

White Paper

Moving the needle in MRI productivity

Leveraging the MRI value chain for the optimal
diagnostic exam and patient experience

siemens-healthineers.us/mri-productivity



Contents

Introduction

Healthcare spending is rising at an unsustainable pace. Providers worldwide face pressure to deliver more and better care with fewer skilled resources as the population ages and the system-wide burden of chronic diseases increases. The consequence of these developments is that healthcare must become more productive. Healthcare organizations are reassessing their clinical, financial, operational, and patient goals. These are set forth in the “Quadruple Aim”: better provider and patient experiences, improved population health, and lower care costs.¹ Although originally conceived within the USA, this aim has been adopted as a set of principles for health system reform within many organizations around the world. This paper examines how stakeholders and activities along the entire imaging value chain can benefit from technology and workflow enhancements in magnetic resonance imaging (MRI).

¹Bodenheimer, Thomas and Sinsky, Christine, *Ann Fam Med* (2014), 12: 573–576.

Top three objectives in the C-level for MRI

A Frost & Sullivan survey of US healthcare providers found that the top three objectives (Figure 1) of investments in medical imaging technology and services are to improve the patient experience, improve cost efficiency and gain the ability to improve patient outcomes. These objectives align well to key points of priority for providers in the changing healthcare environment because they are tied to objectives of the Quadruple Aim.

In order to achieve these objectives Frost & Sullivan examined the clinical and non-clinical performance needs of the MRI exam process. Four focus topics were identified to allow healthcare providers to align their needs with potential investment areas.

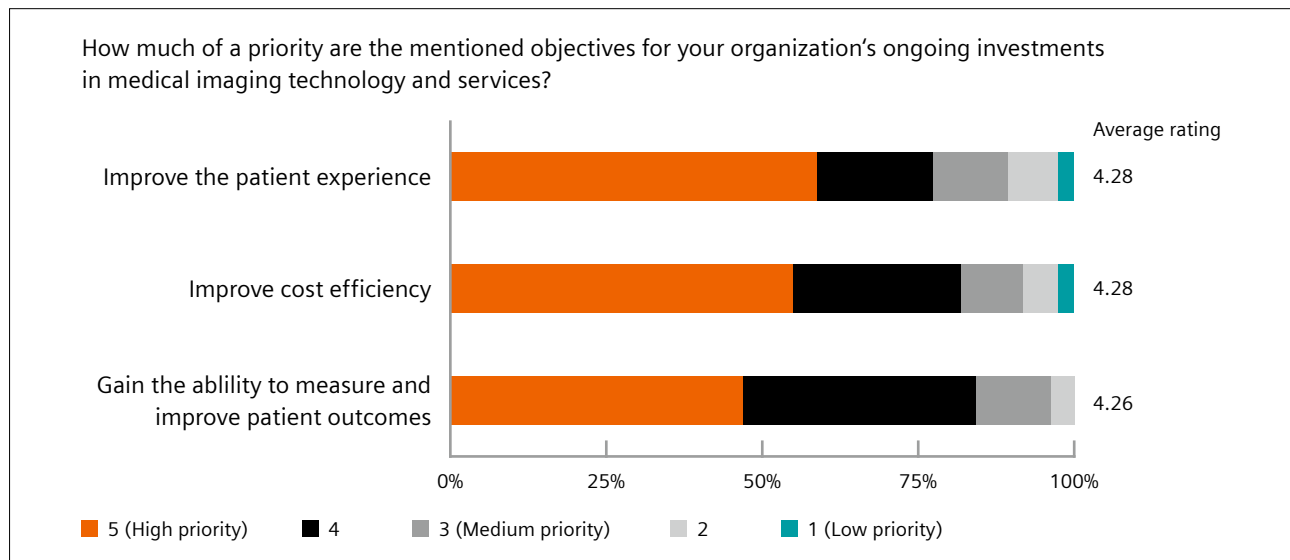


Figure 1: Top three objectives of medical imaging investments, US

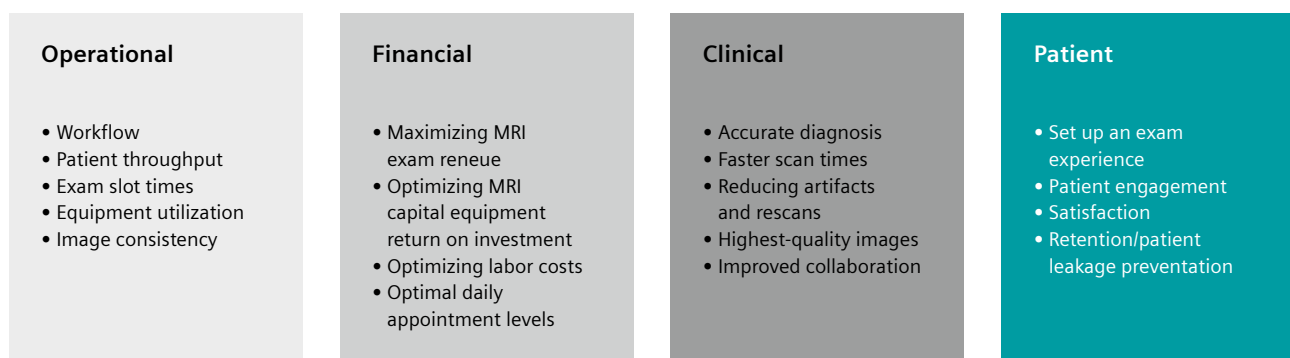


Figure 2: Four focus areas for the MRI exam process

Productivity in MRI

In an industry where every second and every click counts, workflow inefficiencies consume as much as a third of the MRI procedure time.² Exams are scheduled in 20- to 60-minute blocks, automatically capping the number of daily procedures that can be performed. This space is a key area of focus where advances in equipment, software, and protocols can radically change what is possible from an MRI exam.

Given declining reimbursements and value-based care shifts, maximizing MRI exam productivity is a strategic goal for a healthcare organization's optimal performance. This goal can be achieved in the best way by a holistic optimization of the entire imaging value chain: from patient preparation to image acquisition and post-processing / patient changing.

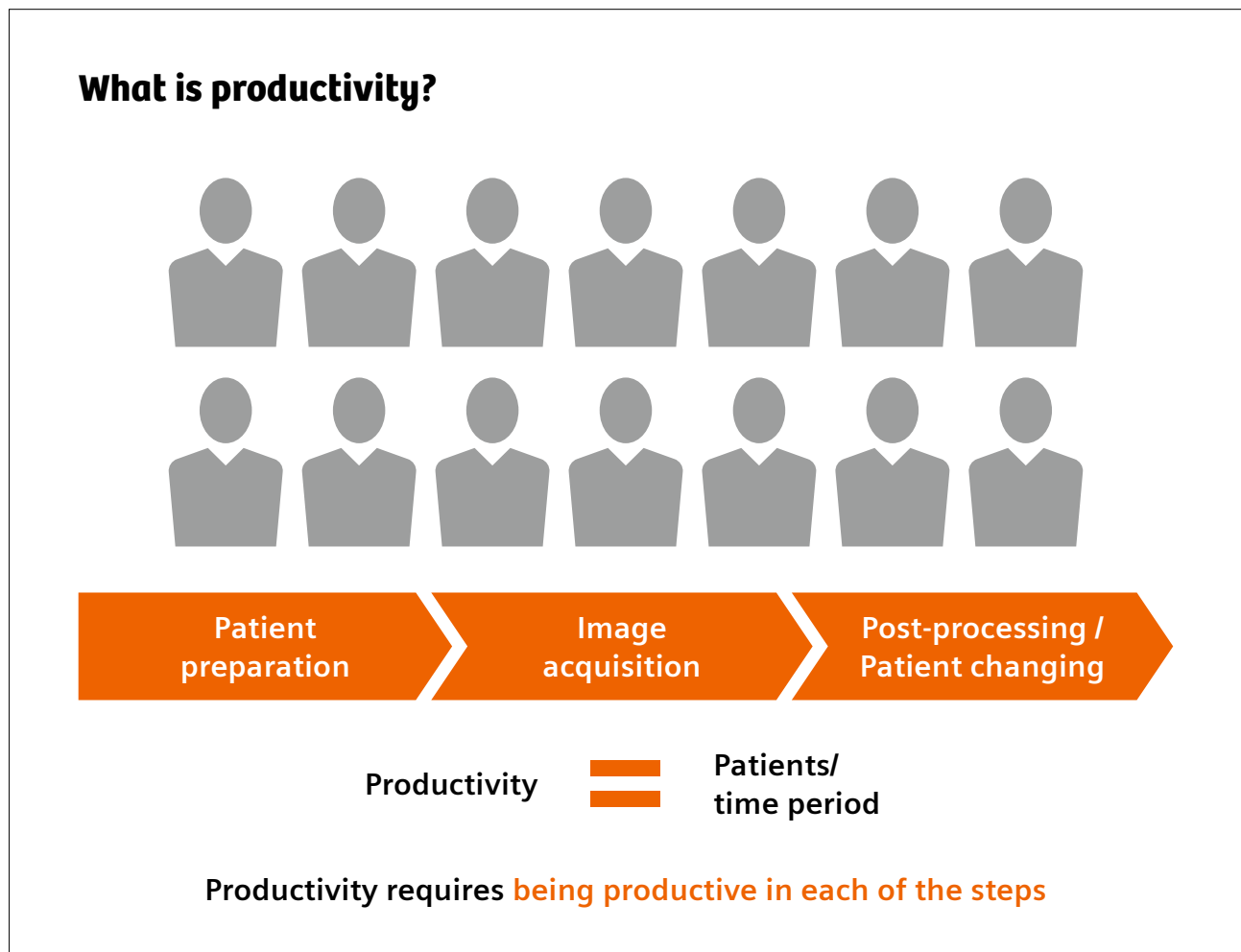


Figure 3: Relevancy of MRI workflow phases for productivity

²Beker, Kevin, et.al, *American Journal of Roentgenology*, 2017, 209: 836-844

Patient preparation

Patient preparation in MRI is a complex task: technologists need to manage software and hardware and require knowledge and people skills to set up the best exam strategy. It is the patient-facing part of the process where a positive patient experience is crucial: one study found that 42% of surveyed adults stated they were afraid of undergoing an MRI.³ The better the patient comfort and experience during patient setup, the easier it is to get the scan right the first time, the better the patient will feel about their diagnostic imaging experience afterward, and the easier it is for the technologist to perform their job.

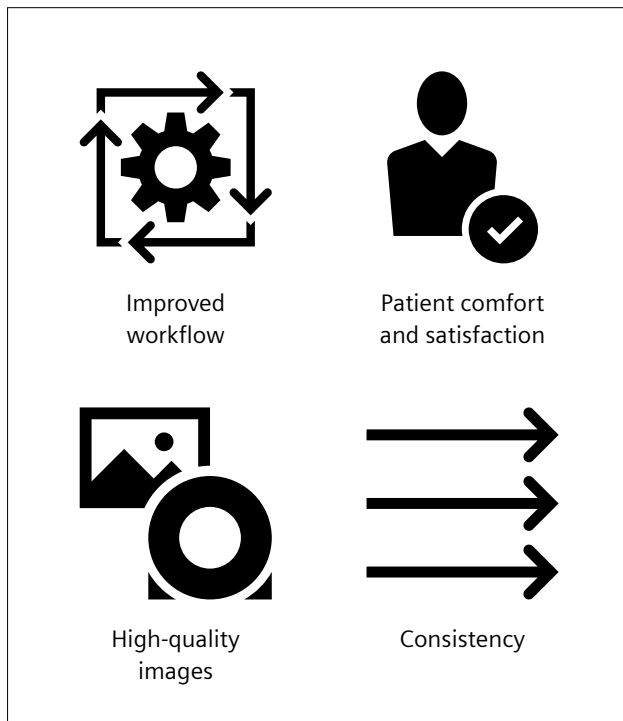


Figure 4: Focus areas of the patient set-up

Provider organizations are seeking innovations that simplify setup (including transport if necessary), improve consistency, avoid voluntary and involuntary motion, and accommodate challenging physiology and anatomy.

For example, some of the most recent innovations are BioMatrix Sensors and Interfaces, which offers a range of value points that directly benefit the technologist during the exam setup:

- BioMatrix Sensors address and anticipate motion and alleviate the need for legacy monitoring technology. Integrated Respiratory Sensors, for example, detect breathing patterns from the moment the patient lies on the table to help the system anticipate motion and secure a high-quality image every time, all while reducing patient set-up time.
- BioMatrix Select&GO leverages artificial intelligence to help the technologist accurately position the patient on the first try.
- BioMatrix dockable tables with eDrive allow a technologist to quickly and easily move a patient to and from the scanner; one patient can be set up while another is in the scanner, improving workflow.

Faster patient set-up higher comfort is provided by ultra-light-weight & anatomy-adaptive coils, such as Contour Coil 24/48, BioMatrix Body 18 and UltraFlex Large/Small 18.

³Siemens Healthineers survey in May 2015 in which 2,000 UK adults were asked about their attitudes on their health, hospitals and medical appointments.

Proof points



<1 min for a more reproducible and automated **patient set-up** with BioMatrix Select&GO. Technologists can save up to 30% compared to laser positioning.⁴



E.g., **from >7 min to <2 min turnaround time** with the help of BioMatrix dockable tables and room layout optimization. NYU saved up to 73% of your turnaround time per patient.⁵

With improved ease of setup and speed, the technologist can spend more time interacting with the patient, reducing worry, educating the patient, and ensuring they have the best MRI experience possible.



Powered by
Artificial Intelligence

⁴Data on file

⁵Michael P. Recht, Kai Tobias Block, Hersh Chandarana, Jennifer Friedland, Thomas Mullholland, Donal Teahan, and Roy Wiggins: Optimization of MRI Turnaround Times Through the Use of Dockable Tables and Innovative Architectural Design Strategies. American Journal of Roentgenology 2019 212:4, 855-858.

Image acquisition

MR Image acquisition is a critical phase in multiple aspects of the diagnostic workflow, including tailoring the MRI exam to specific patients, improving the patient experience, image quality and consistency. Image quality remains the leading concern for radiologists. Voluntary and involuntary patient motion and compliance with instructions significantly affect image quality and lead to approximately \$115,000 per scanner per year.⁶ Exam consistency within the same patient case across multiple scans and follow-ups also supports better accuracy of consultation during the read and better accuracy of diagnosis. The increased workload environment, with higher case volume and staffing concerns, is further putting pressure on the productivity needs of radiologists.⁷

MRI hardware and software solutions that surround the patient on the table must work together cohesively to achieve the goal of optimized image quality. New MRI innovations offer benefits such as reducing time spent on the table, easing patient stress, and enabling more patients to benefit from an MRI examination.

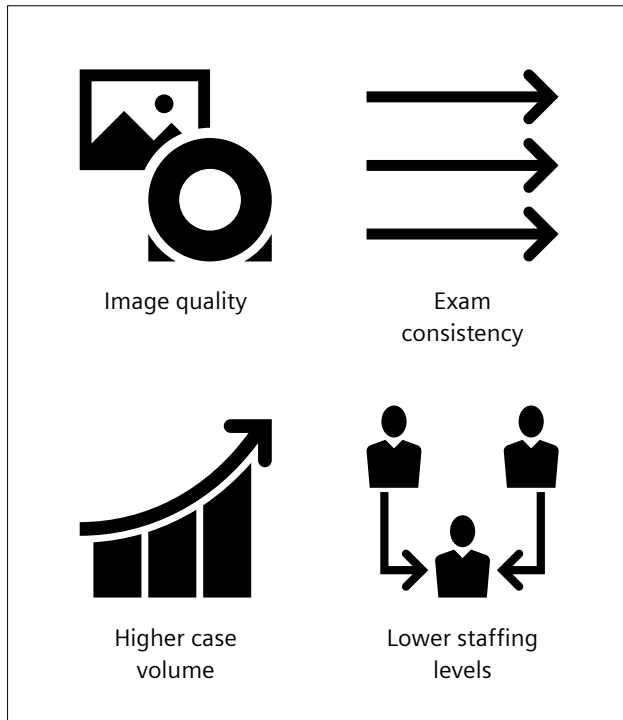


Figure 5: Top-of-mind radiologist concerns

- Dot Engines guide the acquisition and improve productivity, standardization, and consistency across patients and in follow-up exams, independent of scanner or technologist. Dot Engines, which cover more than 90% of exam types⁸, provide an array of protocols that adapt to different patient conditions. These exam strategies can be employed during standard patient workflow processes.
- Accelerated imaging technologies such as Simultaneous Multi-Slice (SMS) and Compressed Sensing (CS) are bringing unprecedented speed to image acquisition and shortening exam times. Benefits from these solutions include improved clinical service efficiency, improved patient compliance, reduced impact of undesirable motion effects and, in certain cases, expanded access of particular MRI applications to some of the sickest patients.
 - SMS is a revolutionary method to significantly reduce imaging times for diffusion, BOLD, DWI, TSE imaging. E.g., SMS can bring a 49% reduction in scan time for routine diffusion-weighted imaging with RESOLVE, shown in clinical practice to accelerate diffusion-weighted imaging of the body with no compromise to image quality.⁹
 - CS is another acceleration technique which incorporates sparse, incoherent subsampling followed by iterative reconstruction for 3D T2 SPACE, Time-of-Flight (ToF), SEMAC for metal artifact reduction, Cardiac Cine, and GRASP-VIBE. E.g., CS GRASP-VIBE helps previously underserved groups, such as pediatric patients and those with limited breath-hold capability, undergo abdominal imaging while breathing freely. It significantly reduces inadequate or compromised image quality and, hence, non-diagnostic exams.
- BioMatrix Respiratory Sensors support more consistent imaging, which reduces the need for rescans and helps avoid recalls for repeat exams.
- BioMatrix Tuners support getting the image right the first time by automatically adapting to challenging anatomies or difficult regions of the body.

⁶Val M. Runge et al: Motion in Magnetic Resonance. New Paradigms for Improved Clinical Diagnosis. Investigative Radiology 2019 54:7.

⁷Steve Holloway: MRI 2028: What to expect in the next decade of MRI?. ECR Today on 1 March 2018.

⁸Evaluation of 70.5 million Siemens Healthineers MR exams, 2017

⁹Shown on MAGNETOM Vida, Sola, Lumina, VidaFit, SolaFit. The MAGNETOM VidaFit and MAGNETOM SolaFit are 510(k) pending. They are not commercially available in all countries. Due to regulatory reasons the future availability cannot be guaranteed.

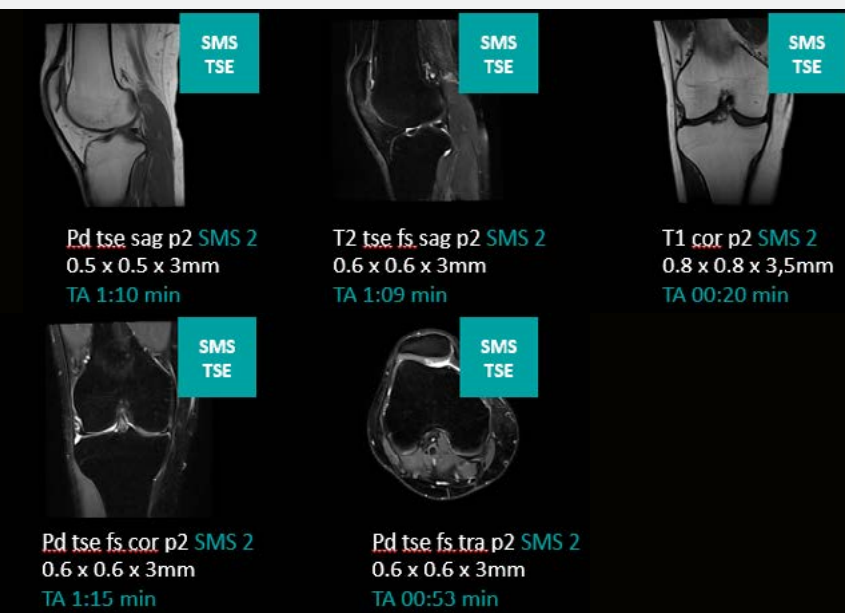
Proof points



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Save up to 1,5 hours per day with the Dot engines by automated and guided scanning, e.g., with AI powered AutoAlign, AutoCoverage, AutoBolus, which enable reproducible and consistent results for every exam.¹⁰

E.g., in a case with Brain Dot Engine, positive results were seen in terms of 46% lower parameter adjustments and 45% lower tasks at hand for the MRI technologists versus using a non-Siemens Dot workflow.¹¹



Study ID: 3aaaa1244

Up to 50 % time savings with SMS and CS for static 2D and 3D imaging. E.g., with clinically validated, push-button 2D knee exams in 5 minutes instead of more than 15 min for a 2D Knee exam. The underlying GOKnee2D^{SMS}¹² was validated by Dr. Jan Fritz, The Johns Hopkins University School of Medicine in Baltimore, USA, and includes multiple orientations and all relevant contrasts.¹³

¹⁰Zhongshang Fudan University Hospital, Fudan, CN, Abdomen Dot Engine Workflow Study

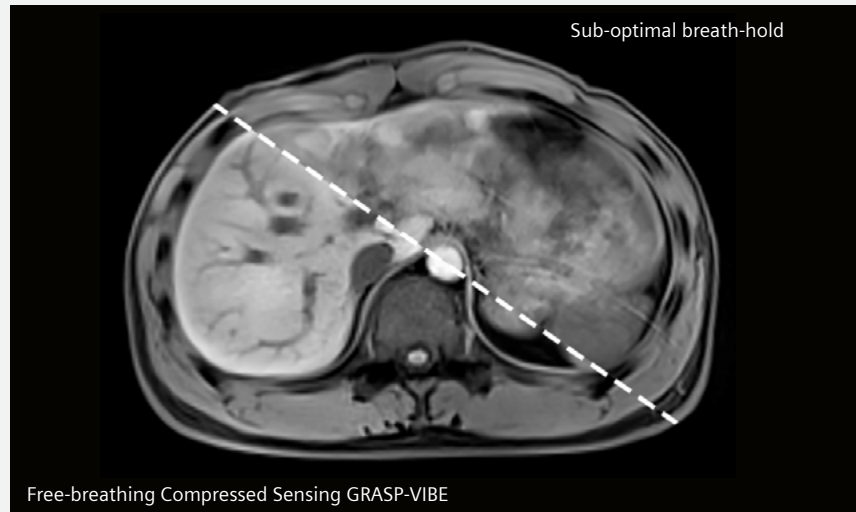
¹¹Case Study by Prof. Forsting, Prof. Antoch, Department of Diagnostic and Interventional Radiology and Neuroradiology, University Hospital, Essen, Germany.

The statements by Siemens Healthineers customers described herein are based on results that were achieved in the customer's unique setting. Since there is no "typical" hospital and many variables exist (e.g., hospital size, case mix, level of IT adoption), there can be no guarantee that other customers will achieve the same results. This statement is from a person whose institution is engaged in a collaboration with Siemens Healthineers.

¹²GoKnee is 510(k) pending. They are not commercially available in all countries. Due to regulatory reasons the future availability cannot be guaranteed.

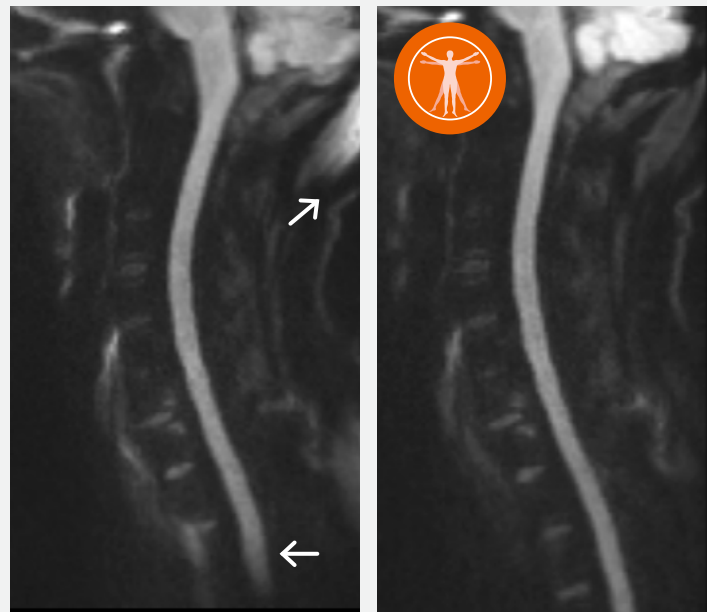
¹³Achieved on MAGNETOM Vida with Tx/Rx Knee 15 Coil, data on file.

Effectively expand the patient population and tackle motion of free-breathing liver imaging with CS GRASP-VIBE. E.g., Dr. Yoon et al evaluated new diagnostic capabilities and the clinical performance of CS GRASP-VIBE: “GRASP-[VIBE] was able to consistently provide acceptable arterial phase imaging in patients who exhibited transient motion.”¹⁴



BioMatrix Tuners SliceAdjust and CoilShim **improve image quality**.

A study at University Hospital Tuebingen, Germany proves: compared to single-shot-EPI, both SliceAdjust and CoilShim, showed a significant improvement in overall image quality for DWI by reducing geometric distortions and areas of signal loss while at the same time providing better fat saturation.¹⁵



Conventional

CoilShim

¹⁴Yoon JH et al. Evaluation of Transient Motion During Gadoteric Acid-Enhanced Multiphasic Liver Magnetic Resonance Imaging Using Free-Breathing Golden-Angle Radial Sparse Parallel Magnetic Resonance Imaging. *Invest Radiol*. 2017 Sep 11. doi: 10.1097/RLI.0000000000000409.

¹⁵Walter S. et al. Improving EPI-based DWI of the head and neck using local shim coils: comparison to slice-specific integrated shimming. *RSNA 2017 Abstract 17016089*.

Post-processing

MRI workflow improvements for post-processing can benefit healthcare organizations in multiple ways. In many countries, the number of MRI exams constantly rises but the number of experts does not grow proportionately. As a result, the workload per radiologist increases dramatically. On average, a radiologist interprets one image every 3–4 seconds, 8 hours a day.¹⁶ Software innovations, including leveraging artificial intelligence, allow for faster post-processing, eliminate errors and inconsistencies.

- Recon&GO features in-line reconstruction and post-processing of the imaging data, including features such as composing, multiplanar reconstruction, and mathematical operations.
- MR View&GO, which simplifies image review and analysis. It provides software automation when distributing all necessary results to further imaging IT infrastructure.
- AI Rad Companion is an AI-powered radiology assistant that supports you by performing automatic measurements and preparing the results in the form of valuable clinical images and quantifications for MR brain and prostate.¹⁷

Typically, post-processing is done parallel to patient changing and starting the next exam. Efficient changing times reduce patient stress and allow providers to focus more on patient care. Similar innovations as described in the chapter “Patient Preparation” can be applied at the MRI system.

Proof points

“Brain Morphometry replaces this guesswork with quantitative and reproducible results to consistently detect changes.”¹⁸

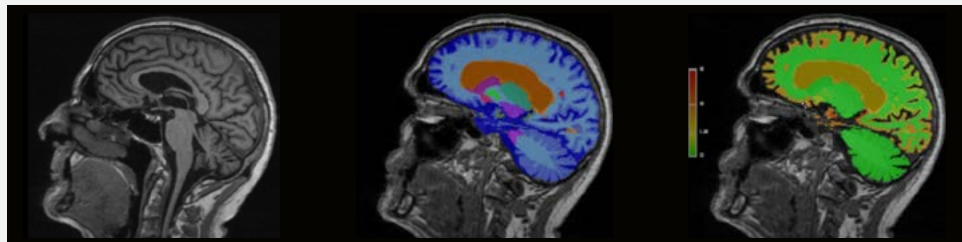
Dr. J. Dehem,
Jan Yperman Ziekenhuis, Belgium

¹⁶McDonald RJ, Schwartz KM, Eckel LJ, Diehn FE, Hunt CH, Bartholmai BJ, et al. The effects of changes in utilization and technological advancements of cross-sectional imaging on radiologist workload. *Academic Radiology*, Volume 22, Issue 9, 1191 – 1198.

¹⁷The AI Rad Companions MR Brain and MR Prostate are 510(k) pending. They are not commercially available in all countries. Due to regulatory reasons the future availability cannot be guaranteed.

¹⁸The statements by Siemens Healthineers customers described herein are based on results that were achieved in the customer's unique setting. Since there is no “typical” hospital and many variables exist (e.g., hospital size, case mix, level of IT adoption) there can be no guarantee that other customers will achieve the same results. This statement is from a person, who or whose institution is engaged in a collaboration with Siemens Healthineers.

Zero clicks & save 4 min¹⁹
per spine exam with
Recon&GO for vertebrae
labeling in all planes,
contrasts, slices
& orientations.



MPRAGE

Label Map

Deviation Map

Quantitative and reproducible results
for a consistent detection
of changes. E.g., with
the AI-Rad Companion
Brain MR to automated
analysis of subtle changes
in brain structure.

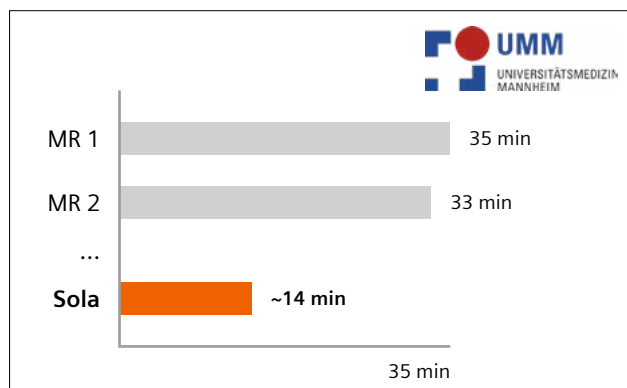
Brain Morphometry Report - 3/6			
Structure	Absolute[ml]	Normalized^[%]	Normative Range^[%]
Hippocampus	4.7	* 0.34	[0.39 - 0.49]
Hippocampus left	2.5	* 0.18	[0.20 - 0.25]
Hippocampus right	2.2	* 0.16	[0.19 - 0.24]
Ventricles	102.1	* 7.46	[2.10 - 5.71]
Lateral ventricle left	53.0	* 3.88	[0.89 - 2.75]
Lateral ventricle right	41.6	* 3.04	[0.85 - 2.55]
3rd ventricle	4.3	* 0.32	[0.14 - 0.30]
4th ventricle	3.1	0.23	[0.13 - 0.27]
^ Percentage of TIV (Total Intracranial Volume)			
* Out-of-range volumes			
Report based on automated processing! Include original data for diagnosis.			

Results table

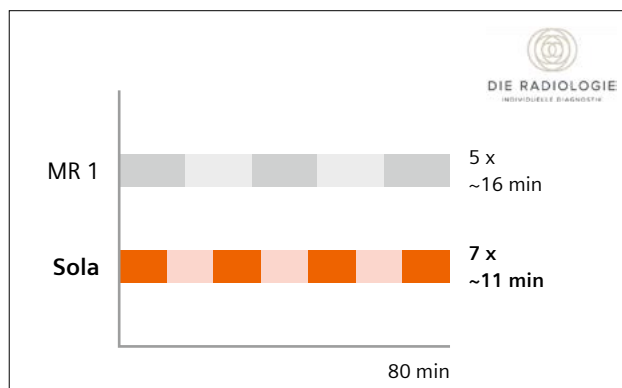
¹⁹Data on file

Customer proof points showcasing measurable productivity gains

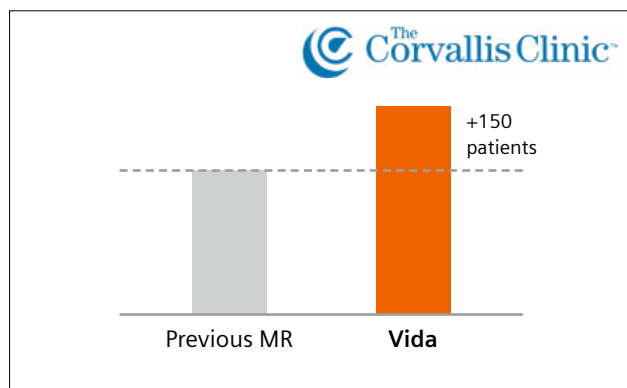
MRI productivity solutions need to demonstrate improvement on the daily ways of working. Relevant factors across the value chain, impacting multiple stakeholders, technologies, and process components can vary by provider. When implementing workflow and technology improvements it is essential to focus on enhancing the activities that generate the most value for patients, care delivery and staff. The examples below showcase measurable productivity gains achieved by some of our customers utilizing productivity solutions across the workflow.²⁰



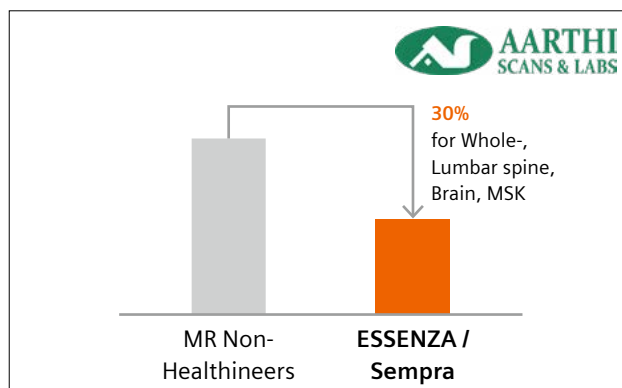
Reducing overall examination times from ~30min to <15min with MAGNETOM Sola²¹



Reducing MSK slot times by 5 min with MAGNETOM Sola²²



Increasing throughput by 150 patients per month with MAGNETOM Vida²³



Outperforming competition with MAGNETOM ESSENZA and Semptra by reducing examination times by overall 30%²⁴

²⁰The statements by Siemens Healthineers customers described herein are based on results that were achieved in the customer's unique setting. Since there is no "typical" hospital and many variables exist (e.g., hospital size, case mix, level of IT adoption) there can be no guarantee that other customers will achieve the same results. This statement is from a person, who or whose institution is engaged in a collaboration with Siemens Healthineers.

²¹Attenberger U et. al, MAGNETOM Sola: Adaptive and anticipatory, predictive and profitable. MAGNETOM Flash (70) 1/2018

²²Data on file

²³Data on file

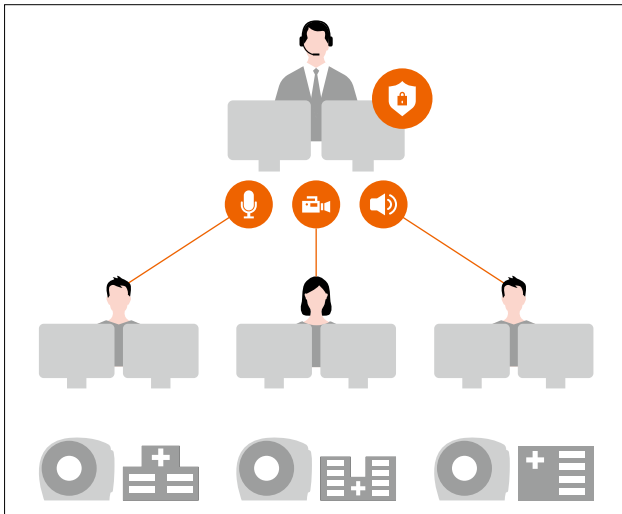
²⁴Data on file

Cross-Enterprise productivity – enabled by digitalization

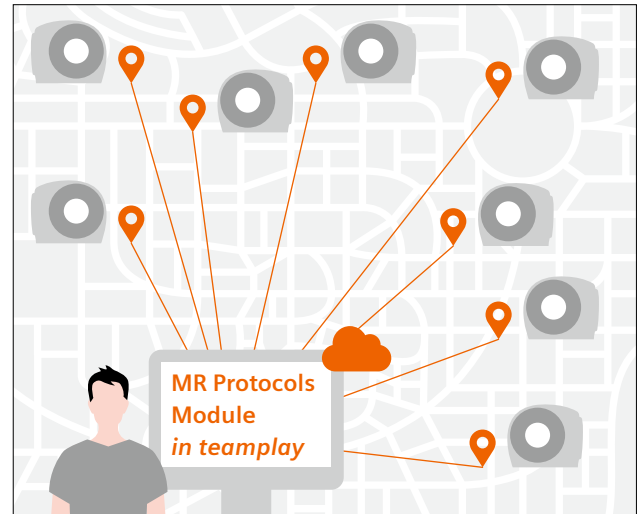
For healthcare providers operating multiple systems at one or many sites productivity is not only relevant on the system workflow level but at the enterprise level. Diverse demographics and specializations at different sites introduce new challenges in terms of varying levels of staff expertise and standards of MRI protocols, both leading to unwanted variations of care. Often not all technologists can confidently realize all examinations at the same high standard. As a result, not all procedures can always be

offered at all sites. Protocol management is still a widely manual and time-consuming activity. Changes are downloaded to a USB flash drive, then the lead technologist navigates to each department to physically install the update on every applicable scanner. It is an inefficient use of time for a highly qualified technologist and requires access to the scanner—that creates a time conflict of protocol updates and scanning patients.

Digitalization enables healthcare enterprises another level of productivity transformation:



syngo Virtual Cockpit, a software for remote scanning assistance. With remote scanning assistance you can connect to MRI scanners over a distance. The software enables a higher level of standardization that leads to more accurate diagnoses, e.g., for challenging examinations or when facing bottlenecks due to vacation periods/illness/nightshifts.



teamplay protocols with the MR Protocols Module allows for better team collaboration and coordination in patient care. teamplay is a secure cloud-based departmental performance management solution that provides protocol management capabilities: The MR Protocols Module enables users to centrally manage all protocols of the MRI scanner fleet,²⁵ beyond physical location, without interrupting scanning.

²⁵The MR Protocols Module is 510(k) pending. It is not commercially available in all countries. Due to regulatory reasons the future availability cannot be guaranteed. It gives access to Siemens Healthineers MAGNETOM scanners. Remote distribution is supported for syngo MR XA-line systems.

Conclusion

MRI productivity ties to factors across the value chain, impacting multiple stakeholders, technologies, and process components. Applying innovative technologies throughout the MRI workflow and leveraging digitalization will provide a pathway to achieving optimal clinical, financial and operational performance. This will be important for creating a stronger continuum of care, therefore, enhance MRI in the context of precision medicine, and improve the patient and provider experience.



Most recently, Frost & Sullivan recognized Siemens Healthineers work and leadership at a best practice level with the 2019 Global Visionary Innovation Award in Precision Imaging, which showcases the company's influential work and principal role in positioning medical imaging in the precision medicine landscape.²⁶

²⁶<https://www.siemens-healthineers.com/insights/news/frost-sullivan-award-precision-imaging.html>



Further readings

- [Benefit from a faster workflow with BioMatrix and GO technologies](#)
- [Set the pace in MRI acceleration with Turbo Suite](#)
- Learn more about our fast protocols and get them on MAGNETOM World:
 - [GOBrain & GOBrain+](#)
 - [CAIPIRINHA SPACE](#)
 - [GOKnee2D \(Work in progress. GOKnee2D protocols coming soon.\)](#)
 - [GOKnee3D](#)
- [Learn more about our customer examples on MAGNETOM World](#)
- Find more information about productivity in MRI here: [siemens-healthineers.com/mri-productivity](https://www.siemens-healthineers.com/mri-productivity)

At Siemens Healthineers, our purpose is to enable healthcare providers to increase value by empowering them on their journey toward expanding precision medicine, transforming care delivery, and improving patient experience, all enabled by digitalizing healthcare.

An estimated 5 million patients globally benefit every day from our innovative technologies and services in the areas of diagnostic and therapeutic imaging, laboratory diagnostics, and molecular medicine, as well as digital health and enterprise services.

We're a leading medical technology company with over 120 years of experience and 18,500 patents globally. With about 50,000 dedicated colleagues in over 70 countries, we'll continue to innovate and shape the future of healthcare.

The outcomes and statements provided by customers of Siemens Healthineers are unique to each customer's setting. Since there is no "typical" hospital and many variables exist (e.g., hospital size, case mix, and level of service/technology adoption), there can be no guarantee that others will achieve the same results.

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