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fondazione italiana
un mondo libero dalla SM
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The ItalianNeuroimagingNetwork Initiative(INNI)

Formazione per l'eccellenza

apr. '23

Fondazione Policlinico Universitario Agostino Gemelli IRCCS
Università Cattolica del Sacro Cuore

BEST HOSPITALS 2022 Newsweek statista
POLICLINICO UNIVERSITARIO A. GEMELLI

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Radiographer

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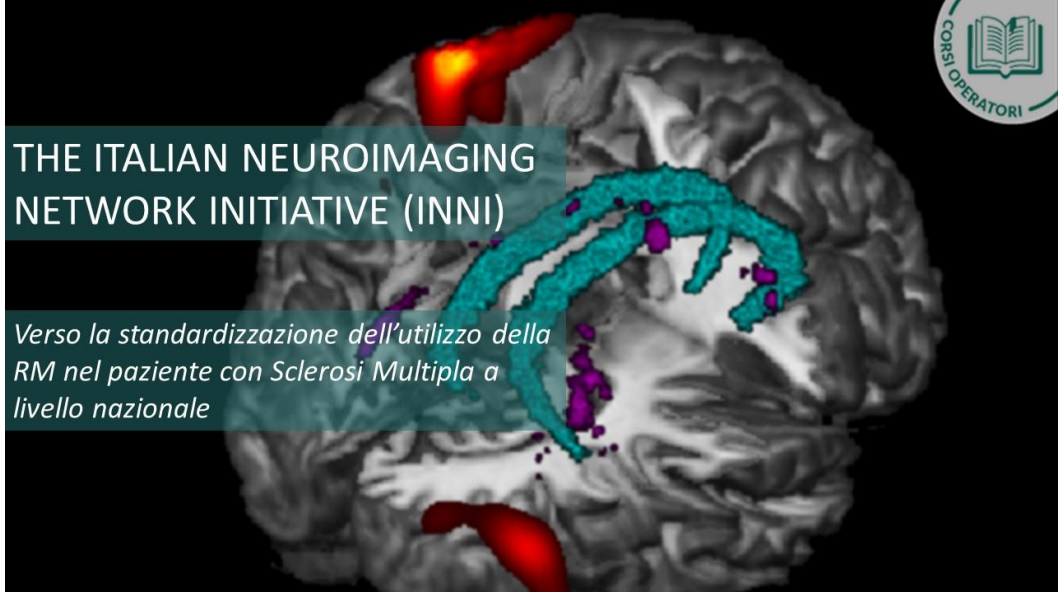

Gemelli

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The Italian Neuroimaging Network Initiative (INNI): verso la standardizzazione dell'utilizzo della RM nel paziente con Sclerosi Multipla a livello nazionale

apr. '23

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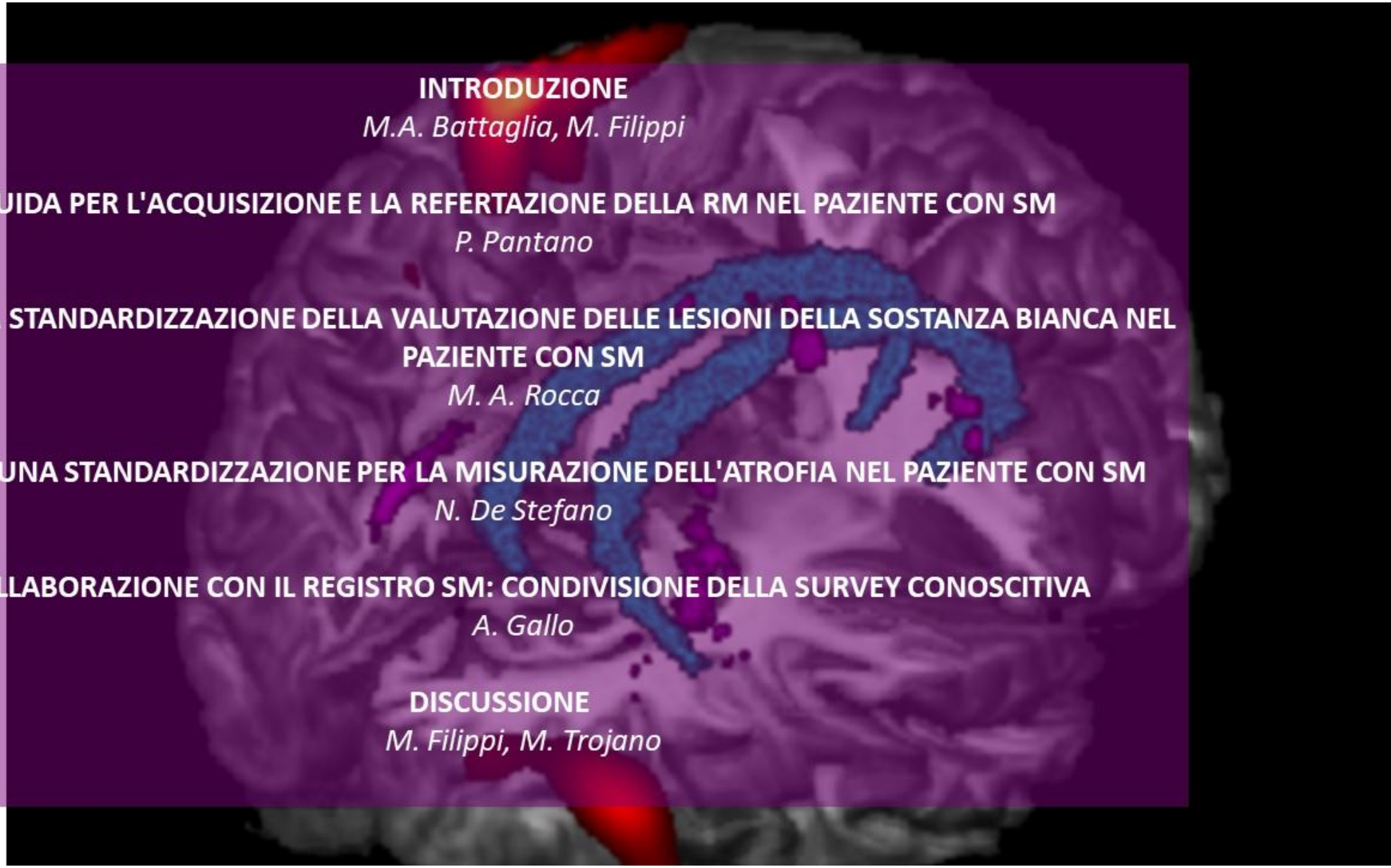
Formazione per l'eccellenza

Programma del Corso



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P. Pantano

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M. A. Rocca

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AISM

Formazione per l'eccellenza

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https://www.aism.it/

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https://fad.aism.it/login/?lang=it

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INNI - database

Il **data base INNI** - **www.inni-ms.org/** - raccoglie oggi i dati di risonanza magnetica di un certo numero di Centri Clinici SM che hanno già aderito al progetto. I dati comprendono non solo esami di risonanza magnetica, ma anche le informazioni demografiche, cliniche e neuropsicologiche. Dal 2014 i progetti di ricerca INNI hanno contribuito a sviluppare nuovi protocolli di risonanza magnetica e metodologie appropriate per la gestione dei dati multicentrici nella SM, in particolare per quanto riguarda l'acquisizione ed elaborazione di immagini relative alla valutazione delle lesioni della sostanza bianca e dell'atrofia. Parametri quest'ultimi strumentali alla diagnosi e al monitoraggio della progressione della malattia.

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DATI EPIDEMIOLOGICI E RICERCHE SPECIFICHE PER VALUTARE L'IMPATTO DELL'INFEZIONE COVID-19 NELLE PERSONE CON SM IN TRATTAMENTO CON TERAPIE MODIFICANTI LA MALATTIA, E ORA CON I VACCINI

REGISTRO ITALIANO SM

https://registroitalianosm.it/index.php

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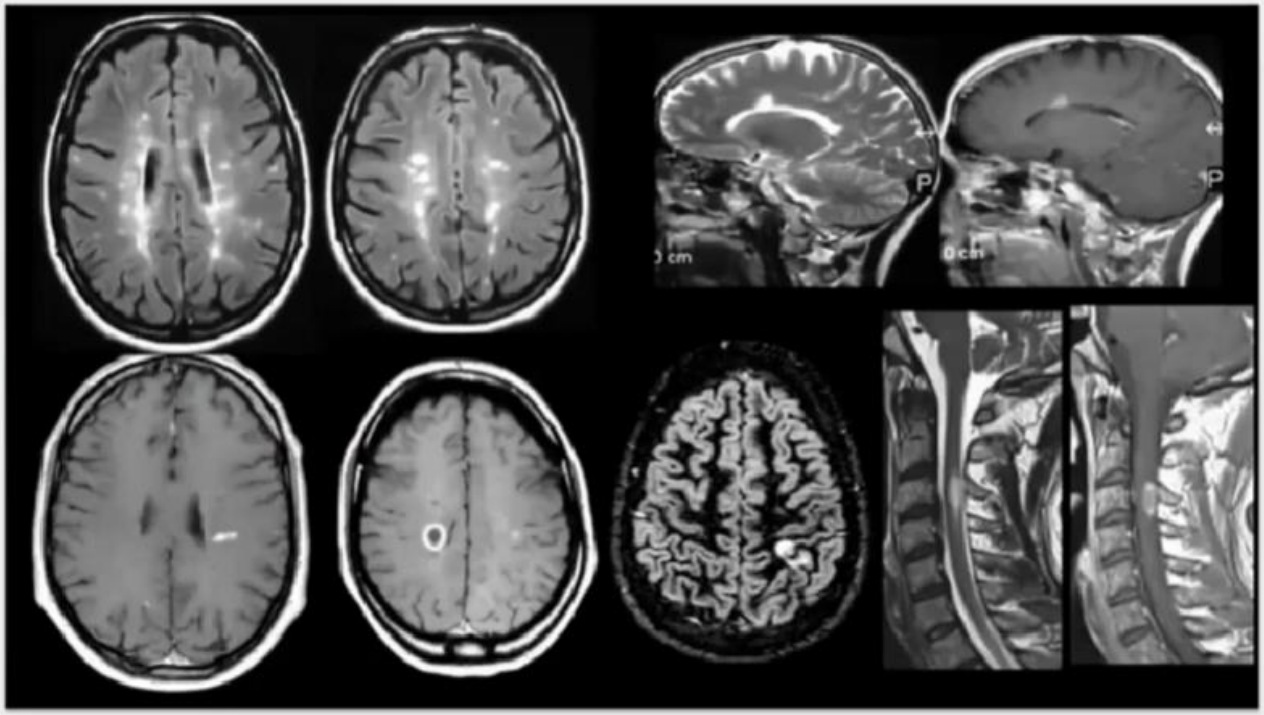
La RM ha completamente rivoluzionato l'approccio al paziente con SM in termini di diagnosi, prognosi e monitoraggio del trattamento



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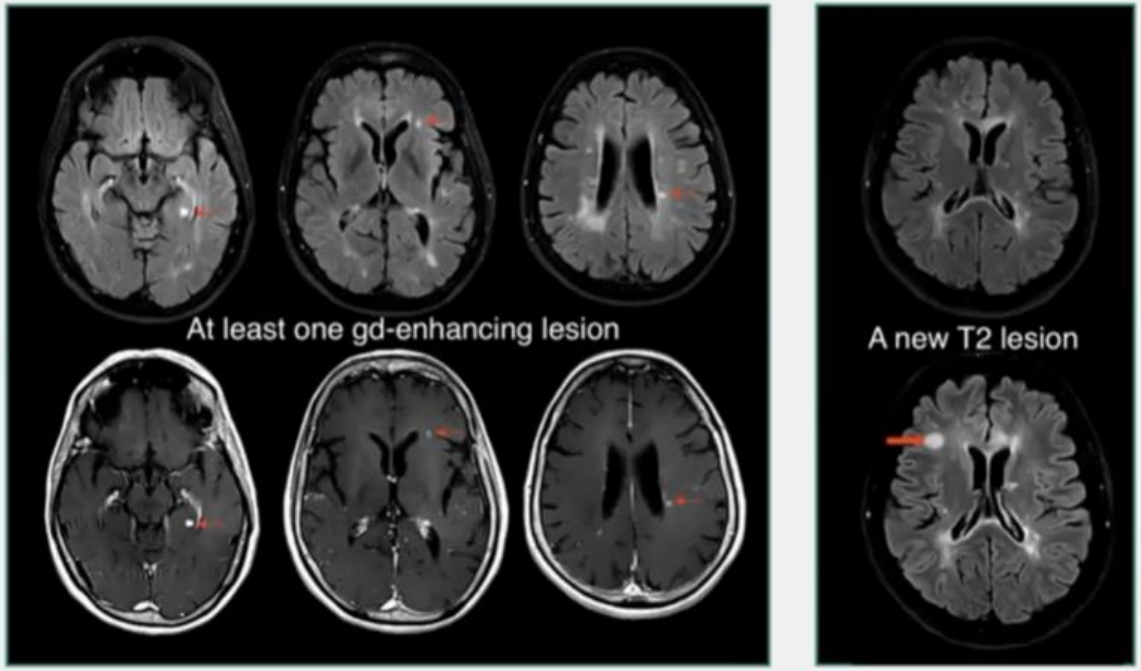
Diagnostic Criteria

Dissemination in time. The development or appearance of new CNS lesions over time.



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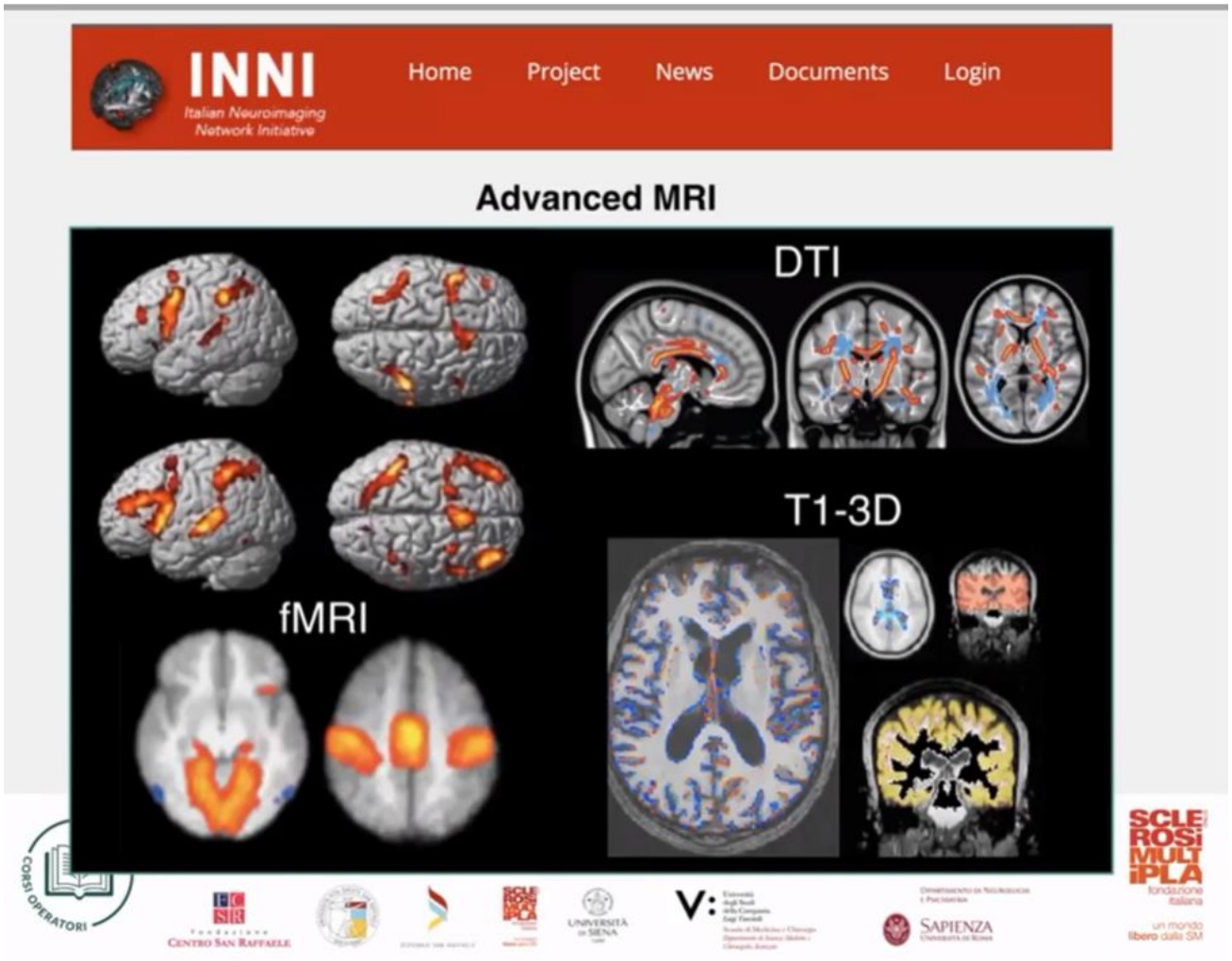

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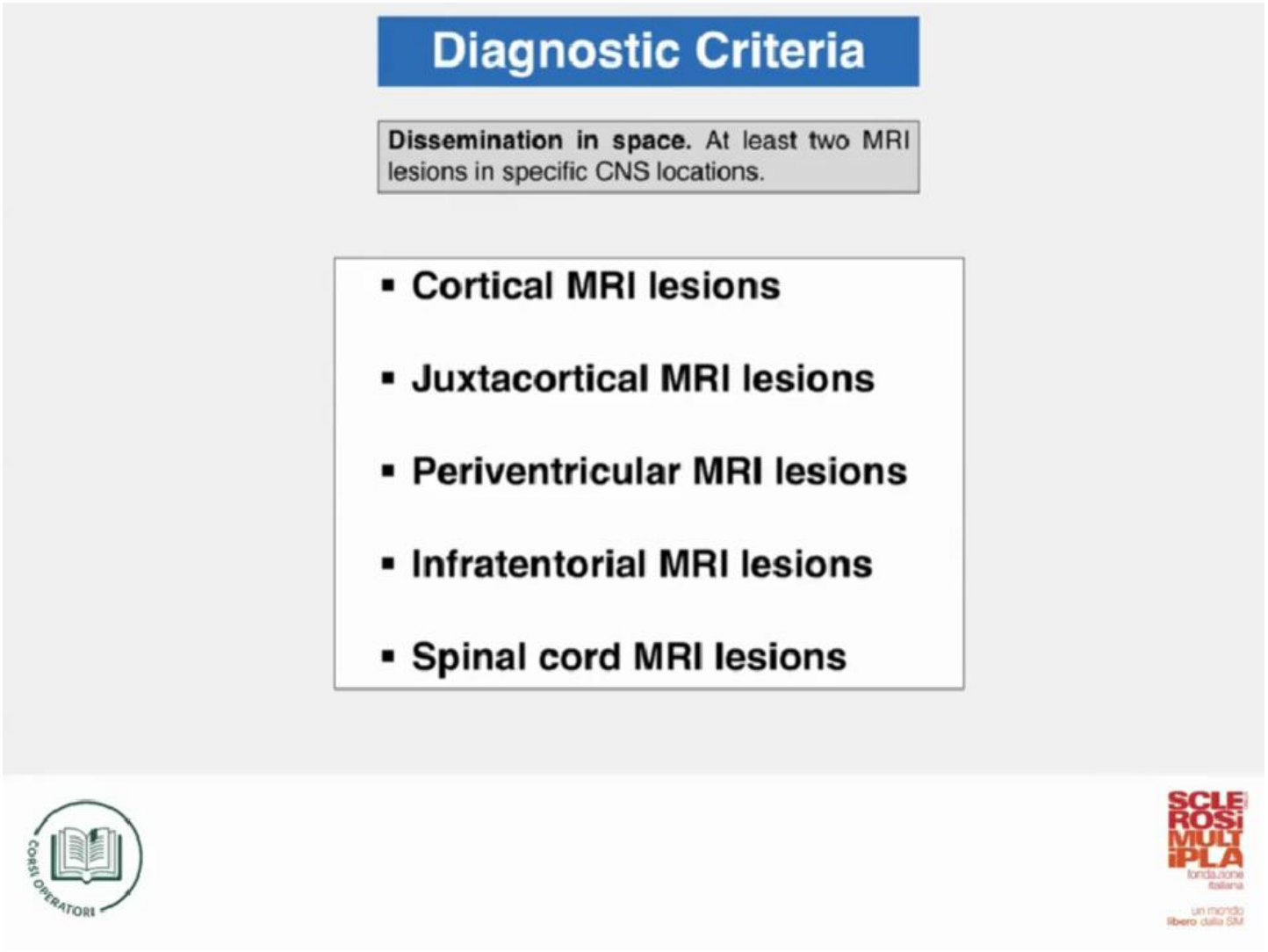

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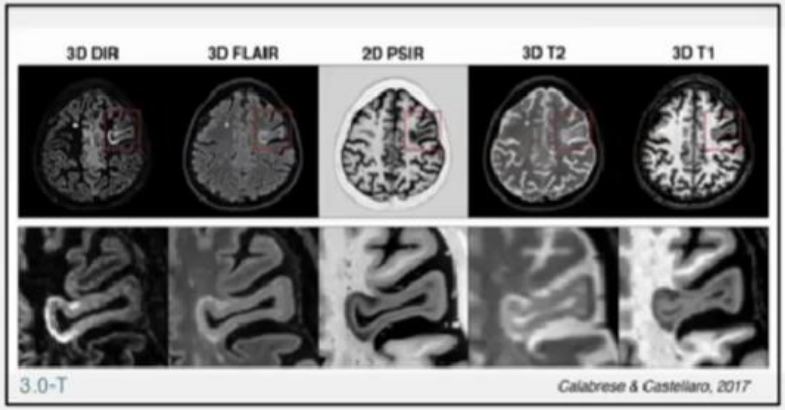
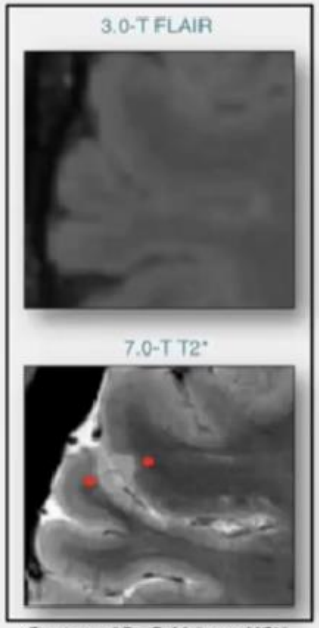
Cortical MRI lesions

Lesions seen with special MRI techniques* within the cerebral cortex (leukocortical, purely intracortical or subpial lesions)

DIR, PSIR, T2, T1





Courtesy of Dr. C. Mainero, MGH

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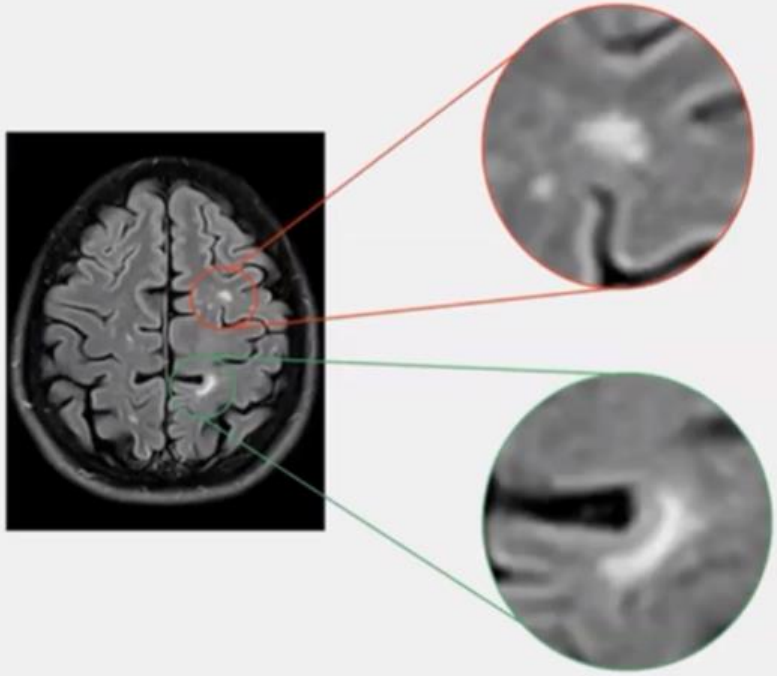
Juxtacortical MRI lesions

T2-w hypeintense white matter lesions abutting the cortex, and not separated from it by white matter



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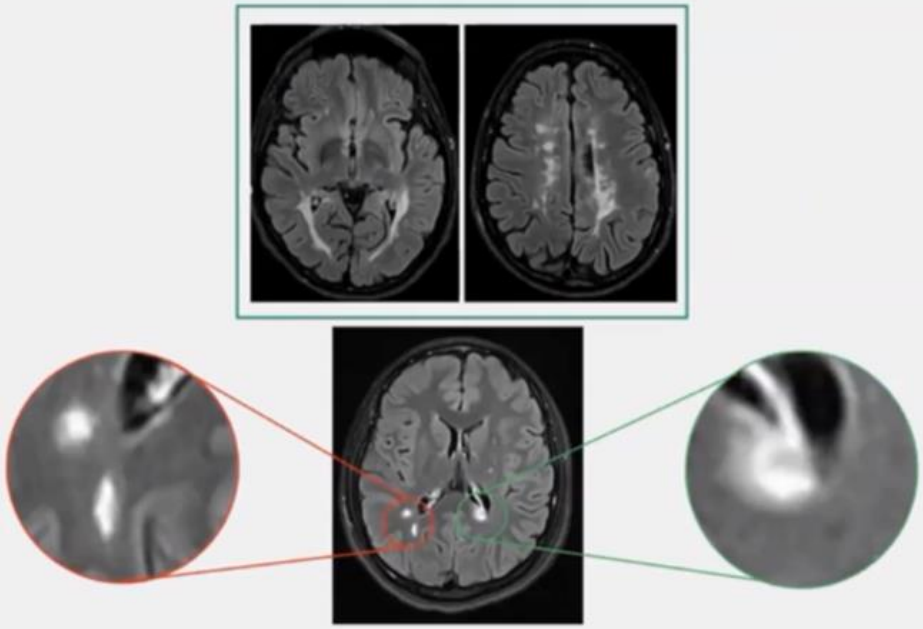
Periventricular MRI lesions

T2-w hypeintense white matter lesions abutting the lateral ventricles without white matter in between, including lesions in the corpus callosum but excluding lesions in deep grey matter structures



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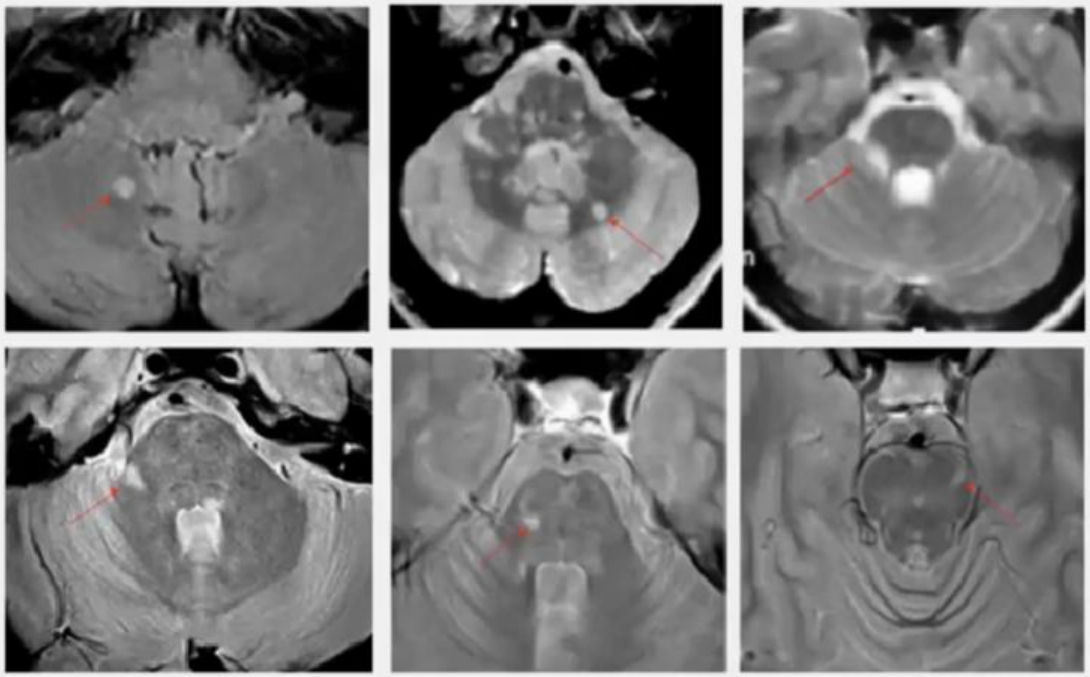
Infratentorial MRI lesions

T2-w hypeintense lesions in the brainstem, cerebellar peduncles, or cerebellum



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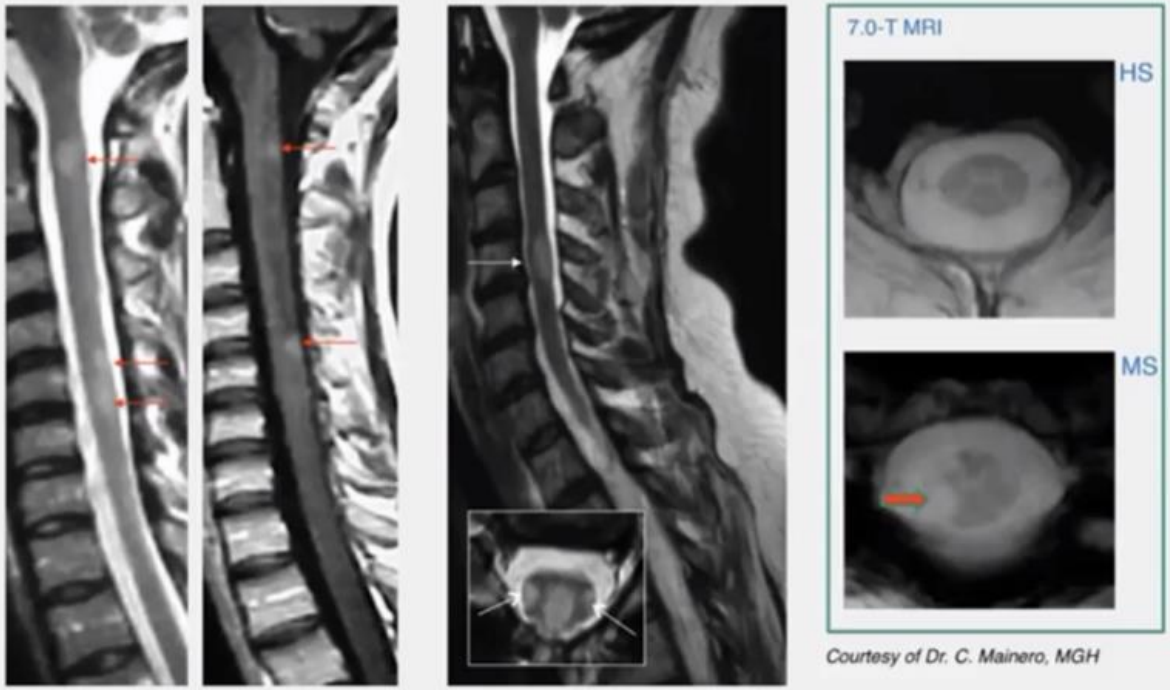
Spinal cord MRI lesions

Hyperintense lesions in the spinal cord seen on T2 plus short tau inversion recovery, proton-density images, or other appropriate sequences, or in two planes on T2 images



Courtesy of Dr. C. Mainero, MGH

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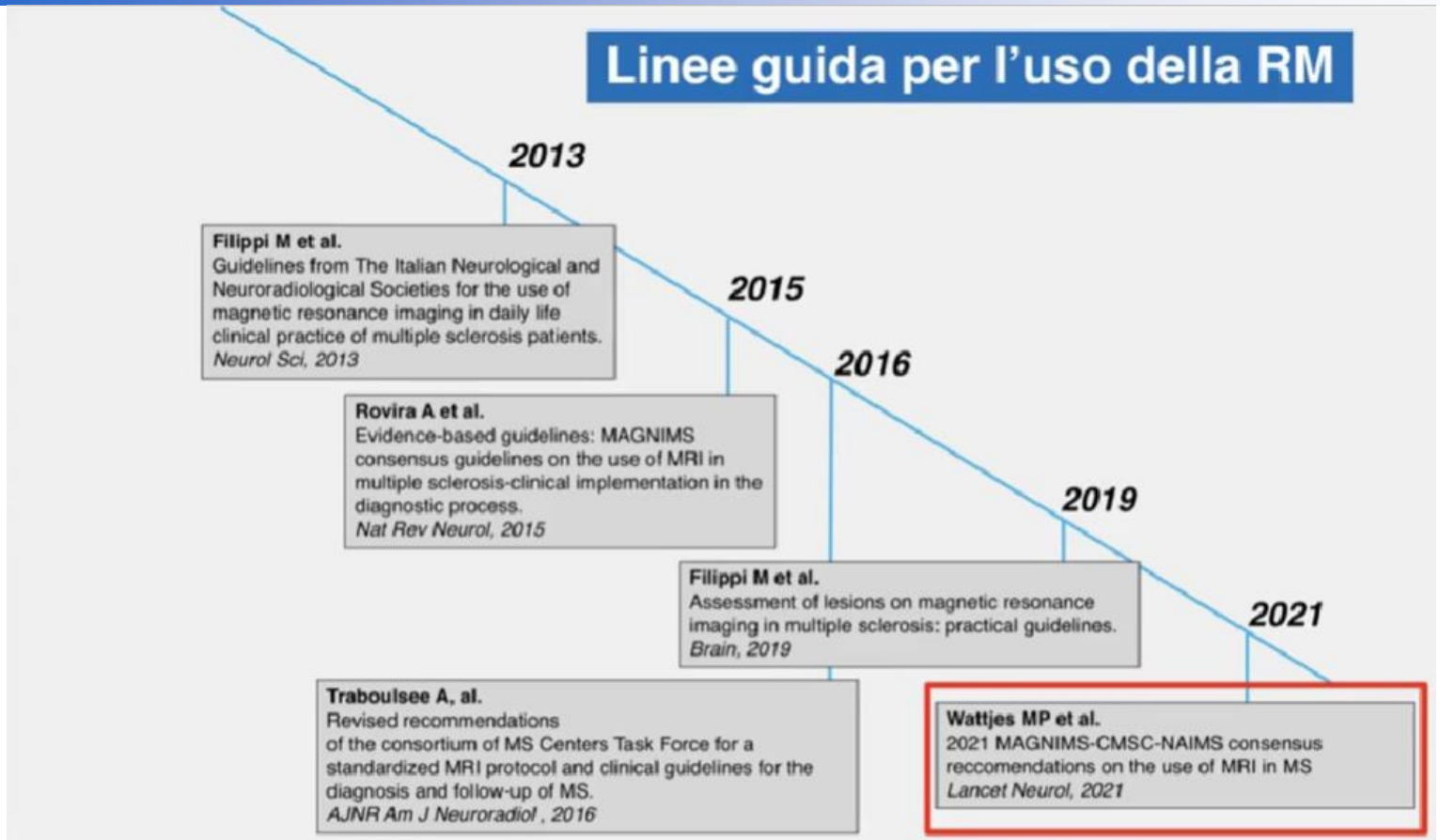

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Formazione per l'eccellenza

Linee guida per l'uso della RM

2021 MAGNIMS–CMSC–NAIMS consensus recommendations on the use of MRI in patients with multiple sclerosis

*Mike P Wattjes, Olga Ciccarelli, Daniel S Reich, Brenda Banwell, Nicola de Stefano, Christian Enzinger, Franz Fazekas, Massimo Filippi, Jette Frederiksen, Claudio Gasperini, Yael Hacohen, Ludwig Kappos, David K B Li, Kshitij Mankad, Xavier Montalban, Scott D Newsome, Jiwon Oh, Jacqueline Palace, Maria A Rocca, Jaume Sastre-Garriga, Mar Tintoré, Anthony Traboulsee, Hugo Vrenken, Tarek Yousry, Frederik Barkhof, Àlex Rovira on behalf of the Magnetic Resonance Imaging in Multiple Sclerosis study group, the Consortium of Multiple Sclerosis Centres, and North American Imaging in Multiple Sclerosis Cooperative MRI guidelines working group**

Lancet Neurol 2021; 20: 653–70

Published Online
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https://doi.org/10.1016/
S1474-4422(21)00095-8

CORSI OPERATORI

SCLEROSI MULTIPLA fondazione italiana un mondo libero dalla SM

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Linee guida per l'uso della RM

Protocollo standardizzato Encefalo
Protocollo standardizzato Midollo

1 **Basale: Diagnosi di SM**

2 **Follow-up: Monitoraggio**

Attività di malattia

Efficacia del Trattamento

Complicanze del Trattamento

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Linee guida per l'uso della RM

1 **Basale: Diagnosi di SM**

BRAIN

Field strength	≥1·5 T (preferably 3 T)
Slice thickness	For 3D imaging, 1 mm isotropic is preferred but, if over contiguous (through plane and in plane), not >1·5 mm, with 0·75 mm overlap; for 2D imaging, ≤3 mm with no gap (except for diffusion-weighted imaging, for which the slice thickness should be ≤5 mm with a 10–30% gap)
In-plane resolution	≤1 mm × 1 mm
Coverage	Whole brain (include as much of cervical cord as possible)
Axial scan orientation	Subcallosal plane to prescribe (ie, for 2D imaging) or reformat (ie, for 3D imaging) axial oblique slices

3D=three dimensional. 2D=two dimensional.

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Linee guida per l'uso della RM

SPINAL CORD

Field strength	≥1·5 T (3 T has no added value compared with 1·5 T)
Slice thickness	Sagittal slices should be ≤3 mm with no gap; axial slices should be ≤5 mm with no gap
In-plane resolution	≤1 mm × 1 mm
Coverage	Cervical and thoracolumbar spinal cord, to include conus
Axial scan orientation	Perpendicular to the sagittal axis of the spinal cord

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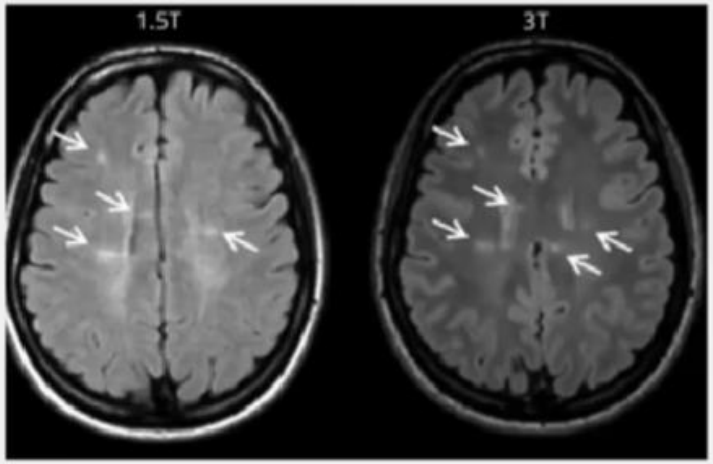
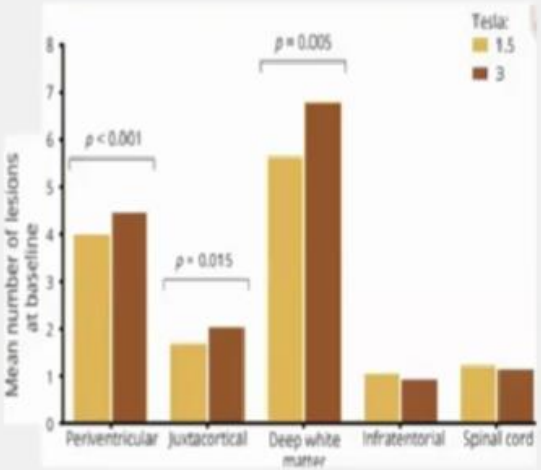
Diagnosi di SM

Three-Tesla MRI does not improve the diagnosis of multiple sclerosis. A multicenter study



66 patients with CIS within 6 months from symptom onset collected in 6 MRI European centers



MAGNIMS, Neurology 2018

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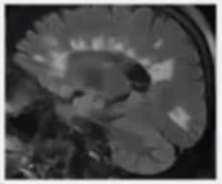
Linee guida per l'uso della RM

Diagnosi di SM



Brain MRI protocol	
Axial T2-weighted (TSE or FSE) sequences†	Recommended
Sagittal T2-weighted FLAIR (preferably 3D; fat suppression is optional)	Recommended
Axial T2-weighted FLAIR (unnecessary if a sagittal 3D FLAIR with multiplanar reconstruction is obtained; fat suppression is optional)	Recommended
Axial (or 3D sagittal) T1-weighted sequences after contrast‡	Recommended
Diffusion-weighted imaging	Optional
Double inversion recovery or PSIR for detecting cortical or juxtacortical lesions	Optional
High-resolution T1-weighted sequences (isotropic 3D acquisition; for quantitative assessment of brain volume)	Optional
Susceptibility-weighted imaging	Optional for assessing the central vein sign

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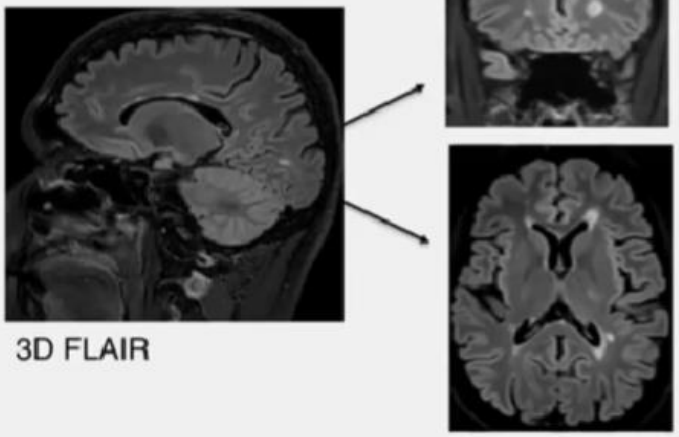
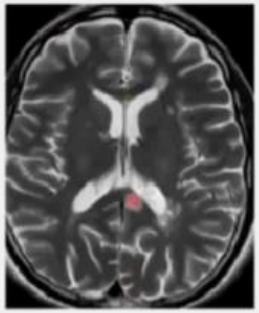
Linee guida per l'uso della RM

Diagnosi di SM

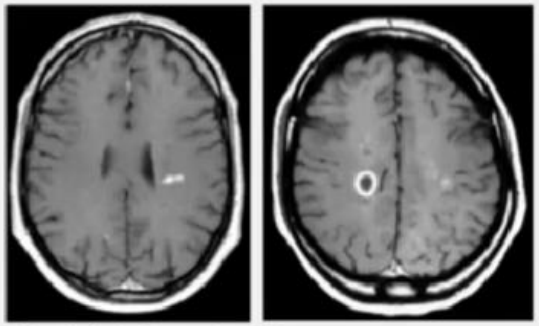
Sequenze raccomandate



3D FLAIR



Assiale T2 TSE



Assiale T1 post mdc

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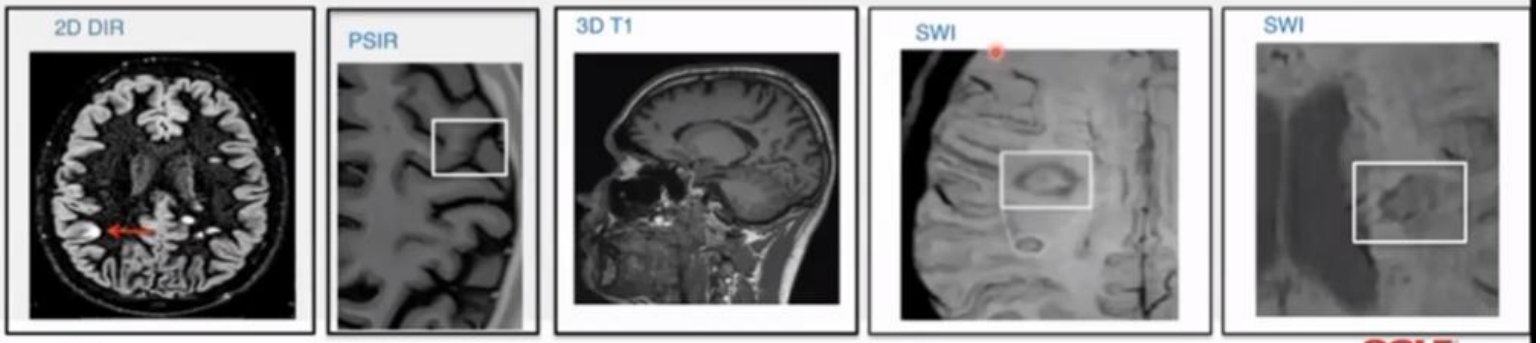
Linee guida per l'uso della RM

Diagnosi di SM

Sequenze facoltative

Diffusion-weighted imaging	Optional	→ PML
Double inversion recovery or PSIR for detecting cortical or juxtacortical lesions	Optional	→ Lesioni corticali
High-resolution T1-weighted sequences (isotropic 3D acquisition; for quantitative assessment of brain volume)	Optional	→ Volumetria
Susceptibility-weighted imaging	Optional	→ Vena centrale, iron ring



Formazione per l'eccellenza

Linee guida per l'uso della RM

Diagnosi di SM

RM ENCEFALO

In sintesi:

- Campo magnetico ≥ 1.5T (preferibile 3T)
- Sezione ≤ 3mm (3D imaging preferibile)
- Protocollo di acquisizione e posizionamento della testa standardizzati
- Dose singola di gadolinio (0.1 mmol/kg pc) con ritardo di 5 min tra iniezione e acquisizione

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Linee guida per l'uso della RM

Diagnosi di SM

Spinal cord MRI protocol	
At least two of: sagittal T2-weighted sequences (TSE or FSE), proton density-weighted sequences (TSE or FSE), or STIR	Recommended ←
Sagittal 3D heavily T1-weighted sequences (PSIR or magnetisation-prepared rapid acquisition of gradient echoes§) only for the cervical segment	Optional
Axial T2-weighted (TSE or FSE) or gradient-recalled echo to corroborate, characterise, and confirm lesions detected on sagittal images or to detect lesions in spinal cord segments with high clinical suspicions of involvement	Optional
Sagittal T1-weighted sequences (TSE or FSE) before contrast	Optional
Sagittal T1-weighted sequences (TSE or FSE) after contrast‡	Recommended ←
Axial T1-weighted sequences (TSE or FSE) after contrast‡	Optional

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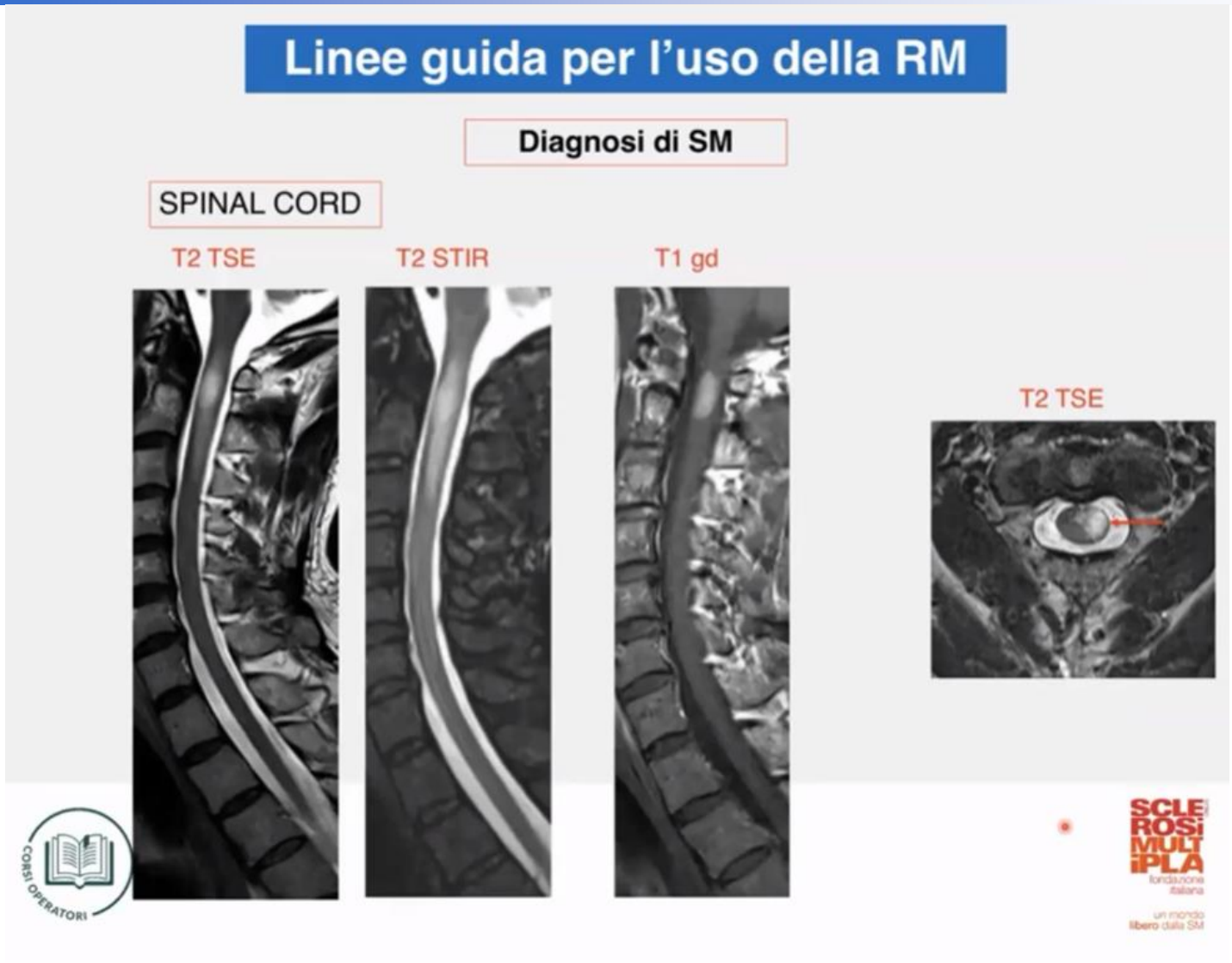

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Formazione per l'eccellenza

Linee guida per l'uso della RM

Diagnosi di SM

SPINAL CORD

Formazione per l'eccellenza

Linee guida per l'uso della RM

Diagnosi di SM

RM MIDOLLO SPINALE

In sintesi:

- Campo magnetico ≥ 1.5T
- Sezione ≤ 3mm sul piano sagittale
- Protocollo di acquisizione standardizzato con almeno due sequenze T2 sul piano sagittale
- Direttamente dopo somm.ne di dose singola di gadolinio

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Linee guida per l'uso della RM

Protocollo standardizzato Encefalo
Protocollo standardizzato Midollo

1 Basale:
Diagnosi di SM

2 **Follow-up:**
Monitoraggio

Attività di malattia

Efficacia del Trattamento

Complicanze del Trattamento

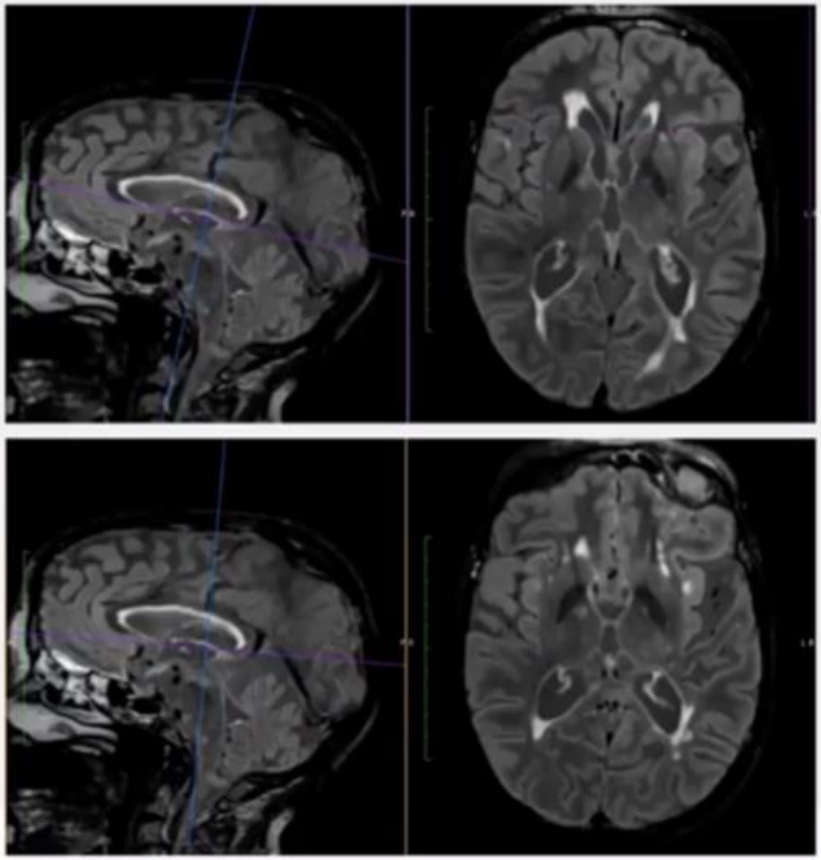
In generale:
- Stesso posizionamento
- Stesso protocollo (semplificato)
- Midollo non sempre necessario
- MDC non sempre necessario

Linee guida per l'uso della RM

Follow-up: Monitoraggio

Posizionamento
Ricostruzione immagini 3D

Linea bicallosale



Diversa ricostruzione dello stesso esame

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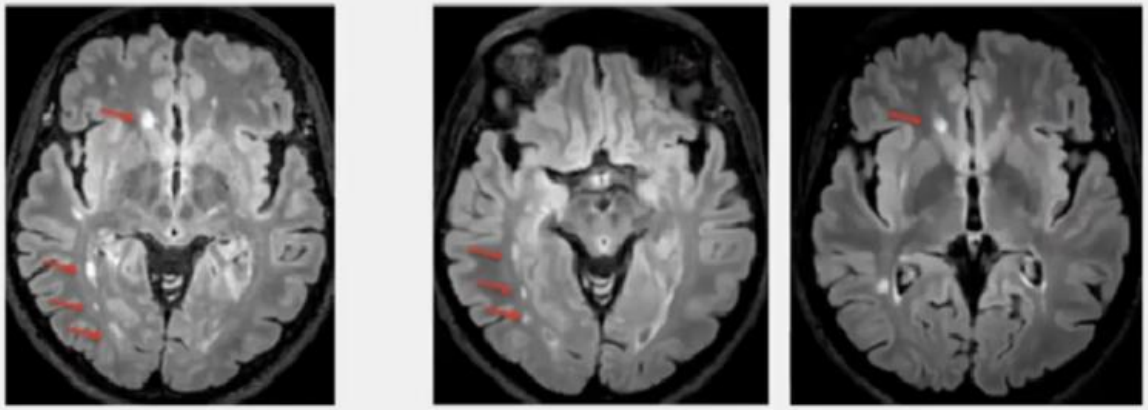
Linee guida per l'uso della RM

Follow-up: Monitoraggio

Riposizionamento non corretto

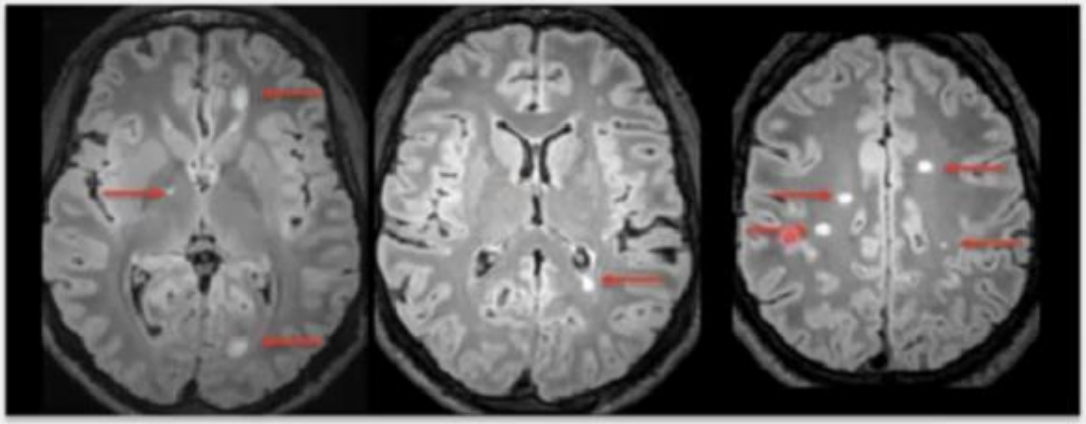
Esame precedente



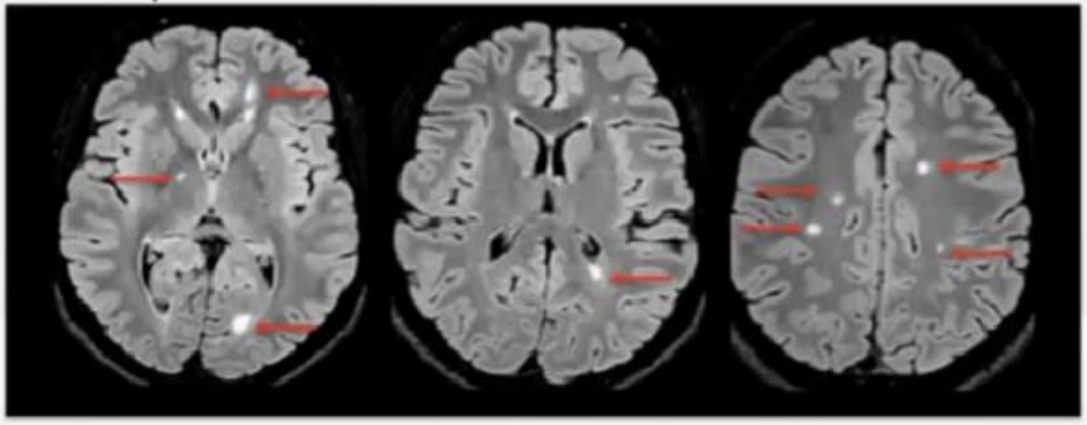
Linee guida per l'uso della RM

Follow-up: Monitoraggio

Riposizionamento corretto



Esame precedente



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Linee guida per l'uso della RM

Follow-up: Monitoraggio

Efficacia del Trattamento

- Protocollo MRI abbreviato (3D-FLAIR + T1 (non sempre necessario post-MDC)
- Se attività MRI (non clinica) follow-up ogni 6 mesi
- Midollo non sempre necessario

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Linee guida per l'uso della RM

Follow-up: Monitoraggio

Complicanze del Trattamento

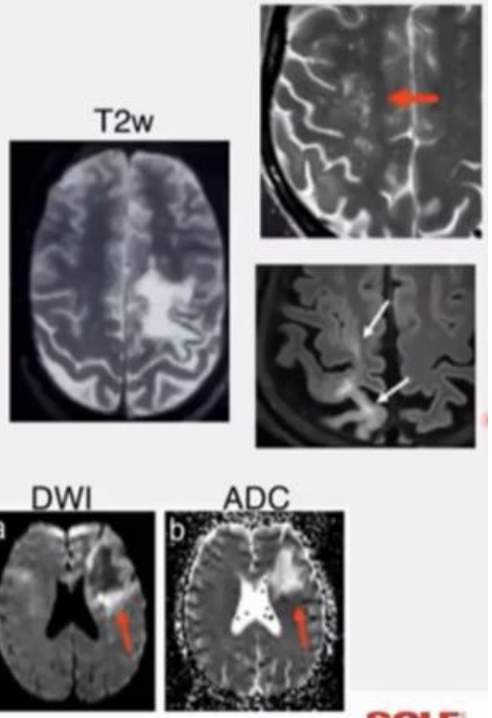
Progressive multifocal leukoencephalopathy (PML)

T2w e FLAIR
Area iperintensa, con coinvolgimento fibre a U, bordi sfumati verso la corteccia, circondata da lesioni puntiformi (milk way)
Senza edema o effetto massa

T1w
iso- o ipointensa

T1 (Gd)
Generalmento NO CE (DD con IRIS)

ADC/DWI
Restrizione ai bordi della lesione



Formazione per l'eccellenza

Il referto radiologico

TECNICA:
Magnete (1.5 vs 3T), elenco sequenze, mdc (tipo e dose).

INDICAZIONI CLINICHE:
Sintomatologia (recidiva?), fenotipo, disabilità, trattamento.
Quesito specifico?

REPERTI:
- Lesioni (T2 e T1gd): numero, dimensioni, forma, sede.
- Valutazione qualitativa o semiquantitativa dell'atrofia cerebrale e/o midollare.
- Follow-up: nuove lesioni T2 e T1gd: numero, dimensioni, forma, sede.
- Altri reperti.

CONCLUSIONI:
Diagnosi: criteri diagnostici DIS e DIT; attività di malattia; interpretazione radiologica in rapporto al questo clinico; eventuale diagnosi differenziale.
Follow-up: attività di malattia; stabilità o progressione; possibili complicanze (es. PML).

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Outline

- The INNI initiative / MRI protocol
- The INNI initiative / Lesion assessment
- The INNI initiative / Quality control
- New automatic approaches for lesion identification and quantification
- Conclusions

Verso una standardizzazione per l'identificazione e misurazione delle lesioni della sostanza bianca nel paziente con SM

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The INNI initiative

- Conventional MR sequences (dual-echo, FLAIR and T1- weighted imaging) provide important pieces of information for diagnosing MS, understanding its natural history and assessing treatment efficacy
- Standardization of MR protocols/procedures outside the setting of clinical trials is still lacking
- The first two goals of the Italian Neuroimaging Network Initiative (INNI) were:
  1. **The creation of a web-based system** with clinical, neuropsychological and MRI data from the participating centers, to allow data sharing
  2. **The use of such data to perform large-scale studies** to define the role of clinical, neuropsychological and advanced MRI biomarkers in understanding MS pathophysiology

The INNI initiative will help to define standardized MRI and clinical protocols for the evaluation of patients with MS at a national level

Verso una standardizzazione per l'identificazione e misurazione delle lesioni della sostanza bianca nel paziente con SM

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The INNI initiative

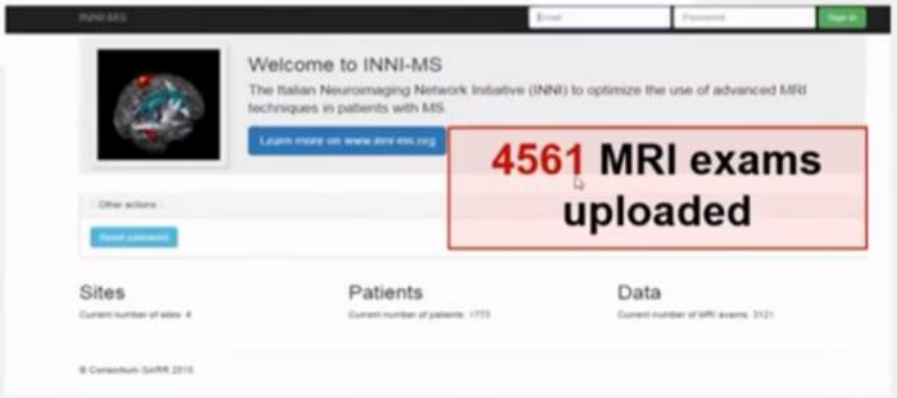
Neurol Sci (2017) 38:1029–1038
DOI 10.1007/s10072-017-2903-z

ORIGINAL ARTICLE

The Italian Neuroimaging Network Initiative (INNI): enabling the use of advanced MRI techniques in patients with MS

M. Filippi[1,2] · G. Tedeschi[3,4] · P. Pantano[5,6] · N. De Stefano[7] · P. Zaratin[8] · M. A. Rocca[1,2] · For the INNI Network

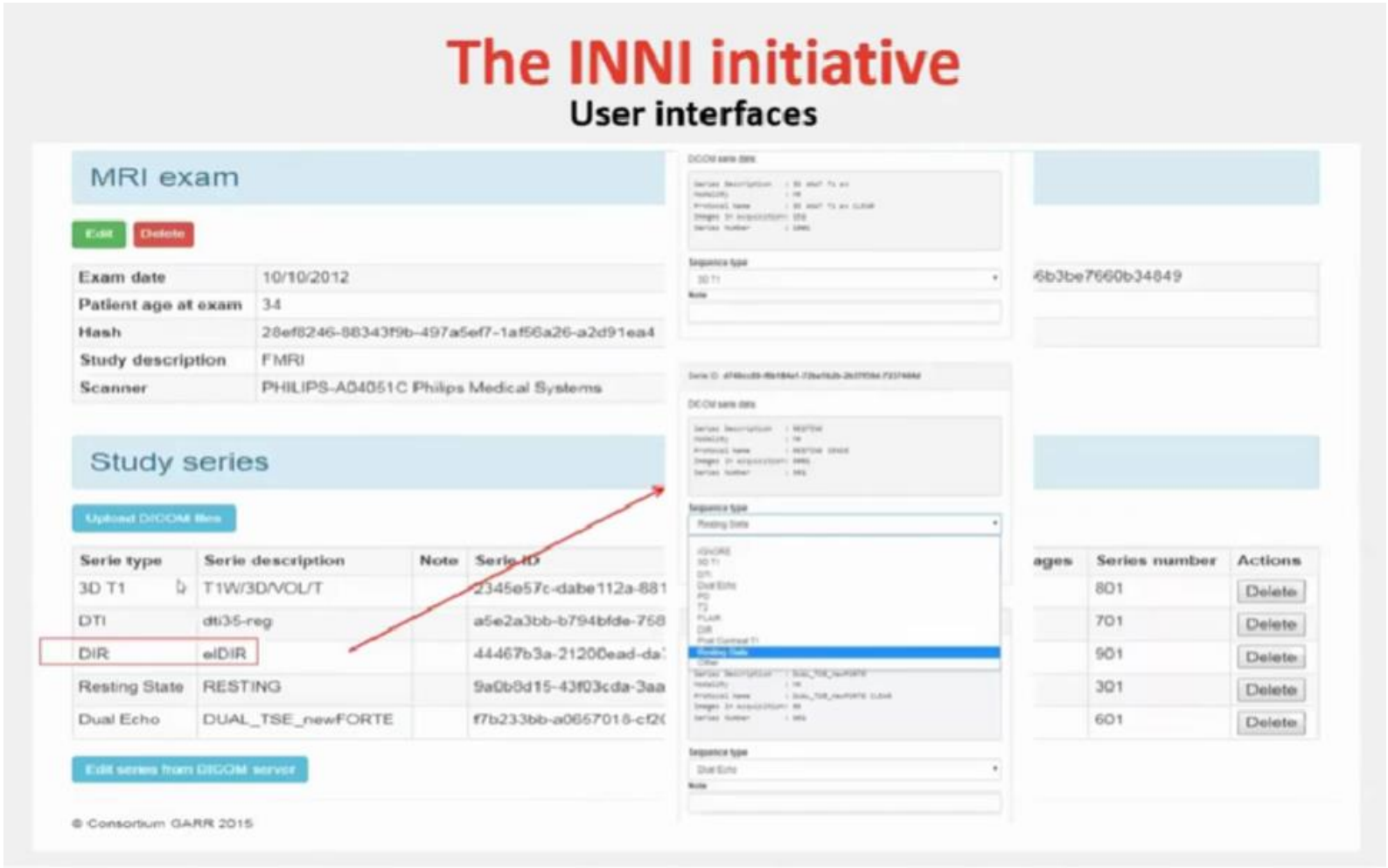
Available at: https://database.inni-ms.org



Financially supported by a research Grant from Fondazione Italiana Sclerosi Multipla (FISM 2013/S/1)

Verso una standardizzazione per l'identificazione e misurazione delle lesioni della sostanza bianca nel paziente con SM

INNI – Sclerosi Multipla



Verso una standardizzazione per l'identificazione e misurazione delle lesioni della sostanza bianca nel paziente con SM

The INNI initiative / MRI protocol

Minimum requirement of the MRI protocol to be uploaded on INNI:

1. Sequences for **lesion quantification**: **dual echo** (DE) or **T2-weighted/FLAIR** scans acquired with axial orientation and a slice thickness of no more than 3 mm
2. Sequences for **atrophy quantification**: high-resolution **3D T1-weighted** scans
3. **DT MRI** sequences acquired with *30 diffusion-weighted direction and a nearly isotropic spatial resolution
4. **RS fMRI** sequences covering all brain, with at least 140 scans and an acquisition session at least 5 min long

All sequences **should** be acquired on a **3T MR** scanner

Filippi et al., Neurol Sci 2017

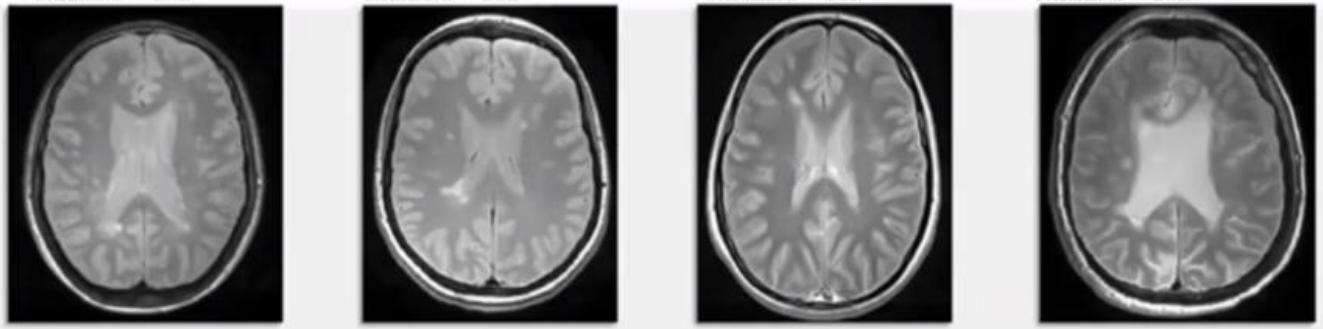
INNI – Sclerosi Multipla

The INNI initiative / MRI protocol

MRI parameters of the sequences used **for lesion assessment** included at the time of the creation of the INNI database by each promoting center

Filippi et al., Neurol Sci 2017

Sequence	Milan	Naples	Rome	Siena
Coil	8 channel head coil	8 channel head coil	12 channel head coil	32 channel head coil
Dual echo	TR = range 2599–2910 ms	TR = 3080 ms	TR = range 3320-5310 ms	TR = 4000 ms
	TE = 16/80 ms	TE = 24/127.5 ms	TE = 10/103 ms	TE = 15/100 ms
	FA = 90°	FA = 90°	FA = 150°	FA = 90°
	Matrix = 256 × 256	Matrix = 256 × 384	Matrix = 384 × 384	Matrix = 240 × 240 (recon 352 × 352)
	FOV = 240 × 240 mm	FOV = 240 × 240 mm	FOV = 220 × 220 mm	FOV = 240 × 240 mm
	Thickness = 3 mm	Thickness = 3 mm	Thickness = range 3 mm	Thickness = 3 mm
	No. of slices = range 44–50	No. of slices = 44	No. of slices = range 45	No. of slices = 44
	Orientation = axial	Orientation = axial	Orientation = axial	Orientation = axial



Prospectively evolving...

Verso una standardizzazione per l'identificazione e misurazione delle lesioni della sostanza bianca nel paziente con SM

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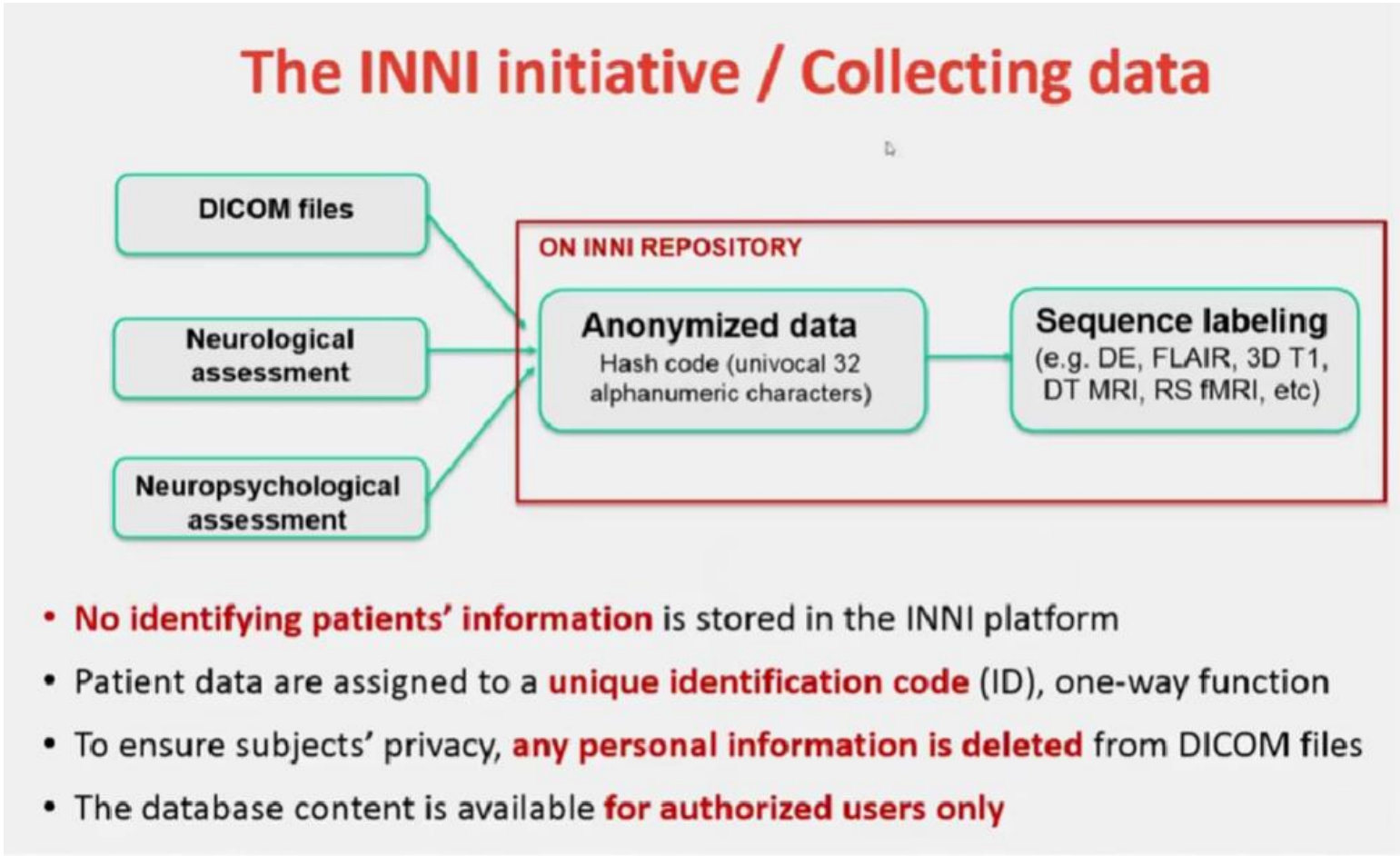


Verso una standardizzazione per l'identificazione e misurazione delle lesioni della sostanza bianca nel paziente con SM

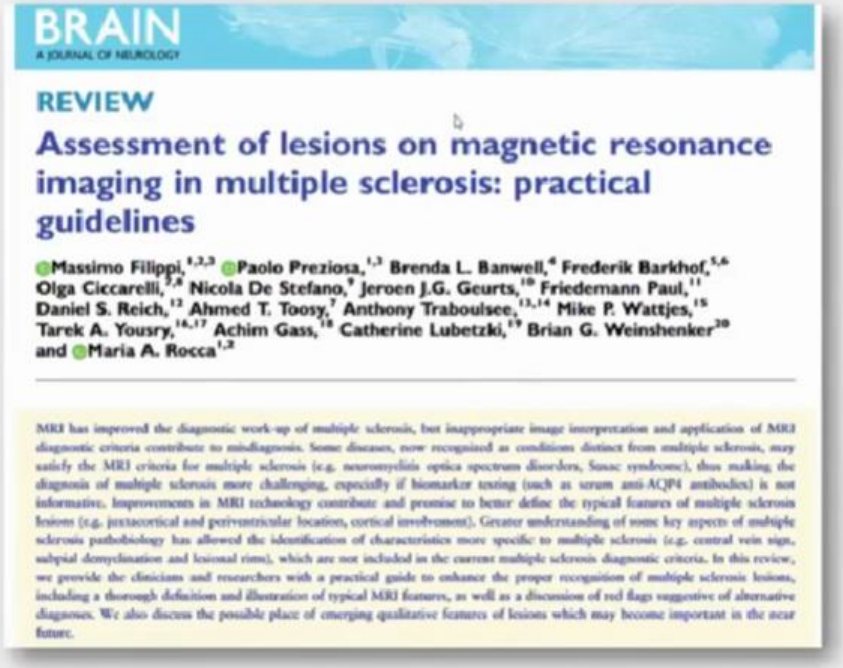
Outline

- The INNI initiative / MRI protocol
- The INNI initiative / Lesion assessment
- The INNI initiative / Quality control
- New automatic approaches for lesion identification and quantification
- Conclusions

INNI – Sclerosi Multipla

The INNI initiative / Lesion assessment

Practical standardize guidelines for brain T2-hyperintense lesion identification applied to INNI data



BRAIN
A JOURNAL OF NEUROLOGY

REVIEW

Assessment of lesions on magnetic resonance imaging in multiple sclerosis: practical guidelines

Massimo Filippi,[1,2,3] Paolo Preziosa,[1,3] Brenda L. Banwell,[4] Frederik Barkhof,[5,6] Olga Ciccarelli,[7,8] Nicola De Stefano,[9] Jeroen J.G. Geurts,[10] Friedemann Paul,[11] Daniel S. Reich,[12] Ahmed T. Toosy,[7] Anthony Traboulsee,[13,14] Mike P. Wattjes,[15] Tarek A. Yousry,[16,17] Achim Gass,[18] Catherine Lubetzki,[19] Brian G. Weinshenker[20] and Maria A. Rocca[1,2]

MRI has improved the diagnostic work-up of multiple sclerosis, but inappropriate image interpretation and application of MRI diagnostic criteria contribute to misdiagnosis. Some diseases, now recognized as conditions distinct from multiple sclerosis, may satisfy the MRI criteria for multiple sclerosis (e.g. neuromyelitis optica spectrum disorders, Susac syndrome), thus making the diagnosis of multiple sclerosis more challenging, especially if biomarker testing (such as serum anti-AQP4 antibodies) is not informative. Improvements in MRI technology contribute and promise to better define the typical features of multiple sclerosis lesions (e.g. juxtacortical and periventricular location, cortical involvement). Greater understanding of some key aspects of multiple sclerosis pathobiology has allowed the identification of characteristics more specific to multiple sclerosis (e.g. central vein sign, subpial demyelination and leisional rims), which are not included in the current multiple sclerosis diagnostic criteria. In this review, we provide the clinicians and researchers with a practical guide to enhance the proper recognition of multiple sclerosis lesions, including a thorough definition and illustration of typical MRI features, as well as a discussion of red flags suggestive of alternative diagnoses. We also discuss the possible place of emerging qualitative features of lesions which may become important in the near future.

Verso una standardizzazione per l'identificazione e misurazione delle lesioni della sostanza bianca nel paziente con SM

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T2-hyperintense lesions

- Focal hyperintensity on a T2-w (T2, T2-FLAIR or similar) or a proton density (PD)-w sequence
- **Round to ovoid** in shape, ranging from a few millimeters to more than one or two centimeters in diameter. Generally, **≥3 mm** in their long axis
- Lesions should be visible on at least **2 subsequent slices** to exclude artifacts or small hyperintensities, although in acquisitions with higher slice thickness (e.g., ≥ 3 millimetres), smaller lesions could be visible on a single slice
- Asymmetrically distributed mainly in the early stages
- Lesions can occur in any CNS region, with a predilection of specific WM regions (periventricular and juxtacortical WM, corpus callosum, infratentorial areas and spinal cord)

Filippi et al., Brain 2019

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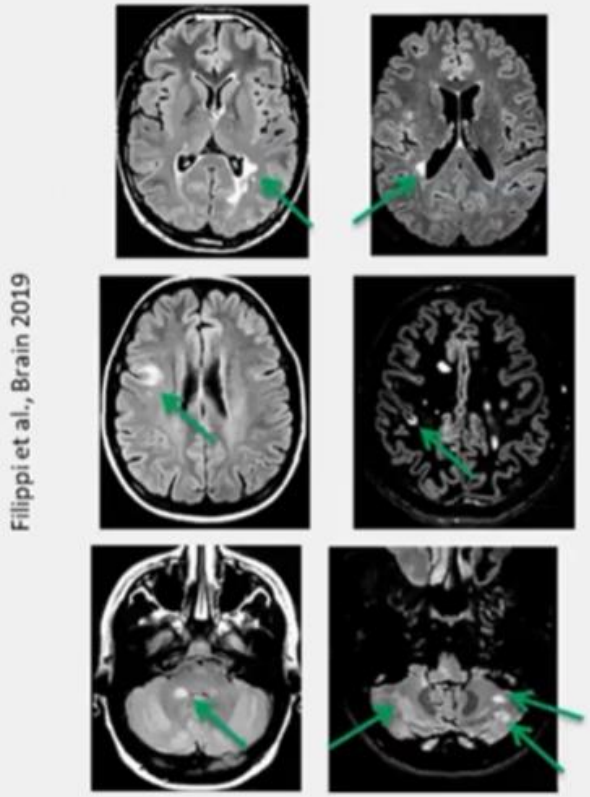
The INNI initiative / Lesion assessment



Filippi et al., Brain 2019

Lesion category	Green flags
Periventricular	Location: **abutting the lateral ventricles without intervening white matter**
Juxtacortical/ Cortical	Location: **touching or within the cortex**
Infratentorial	Location: brainstem, cerebellar peduncles and cerebellar hemispheres; contiguous to cisterns or the floor of the fourth ventricle; surface of the pons and the pontine trigeminal root entry zone; lining of CSF border zones; cerebral peduncles and close to the periaqueductal gray matter; uni- or bilateral paramedian location in medulla oblongata

Verso una standardizzazione per l'identificazione e misurazione delle lesioni della sostanza bianca nel paziente con SM

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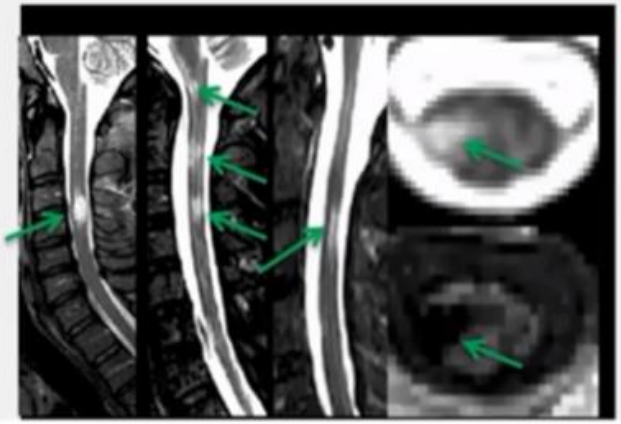
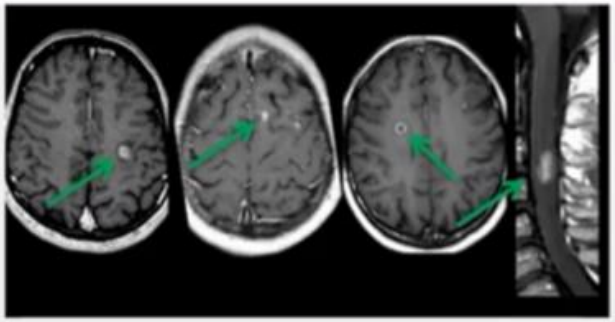
The INNI initiative / Lesion assessment





Filippi et al., Brain 2019

Lesion category	Green flags
Spinal cord	Multiple discrete (**focal**) lesions - Shape: sagittal: cigar-like; axial: wedge-shaped - Size: small; ≤ 2 vertebral segments; < half of the cord - Location: cervical>thoracic; peripheral region; lateral and posterior columns, but central gray matter not spared - Signal characteristics: T1-hypointensity (> at higher field strengths)
Gadolinium-enhancing lesions	- Shape: nodular; open-ring; closed-ring - Location: brain>spinal cord

Verso una standardizzazione per l'identificazione e misurazione delle lesioni della sostanza bianca nel paziente con SM

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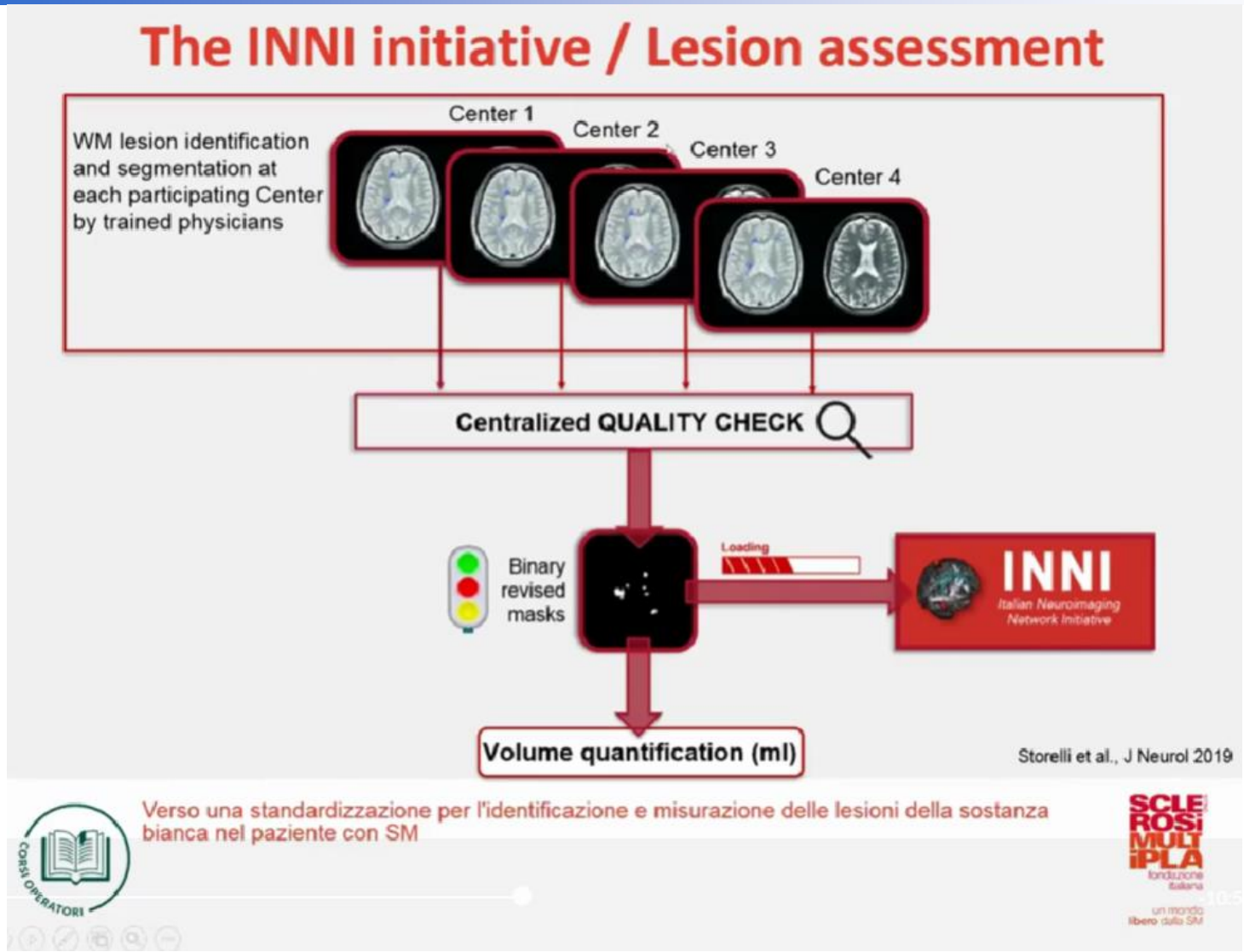
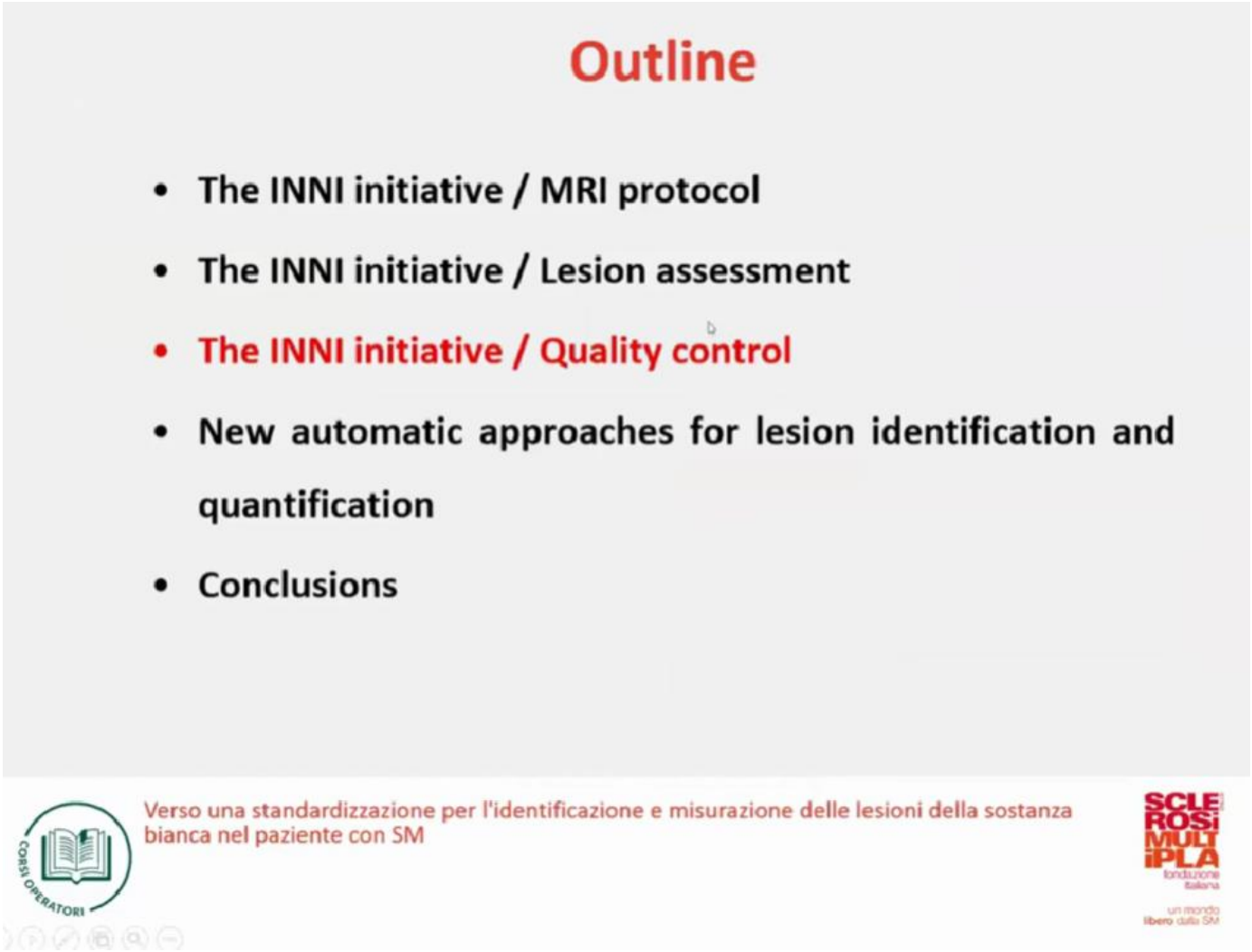


INNI – Sclerosi Multipla



INNI – Sclerosi Multipla

The INNI initiative / Quality control

The collection of multicenter MRI data raises the important issues of **standardization** and **quality control**

Journal of Neurology (2019) 266:2848–2858
https://doi.org/10.1007/s00415-019-09509-4

ORIGINAL COMMUNICATION

Check for updates

MRI quality control for the Italian Neuroimaging Network Initiative: moving towards big data in multiple sclerosis

Loredana Storelli[1,2] · Maria A. Rocca[1,3] · Patrizia Pantano[4,5] · Elisabetta Pagani[1] · Nicola De Stefano[6] · Gioacchino Tedeschi[7] · Paola Zaratin[8] · Massimo Filippi[1,2,3] · For the INNI Network

CORSI OPERATORI

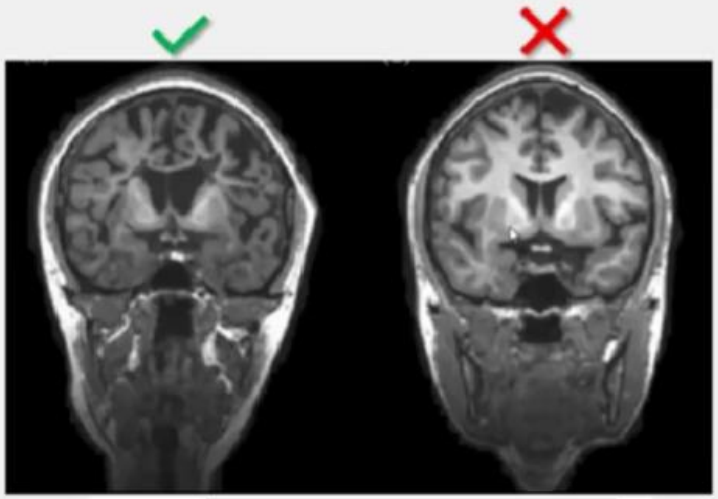
Verso una standardizzazione per l'identificazione e misurazione delle lesioni della sostanza bianca nel paziente con SM

Formazione per l'eccellenza

The INNI initiative / Quality control

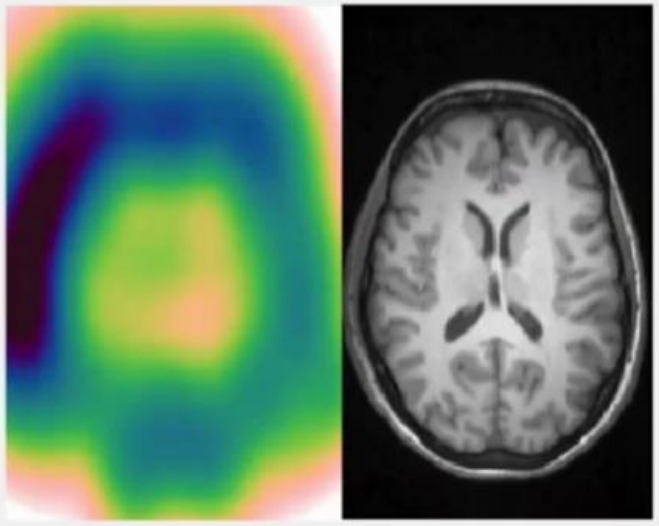
A quality control (QC) procedure is implemented to characterize and monitor the INNI database, including:

(1) Subject positioning into the MR scanner



$$ED = \sqrt{(x_I - x_C)^2 + (y_I - y_C)^2 + (z_I - z_C)^2}.$$

(2) Intensity inhomogeneity

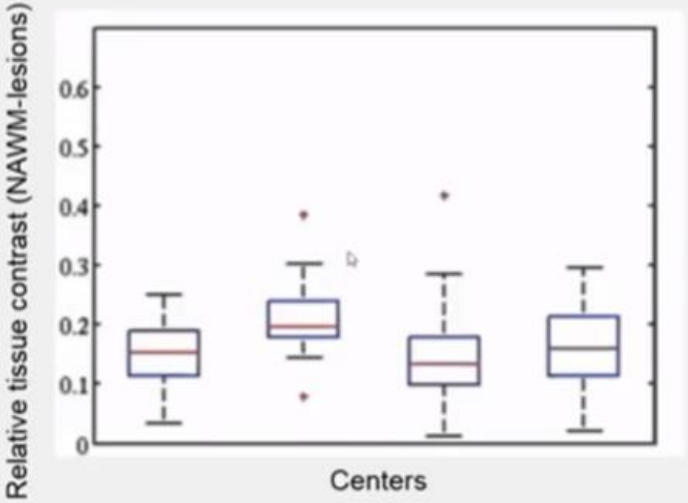


Storelli et al., J Neurol 2019

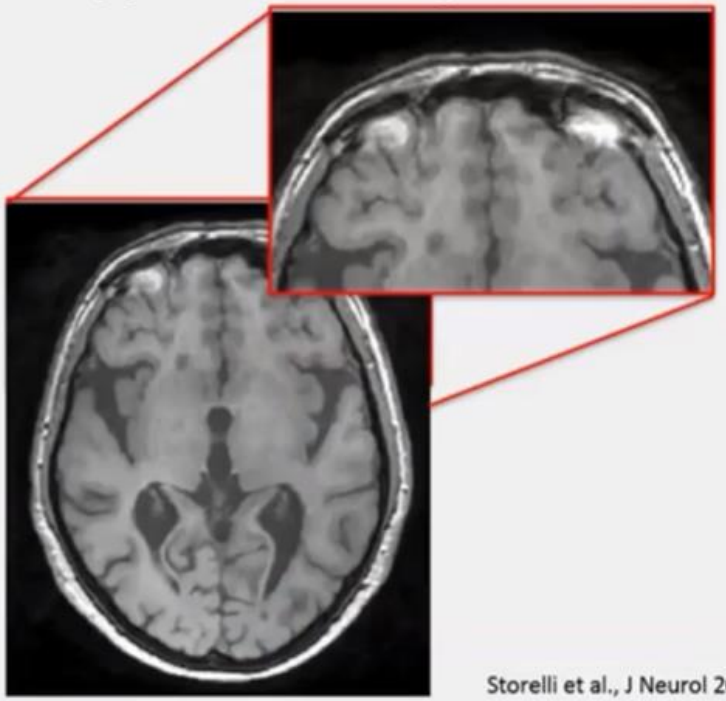
INNI – Sclerosi Multipla

The INNI initiative / Quality control

(3) Image tissue contrast



(4) Presence of image artifacts



Storelli et al., J Neurol 2019

Verso una standardizzazione per l'identificazione e misurazione delle lesioni della sostanza bianca nel paziente con SM

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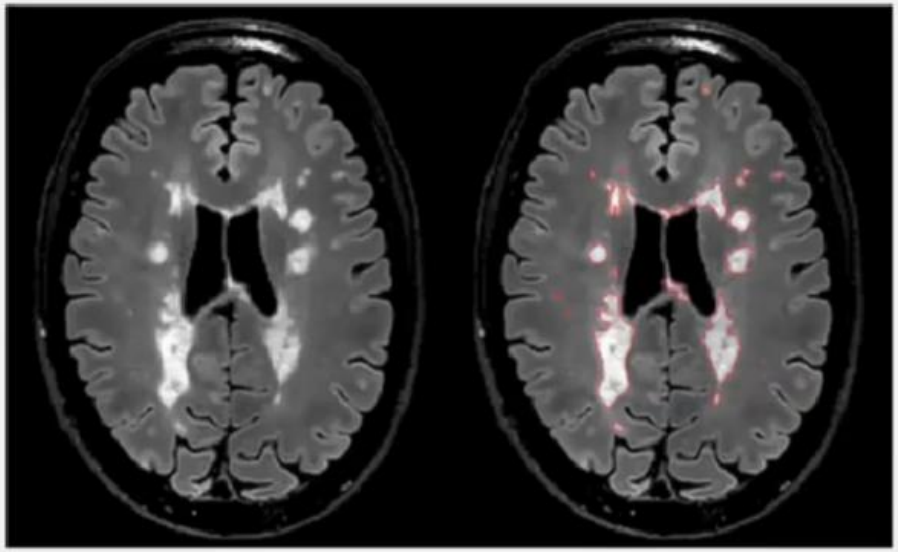
The INNI initiative / Quality control

(4) Quality check and standardization of lesion assessment



1. The **best contrast** between WM, GM, and lesions is set
2. Region of interests (ROIs) should be defined using a **conservative approach** (mildly hyperintense areas around visible lesions should not be included)
3. Check on **longitudinal consistency** of lesion maps

Verso una standardizzazione per l'identificazione e misurazione delle lesioni della sostanza bianca nel paziente con SM

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The INNI initiative / Quality control

- To reduce variability, the procedure of **QC and pre-processing is centralized**
- QC measures would be available together with MRI data to promote the use of a quality-assessed and standardized database

Verso una standardizzazione per l'identificazione e misurazione delle lesioni della sostanza bianca nel paziente con SM

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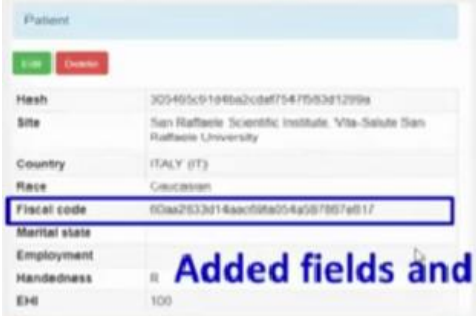
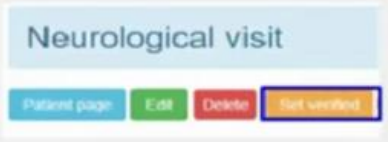
The INNI initiative / Quality control



Added fields and sections



Datasets verification by the Data Controller

Automatization of data upload

MRI exam interface

Verso una standardizzazione per l'identificazione e misurazione delle lesioni della sostanza bianca nel paziente con SM

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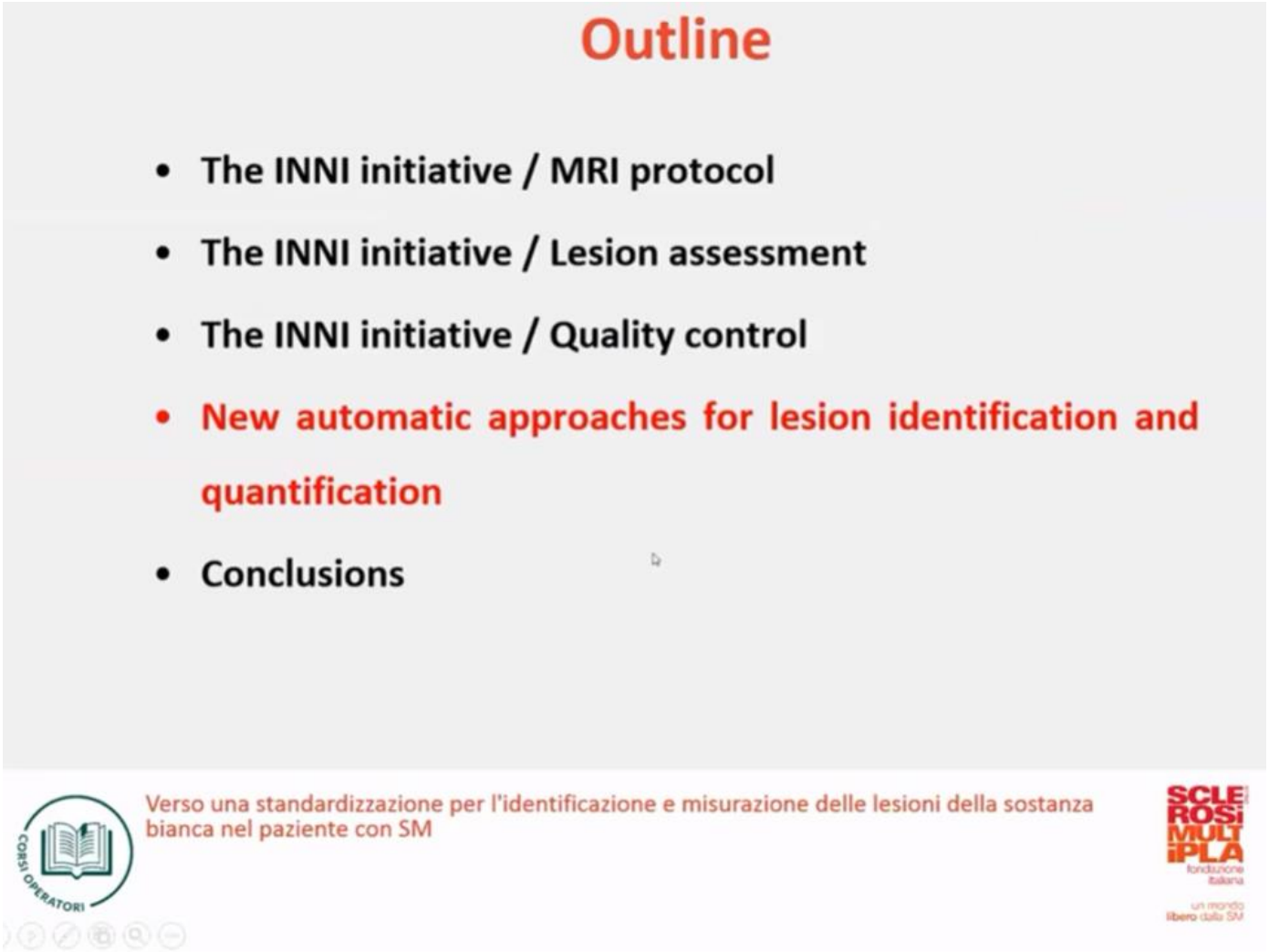

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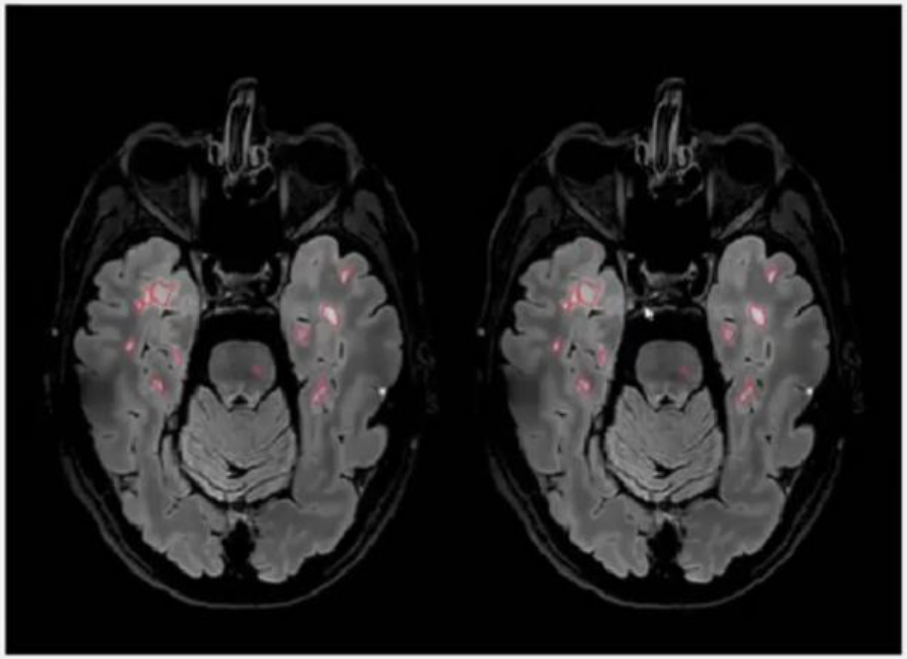
T2-lesion identification in MS: standard approach

- **Time-consuming**
  - 3D > 2D sequences
  - High > low lesion load
- **High intra- and inter-rater variability**

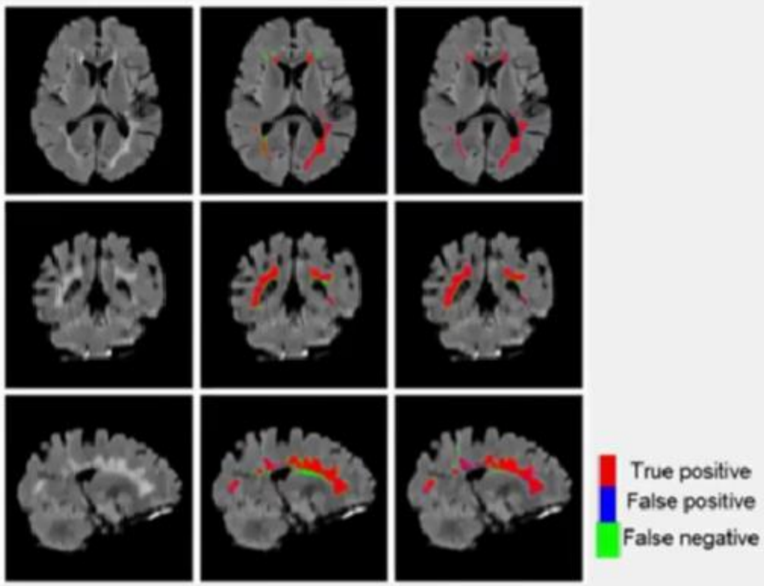


Verso una standardizzazione per l'identificazione e misurazione delle lesioni della sostanza bianca nel paziente con SM

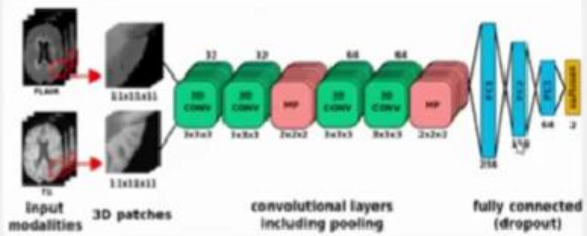
Formazione per l'eccellenza

T2-lesion identification in MS: new approaches

Lesions segmentation Deep learning



Aslani, Dayan, Storelli et al., Neuroimage 2019



Method	DSC	Sensitivity	Precision	Score
Andermatt et al. (2017)	0.63 (0.14)	0.54 (0.19)	0.84 (0.10)	92.07
Hashemi et al. (2018)	0.66 (0.11)	0.67 (0.20)	0.71 (0.16)	91.52
Valverde et al. (2017)	0.64 (0.12)	0.57 (0.17)	0.79 (0.15)	91.44
Birenbaum and Greenspan (2017)	0.63 (0.14)	0.55 (0.18)	0.80 (0.15)	91.26
Roy et al. (2018)[a]	0.52 (– –)	-- (– –)	0.86 (– –)	90.48
Deshpande et al. (2015)	0.60 (0.13)	0.55 (0.17)	0.73 (0.18)	89.81
Jain et al. (2015)	0.55 (0.14)	0.47 (0.15)	0.73 (0.20)	88.74
Shiee et al. (2010)	0.55 (0.19)	0.54 (0.15)	0.70 (0.29)	88.46
Valcarcel et al. (2018)	0.57 (0.13)	0.57 (0.18)	0.61 (0.16)	87.71
Sudre et al. (2015)	0.52 (0.14)	0.46 (0.15)	0.66 (0.18)	86.44
Full train	0.63 (0.13)	0.55 (0.16)	0.79 (0.14)	91.33
One-shot (3 layers, 26.8 ml.)	0.58 (0.16)	0.48 (0.19)	0.84 (0.13)	90.32

Valverde et al., Neuroimage 2018

Method	DSC	PPV	LTPR	LFPR	VD	SD	HD
TOADS (Shiee et al., 2010)	0.5241	0.5965	0.4608	0.6277	0.4659	5.4392	13.60
LST (Schmidt et al., 2012)	0.3022	0.5193	0.1460	0.3844	0.6966	7.0919	14.35
OASIS (Sweeney et al., 2013)	0.4193	0.3483	0.3755	0.4143	2.0588	3.5888	18.33
U-NET [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OURS	0.6655	0.8032	0.4465	0.0842	0.3372	2.5751	6.728

Verso una standardizzazione per l'identificazione e misurazione delle lesioni della sostanza bianca nel paziente con SM

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Gemelli

2022 HOSPITALS Newsweek statista
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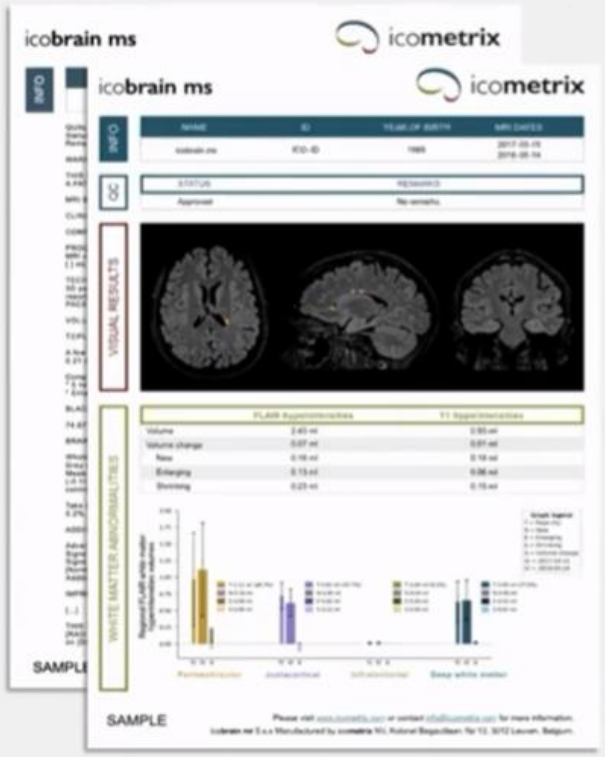
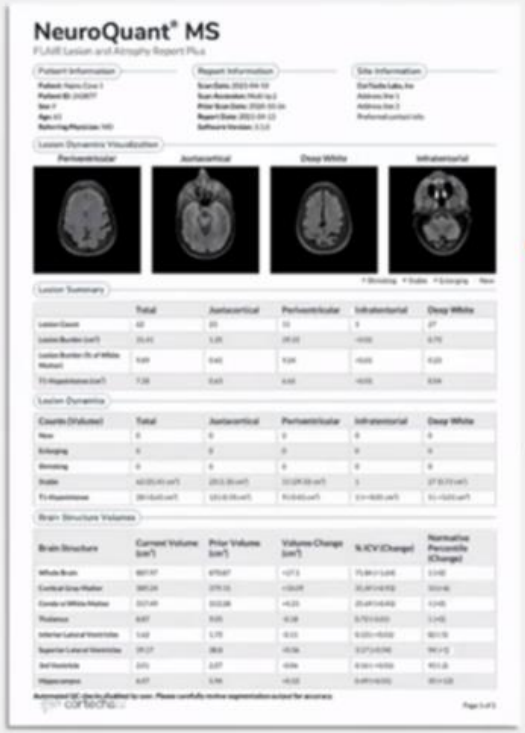
INNI – Sclerosi Multipla

Automatic assessment of lesion dissemination in space and time





- **Automatic reports** to visualize and obtain volumetric quantification and segmentation of brain structures and lesions
- **T2-hyperintense lesion distribution** according to the McDonald criteria
- Directly **installed on PACS**

Verso una standardizzazione per l'identificazione e misurazione delle lesioni della sostanza bianca nel paziente con SM

Formazione per l'eccellenza

Conclusions

- The creation of a standardized protocol of MRI acquisition to be applied for the study of patients with MS will provide an important step towards a better harmonization of MRI application in the MS field at a national level
- The proposed guidelines for lesion assessment are essential to apply more standardized lesion assessment criteria in MS
- Image QC is another important aspect to ensure a good quality repository for future quantitative analyses using INNI dataset
- The INNI initiative paved the way for a future standardization of MRI analysis in patients with MS
- The use of automatic approaches is appealing, but needs further validations and confirmation on larger multicenter datasets

Ongoing effort and future steps

- Developments of methods for longitudinal assessment of T2 lesion volume and new/enlarged T2 lesions
- Inclusion of T1-hypointense lesions
- Inclusion of cortical lesions
- Verification of availability of other sequences for testing other possible MRI biomarkers (e.g., SWI, quantitative sequences)

Formazione per l'eccellenza

Towards the Standardization of Brain Atrophy in MS

Nicola De Stefano

Department of Medicine, Surgery and Neuroscience

University of Siena, Italy

CORSI OPERATORI

SCLEROSI MULTIPLA fondazione italiana

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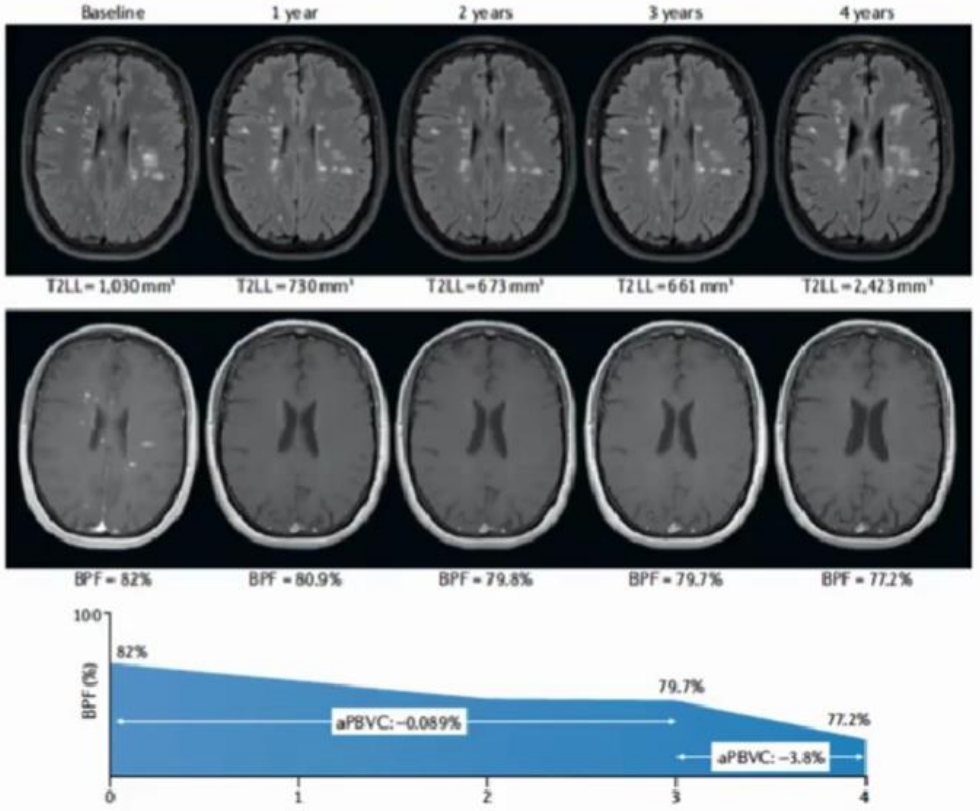
Formazione per l'eccellenza

MAGNIMS consensus recommendations on the use of brain and spinal cord atrophy measures in clinical practice

NATURE REVIEWS | NEUROLOGY
VOLUME 16 | MARCH 2020 | 171

Jaume Sastre-Garriga[1,2], Deborah Pareto[3], Marco Battaglini[4], Maria A. Rocca[5], Olga Ciccarelli[6,7], Christian Enzinger[7], Jens Wuerfel[8], Maria P. Sormani[9,10], Frederik Barkhof[6,11,12], Tarek A. Yousry[6,13], Nicola De Stefano[4], Mar Tintoré[1], Massimo Filippi[5,14], Claudio Gasperini[15], Ludwig Kappos[16], Jordi Rio[1], Jette Frederiksen[17], Jackie Palace[18], Hugo Vrenken[11], Xavier Montalban[1,19], Àlex Rovira[2] and on behalf of the MAGNIMS study group



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N. De Stefano

INNI – Sclerosi Multipla

JOURNAL OF MAGNETIC RESONANCE IMAGING 37:1–14 (2013)

Review

Clinical Use of Brain Volumetry

CME

Antonio Giorgio, MD, PhD and Nicola De Stefano, MD, PhD*

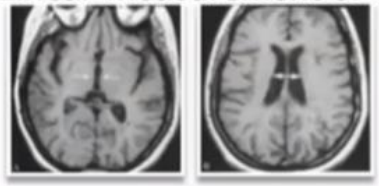
Use of MRI-based brain volumetry in different clinical scenarios

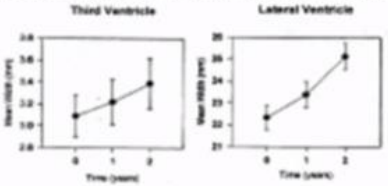
Supporting disease diagnosis	Understanding mechanisms and tracking clinical progression of disease	Monitoring treatment effect
Alzheimer's disease	Alzheimer's disease	Alzheimer's disease
Frontotemporal dementia	Multiple sclerosis	Multiple sclerosis
Focal epilepsy	Focal epilepsy	
Parkinsonisms	Headache/migraine	
	Amyotrophic lateral sclerosis	
	CADASIL	

INNI – Sclerosi Multipla

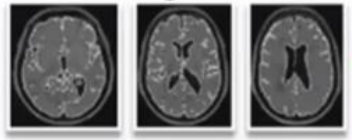
MRI-Based measures to assess brain volumes

- *Linear measurement of the third ventricle and lateral ventricles*[2]





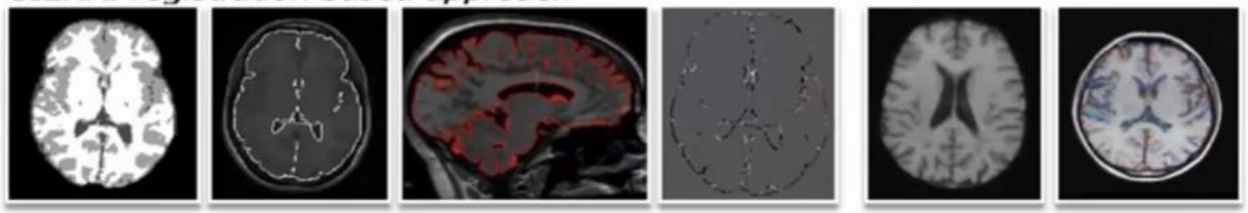
- *BPF: distinguishes skull and CSF from brain tissue*[3]



BPF = 0.7937

BPF = 0.7746,
(difference: –0.0191, % change: –2.40)

- *SIENA: registration based approach*



1. Cohen RM, et al. Neurobiol Aging 2006;27(10):1385-94; 2. Simon JH, et al. Neurology 1999;53(1):139-48;
3. Fisher E, et al. . Neurology 2002;59(9):1412-20; 4. Battaglini M, et al. . J Neurol Sci 2009;282(1-2):55-60

4

Challenges to the Use of BV in Clinical Practice

Category	Topic
Physiological factors [11, 57, 64, 66, 70, 74, 75]	Age
	Body mass index
	Diurnal variation
	Genotype (ApoE expression)
	Hydration state
	Menstrual cycle
Disease-related factors [11, 57, 64, 74–77]	Fluid-level changes attributable to inflammation (edema)
	Fluid-level changes attributable to resolution of inflammation (treatment-related pseudoatrophy)
Habits and comorbidities [11, 64, 66, 74]	Alcohol consumption
	Cardiovascular hypertension
	Diabetes mellitus
	Obesity
	Smoking
MRI-related factors [11, 57, 64, 65, 74, 76]	Changes in acquisition protocols
	Changes in scanner type and scanner upgrades
	Factors influencing scan quality (head motion, distortions, inhomogeneity artifacts)
	Measurement error
	Non-standardized quantification methods
	Patient repositioning in the scanner
Logistical factors [11, 57, 64, 65, 76]	Reimbursement
	Complexity of use (e.g. PACS integration)
	Lack of normative data
	Methods dependent on real-time data
	Poor integration of some image formats

De Stefano et al CNS Drugs 2017

Challenges to the Use of BV in Clinical Practice

- MRI Acquisition
- MRI Analysis
- Data interpretation

De Stefano et al CNS Drugs 2017

6

INNI – Sclerosi Multipla

MRI Acquisition for Volumetry - GE

GE 1.5T Signa Excite, Discovery, Optima, Brivo, Voyager, Creator, Explorer & Artist Excite, Discovery, Pioneer, Architect and Premier				GE 3T Signa	
		1.5 T	1.5 T	3 T	3 T
	Sequence name	C-Spine 3D IR-FSPGR	Brain 3D IR-FSPGR	C-Spine 3D IR-FSPGR	Brain 3D IR-FSPGR
Imaging parameters	Plane	Sagittal	Sagittal	Sagittal	Sagittal
	Mode	3D	3D	3D	3D
	Pulse sequence	FSPGR	FSPGR	FSPGR	FSPGR
	Grad Mode (twinspeed only)	Zoom	Zoom	Zoom	Zoom
	Imaging options	EDR, Fast, IR prep, Asset/ARC	EDR, Fast, IR prep, Asset/ARC	EDR, Fast, IR prep, Asset/ARC	EDR, Fast, IR prep, Asset/ARC
Acquisition	Freq. FOV	25.0	25.0	25.0	25.0
	Phase FOV	1.0	1.0	1.0	1.0
	Slice thickness	1.0	1.0	1.0	1.0
	Spacing (2D)				
	Freq Dir	SI	SI	SI	SI
	TR (ms)	-	-	-	-
	# slices / locs per slab	192	192	192	192
	Chem SAT				
Details	# of TE(s) per scan	1	1	1	1
	Num shots				
	TE (ms)	Min Full	Min Full	Min Full	Min Full
	Flip angle	12	12	11	11
	Prep Time/TI (ms)	400	400	450	450
	ETL				
	Intensity Correction	PURE	PURE	PURE	PURE
	Intensity Filter	None	None	None	None
	3D Geometry Corr	Yes	Yes	Yes	Yes
	Frequency	256	256	256	256
	Phase	256	256	256	256
	NEX	1	1	1	1
	Bandwidth (kHz)	22.5	22.5	22.73	22.73
	Flow comp direction	-	-	-	-
Acceleration	Phase	1,75/2	1,75/2	1,75/2	1,75/2
	Slice	1/1,5	1/1,5	1/1,5	1/1,5
Additional instructions	User CV	Excitation = Slab Selective	Excitation = NON Selective	Excitation = Slab Selective	Excitation = NON Selective
	Other	No ZIP2. No ZIP512. Use of HyperSense is allowed if available.	No ZIP2. No ZIP512. Use of HyperSense is allowed if available.	No ZIP2. No ZIP512. Use of HyperSense is allowed if available.	No ZIP2. No ZIP512. Use of HyperSense is allowed if available.
Scan info	Imaging time	~4:40	~4:40	~4:40	~4:40

7

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MRI Acquisition for Volumetry - Siemens

		Siemens 1.5T SymphonyTim, Espree, Essenza, Avanto, Amira, Aera, Sempra and Sola Verio, Skyra, Spectra, Prisma, Biograph mMR, Vida and Lumina			Siemens 3T Trio,
		1,5 T	1,5 T	3 T	3 T
Sequence name		Spine 3D MP-RAGE	Brain 3D MP-RAGE	Spine 3D MP-RAGE	Brain 3D MP-RAGE
Sequence variant		*tfl3d1_ns	*tfl3d1_ns	*tfl3d1_ns	*tfl3d1_ns
Routine	Orientation	Sagittal	Sagittal	Sagittal	Sagittal
	Phase enc. direction	A >> P	A >> P	A >> P	A >> P
	Phase oversampling [%]	0 – 16,7	0 -16,7	0 -16,7	0 – 16,7
	Slice oversampling [%]	12.5	16.7	12.5	16.7
	Slices per group/slab	192	192	192	192
	FOV read [mm]	250	250	250	250
	FOV phase [%]	100	100	100	100
	Slice thickness [mm]	1.0	1.0	1.0	1.0
	Distance factor [%]				
	TR [ms]	2200/2300	2200/2300	2300/2400	2300/2400
	TE [ms]	minimum	minimum	minimum	minimum
	Averages	1	1	1	1
	Concatenations				
Contrast	Measurements	1	1	1	1
	Magn. preparation	Sel IR	Non-Sel IR	Sel IR	Non-Sel IR
	TI [ms]	900/950	900/950	900/1050	900/1050
	Flip Angle	8	8	9	9
	Fat suppr.	None	None	None	None
Resolution	Base resolution	256	256	256	256
	Phase resolution [%]	100	100	100	100
	Slice resolution [%]	100	100	100	100
	Phase partial Fourier	Off	Off	Off	Off
	Slice partial Fourier	Off	Off	Off	Off
	Filter	Prescan Normalize, Elliptical Filter Distortion Corr. 3D	Prescan Normalize, Elliptical Filter Distortion Corr. 3D	Prescan Normalize, Elliptical Filter Distortion Corr. 3D	Prescan Normalize, Elliptical Filter Distortion Corr. 3D
	Interpolation	Off	Off	Off	Off
	iPAT	Grappa/CAIPIRIHA acceleration AP = 2, Acceleration RL= 1	Grappa/CAIPIRIHA acceleration AP = 2, Acceleration RL= 1	Grappa/CAIPIRIHA acceleration AP = 2, Acceleration RL= 1 - 2	Grappa/CAIPIRIHA acceleration AP = 2, Acceleration RL= 1 - 2
Sequence	Contrasts				
	Bandwidth [Hz/Px]	130	130	190	190
	Flow comp.	No	No	No	No
	Asymmetric echo	Allowed	Allowed	Allowed	Allowed
	Turbo factor				
	Gradient mode	Fast	Fast	Fast	Fast
	Excitation	Non-sel.	Non-sel.	Non-sel.	Non-sel.
	RF spoiling	On	On	On	On
Additional instructions		USE of GRASP is allowed if available	USE of GRASP is allowed if available	USE of GRASP is allowed if available	USE of GRASP is allowed if available
Approximate scan time [min:sec]		~5:00	~5:00	~5:00	~5:00

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Formazione per l'eccellenza

MRI Acquisition for Volumetry - Philips

PROTOCOL FOR sagittal 3D T1-W OF THE BRAIN AND C-SPINE
Philips 1.5 T & 3 T (Intera, Achieva, and Ingenia)

		1.5 T	1.5 T	3 T	3 T
Sequence name		Spine 3D BrainVIEW T1	Brain 3D BrainVIEW T1	Spine 3D BrainVIEW T1	Brain 3D T1
Geometry	CLEAR	yes	yes	yes	yes
	FOV (mm)	250 (AP) × 250 (FH) × 192 (RL)	250 (AP) × 250 (FH) × 192 (RL)	250 (AP) × 250 (FH) × 192 (RL)	250 (AP) × 250 (FH) × 192 (RL)
	RFOV (%)	100	100	100	100
	Foldover suppression	no	no	no	no
	Voxel size (mm)	0.98 (AP) × 0.98 (FH) × 1.0 (RL)	0.98 (AP) × 0.98 (FH) × 1.0 (RL)	0.98 (AP) × 0.98 (FH) × 1.0 (RL)	0.98 (AP) × 0.98 (FH) × 1.0 (RL)
	Recon voxel size (mm)	0.98 (AP) × 0.98 (FH) × 1.0 (RL)	0.98 (AP) × 0.98 (FH) × 1.0 (RL)	0.98 (AP) × 0.98 (FH) × 1.0 (RL)	0.98 (AP) × 0.98 (FH) × 1.0 (RL)
	Matrix scan	256	256	256	256
	Reconstruction matrix	256	256	256	256
	Scan percentage (%)	100	100	100	100
	SENSE	S reduction (RL) = 2, P reduction (AP) = 1, P os factor = 1	S reduction (RL) = 2, P reduction (AP) = 1, P os factor = 1	S reduction (RL) = 2, P reduction (AP) = 1, P os factor = 1	S reduction (RL) = 2, P reduction (AP) = 1, P os factor = 1
	Slices	192	192	192	192
	Slice thickness (mm)	1.0	1.0	1.0	1.0
	Slice gap (mm)	overcontiguous = no	overcontiguous = no	overcontiguous = no	overcontiguous = no
	Slice orientation	sagittal	sagittal	sagittal	sagittal
	Foldover direction	AP	AP	AP	AP
	Fat shift direction	F	F	F	F
	Rest slabs	0	0	0	0
Contrast	Scan mode	3D	3D	3D	3D
	Technique	FFE	FFE	FFE	FFE
	Contrast enhancement	T1	T1	T1	T1
	Fast Imaging mode	TFE	TFE	TFE	TFE
	Shot mode	multishot	multishot	multishot	multishot
	TFE factor	254	254	254	254
	Shot Interval (ms)	shortest	shortest	shortest	shortest
	Profile order	linear	linear	linear	linear
	Echoes	1	1	1	1
	Partial echo	no	no	no	no
	TE (ms)	shortest	shortest	shortest	shortest
	Flip angle (deg)	8	8	8	8
	TR (ms)	shortest	shortest	shortest	shortest
	Half Scan	no	no	no	no
	Water fat shift	0,8/1,6 (user-defined)	0,8/1,6 (user-defined)	1,8/2 (user-defined)	1,8/2 (user-defined)
	Fat suppression	no	no	no	no
	TFE / IR prepulse	invert	invert	invert	invert
	Slice selection	no	no	no	no
	TI (ms)	950 (TFE prepulse delay)	950 (TFE prepulse delay)	1060 (TFE prepulse delay)	1060 (TFE prepulse delay)
	Diffusion mode	no	no	no	no
Motion	Flow compensation	no	no	no	no
	NSA	1	1	1	1
Other		USE of CompressedSENSE is allowed if available	USE of CompressedSENSE is allowed if available	USE of CompressedSENSE is allowed if available	USE of CompressedSENSE is allowed if available
Approximate scan time		~5:00	~5:00	~5:00	~5:00

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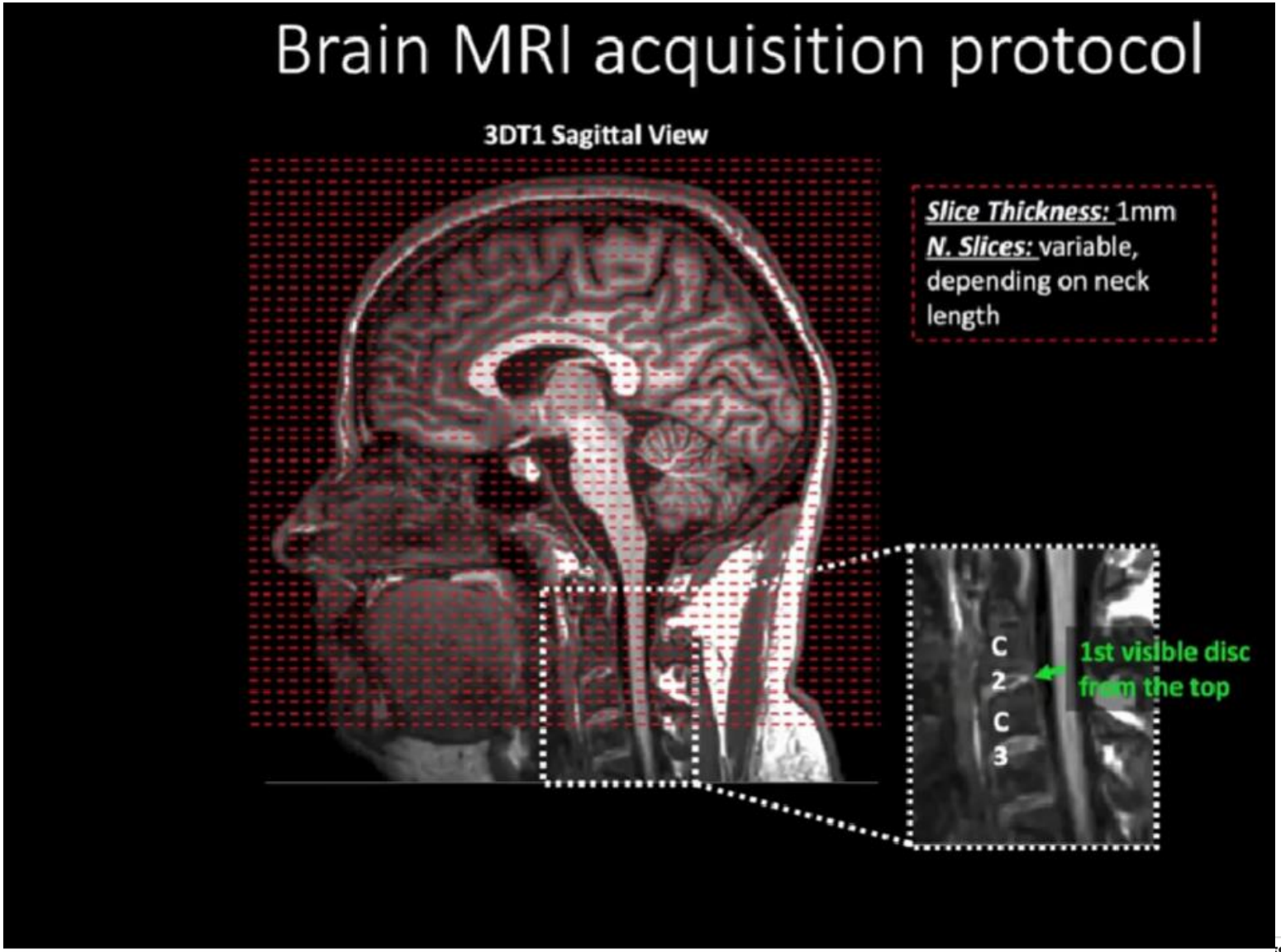
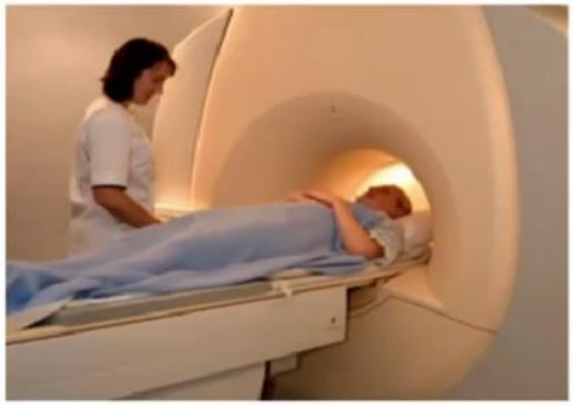
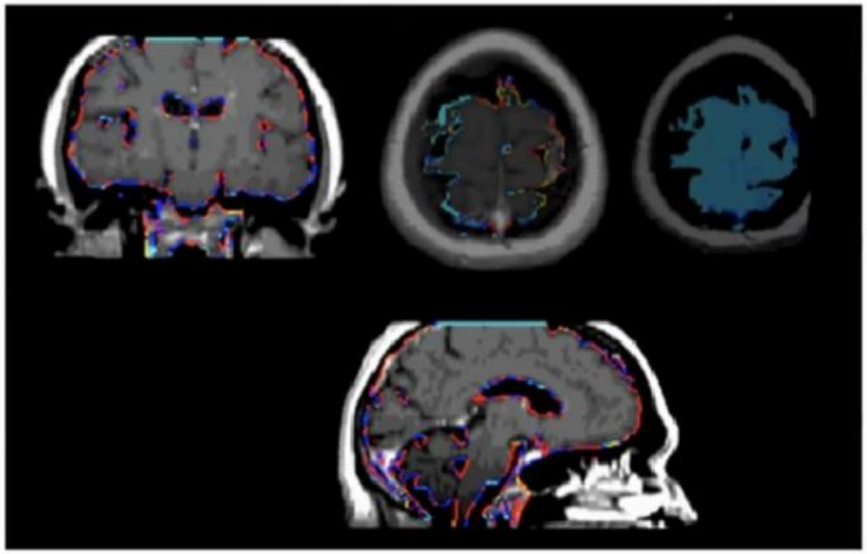


Image Acquisition – Data Quality

Patient/Operator



Partial head acquisition



Courtesy of Department of Medicine, Surgery and NeuroScience, University of Siena, Italy.

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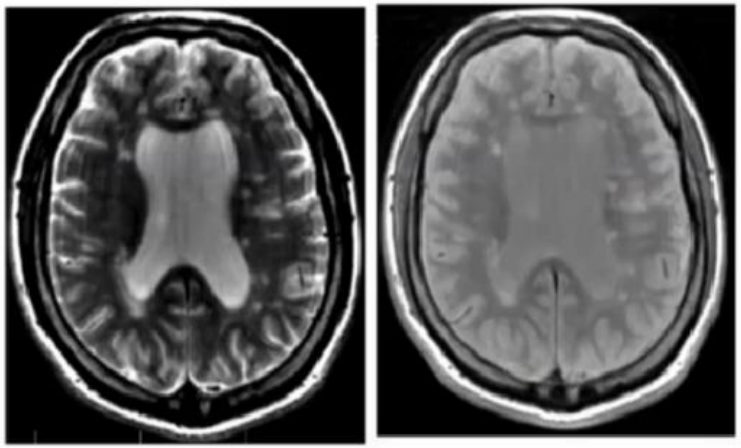
N. De Stefano

Image Acquisition – Data Quality

Patient/Operator

Intensity and movement artifacts



Courtesy of Department of Medicine, Surgery and NeuroScience, University of Siena, Italy.

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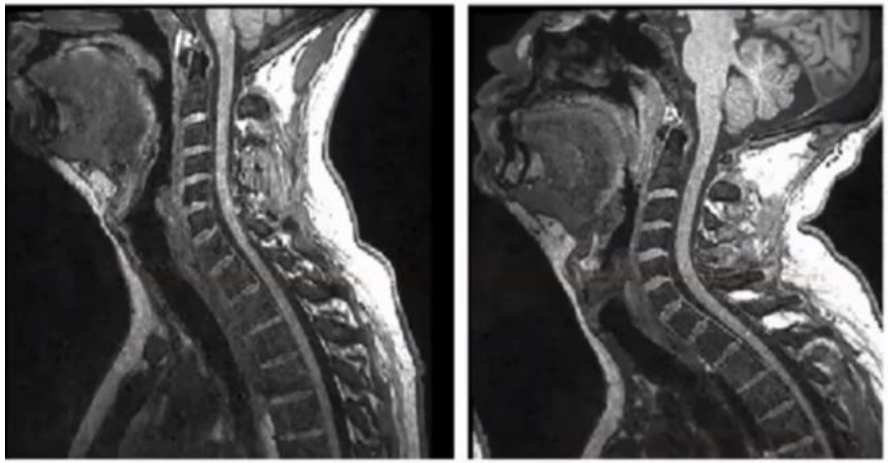
Image Acquisition – Data Quality

- Incorrect repositioning



Baseline

Courtesy of Paola Valsalsina & Mara Rocca

Follow-up

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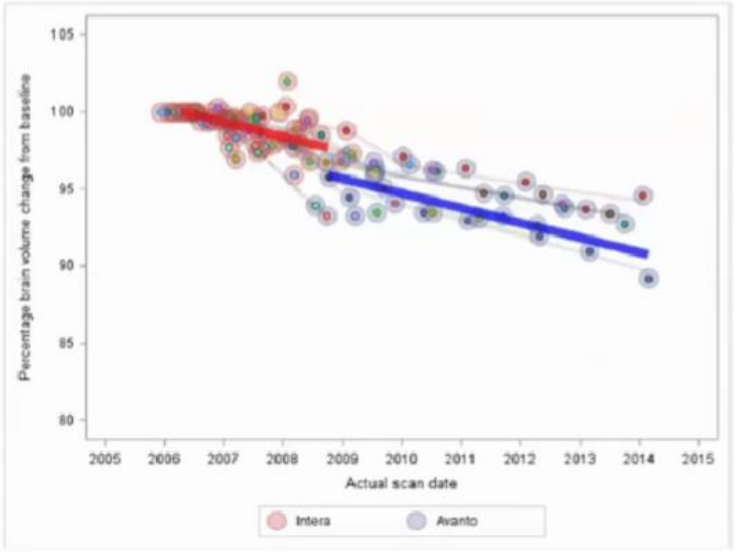
Formazione per l'eccellenza

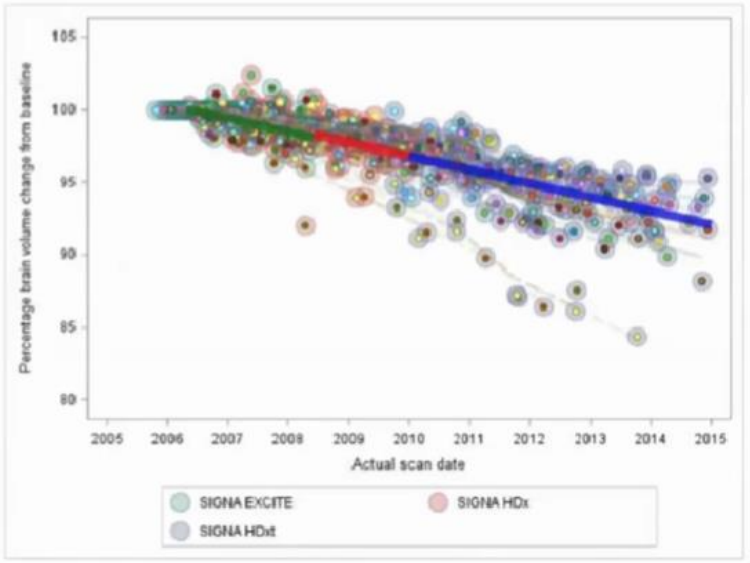
Estimating and accounting for the effect of MRI scanner changes on longitudinal whole-brain volume change measurements

Hyunwoo Lee [a,*], Kunio Nakamura [b], Sridar Narayanan [a], Robert A. Brown [a], Douglas L. Arnold [a], for the Alzheimer's Disease Neuroimaging Initiative[1]

[a] Montreal Neurological Institute, McGill University, Montreal, Quebec, Canada
[b] Lerner Research Institute, Cleveland Clinic, Cleveland, OH, USA

NeuroImage 184 (2019) 555–565





INNI – Sclerosi Multipla

Formazione per l'eccellenza

Estimating and accounting for the effect of MRI scanner changes on longitudinal whole-brain volume change measurements

Hyunwoo Lee [a,*], Kunio Nakamura [b], Sridar Narayanan [a], Robert A. Brown [a], Douglas L. Arnold [a], for the Alzheimer's Disease Neuroimaging Initiative [1]

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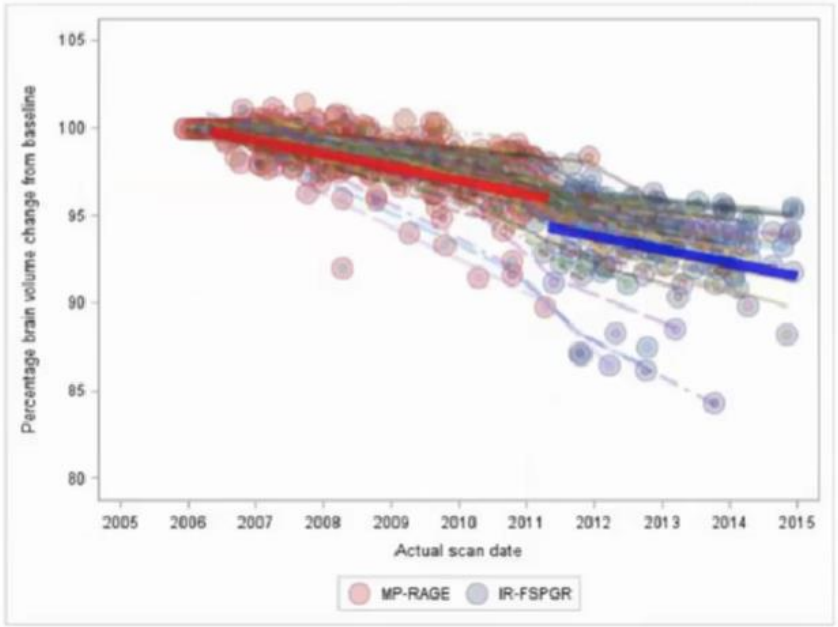
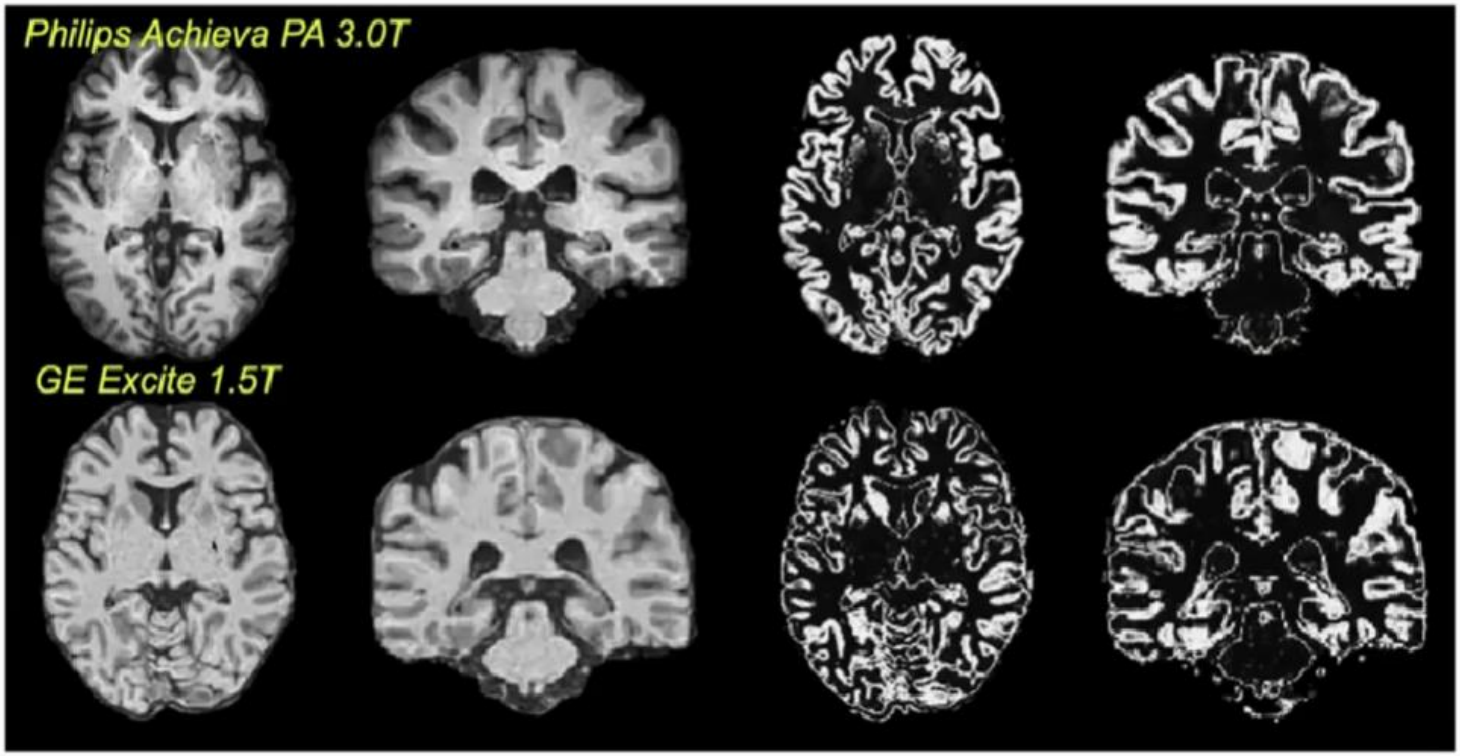
NeuroImage 184 (2019) 555–565



15

INNI – Sclerosi Multipla

Image Acquisition – The issue of standardization



Kruggel et al Neuroimage 2010

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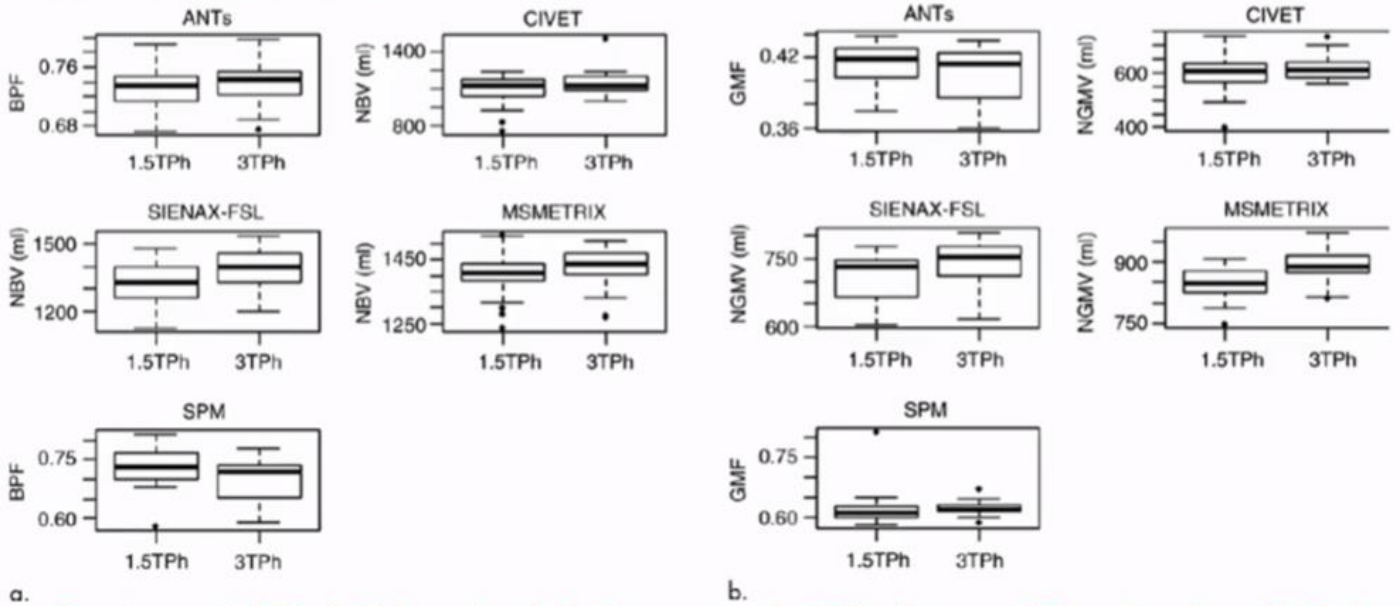
INNI – Sclerosi Multipla

Formazione per l'eccellenza

Measurement of Whole-Brain and Gray Matter Atrophy in Multiple Sclerosis: Assessment with MR Imaging

Loredana Storelli, MSc • Maria A. Rocca, MD • Elisabetta Pagani, MSc • Wim Van Hecke, PhD • Mark A. Horsfield, PhD • Nicola De Stefano, MD, PhD • Alex Rovira, MD • Jaume Sastre-Garriga, MD • Jacqueline Palace, MD • Diana Sima, PhD • Dirk Smeets, PhD • Massimo Filippi, MD • for the MAGNIMS Study Group

- 19 MS (Philips 1.5T & 3T)



- Great repeatability (within system), but poor reproducibility (among different systems/field strengths)
- An improved reproducibility is required for clinical application

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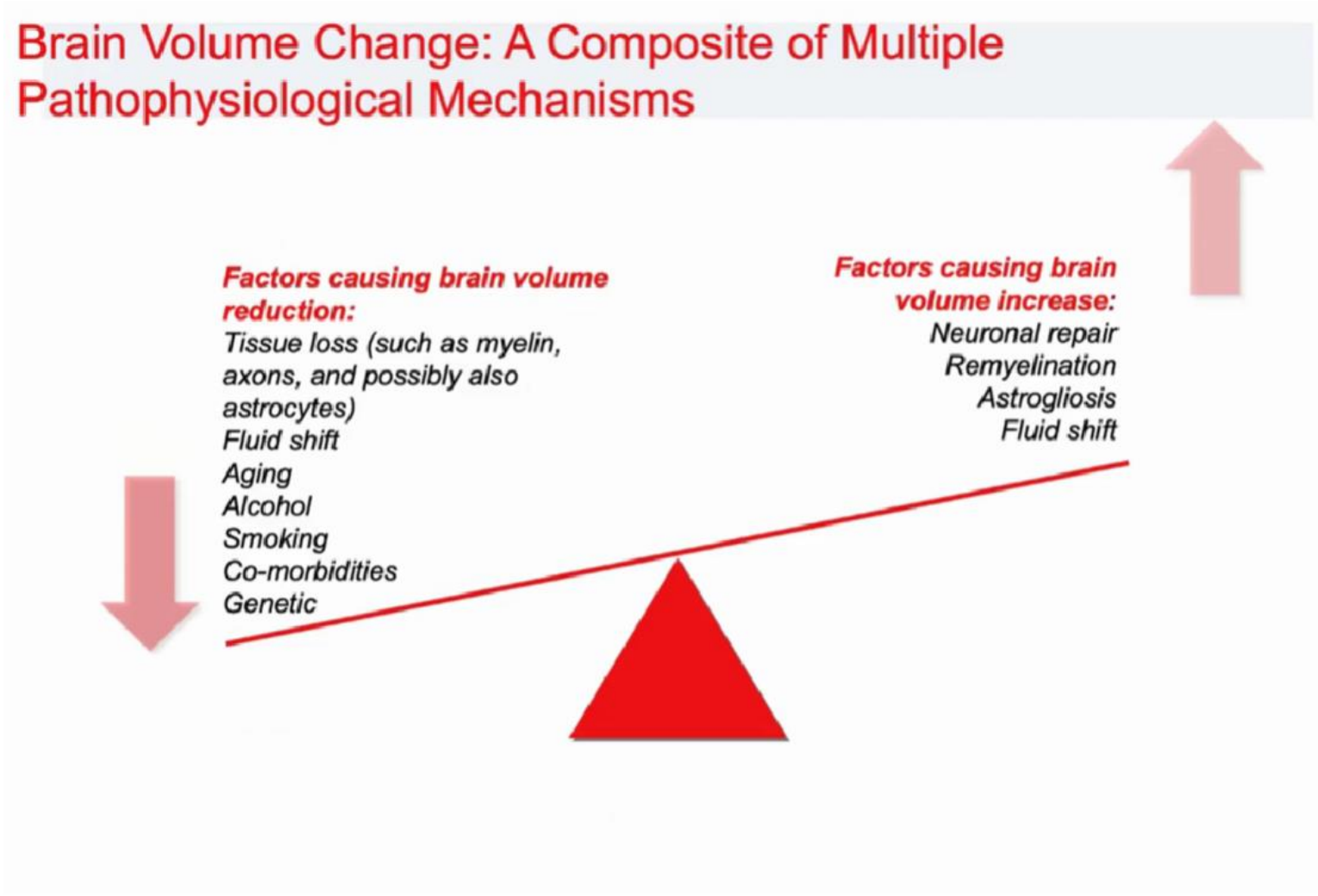
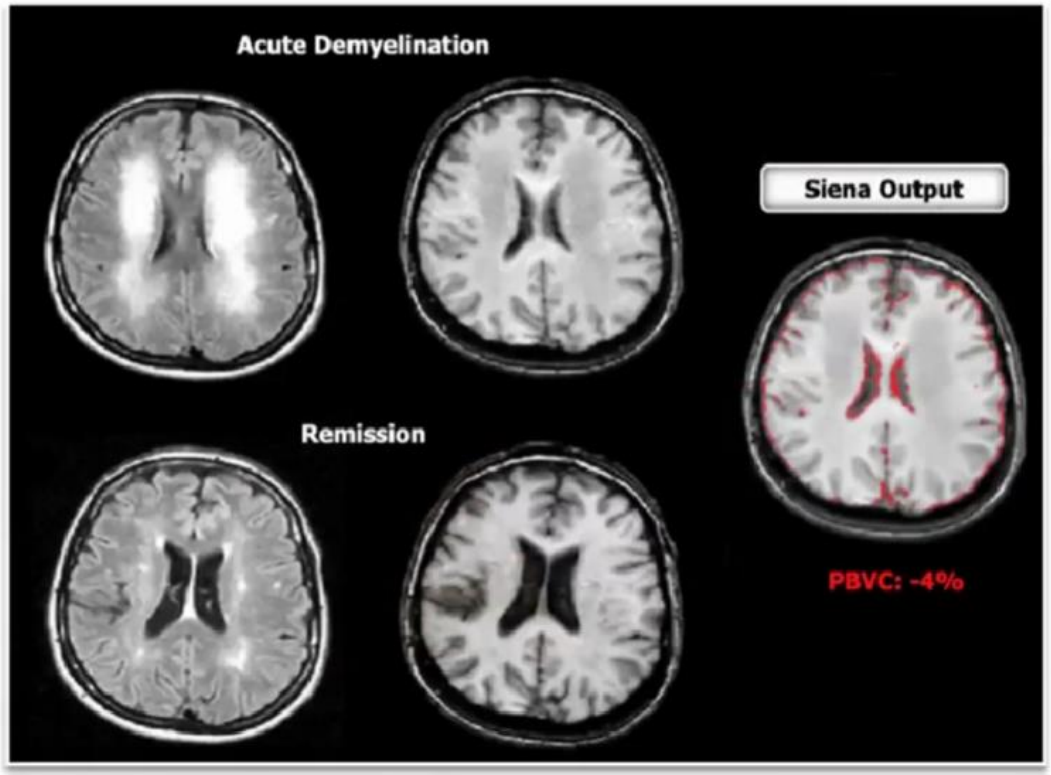


Formazione per l'eccellenza

Interpreting Brain Atrophy in MS

Pseudoatrophy



Giorgio A, et al. J Magn Reson Imaging 2013;37(1):1-14

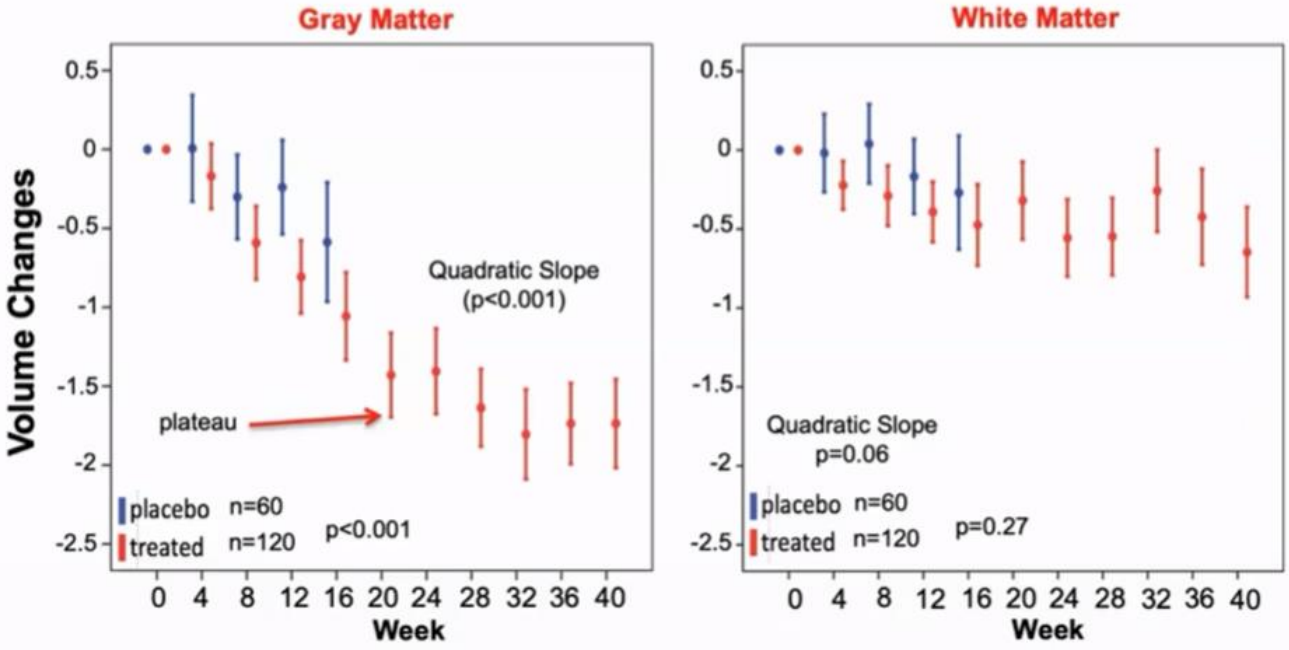
INNI – Sclerosi Multipla

ANNALS of Clinical and Translational Neurology
Open Access
RESEARCH ARTICLE

Dynamics of pseudo-atrophy in RRMS reveals predominant gray matter compartmentalization

Nicola De Stefano[1], Antonio Giorgio[1], Giordano Gentile[1], Maria Laura Stromillo[1], Rosa Cortese[1], Claudio Gasperini[2], Andrea Visconti[3], Maria Pia Sormani[4] & Marco Battaglini[1]

[1]Department of Medicine, Surgery and Neuroscience, University of Siena, Siena, Italy
[2]San Camillo-Forlanini Hospital, Rome, Italy
[3]Medical Affairs Department, Merck Serono, Rome, Italy
[4]Biostatistics Unit, Department of Health Sciences, University of Genoa, Genoa, Italy



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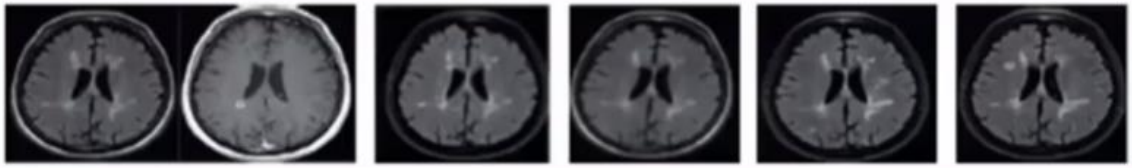
N. De Stefano

INNI – Sclerosi Multipla

Standardised brain MRI protocol for MS monitoring

Initial	New baseline	First follow-up*†	Second follow-up*†	Follow-ups*†
Pretreatment‡	3–6 months after treatment onset§	12 months after treatment onset	24 months after treatment onset	Every year while on treatment¶
Gadolinium recommended	Gadolinium usually not required‖	Gadolinium optional	Gadolinium optional	Gadolinium optional



Magnetic field strength: 3T (recommended, not mandatory)
Spatial resolution:
2D: 3 mm slice thickness (no gap), in-plane 1x1 mm
3D: isotropic voxel size 1x1x1 mm

Wattjes MP...Rovira A. *Lancet Neurol* 2021;20:653-670
Rovira A et al. *Nat Rev Neurol* 2015;11:471-82
Wattjes MP et al. Nat Rev Neurol 2015; 11: 597-606

Magnims

NAIMS
North American Imaging in MS Cooperative

CMSC

N. De Stefano

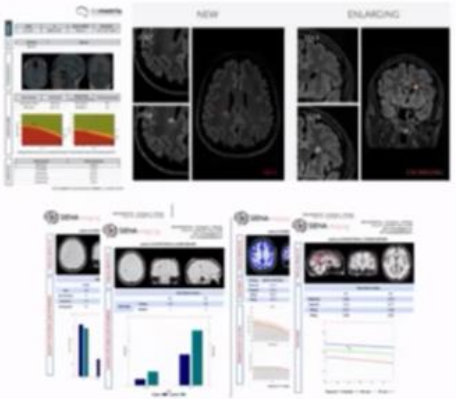
INNI – Sclerosi Multipla

Can we assess brain atrophy in the single patient?

- Increasing desire to use measures of brain volumes in clinical setting.
  - To assess prognosis
  - To monitor treatment effect

Integrated Platforms for MRI Quantification

- ✓ BrainMagix - amagylis
- ✓ Icobrain MS – icometrix
- ✓ Lesion Quant – Neuroquant
- ✓ Quantib ND - quantib
- ✓ Olea – subtraction module
- ✓ SIENA Imaging - SinLab



CORSI OPERATORI

SCLEROSI MULTIPLA fondazione Italiana un mondo libero dalla SM

N. De Stefano

Conclusions

- MRI-derived measures of brain volumes are feasible, sensitive to changes and clinically relevant. Need of standardised MRI acquisition
- Issues with data processing. To be done in specialized centres
- Issue with data interpretation (e.g. confounding factors). To be done by the clinician.
- Increasing desire to use measures of brain volumes in the clinical setting. Difficult for single patient assessment.

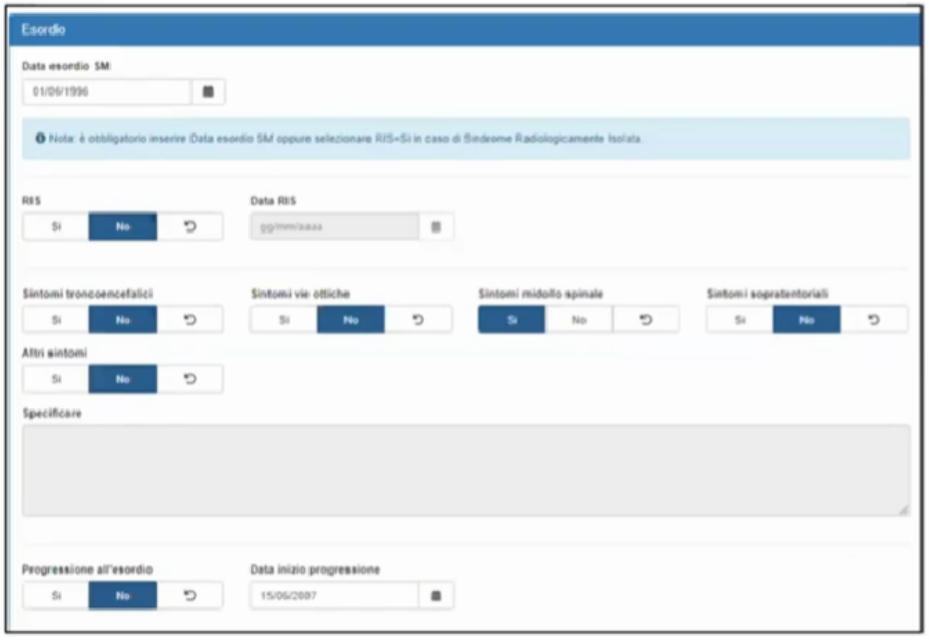
INNI – Sclerosi Multipla

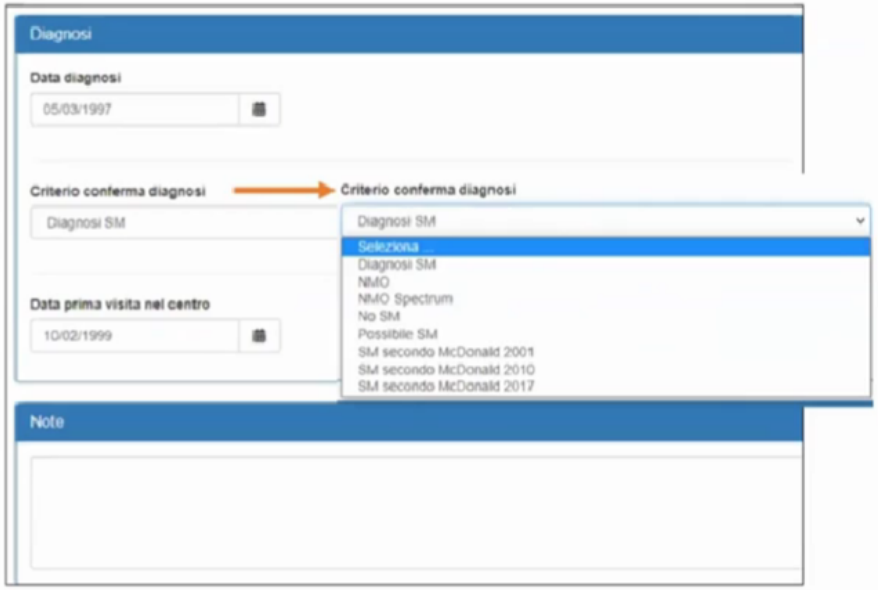
21 Giugno 2022 - Corso Virtuale
"The Italian neuroimaging network initiative (INNI): verso la standardizzazione dell'utilizzo della RM nel paziente con sclerosi multipla a livello nazionale"

A. Gallo

Formazione per l'eccellenza

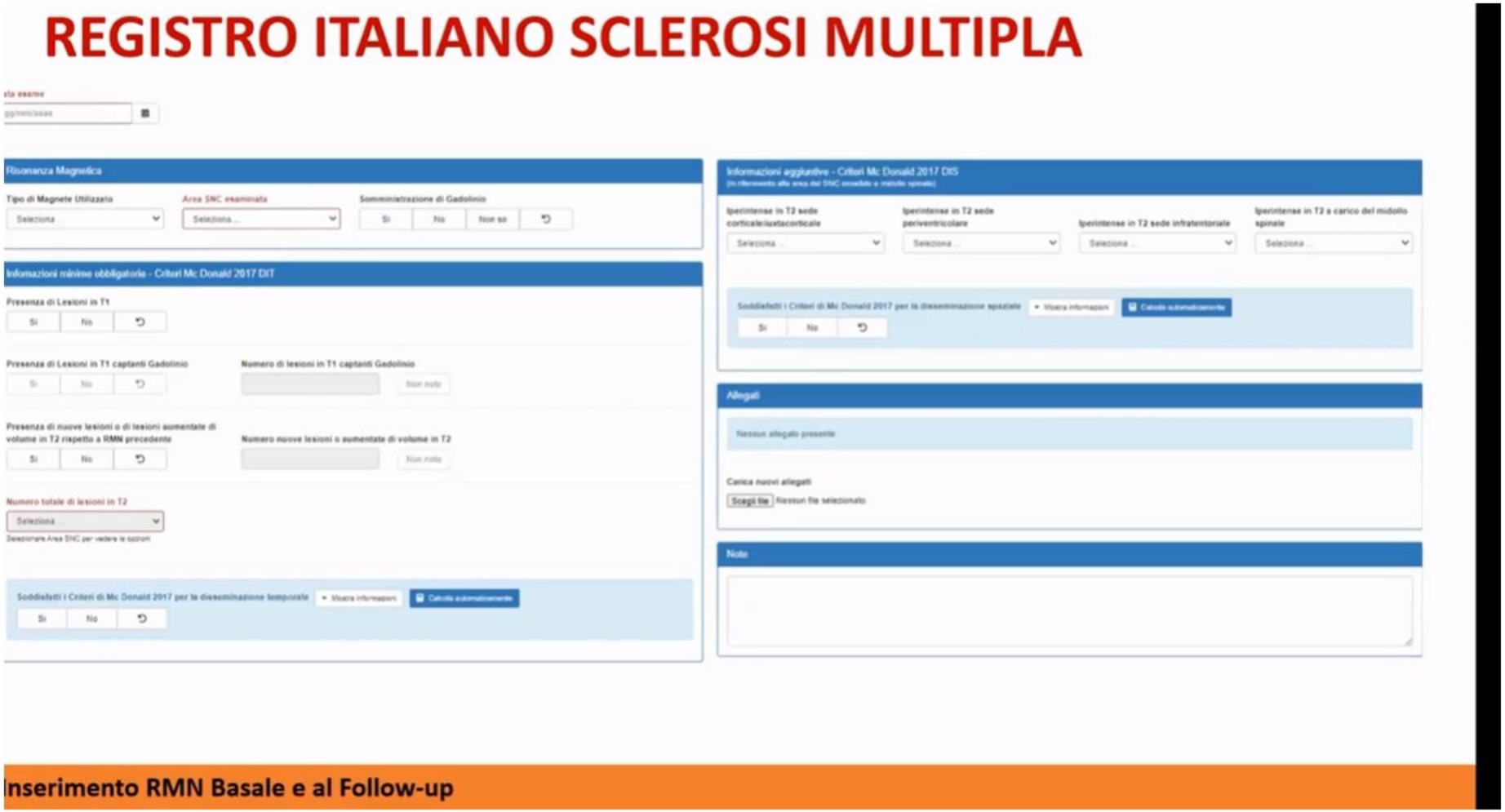
REGISTRO ITALIANO SCLEROSI MULTIPLA





Esordio e Diagnosi

INNI – Sclerosi Multipla



A. Gallo

Formazione per l'eccellenza

INTEGRAZIONE RISM-RM

- **Obiettivo strategico di FISM e del RISM:**

Integrazione dei dati clinico-demografici-terapeutici del RISM con gli esami RM dei pazienti, al fine di poter svolgere studi retrospettivi e prospettici (di correlazione, monitoraggio e predizione) ancora più accurati e completi.

Questo avanzamento del RISM prevede che i Centri SM possano caricare sulla piattaforma/server del RISM (sempre in maniera criptata) gli esami di RM dei pazienti, laddove vengano richiesti per un progetto del RISM (*) che prevede l'analisi anche dei dati di RM.

Survey conoscitiva sviluppata dai *core centers* di INNI (durata per la compilazione ca. 15 minuti)(**) per "fotografare" le attuali procedure di acquisizione/gestione degli esami RM eseguiti presso i Centri SM partecipanti al RISM.

(*) possibile/da valutare anche, per i Centri SM che lo preferissero, un caricamento dei dati continuo/parallelo all'inserimento dei dati clinici

(**) valutare anche il supporto e la condivisione con un neuroradiologo della struttura a cui afferisce il Centro SM

A. Gallo

Survey RISM-RM (6)

STUDIO ENCEFALO

Linee guida MAGNIMS-CMSC-NAIMS 2021 (requisiti minimi) - Wattjes et al. Lancet Neurology 2021

Raccomandate:

- Immagini T2 (TSE o FSE) assiali con spessore ≤3 mm, gap 0 mm e risoluzione sul piano 1x1x1 mm
- Immagini T2-FLAIR sagittali (meglio se 3D T2-FLAIR isotropiche 1x1x1 mm o cmq con spessore sempre ≤1.5 mm)
- Immagini T2-FLAIR assiali (**se non disponibile immagini 3D T2-FLAIR sagittali**) con spessore ≤3 mm, gap 0 mm
- Immagini T1 assiali post-mdc (oppure 3D sagittali) (raccomandate alla diagnosi; opzionali durante il monitoraggio)

Opzionali:

- Immagini 3D-T1 isotropiche ad alta risoluzione, DWI, DIR, PSIR, SWI

Formazione per l'eccellenza

Survey RISM-RM (8)

Quanti esami RM del midollo cervicale di pazienti con SM vengono eseguiti in media ogni anno con questo scanner e con il suddetto protocollo standardizzato? *menù a scelta multipla: <50/anno, 50-100/anno, >100/anno, >200/anno, >500/anno*

Quanti esami RM del midollo cervicale di pazienti con SM sono stati eseguiti fino ad oggi con questo scanner e con il suddetto protocollo standardizzato? *menù a scelta multipla: <50, 50-100, >100, >200, >500*

Quanti degli esami RM del midollo cervicale eseguiti fino ad oggi, con questo scanner e con il suddetto protocollo standardizzato, rispettano i requisiti minimi previsti specificamente dalle recenti linee guida MAGNIMS-CMSC-NAIMS 2021 (riportate di seguito)? *menù a scelta multipla: <50, 50-100, >100, >200, >500, Non so, Altro/Commenti (specificare)*

Linee guida MAGNIMS-CMSC-NAIMS 2021 (requisiti minimi) - Wattjes et al. Lancet Neurology 2021

Raccomandate:

- Almeno 2 immagini/sequenze sagittali tra le seguenti: T2 (TSE o FSE), PD (TSE o FSE) o STIR con spessore ≤3 mm, gap 0 mm
- Immagini T1 sagittali dopo contrasto (raccomandate alla diagnosi; opzionali durante il monitoraggio)

Opzionali:

- Immagini T1 sagittali e assiali pre-contrasto, T2 assiali (TSE o FSE), 3D-T1 sagittali (PSIR, FSPGR, MPRAGE)
