How Remote Scanning is Changing MRI Tasks and Procedure: An Experience Report with *syngo* Virtual Cockpit

Nicole Bäz, M. Eng; Daniel Sievritts, Dipl.-Ing.

medneo GmbH, Expert Services, Berlin, Germany

Abstract

Introduction
Radiology is facing an impending shortage of qualified medical staff. Radiographers in particular are very rare. This leads to overloading of remaining staff and can cause mental and physical health problems. Since 2018, medneo has been using remote support to minimize these burdens and to train radiographers on-site. Nevertheless, more than 8% of all examinations had to be cancelled or postponed in 2022 due to a lack of staff. To avoid carrying this loss into 2023, medneo transitioned its remote support to remote scanning. This report will evaluate remote scanning in terms of its benefits, impact, challenges, and outlook, based on medneo's experience in 2023.

Materials and methods
Specific software [1] and cameras were rolled out across 21 modalities by two different manufacturers at 16 locations in Germany. In addition, a new remote scanning team was formed and equipped with the required hardware. The examination process was adjusted by splitting the role of the radiographer into two: While the remote operator is primarily responsible for planning and conducting the examination, the local operator focuses on patient safety, preparation, and follow-up care. Well-coordinated communication between both operators is essential. Regardless of the location, up to three remote examinations can be carried out in parallel per remote operator.

Results
The remote operators carried out 11% of all magnetic resonance (MR) examinations in Germany in 2023. The peak was reached in December with a remote scanning rate of 19%. In that month, 74% of all examinations in one location were done remotely. Overall, we were able reduce downtime caused by lack of staff to less than 0.3% of our opening hours. The growth of the remote scanning team made it possible to focus on locations that are struggling with high levels of staff absences due to illness, vacation, etc. In addition, remote scanning is very well suited to relieving the burden on staff on-site and to addressing radiographer staffing challenges by removing limitations on where radiographers can live.

Challenges
When introducing remote scanning, we faced some technical, personnel, and procedural challenges. Doctors and other staff had to familiarize themselves with new processes and standard operating procedures. Specific training sessions were held to coordinate the new roles of local and remote operators. The remote operators have to work with MRI scanners that come from different manufacturers, use different software versions, and require different contrast media application processes. They also face some technical issues and error concepts.

Conclusion and outlook
Remote scanning has shown that examination cancellations due to staff shortages can be reduced. In addition, there is great potential for streamlining the workload of on-site staff. Regular remote scanning opens up new possibilities in staff planning and efficient staff scheduling. Addressing the shortage of radiographers by increasing the efficiency of individual employees could reshape the entire concept of radiology.

Introduction

medneo offers radiological examinations as a service for doctors, hospitals, and research institutions, and delivers clinical images instead of devices. medneo is not a medical service provider, but rather a provider of process-optimized services in radiology, including state-of-the-art diagnostic equipment, appointment management, non-medical specialists, and IT infrastructure. As a result, medneo is transforming a classic hardware business into a service business, thereby optimizing the entire diagnostic value chain. The use of state-of-the-art diagnostic platforms allows our customers to carry out their examinations without investing in expensive diagnostic equipment or IT infrastructure. Patients can book their examination appointments quickly, with over 150 experts at 17 locations throughout Germany and Switzerland, including three mobile trailer units. With medneo's trailer fleet, diagnostic MR imaging can reach rural and remote regions to improve local healthcare. Demographic change is leading to an aging society, particularly in rural regions with limited infrastructure, and therefore there is a decline in the number of practicing doctors as they retire. By 2035, up to 11,000 positions for primary-care physicians will be vacant and almost 40% of rural districts will be underserved [2]. Specialists are already rare in rural regions; patients must travel long distances and endure long waiting times. There is also a shortage of medical staff, and the lack of qualified radiographers is an industry-wide problem. Nationwide, we are faced with an impending shortage of qualified medical and nursing staff. In 2019, 46% of vacancies for radiographers in German hospitals could not be filled. Almost every second hospital in Germany faces recruitment problems when searching for radiographers. Non-clinical vacancies were not considered in the study and will lead to a further gap [3]. This results in an overload for the remaining clinical and non-clinical staff. Constantly high workloads lead to stress and could cause mental and physical health problems. [4]

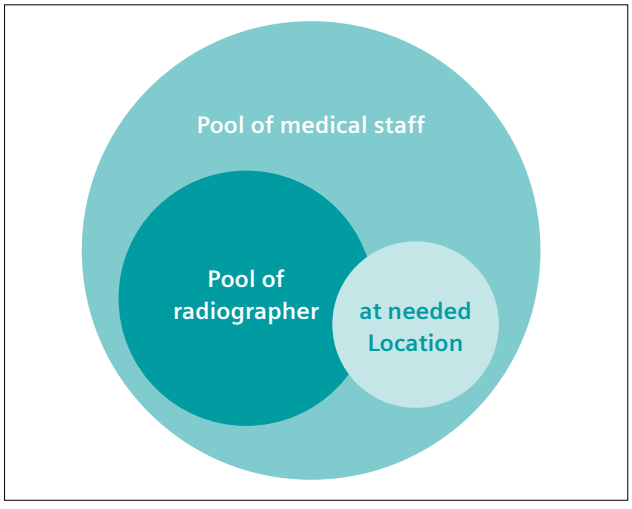
In response to this recruitment crisis, medneo has pioneered an innovative new approach: remote MRI support and scanning. As the predecessor of remote scanning, remote support was first carried out in 2018 and used for MR-sequence adjustments and optimization outside of patient hours. Training and upskilling for new or inexperienced on-site radiographers was carried out remotely by our application specialists. This allows real-time remote support for unusual, less common, or difficult examinations. Due to the shortage of radiographers, however, we were unable to meet the demand for support. The application team were often called to medneo locations to provide on-site scanning support. This resulted in increased travel costs and ineffectiveness, as the team could not provide national support and wasted a lot of time travelling. In 2022, more than 8% of all examinations had to be cancelled or postponed due to lack of staff. To avoid carrying this loss into 2023, a new remote scanning team was formed in January 2023. The remote radiographers are located throughout Germany and work from home. The first examination performed entirely by a remote operator took place in January 2023. Maintaining patient care and limiting the workload of non-medical personnel is the fundamental mission of remote scanning, and with safeguards in place, customer and patient satisfaction should not be affected. This report will evaluate the benefit of remote scanning based on experience at medneo in 2023. We highlight procedural adjustments, reveal recruiting opportunities, and explain how we faced the challenges. In addition, we show the remote scanning volume and impact, and share further plans for increasing efficiencies.

Setup

To enable remote scanning from a technical perspective, specific software, *syngo* Virtual Cockpit [1] was rolled out across the entire fleet. Twenty-one modalities from two different manufacturers were connected to the software at 16 locations in Germany. In addition, cameras observing the patient in the MRI scanner, along with network devices were installed and connected to the software at each site. Every member of the remote scanning team was equipped with a computer connected to the *syngo* Virtual Cockpit software, two monitors, one modality keyboard, and a mouse. Local physician workstations were also upgraded and connected to the software.

Removing on-site radiographers from the regular radiology workflow clearly requires adjustment of the examination process. We therefore divided the original radiographer role into two: a local and a remote operator. The local operator provides the face-to-face patient care, prepares and positions the patient on the MRI table, applies the correct coils, and administers contrast media as needed and directed by the physician. Safety considerations are paramount to the well-being of our patients and staff. Our regular safety training has been adapted to the new process, giving the local operator more responsibility for the patient's safety. They are trained in MR safety as well as first aid and contrast reactions. A key difference from the previous standard procedure is that the local operator must always be close to the patient during the scan and must be available to the remote operator. Therefore, tasks such as welcoming the next patient or accompanying the patient to the physician's debrief after the examination must be taken on by other employees. We retained medneo's optimized three-patient workflow, and had to create new standard operation procedures. The tasks of the local operator can either be done by a radiographer or an individual with a healthcare background, e.g., a nurse. This offers new opportunities in terms of recruitment. The pool

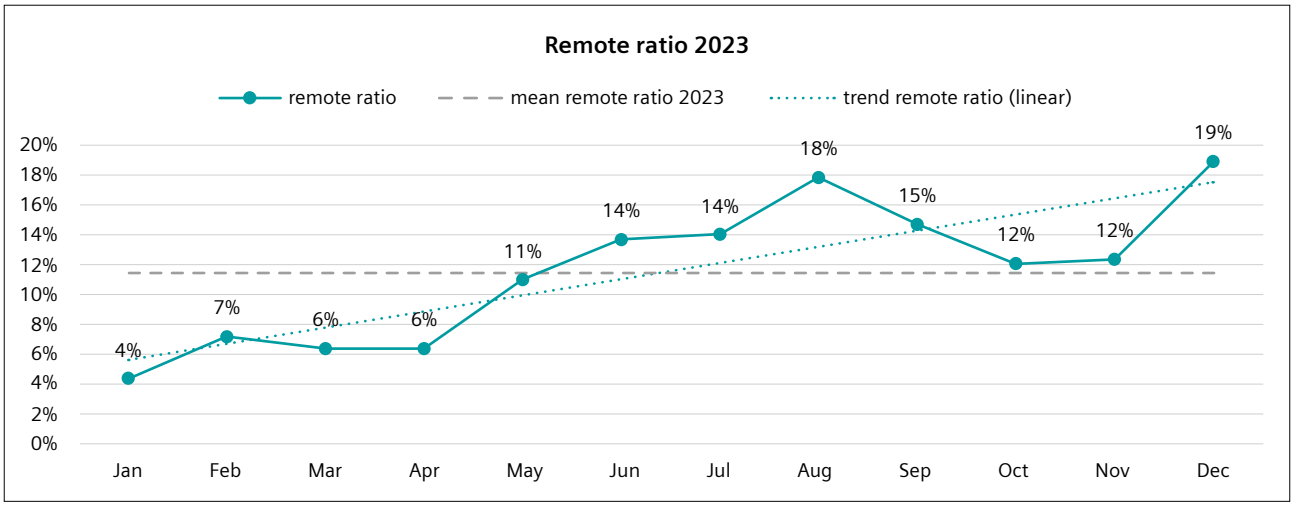
of medical staff available is small, and that of radiographers even smaller (Fig. 1). Remote scanning enables recruitment of local operators from the first, larger pool and thus enables a wider geographical recruitment as location restrictions persist. In contrast, the pool of remote operators is completely location-independent and thus increases the chances of filling vacant radiographer positions. The role of the remote operator is to acquire the MR images. Responsible for selecting the appropriate sequences, the remote operator starts and ends the examination and is in constant communication with the physician and the local operator. The qualifications for both roles are based on the regulatory and legal requirements for patients with statutory health insurance in Germany [5], regardless of whether patients have statutory, private, or other insurance. With internal quality and safety assurance, we can always ensure that the tasks are carried out by appropriately qualified employees. The attending physician remains responsible for the informed consent from the patient and support from the local operator. Therefore, remote scanning software ensures that the examining physician not only has access to the image acquisition but can also contact the remote operator at any time during the MRI examination via remote communication. In addition, the examination process can be followed via a camera. The camera is used exclusively for patient safety and workflow optimization between the local and remote operator and the physician, and the images are not stored or recorded. Obtaining a comprehensive visualization of the patient's position on the MR table and knowing when the local operator has completed patient positioning can minimize the need for communication. If the communication is well coordinated, and depending on the experience and qualifications of the remote operator, up to three remote examinations can be carried out in parallel at different locations.



1 Visualization of recruitment opportunities with remote scanning.

Volume and impact

In December 2023, the proportion of remote operators had reached 8% of all employed radiographers, compared with just 2% in January 2023. The remote scanning team performed 11% of all MR examinations in 2023. Figure 2 clearly shows a steady increase in remote examinations from January to August. In April, June, and December, we increased the remote operator team. The rise in remote examinations can be attributed to this, although there are always slight delays as new employees are trained. The summer peak in remote examinations was reached during the August vacation season, with 18% of all MR examinations. In fall, which is the beginning of sickness season, there was a decline in remote scanning, which did not fall below the 2023 average (11%). In December 2023, we reached the total peak of remote MR examinations (19%), due to a wave of illness. According to the latest health report from one German statutory health insurance company, the healthcare sector once again recorded the highest sickness rate in 2022, at 6.4% (+ 1.7% compared to 2021) [6]. In 2023, the sickness rate among radiographers at medneo was below this, with 4.7% averaged across all 16 locations. This value is useful, for example, for planning a corresponding surplus in shift planning to relieve the burden on the remaining medical staff. However, this is difficult to fulfil due to the shortage of qualified personnel. Even calculable types of absence such as vacations, time off in lieu, or parental leave are an additional burden on the remaining medical staff, in addition to the current understaffing at some locations. Of course, it is possible that individual locations are well staffed or that staff from other locations are able to help, but remote scanning is always the first choice because of the short-term availability. In addition, by using remote operators, sickness absences in the remote team can be covered much more easily than for on-site staff. There is less uncertainty regarding staff absences, and shifts can be planned more flexibly. However, the absence of staff does not always mean a loss of examinations. We are closely monitoring the cancellations caused by staff shortages and, in 2023, we reduced this type of downtime to less than 0.3% of the opening hours, compared to 8% in 2022. Table 1 shows the remote share of the top five radiology departments and proves that it is possible to perform 39% of all MR examinations remotely (August average), with more than half of the examinations in one location (site #1 in August at 54%). The maximum of all remote examinations in one month was achieved in the same location in December 2023, with 74%. Site #1 acted as pilot center, where the hardware and IT infrastructure were set up first, and the roles and responsibilities of the local and remote operators were defined and tested. The annual remote average of the remaining 11 locations is less than 8% for each location. Thus, medneo has not yet tapped into the full potential of remote scanning for each location.



2 MR exam ratio: Remote MR exams divided by all MR exams per month (petrol line), as an average (dashed line), and the linear trend (dotted line).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Average
Site #1	14%	26%	27%	22%	38%	44%	44%	54%	39%	24%	32%	74%	**35%**
Site #2	19%	13%	10%	10%	20%	39%	17%	33%	33%	34%	29%	7%	**21%**
Site #3	0%	1%	5%	3%	16%	18%	16%	21%	22%	14%	27%	8%	**13%**
Site #4	0%	1%	10%	7%	21%	11%	8%	14%	16%	10%	0%	22%	**10%**
Site #5	0%	0%	0%	7%	0%	6%	3%	38%	7%	39%	13%	6%	**10%**
Average	**9%**	**14%**	**13%**	**13%**	**23%**	**28%**	**24%**	**39%**	**27%**	**24%**	**24%**	**36%**	**22%**

Table 1: Share of remote scanning in all exams for the top five sites (average) per month from January to December 2023. The figures are displayed using a color scale from dark green (maximum remote scanning share) to white (minimum remote scanning share).

Challenges

We faced a number of technical, procedural, and personnel challenges. Communication is an essential component for each procedural step; smooth, uninterrupted communication between the local and remote operators is imperative to ensure patient safety. After a trial period, it became clear that multiple telephone conversations between the operators were only necessary to familiarize themselves with the new process. The more often remote scanning is carried out, the better the implementation and routine becomes on both sides. By using a camera, the progress of the examination is displayed for both operators at every stage. At most locations, communication is limited to abbreviations transmitted via chat in the remote software. Sometimes it is enough to pay attention to the radiofrequency (RF) door: When the local operator closes it, the remote operator can start the examination. Equally, moving the patient table out of the gantry is enough to signal that the examination has ended. However, when planning the examination, special requests from doctors that are not included in standard MRI protocols always require verbal communication to avoid misunderstandings. Verbal communication is also required for special examinations with contrast media, e.g., heart, prostate, mammography, head, abdomen, or angiography exams. Whenever the contrast flow is important for diagnosis, the local and remote operator must coordinate the time of contrast medium administration to the second. The remote operators have to work with MRI scanners that come from different manufacturers, use different software versions, and require different contrast media application processes. Therefore, we spent a lot of time training those processes. With this in mind, parallel scanning is currently only carried out for non-contrast examinations. The coordination effort for contrast scans is currently still too high to ensure safe examination of the patient.

Regarding the personnel challenges, it naturally made sense to roll out remote scanning at those sites where the roles of preparer and radiographer are already split and performed by different medical staff in one shift. In some locations, however, patient positioning and examination are carried out by one radiographer in one shift. Consequently, radiographers in some locations have taken on the role of local operator even if they are able to carry out both preparation and examination. During remote scanning, they hand over the examination planning and execution to the remote operator. In doing so, they can concentrate fully on preparation and follow-up, and communicating with the patient. Some employees criticized this new organization of responsibilities and felt that their resources were being misallocated. But this personnel setup is not a permanent reallocation of roles. The focus here is only on being able to provide support in difficult examinations and to reduce the workload of on-site staff. It is also possible to swap between roles in a cycle that can be individually organized by the employees.

Regarding technical challenges, we had to find a solution for camera installation. To avoid RF interference, we installed the camera outside the RF cage. This led to reflections on the RF window, which were eliminated by installing an additional cover. The cover also made on-site staff feel more comfortable. The camera created an observational effect, although it is only accessible during a remote scan and is aimed at the patient table and gantry. It provides helpful images for the workflow. Nevertheless, video signal failures occasionally occur due to network interference or small delays in mouse movement at the MRI computer. Remote scanning remains a technical solution and we are constantly working on improving the technical setup to minimize disruptions. In addition, different connection methods are provided for the remote operators. They were trained in switching between different IT infrastructure and finding the most stable remote connection. Therefore, we are not dependent on a fixed IT infrastructure and software solution.

Conclusion and outlook

Within a year, we created the technical and procedural requirements for remote scanning at all 16 medneo locations in Germany. The rollout of remote scanning began with standard sick-leave and vacation cover, as well as covering radiographer vacancies at affected locations. Remote scanning helps medneo to avoid examination cancellations caused by staff shortages for both planned and unplanned reasons. Without remote scanning, examinations would have had to be cancelled or at least postponed. In addition, remote scanning has great potential to relieve on-site staff and can reduce their stress levels. It also allows the local operator to fully concentrate on the patient's well-being. Furthermore, this kind of work-life balance for a radiographer was previously unimaginable. Travel times can be reduced and working hours are flexible. Remote operators can live anywhere, which can bring radiographers from rural regions of Germany back to MRI. They deal with the challenges and are open to new experiences with the various scanner types and field strengths variations.

In terms of the outlook, and to achieve maximum efficiency, the question arises as to whether personnel planning needs to be fundamentally reconsidered. The profitability of remote scanning is influenced by the personnel costs of on-site staff and whether the remote operator performs parallel scanning. Table 2 shows staffing requirements per shift. In the initial setup, there is one local radiographer and one local preparer in one radiology department to examine patients at one MR scanner. So, for three locations with one MRI scanner each, we need three local preparers and three local radiographers. In the remote scanning setup, one local operator is needed at each location. This could be done either by a local preparer or radiographer, or someone else with the necessary medical qualification. And, of course, a remote operator is needed. If the remote operator performs parallel scans, their effectiveness will increase. Thus, two qualified radiographer positions can be removed within a remote scanning

	Three locations, no remote scanning	Three locations, remote scanning, not parallel	Three locations, remote scanning, two MRIs in parallel	Three locations, remote scanning, three MRIs in parallel
Local radiographer	3	0	0	0
Local preparer	3	0	0	0
Local operator	0	3	3	3
Remote operator	0	3	2	1
Total staff	**6**	**6**	**5**	**4**

Table 2: Staffing for a three-location setup (one MRI scanner in each location), with and without remote parallel scanning.

setup of three scanners or locations. This not only saves two specialist salaries, it also overcomes the difficulty of recruiting qualified personnel and adds flexibility across the business. Further tests are needed to verify how practicable parallel scanning on three MR scanners is. Therefore, the next step will be to implement remote scanning in a fixed shift plan. By introducing scheduled remote scanning for one, two, or even three shifts, we expect an extraordinary increase in remote scanning examinations and therefore more experience. In order to achieve this, we will face the challenges and continue to evolve and fine-tune the operational processes and technical setup. We are in close contact with the manufacturer of the remote scanning software, and are discussing ways of implementing our ideas in future software versions. Through direct communication between the remote operator and the patient, movement artifacts could be addressed more quickly, and breathing commands could be transmitted directly. In addition, listening to the sequence tones of the MR scanner gives the remote operator information that simplifies the examination workflow. The use of remote-control contrast media injectors, which are already on the market, will be the next logical step toward further optimization and professionalization of the contrast media application processes. This is fundamental to being able to take full advantage of parallel scanning at up to three scanners, regardless of the examination type. Overall, remote scanning shows great potential for meeting the current challenges of staff shortages in radiology; it can lead to a complete rethinking of existing processes in a radiology department.

References

1 Kraft P, Dummet J. *syngo* Virtual Cockpit – Your Software for Remote Scanning Assistance and More Flexible Workforce Management. ↗MAGNETOM Flash. 2019;73(2):119–122.

2 Robert Bosch Stiftung. 2035 fehlen in Deutschland rund 11.000 Hausärzte – Experten empfehlen den Aufbau von Gesundheitszentren. May 27, 2021. Accessed on Nov 7, 2023.

3 Blum K. Fachkräftemangel und Fachkräftebedarf in MTA-Berufen. Deutsches Krankenhausinstitut e.V. May 31, 2019. Accessed on Dec 7, 2023. Available from: https://dvta.de/sites/default/files/2019_05_Fachkräftemangel%20und%20Fachkräftebedarf%20in%20MTA-Berufen_final.pdf

4 Ballinger JM, Comello RJ, Vealé B. Stressors That Negatively Affect the Health of Radiology Professionals. J Med Imaging Radiat Sci. 2008;39(1):11–15.

5 Vereinbarung über die Delegation ärztlicher Leistungen an nichtärztliches Personal in der ambulanten vertragsärztlichen Versorgung gemäß § 28 Abs. 1 S. 3 SGB V. In: Anlage 24 zum Bundesmantelvertrag-Ärzte (BMV-Ä). October 1, 2013. Updated January 1, 2015. Accessed on Nov 1, 2023. Available from: https://www.kbv.de/media/sp/24_Delegation.pdf

6 Hildebrandt S, Dehl T, Zich K, Nolting H-D. Gesundheitsreport 2023: Analyse der Arbeitsunfähigkeiten Gesundheitsrisiko Personalmangel: Arbeitswelt unter Druck. DAK Gesundheit. April 2023. Accessed on Dec 7, 2023. Available from: https://caas.content.dak.de/caas/v1/media/34600/data/3bf3cdb115a277d604678cf6e8661d0b/gesundheitsreport2023-ebook.pdf

Contact

Nicole Bäz, M. Eng.
medneo Deutschland GmbH
Expert Services
Reinhardtstraße 23-27
10117 Berlin
Germany
nicole.baez@medneo.com

Daniel Sievritts, Dipl.-Ing.
medneo GmbH
Expert Services
Reinhardtstraße 23-27
10117 Berlin
Germany
daniel.sievritts@medneo.com

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