any medical condition that may increase the risk associated with study participation, or in the judgement of the investigators make it unsuitable for the patient to enter the study.
3. Have a known allergy, adverse reaction or contraindication to any of the injected contrast agents used in this study including gadolinium contrast agents or pyruvate.
4. Be otherwise unsuitable for MRI e.g. having a permanent pacemaker, severe obesity or inability to lie still.
5. Be pregnant or breastfeeding
6. Any previous or current neurological condition deemed to be significant by the research team.

Date of first enrolment

30/03/2016

Date of final enrolment

31/12/2026

Locations**Countries of recruitment**

United Kingdom

England

Study participating centre

Cambridge University Hospitals NHS Foundation Trust

Cambridge Biomedical Campus

Hills Road

Cambridge
England
CB2 0QQ

Sponsor information

Organisation

Cambridge University Hospitals NHS Foundation Trust

ROR

<https://ror.org/04v54gj93>

Funder(s)

Funder type

Not defined

Funder Name

Multiple Sclerosis Society

Alternative Name(s)

mssocietyuk, MS Society UK, Multiple Sclerosis Society UK, Multiple Sclerosis Society of Great Britain and Northern Ireland, The MS Society, MS Society

Funding Body Type

Private sector organisation

Funding Body Subtype

Associations and societies (private and public)

Location

United Kingdom

Results and Publications

Individual participant data (IPD) sharing plan

Data requests can be submitted starting 9 months after article publication and the data will be made accessible for up to 24 months. Extensions will be considered on a case-by-case basis. Access to trial IPD can be requested by qualified researchers engaging in independent scientific research and will be provided following review and approval of a research proposal and Statistical Analysis Plan (SAP) and execution of a Data Sharing Agreement (DSA). For more information or to submit a request, please contact cuh.radiologyresearch@nhs.net.

IPD sharing plan summary

Available on request

Study outputs

Output type	Details	Date created	Date added	Peer reviewed?	Patient-facing?
Results article		01/04/2019	19/11/2024	Yes	No
Results article		15/08/2022	19/11/2024	Yes	No
Other publications		15/04/2018	19/11/2024	Yes	No
Other publications		01/02/2018	19/11/2024	Yes	No
Other publications		01/06/2020	19/11/2024	Yes	No
Other publications		18/01/2016	19/11/2024	Yes	No
Other publications		04/09/2017	19/11/2024	Yes	No
Other publications		22/10/2021	19/11/2024	Yes	No
Participant information sheet	C13 Patient Information Sheet version 6.0	06/05/2022	21/11/2023	No	Yes
Participant information sheet	C13 Volunteer Information Sheet version 6.0	06/05/2022	21/11/2023	No	Yes
Participant information sheet	DMI Patient Information Sheet version 6.0	06/05/2022	21/11/2023	No	Yes
Participant information sheet	DMI Volunteer Information Sheet version 6.0	06/05/2022	21/11/2023	No	Yes
Participant information sheet	version 8.0	14/01/2026	27/02/2026	No	Yes
Participant information sheet	version 8.0	14/01/2026	27/02/2026	No	Yes
Protocol file	version 6.0	06/05/2022	21/11/2023	No	No