

# Structured Reporting in Multiple Sclerosis – Consensus-Based Reporting Templates for Magnetic Resonance Imaging of the Brain and Spinal Cord

## Strukturierte Befundung bei Multipler Sklerose – Konsensbasierte Befundvorlagen für die magnetresonanztomografische Untersuchung des Gehirns und des Rückenmarks

### Authors

Isabelle Riederer<sup>1</sup>, Mark Mühlau<sup>2</sup>, Benedikt Wiestler<sup>1</sup>, Benjamin Bender<sup>3</sup>, Johann-Martin Hempel<sup>3</sup>, Markus Kowarik<sup>3</sup>, Thomas Huber<sup>4</sup>, Claus Zimmer<sup>1</sup>, Tiberiu Andrisan<sup>1</sup>, Maximilian Patzig<sup>5</sup>, Hanna Zimmermann<sup>5</sup>, Joachim Havla<sup>6</sup>, Ansgar Berlis<sup>7</sup>, Lars Behrens<sup>7</sup>, Meinrad Beer<sup>8</sup>, Jennifer Dietrich<sup>8</sup>, Nico Sollmann<sup>1, 8</sup>, Jan Stefan Kirschke<sup>1</sup>

### Affiliations

- 1 Klinikum rechts der Isar, Technische Universität München, Abteilung für Diagnostische und Interventionelle Neuroradiologie, München, Deutschland
- 2 Klinikum rechts der Isar, Technische Universität München, Neurologische Klinik und Poliklinik, München, Deutschland
- 3 Radiologische Universitätsklinik Tübingen, Abteilung Diagnostische und Interventionelle Neuroradiologie, Tübingen, Deutschland
- 4 Universitätsmedizin Mannheim, Klinik für Radiologie und Nuklearmedizin, Mannheim, Deutschland
- 5 Klinikum der Universität München, LMU, Institut für diagnostische und interventionelle Neuroradiologie, München, Deutschland
- 6 LMU Klinikum, Institut für Klinische Neuroimmunologie, Ludwig-Maximilians-Universität, München, Deutschland
- 7 Universitätsklinikum Augsburg, Klinik für Diagnostische und Interventionelle Neuroradiologie, Augsburg, Deutschland
- 8 Klinik für Diagnostische und Interventionelle Radiologie, Universitätsklinikum Ulm, Ulm, Deutschland

### Key words

structured reporting, multiple sclerosis, magnetic resonance imaging

received 19.10.2021

accepted 09.05.2022

published online 29.07.2022

### Bibliography

Fortschr Röntgenstr 2023; 195: 135–138

DOI 10.1055/a-1867-3942


ISSN 1438-9029

© 2022, Thieme. All rights reserved.

Georg Thieme Verlag KG, Rüdigerstraße 14, 70469 Stuttgart, Germany

### Correspondence

Frau Dr. Isabelle Riederer  
Neuroradiologie, Klinikum rechts der Isar der Technischen Universität München, Ismaningerstr. 22, 81675 München, Germany  
Tel.: +49/89 41 40 57 15  
isabelle.riederer@tum.de

 Supplementary material is available under  
<https://doi.org/10.1055/a-1867-3942>

### ABSTRACT

As a result of technical developments and greater availability of imaging equipment, the number of neuroradiological examinations is steadily increasing [1]. Due to improved image quality and sensitivity, more details can be detected making reporting more complex and time-intensive. At the same time, reliable algorithms increasingly allow quantitative image analysis that should be integrated in reports in a standardized manner. Moreover, increasing digitalization is resulting in a decrease in the personal exchange between neuroradiologists and referring disciplines, thereby making communication more difficult. The introduction of structured reporting tailored to the specific disease and medical issue [2, 3] and corresponding to at least the second reporting level as defined by the German Radiological Society (<https://www.befundung.drg.de/de-DE/2908/strukturierte-befundung/>) is therefore desirable to ensure that the quality standards of neuroradiological reports continue to be met.

The advantages of structured reporting include a reduced workload for neuroradiologists and an information gain for referring physicians. A complete and standardized list with relevant details for image reporting is provided to neuroradiologists in accordance with the current state of knowledge, thereby ensuring that important points are not forgotten [4]. A time savings and increase in efficiency during reporting were also seen [5]. Further advantages include report clarity and consistency and better comparability in follow-up exami-

nations regardless of the neuroradiologist's particular reporting style. This results in better communication with the referring disciplines and makes clinical decision significantly easier [6, 7]. Although the advantages are significant, any potential disadvantages like the reduction of autonomy in reporting and inadequate coverage of all relevant details and any incidental findings not associated with the main pathology in complex cases or in rare diseases should be taken into consideration [4]. Therefore, studies examining the advantages of structured reporting, promoting the introduction of this system in the clinical routine, and increasing the acceptance among neuroradiologists are still needed.

Numerous specific templates for structured reporting, e. g., regarding diseases in cardiology and oncology, are already available on the website [www.befundung.drg.de](http://www.befundung.drg.de). Multiple sclerosis (MS) is an idiopathic chronic inflammatory and neurodegenerative disease of the central nervous system and is the most common non-trauma-based inflammatory neurological disease in young adults. Therefore, it has significant individual and socioeconomic relevance [8]. Magnetic resonance imaging (MRI) plays an important role in the diagnosis, prognosis evaluation, and follow-up of this disease. MRI is established as the central diagnostic method in the diagnostic criteria. Therefore, specific changes are seen on MRI in almost all patients with a verified MS diagnosis [9]. Reporting of MRI datasets regarding the brain and spinal cord of patients with MS includes examination of the images with respect to the relevant medical issue in order to determine whether the McDonald criteria, which were revised in 2017 [10] and define dissemination in time and space clinically as well as with respect to MRI based on the recommendations of the MAGNIMS groups [11, 12], are fulfilled. A more precise definition of lesion types and locations according to the recommendations of an international expert group [13] is discussed in the supplementary material. Spinal cord signal abnormalities are seen in up to 92% of MS patients [14–16] and are primarily located in the cervical spine [15]. The recommendations of the MAGNIMS–CMSC–NAIMS working group published in 2021 [11] explicitly recommend the use of structured reporting for MS patients.

Therefore, a reporting template for evaluating MRI examinations of the brain and spinal cord of patients with MS was created as part of the BMBF-funded DIFUTURE consortium in consensus with neuroradiological and neurological experts in concordance with the recommendations mentioned above [11] and was made available for broad use ([https://github.com/DRGagit/ak\\_befundung](https://github.com/DRGagit/ak_befundung)). The goal is to facilitate efficient and comprehensive evaluation of patients with MS in the primary diagnostic workup and follow-up imaging. These reporting templates are consensus-based recommendations and do not make any claim to general validity or completeness. The information technology working group (@GIT) of the German Radiological Society and the German Society for Neuroradiology strive to keep the reporting templates presented here up-to-date with respect to new research data and recommendations of the MAGNIMS–CMSC–NAIMS group [11].

### Key Points:

- consensus-based reporting templates
- template for the structured reporting of MRI examinations of patients with multiple sclerosis
- structured reporting might facilitate communication between neuroradiologists and referring disciplines

### Citation Format

- Riederer I, Mühlau M, Wiestler B et al. Structured Reporting in Multiple Sclerosis – Consensus-Based Reporting Templates for Magnetic Resonance Imaging of the Brain and Spinal Cord. *Fortschr Röntgenstr* 2023; 195: 135–138

### ZUSAMMENFASSUNG

Aufgrund technischer Entwicklungen und der breiteren Verfügbarkeit von Geräten der Bildgebung nimmt die Zahl an neuro-radiologischen Untersuchungen stetig zu [1]. Mit steigender Bildqualität und Sensitivität können zusätzlich mehr Details erkannt werden, sodass auch die Befundung komplexer und zeitaufwendiger wird. Gleichzeitig erlauben zuverlässige Algorithmen auch vermehrt quantitative Bildanalysen, die standardisiert in Befunde integriert werden sollten. Mit zunehmender Digitalisierung nimmt außerdem der persönliche Austausch zwischen den Neuroradiologen und zuweisenden Disziplinen ab, wodurch die Kommunikation erschwert wird. Um weiterhin die gewohnten Qualitätsstandards der neuroradiologischen Befunde gewährleisten zu können, ist daher die Einführung der strukturierten Befundung wünschenswert, die auf die jeweilige spezifische Erkrankung und Fragestellung zugeschnitten sein muss [2, 3] und mindestens der zweiten Stufe entsprechend der Definition der Deutschen Röntgengesellschaft entsprechen sollte (<https://www.befundung.drg.de/de-DE/2908/strukturierte-befundung/>). Zu den Vorteilen der strukturierten Befundung gehört eine Arbeitserleichterung für die Neuroradiologen sowie ein Informationsgewinn für den Zuweiser. Eine vollständige und standardisierte Liste mit relevanten Details für die Bildbefundung werden den Neuroradiologen auf dem jeweils aktuellen Wissenstand zur Verfügung gestellt, wodurch dem Vergessen wichtiger Punkte vorgebeugt wird [4]. Zusätzlich sind eine Zeitersparnis und Effizienzsteigerung bei der Befundung festgestellt worden [5]. Ein weiterer Vorteil liegt in der Klarheit und Konstanz des Befundes sowie in der besseren Vergleichbarkeit in Verlaufsuntersuchungen, die unabhängig vom jeweiligen Befundstil der Neuroradiologen sind. Dadurch wird die Kommunikation mit den zuweisenden Disziplinen verbessert und die klinische Entscheidungsfindung wesentlich erleichtert [6, 7]. Obwohl diese Vorteile deutlich überwiegen, sollten potenzielle Nachteile, wie die Reduzierung der Autonomie in der Befunderstellung und die inadäquate Abdeckung aller relevanten Einzelheiten und ggf. von nicht mit der Hauptpathologie assoziierten Nebenbefunden in komplexen Fällen oder bei seltenen Erkrankungen, bedacht werden [4]. Daher sind weiterhin Studien erforderlich, die die Vorteile

der strukturierten Befundung untersuchen, die Einführung dieses Systems in den klinischen Alltag fördern und die Akzeptanz bei den Neuroradiologen erhöhen. Auf der Website [www.befundung.drg.de](http://www.befundung.drg.de) sind bereits zahlreiche spezifische Vorlagen für die strukturierte Befundung vorhanden, wie z. B. zu Erkrankungen aus dem Bereich der Kardiologie und Onkologie. Die Multiple Sklerose (MS) ist eine idiopathische chronisch-entzündliche und neurodegenerative Erkrankung des zentralen Nervensystems und die häufigste nicht traumatisch bedingte entzündliche neurologische Erkrankung bei jungen Erwachsenen und daher von bedeutender individueller, aber auch sozioökonomischer Relevanz [8]. Die Magnetresonanztomografie (MRT) spielt bei dieser Erkrankung eine bedeutende Rolle bei der Diagnose, Prognoseabschätzung und Verlaufsbeurteilung. Die Diagnosekriterien haben als zentrale Diagnostik die MRT verankert, sodass praktisch alle Patienten mit einer gesicherten MS-Diagnose spezifische Veränderungen im MRT aufweisen [9]. Bei der Befundung von MRT-Datensätzen des Gehirns und des Rückenmarks von Patienten mit einer MS werden die Bilder hinsichtlich der Fragestellung untersucht, ob die Diagnosekriterien der sogenannten im Jahr 2017 revidierten McDonald-Kriterien [10] erfüllt sind, welche die zeitliche und räumliche Dissemination klinisch, aber auch kernspintomografisch nach den Empfehlungen der MAGNIMS-Gruppe [11, 12] definieren. Eine genauere Definition der Läsionstypen und -lokalisationen gemäß den Empfehlungen einer internationalen Experten-

gruppe [13] wird im Zusatzmaterial erläutert. Signalauffälligkeiten im Myelon zeigen sich in bis zu 92 % der MS-Patienten [14–16] und sind vor allem im zervikalen Myelon lokalisiert [15]. Die 2021 erschienenen Empfehlungen der MAGNIMS-CMSC-NAIMS Arbeitsgruppe [11] empfehlen auch explizit die Verwendung einer strukturierten Befundung für MS-Patienten. Daher wurde in einem Konsensverfahren im Rahmen des BMBF geförderten DIFUTURE-Konsortiums interdisziplinär mit neuroradiologischen und neurologischen Experten in Übereinstimmung mit den oben genannten aktuellen Empfehlungen [11] eine Befundvorlage für die Beurteilung von magnetresonanztomografischen Untersuchungen des Gehirns und Rückenmarks von Patienten mit MS erstellt und zur möglichst breiten Anwendung zur Verfügung gestellt ([https://github.com/DRGagit/ak\\_befundung](https://github.com/DRGagit/ak_befundung)). Es soll dadurch eine effiziente und vollständige Beurteilung von Patienten mit MS in der Primärdiagnostik und der Verlaufsbeurteilung ermöglicht werden. Diese Befundvorlagen sind als konsensbasierte Empfehlung anzusehen und besitzen keinen Anspruch auf Allgemeingültigkeit oder gar Vollständigkeit. Die AG für Informationstechnologie (@GIT) der DRG und die DGNR sind bestrebt, die hier vorgestellten Befundvorlagen bei neuen Forschungserkenntnissen oder Empfehlungen der MAGNIMS-CMSC-NAIMS-Gruppe [11] auf dem jeweils aktuellen Stand zu halten.

---

## Editorial/Consensus

### Structured Reporting in Multiple Sclerosis – Consensus-Based Reporting Templates for Magnetic Resonance Imaging of the Brain and Spinal Cord

As a result of technical developments and greater availability of imaging equipment, the number of neuroradiological examinations is steadily increasing [1]. Due to improved image quality and sensitivity, more details can be detected making reporting more complex and time-intensive. At the same time, reliable algorithms increasingly allow quantitative image analysis that should be integrated in reports in a standardized manner. Moreover, increasing digitalization is resulting in a decrease in the personal exchange between neuroradiologists and referring disciplines, thereby making communication more difficult. The introduction of structured reporting tailored to the specific disease and medical issue [2, 3] and corresponding to at least the second reporting level as defined by the German Radiological Society (<https://www.befundung.drg.de/de-DE/2908/strukturierte-befundung/>) is therefore desirable to ensure that the quality standards of neuroradiological reports continue to be met.

The advantages of structured reporting include a reduced workload for neuroradiologists and an information gain for referring physicians. A complete and standardized list with relevant details for image reporting is provided to neuroradiologists in accordance with the current state of knowledge, thereby ensuring that important points are not forgotten [4]. A time savings and

increase in efficiency during reporting were also seen [5]. Further advantages include report clarity and consistency and better comparability in follow-up examinations regardless of the neuro-radiologist's particular reporting style. This results in better communication with the referring disciplines and makes clinical decision significantly easier [6, 7]. Although the advantages are significant, any potential disadvantages like the reduction of autonomy in reporting and inadequate coverage of all relevant details and any incidental findings not associated with the main pathology in complex cases or in rare diseases should be taken into consideration [4]. Therefore, studies examining the advantages of structured reporting, promoting the introduction of this system in the clinical routine, and increasing the acceptance among neuroradiologists are still needed.

Numerous specific templates for structured reporting, e. g., regarding diseases in cardiology and oncology, are already available on the website [www.befundung.drg.de](http://www.befundung.drg.de). Multiple sclerosis (MS) is an idiopathic chronic inflammatory and neurodegenerative disease of the central nervous system and is the most common non-trauma-based inflammatory neurological disease in young adults. Therefore, it has significant individual and socioeconomic relevance [8]. Magnetic resonance imaging (MRI) plays an important role in the diagnosis, prognosis evaluation, and follow-up of this disease. MRI is established as the central diagnostic method in the diagnostic criteria. Therefore, specific changes are seen on MRI in almost all patients with a verified MS diagnosis [9]. Reporting of MRI datasets regarding the brain and spinal cord of patients

with MS includes examination of the images with respect to the relevant medical issue in order to determine whether the McDonald criteria, which were revised in 2017 [10] and define dissemination in time and space clinically as well as with respect to MRI based on the recommendations of the MAGNIMS groups [11, 12], are fulfilled. A more precise definition of lesion types and locations according to the recommendations of an international expert group [13] is discussed in the supplementary material. Spinal cord signal abnormalities are seen in up to 92% of MS patients [14–16] and are primarily located in the cervical spine [15]. The recommendations of the MAGNIMS–CMSC–NAIMS working group published in 2021 [11] explicitly recommend the use of structured reporting for MS patients.

Therefore, a reporting template for evaluating MRI examinations of the brain and spinal cord of patients with MS was created as part of the BMBF-funded DIFUTURE consortium in consensus with neuroradiological and neurological experts in concordance with the recommendations mentioned above [11] and was made available for broad use ([https://github.com/DRGagit/ak\\_befundung](https://github.com/DRGagit/ak_befundung)). The goal is to facilitate efficient and comprehensive evaluation of patients with MS in the primary diagnostic workup and follow-up imaging. These reporting templates are consensus-based recommendations and do not make any claim to general validity or completeness. The information technology working group (@GIT) of the German Radiological Society and the German Society for Neuroradiology strive to keep the reporting templates presented here up-to-date with respect to new research data and recommendations of the MAGNIMS-CMSC-NAIMS group [11].

## Funding

Funding Acknowledgement: “BMBF – Future Medicine, DIFUTURE, Consortium, Germany”

JH is (partially) funded by the German Federal Ministry of Education and Research (Grant Numbers 01ZZ1603[A-D] and 01ZZ1804[A-H] (DIFUTURE)).

## Conflict of Interest

JH reports grants for OCT research from the Friedrich-Baur-Stiftung and Merck, personal fees and non-financial support from Celgene, Merck, Alexion, Novartis, Roche, Santhera, Biogen, Heidelberg Engineering, Sanofi Genzyme and non-financial support of the Guthy-Jackson Charitable Foundation, all outside the submitted work.

Thomas Huber ist neben seiner im Manuskript genannten Affiliation bei der Firma Smart Reporting GmbH beschäftigt.

Jan Kirschke ist neben seiner im Manuskript genannten Affiliation Co-Founder der Firma BoneScreen GmbH.

## References

- [1] European Society of R. The future role of radiology in healthcare. *Insights Imaging* 2010; 1 (1): 2–11
- [2] Kahn CE Jr, Langlotz CP, Burnside ES et al. Toward best practices in radiology reporting. *Radiology* 2009; 252 (3): 852–856
- [3] European Society of R. ESR paper on structured reporting in radiology. *Insights Imaging* 2018; 9 (1): 1–7
- [4] Rocha DM, Brasil LM, Lamas JM et al. Evidence of the benefits, advantages and potentialities of the structured radiological report: An integrative review. *Artif Intell Med* 2020; 102: 101770
- [5] Lee JK, Bermel R, Bullen J et al. Structured Reporting in Multiple Sclerosis Reduces Interpretation Time. *Acad Radiol* 2020. doi:10.1016/j.acra.2020.08.006
- [6] Schwartz LH, Panicek DM, Berk AR et al. Improving communication of diagnostic radiology findings through structured reporting. *Radiology* 2011; 260 (1): 174–181
- [7] Alessandrino F, Pichiecchio A, Mallucci G et al. Do MRI Structured Reports for Multiple Sclerosis Contain Adequate Information for Clinical Decision Making? *Am J Roentgenol American journal of roentgenology* 2018; 210 (1): 24–29
- [8] Dobson R, Giovannoni G. Multiple sclerosis – a review. *Eur J Neurol* 2019; 26 (1): 27–40
- [9] Lovblad KO, Anzalone N, Dorfler A et al. MR imaging in multiple sclerosis: review and recommendations for current practice. *AJNR American journal of neuroradiology* 2010; 31 (6): 983–989
- [10] Thompson AJ, Banwell BL, Barkhof F et al. Diagnosis of multiple sclerosis: 2017 revisions of the McDonald criteria. *Lancet neurology* 2018; 17 (2): 162–173
- [11] Wattjes MP, Ciccarelli O, Reich DS et al. 2021 MAGNIMS-CMSC-NAIMS consensus recommendations on the use of MRI in patients with multiple sclerosis. *The Lancet Neurology* 2021. doi:10.1016/S1474-4422(21)00095-8
- [12] Filippi M, Rocca MA, Ciccarelli O et al. MRI criteria for the diagnosis of multiple sclerosis: MAGNIMS consensus guidelines. *Lancet neurology* 2016; 15 (3): 292–303
- [13] Filippi M, Preziosa P, Banwell BL et al. Assessment of lesions on magnetic resonance imaging in multiple sclerosis: practical guidelines. *Brain: a journal of neurology* 2019; 142 (7): 1858–1875
- [14] Bot JC, Barkhof F, Lycklama a Nijeholt G et al. Differentiation of multiple sclerosis from other inflammatory disorders and cerebrovascular disease: value of spinal MR imaging. *Radiology* 2002; 223 (1): 46–56
- [15] Bot JC, Barkhof F, Polman CH et al. Spinal cord abnormalities in recently diagnosed MS patients: added value of spinal MRI examination. *Neurology* 2004; 62 (2): 226–233
- [16] Weier K, Mazraeh J, Naegelin Y et al. Biplanar MRI for the assessment of the spinal cord in multiple sclerosis. *Multiple sclerosis* 2012; 18 (11): 1560–1569