

The EPSMS Clinical Trial: Immuno-Neuro-PET and Theranostics for Multiple Sclerosis

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Disclosures

- The author has no financial, employment, relationship or other conflicts of interest to declare.
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- All citations to references, identified with first author's last name and the publication year, are active hyperlinks to the original sources.
- Please notify the author of any errors or omissions, which will be corrected in a revised version.

Nonprofit Brain Health Alliance Virtual Institute

- Founded in 2007, nonprofit Brain Health Alliance ([BHA](#)) promotes education and pursues research *to advance theranostics (therapeutics + diagnostics) with precision medicine and molecular imaging for disorders of the brain and behavior, and dysfunction of the immune and nervous systems.*
- Nonprofit BHA Virtual Institute ([BHAVI](#)) focuses activities on the search for cures to prevent, and interventions to alleviate, the suffering of patients and their families who struggle to cope with degenerative disorders and dementias.
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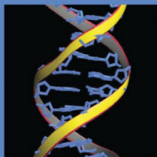
CME Learning Objectives

- Review the history and investigational “off label” use for multiple sclerosis (MS) of amyloid imaging agents that have been FDA-approved for evaluation of Alzheimer’s disease (AD).
- Review the use of psychometrics to monitor psychological health and the safety of imaging results disclosure to patients and family for neurodegenerative disorders and dementias — with attention to EPSMS where results may be available for more than just one disorder (ie, both MS and AD).
- Explain the concept and future potential of immuno-neuro-PET for patients with auto-immune disorders such as MS.
- Explain the concept of “complex systems of complex systems” and the potential of EPSMS theranostics to serve as a pathway to find the cure for MS.
- More info at EPSMS.brainhealthalliance.net with EPSMS the acronym for *Entire-body PET Scans for Multiple Sclerosis*.

Outline

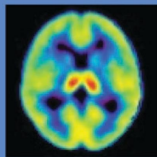
- Biomedical Informatics with Multimedia Data
- Multiple Sclerosis: An Auto-Immune Degenerative Disorder
- Imaging Demyelination and Remyelination in MS
- Advances in PET-CT and PET-MR Medical Imaging
- Psychometrics and Safety of Imaging Results Disclosure
- Entire-body PET Scans for MS (EPSMS) Clinical Trial
- Neural Dynamics for Immuno-Neuro-PET
- Immunol Dynamics for Immuno-Neuro-PET
- Theranostics for Complex Systems of Complex Systems

Gene - Brain - Behavior Relationships



Genes

MAO A, low/high



Brain MAO A

PET, [^{11}C]clorgyline



Behavior

Multi-Dimensional Personality Questionnaire (MPQ)

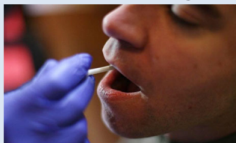


Alia-Klein 2007 J Nuc Med v48 n7 p15N Image of the Year

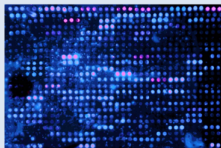
Biomedical Informatics Data Mining Grand Challenge

PharmacoGenomic Molecular Imaging

Genetic Testing



Cheek swab

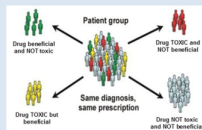


Gene chip image

Drug Dosing



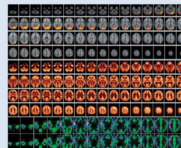
Gene-specific drug and dose selection individualized per patient to optimize care and avoid undesirable outcomes shown below for non-individualized treatment



Molecular Imaging



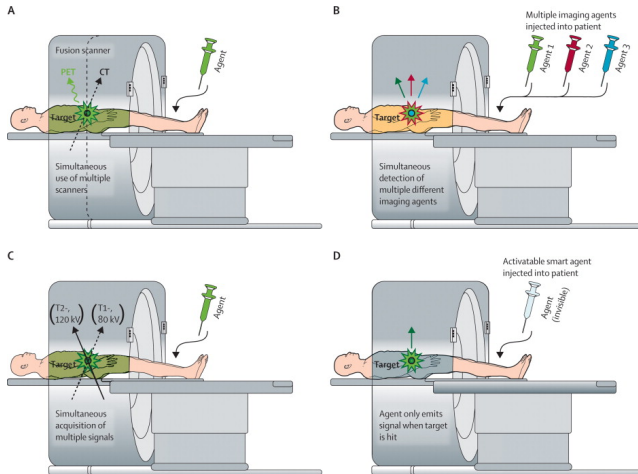
Mobile SPECT scanner



Tri-modal PET/MRI/EEG scans

Taswell 2010 WSRNM Conference

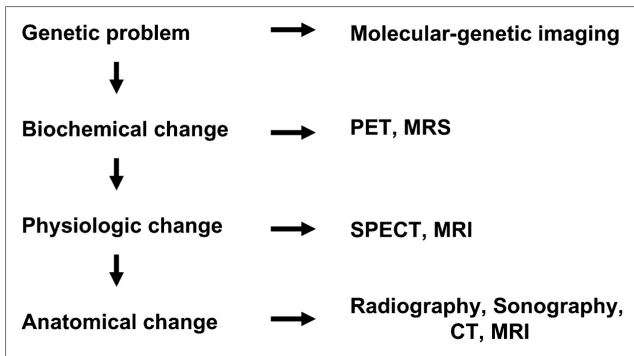
Multiplexed Medical Imaging: Multi-Modal vs Multi-Color vs Multi-Signal vs Multi-Activation



Reprinted from Kobayashi 2010

Molecular-Genetic Imaging Enables Earliest Detection

Molecular-Genetic Imaging Based on Reporter Gene Expression



Reprinted from [Kang 2008](#)

Multiple Sclerosis: An Auto-Immune Degenerative Disorder

- Multiple sclerosis (MS) was first described by French neurologist Jean-Martin Charcot in 1868 ([Kumar 2010](#), [Zalc 2018](#))
- An auto-immune mediated demyelinating disease which damages the insulating myelin sheaths of nerve cells in the brain and spinal cord
- Destruction of oligodendrocytes, the myelin-producing cells, results in disruption of communication between neurons
- Demyelination in both peripheral and central nervous systems plays a key role in the neuronal and axonal degeneration that occurs in the pathophysiology of MS ([Lucchinetti 2000](#), [Zephir 2008](#), [Friesse 2014](#))
- Classification of MS ([Lublin 2014](#)) considers several types:
 - Clinically isolated syndrome (CIS)
 - Relapsing-remitting MS (RRMS)
 - Primary progressive MS (PPMS)
 - Secondary progressive MS (SPMS)

Multiple Sclerosis: 2024 Update of McDonald Criteria

- Clinical phenotypes (CIS, RRMS, PPMS, SPMS) supported, but new unified framework now promoted
- *Diagnosis of Multiple Sclerosis: 2024 Revisions of the McDonald Criteria* ([Montalban 2025](#), [Rovira 2025](#))
- Changes in the dissemination in space (DIS) and dissemination in time (DIT) requirements, new MRI biomarkers central vein sign (CVS) and paramagnetic rim lesions (PRL), new CSF biomarker kappa free light chains (kFLC), stricter criteria for age > 50
- Main focus for diagnosis remains on MRI and CSF biomarkers

Multiple Sclerosis: Smoldering MS

- Clinical features undetected by MRI: Progression Independent of Relapse Activity (PIRA), Smoldering-Associated Worsening (SAW)
- *Smouldering Multiple Sclerosis: The 'Real MS'*, [Giovannoni 2022](#)
- *Smouldering-Associated Worsening in Multiple Sclerosis: An International Consensus Statement on Definition, Biology, Clinical Implications, and Future Directions*, [Scalfari 2024](#)
- PET molecular imaging should be considered for evaluation of smoldering MS — if one assumes by definition that features of smoldering MS cannot be detected by MRI.
- PET molecular imaging of the immune system should be considered for prevention of all MS — if one assumes that MS is an auto-immune disorder in which the immune system attacks and destroys myelin in the nervous system.
- Note spelling differences *smoldering* (US) and *smouldering* (UK)

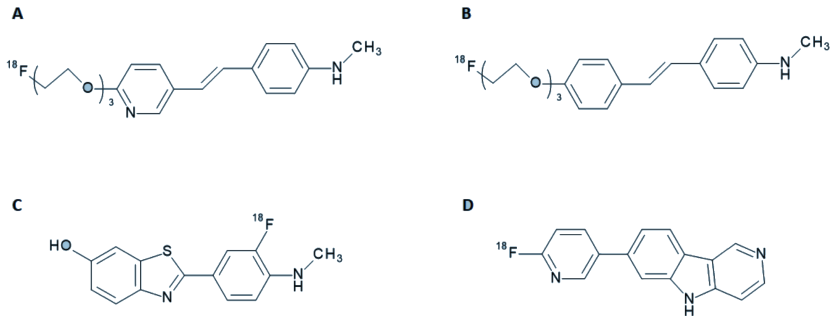
How to Study the 'Real MS'?

- “...we challenge the dominant clinico-radiological worldview that defines multiple sclerosis (MS) as a focal inflammatory disease of the central nervous system (CNS).” ([Giovannoni 2022](#))
- “We hypothesise that therapeutically targeting a state of ‘no evident inflammatory disease activity’ (NEIDA) cannot sufficiently prevent disability accumulation in MS...” ([Giovannoni 2022](#))
- If we assume that MS, as an auto-immune degenerative disorder, is the dysfunction of *complex systems of complex systems*, then we must investigate all interacting biological systems involved with all tools and technologies available to us.
- Doing so will require moving beyond the use of mostly MRI for the study of just the nervous system to the use of PET for the study of both the immune system and the nervous system.

Imaging demyelination and remyelination in MS

- Magnetic resonance imaging (MRI) has been well established as the imaging modality most used in routine clinical practice ([Losseff 1996](#), [Thorpe 1996](#), [Barkhof 1999](#), [Lycklama 2003](#), [Bakshi 2008](#))
- Molecular imaging with PET scanners has been considered an alternative imaging modality for MS ([Stankoff 2011](#), [Matias-Guiu 2015](#), [Niccolini 2015](#), [Moccia 2017](#), [Pietroboni 2018](#), [Bodini 2021](#))
- PET imaging has been demonstrated to be safe for monitoring neurodegenerative disorders other than MS, and the amyloid imaging radiotracers are known to bind to myelin in addition to amyloid
- FDA-approved amyloid imaging agents ([Amyvid](#) F18-florbetapir, [Neuraceq](#) F18-florbetaben, [Vizamyl](#) F18-flutemetamol) have not yet been validated as myelin imaging probes for the routine clinical evaluation of MS patients

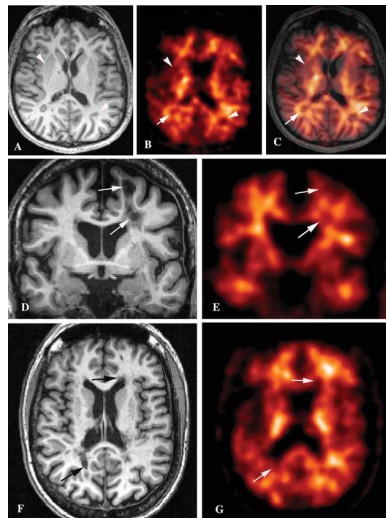
FDA-approved amyloid and tau imaging agents



A: F18-florbetapir (Amyvid), B: F18-florbetaben (Neuraceq)
C: F18-flutemetamol (Vizamyl), D: F18-flortaucipir (Tauvid)
Chemical structures from Figure 1 of [Capponi 2023](#)

Stankoff et al 2011 imaging of MS with C11-PiB PET

MP-RAGE 3T MRI and C11-PiB PET images for MS: patient 1 (A-C) and patient 2 (D-G); reprinted from [Stankoff 2011](#).

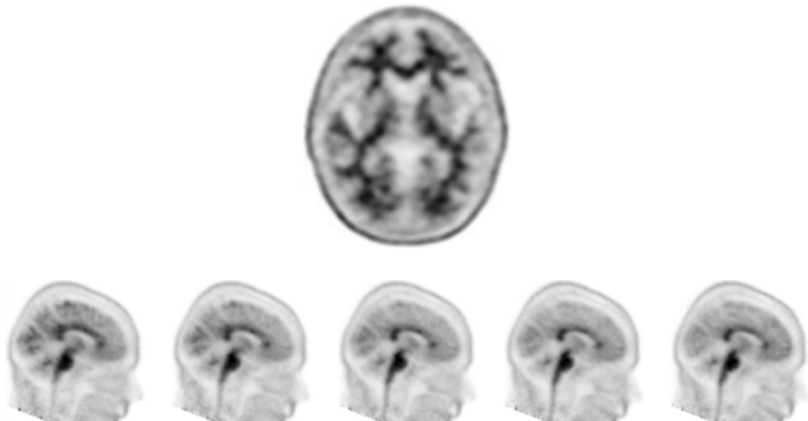


Signal versus Noise for Amyloid Imaging Agents

	Target Signal	Off-target Noise
Alzheimer's Disease	grey matter	white matter
Multiple Sclerosis	white matter	grey matter

- What is indication for amyloid imaging PET scan? AD or MS?
- What is considered answer to diagnostic question present in target signal rather than an incidental finding present in off-target noise?
- With results that may or may not be reported to patient per personal preferences of the patient in routine clinical setting?
- Questions relevant to appropriate use criteria and informed consent for both clinical practice and research trials.

Myelin binding of F18-flutemetamol



High binding of F18-flutemetamol in white matter with low binding in gray matter; images courtesy of Chris Rowe, Univ Melbourne, Australia.

Advances in PET-CT and PET-MR imaging

- Improved detector sensitivity and spatial resolution of recent state-of-the-art PET-CT and PET-MR scanners
 - GE Healthcare [Discovery MI PET-CT](#)
 - GE Healthcare [SIGNA PET-MR](#)
 - Siemens [Biograph Vision Quadra PET-CT](#)
 - Siemens [Biograph mMR PET-MR](#)
 - United Imaging [uEXPLORER PET-CT](#)
 - United Imaging [uMI Panorama GS PET-CT](#)
 - United Imaging [uPMR 790 PET-MR](#)
- For tech specs and performance characteristics of these scanners, see [Karlberg 2016](#), [Cherry 2018](#), [Badawi 2019](#), [Sluis 2019](#), [Caribe 2019](#), [Chen 2021](#), [Prenosil 2022](#), [Zhang 2024](#)
- Entire-body (also called whole-body and total-body) PET scanners enable molecular imaging of both central and peripheral nervous system, to include brain, spinal cord, and peripheral nerve roots

Psychometrics and Safety of Imaging Results Disclosure

- “Safety of Disclosing Amyloid Imaging Results to MCI and AD Patients”, published 2018 Ment Health Fam Med 13:748-756, reprinted 2023 Brainiacs 4.1.X661B91A3, [Taswell 2018](#).
- Assess safety and tolerability of disclosing a positive or negative amyloid brain scan result to symptomatic individuals with mild cognitive impairment (MCI) or mild Alzheimer’s disease (AD)
- Evaluate psychologic health pre- and post-scan results disclosure with well-established panel of psychometric scales (CES-D, GDS, HADS-A, HADS-D, STAI) for mood including anxiety and depression
- We did not observe any worsening of psychological health, and we considered it safe, without apparent risk of harm to patients, to disclose amyloid imaging results to patients who have no prior history of neuropsychiatric illness.
- “Avoiding Methodological Bias in Studies of Amyloid Imaging Results Disclosure”, 2019 Alz Res Therapy 11:52, [Taswell 2019](#).

Entire-body PET scans for MS (EPSMS) Clinical Trial

- Basic question: Can an entire-body PET scanner be exploited to improve evaluation, monitoring and measurement of both peripheral and central demyelination in multiple sclerosis (MS) patients?
- Initial approach: Adopt a cost-effective and reduced-risk approach for an exploratory phase study by using commercially available and already FDA-approved PET amyloid imaging radiopharmaceuticals that also bind to myelin to follow radiotracer uptake in white matter, thereby tracking demyelination versus remyelination for MS patients in comparison with normal healthy subjects.
- Future approach: Investigate other possible radiotracers (including those not yet FDA approved) that may be useful for monitoring demyelination, neuroinflammation, and microglial activation in both the PNS and CNS of MS patients. In addition, PET myelin imaging by PET-CT scanners will be compared with analogous imaging by PET-MR scanners.

EPSMS clinical trial: objectives and design

- Pilot study conducted on 20 participants as clinical research trial of PET amyloid and myelin imaging with
 - *primary objective* of identifying differences in F18-florbetapir radiotracer activity for MS patients compared to normal healthy subjects,
 - *secondary objective* of monitoring psychological health of those participants who complete a panel of psychometric scales before and after imaging results disclosure
- Trial design established as a non-randomized prospective longitudinal cohort study following a protocol similar to that described by [Taswell 2018](#) with an approximate ratio of 3:1 for MS patients to normal healthy subjects and the
 - protocol for *both study groups*, MS patients and normal healthy subjects, will be the same
 - protocol for *different study arms* will be distinguished only by the make and model of the PET-CT or PET-MR scanner

EPSMS participants: inclusion criteria

- Adult men and women between the ages of 25 and 65 inclusive will be selected for both MS patients and normal healthy subjects
- MS patients diagnosed by credentialed neurologist according to the updated McDonald criteria ([Montalban 2025](#))
- Participants must be able to designate a study partner (family member, relative or friend) to assist and accompany them
- Willing and able to lie motionless in a supine position on the PET-CT scanner bed for at least 10 and up to 30 minutes
- Willing and able to give informed consent, personal contact information (phone number, email and postal address), their health care insurance information, and the contact information for their primary care or specialty care physician

EPSMS participants: exclusion criteria (partial list)

- MS patients with any additional complicating medical illness other than MS such as major gastro-intestinal, pulmonary or cardiovascular disease, and any other neuropsychiatric illness unrelated to MS diagnosed prior to the onset of initial symptoms of MS
- No direct care provider and/or no health insurance
- Body weight more than 200 kilograms (440 pounds). Claustrophobia. Inability to lie in PET-CT scanner
- Creatinine levels > 1.5 mg/dL or estimated glomerular filtration rate (eGFR) < 60 ml/minute Recent (< 90 days) CT scan with contrast
- Any known concomitant acute infection including upper respiratory infections, genitourinary infections, etc.
- History of metastatic or newly (last 5 years) diagnosed locally invasive cancer Chemotherapy in the last 5 years Radiation therapy in the last 3 years Major surgery within the last 6 months
- Pregnancy or breast-feeding

EPSMS clinical trial: status and timeline

- EPSMS Study registered 14 May 2020 at [ClinicalTrials.gov](https://clinicaltrials.gov) with Identifier [NCT04390009](https://clinicaltrials.gov/ct2/show/study/NCT04390009)
- Complete details for the EPSMS Study with citations to references available in the BHA-2020-11 [research protocol](#) and [amended protocol](#) with accompanying [BHA informed consent](#) and [UCSD informed consent](#) for trial participants
- Funding from [Brain Health Alliance](#) for operational and management support; [Avid Radiopharmaceuticals](#) for material support providing use of the Amyvid radiopharmaceutical; collaborating medical imaging centers for material support providing use of PET-CT scanners
- EPSMS Study now recruiting trial participants who may register online at [EPSMS.brainhealthalliance.net](https://epsms.brainhealthalliance.net)

EPSMS clinical trial: imaging sites

- **NCPIC**: Northern California PET Imaging Center (Sacramento); RMAU: Dafang Wu; Executive Director, Bradley Schmidt
- **CMITLA**: Center for Molecular Imaging and Therapy Louisiana (Shreveport); RMAU: Twyla Bartel; Radiopharm Director, Rachid Nazih; Executive Director, Stephen Lokitz
- Local site IRBs have approved the EPSMS Study for scans at UC Davis and UC San Diego, but scheduling remains on hold
- Plans in progress for multi-site international clinical trial with other medical imaging sites across America and around the world with serial scans in longitudinal studies for MS participants over next decade

Computing and CSSE for Brain Imaging Informatics

- CSSE: Computational Sciences and Software Engineering
- Preprocessing (image generation): Tomographic reconstruction algorithms that address denoising for PET-CT, PET-MR, dynamic and quantitative imaging, time-of-flight, attenuation correction
- Processing (image management): Numeric, semantic, UI and system design; integration of images and reports in knowledge engineering workbench, electronic patient record, healthcare information system
- Postprocessing (image analysis and display): Numeric, semantic, UI and system design; pattern recognition for feature extraction from images; integration of images with semantic AI in CAD algorithms, visualization for display and interactive viewing in VR/AR/MR

Diverse Interpretations of Neural Dynamics

- From artificial to biological neural networks, from dynamic graphs to differential equations, using mathematical deterministic or statistical probabilistic models, there exist a panoply of network models for neural dynamics with varying scales in time/space.
- Biological neural networks must consider several hierarchical levels from cell-to-cell communication, local neural pathways in the brain for cognition emotion communication and language comprehension, and nervous system connections from the brain to the rest of the body for both sensory perception and motor control.
- A practical interpretation of the phrase *neural dynamics* is presented here for the EPSMS Clinical Trial as it applies to the changing function of the brain and nervous system in time/space for multiple sclerosis patients who experience demyelination and remyelination of neural pathways in the brain and nervous system.

Neural Dynamics for the EPSMS Clinical Trial

- Track presence/absence of myelin lesions on PET scans
- Myelin lesions may appear/disappear sequentially over time
- Lesion size may increase/decrease: can use max dim length, or approximated spherical, cylindrical, ellipsoid dimensions
- Lesion morphology may change: can use simple list of descriptive categories to characterize form and shape of lesion
- Lesion location may move: can use anatomically labeled region of interest (ROI) and center of xyz spatial coordinates for ROI
- Lesion intensity/activity may increase/decrease: can use min-max range, median-IQR, and summed activity metrics for voxels in ROI
- Lesion duration over time may start/stop, cycle on/off, or be present on all PET scans in the time-ordered sequence of scans
- When using multi-tracers for multi-system biomarkers, lesions may involve both the nervous system and/or tissues of other organ systems

Temporal-Spatial Graphs for Lesions in Serial PET Scans

- For the graph $G(V, E)$, temporal graphs may assume a fixed number of vertices in V with varying number and/or weights of edges in E ; this static V simplification should *not* be applied to PET scan lesions
- Associate the scan s -indexed graph G^s with each PET scan as a snapshot in time for the date-ordered s -indexed sequence of S scans
- For each graph G^s , associate the lesion l -indexed vertex V_l^s with lesion l in scan s for the APSI-ordered l -indexed V_l^s list of L_s lesions (APSI = anterior-posterior within slice, superior-inferior across slices)
- For graphs G^s and G^t and any neuroanatomically adjacent vertices V_l^s and V_m^t , define edges E_{lm}^{st} as the unordered pairs (V_l^s, V_m^t)
- $G = \{V_l^s, E_{lm}^{st} \mid \forall s, t \in 1, \dots, S; \forall l, m \in 1, \dots, L_s\}$ is the temporal-spatial graph G for all lesions in all scans
- Spatial information, ie, spatial locations and topological connections are included in sets of characteristic properties (sometimes called 'colors' and 'weights') associated with each graph vertex and edge

Potential Significance of Temporal-Spatial Graphs

- If our goal is explainability, reproducibility, validity, and sustainability, then when should we use which models and methods to answer which questions in neuroscience and neurobiology? For which scenarios do we prioritize, or consider more important, the relative change of a feature activity in time over relative change in space and vice versa?
- Various approaches based on time-frequency time-space wave-propagation etc exist, but what about time-scale analyses as studied in the wavelets community? Consider a hybridized approach that fuses temporal-spatial graphs with time-scale wavelet-based multi-resolution analyses of immunal and neural dynamics? Will the models and methods be explainable, tractable, and sustainable?
- *All animals, including humans, are complex systems of complex systems.* No mammalian brain has ever existed without multiple other companion systems: immune, endocrine, respiratory, cardiovascular, musculoskeletal, gastrointestinal, urinary, dermatological, etc.

Immunal Dynamics for the EPSMS Clinical Trial

- Neural dynamics with temporal-spatial graphs for myelin lesions provides outcome measures for monitoring clinical interventions with disease-modifying treatments.
- Immunal dynamics with temporal-spatial graphs for immune system activity levels may provide earlier outcome measures that precede the appearance of outcome measures associated with myelin lesions.
- Monitoring immunal dynamics can be done with PET molecular imaging of T lymphocytes, B lymphocytes, NK cells, glial cells.
- Immuno-PET research until now has addressed immunotherapy mostly for cancer or COVID19 rather than for multiple sclerosis.

Radiotracers for Imaging Immune System Activity

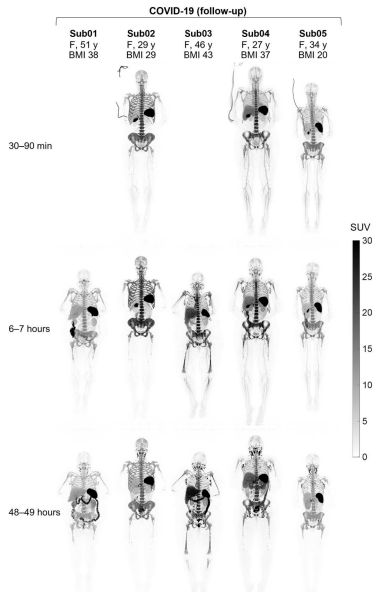
- [Wierstra 2019](#): *Tracers for Non-invasive Radionuclide Imaging of Immune checkpoint Expression in Cancer*
- [McCarthy 2020](#): *In vivo Imaging Technologies to Monitor the Immune System*
- [Alluri 2021](#): *PET Imaging Radiotracers of Chemokine Receptors*
- [Liberini 2021](#): *The Future of Cancer Diagnosis, Treatment and Surveillance: A Systemic Review on Immunotherapy and Immuno-PET Radiotracers*
- [Gawne 2022](#): *Direct Cell Radiolabeling for in Vivo Cell Tracking with PET and SPECT Imaging*
- [Lauwerys 2022](#): *Radionuclide Imaging of Cytotoxic Immune Cell Responses to Anti-Cancer Immunotherapy*
- [Volpe 2022](#): *Imaging Cellular Immunotherapies and Immune Cell Biomarkers: From Preclinical Studies to Patients*

PET Molecular Imaging of Immune System Activity

- [Wei 2020](#): *ImmunoPET: concept, design, and applications*
- [Lauri 2022](#): *Present status and future trends in molecular imaging of lymphocytes*
- [Li 2022](#): *Visualizing T-Cell Responses: T-Cell PET Imaging Toolbox*
- [Gao 2022](#): *PET/CT molecular imaging in the era of immune-checkpoint inhibitors therapy*
- [Xing 2023](#): *Positron emission tomography molecular imaging to monitor anti-tumor systemic response for immune checkpoint inhibitor therapy*
- [Omidvari 2023](#): *First-in-human immunoPET imaging of COVID-19 convalescent patients using dynamic total-body PET and a CD8-targeted minibody*
- [Zhang 2024](#): *The role of CD8 PET imaging in guiding cancer immunotherapy*

Dynamic Immuno-PET Imaging of COVID19 Patients

Dynamic immuno-PET imaging of COVID19 convalescent patients with CD8-targeted minibody; reprinted from [Omidvari 2023](#).



Recent Abstracts from SNMMI 2026 Los Angeles

- [261219](#) S. Jadhav et al: *Radiosynthesis and Validation of a Promise Radiotracer [18F]-TZ10810 for Imaging TREM2 in the Brain*
- [261222](#) P. Chia et al: *Tracking Synaptic Density Loss in the Spinal Cord of EAE Mice and Pilot Evaluation of SV2A PET in Patients with Multiple Sclerosis*
- [261408](#) J. Gujral et al: *Diagnostic Role of [18F]-FDG PET in Amyotrophic Lateral Sclerosis*
- [261638](#) A. Tiss et al: *[18F]-3F4AP PET in multiple sclerosis: first evaluation in gray matter lesions and gadolinium-enhancing lesions*
- [262161](#) F. Moradi et al: *[18F]-Flurimedrimer, a Novel Nanomedicine Radiotracer, Selectively Detects Activated Microglia in Human Brain*

EPSMS Theranostics

- Entire-body PET scans will soon enable molecular imaging with neuro-PET of both central and peripheral nervous system to include brain, spinal cord and peripheral nerve roots.
- Entire-body PET scans will also enable molecular imaging with immuno-PET of the immune system with biomarkers in bone marrow, spleen, thymus, and lymphatic system ([DeLucas 2023](#), [Mohr 2024](#)).
- Dual-tracer PET scans will enable multiplexed molecular imaging of both immune and nervous systems with immuno-neuro-PET for MS.
- The EPSMS Pathway with immuno-neuro-PET theranostics as a research framework can serve all three of the [NMSS Pathways](#) *Stop* (worsening progression), *Restore* (lost function), and *End* (by prevention) to find a cure for MS ([Taswell 2026](#)).

Significance of the EPSMS Clinical Trial

- Molecular imaging with entire-body PET scanners that provide improved detection sensitivity and spatial resolution for *quantitative measurement of demyelination, remyelination, inflammation, and immune system activity with immuno-neuro-PET* will support better decision-making for patient care with more robust outcome measures when monitoring therapeutic drugs evaluated in clinical trials for the treatment of multiple sclerosis.
- Knowledge engineering with pharmacogenomic molecular imaging presents a data mining grand challenge in biomedical informatics with analysis of multiscalar multimodal multimedia data for gene-brain-behavior relationships.

MS Support Organizations

- MS America
- MS Australia
- MS Canada
- L'association France Sclérose en Plaques
- Société Suisse de la Sclérose en Plaques
- Multiple Sclerosis Foundation
- Multiple Sclerosis World
- National Multiple Sclerosis Society
- Can Do Multiple Sclerosis
- My MS Team
- Multiple Sclerosis International Federation lists many more MS organizations around the world

Contacts for the EPSMS Clinical Trial

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- NCPIC Site: Dr. Dafang Wu, 1-916-737-3211, dwu@ncpic.org, Northern California PET Imaging Center, 3195 Folsom Boulevard, Suite 110, Sacramento, CA 95816
- CMIT Site: Dr. Stephen Lokitz, 1-318-716-4000, stephen.lokitz@cmitla.org, Center for Molecular Imaging and Therapy, 2120 Kings Highway, Shreveport, LA 71103

For more information...

- Entire-body PET Scans for Multiple Sclerosis (EPSMS)
[NCT04390009](#) registered at ClinicalTrials.gov
- Taswell 2020 Research Protocol for Exploratory Study of Entire-body PET Scans for Multiple Sclerosis (EPSMS)
DOI: [10.48085/EFAE44345](#)
- Taswell 2023 Amended Protocol for Exploratory Study of Entire-body PET Scans for Multiple Sclerosis (EPSMS)
DOI: [10.48085/HC5B990B0](#)
- Taswell *et al.* 2025 Second Amended Protocol for Exploratory Study of Entire-body PET Scans for Multiple Sclerosis (EPSMS)
DOI: [10.48085/L5BA45BCC](#)