Moving the Needle in MRI Productivity

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

siemens-healthineers.com/mri-productivity

SIEMENS
Healthineers

Contents

Introduction

Healthcare spending is rising at an unsustainable pace. Providers worldwide face pressure to deliver more and better care at lower costs 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 laid down in the "Quadruple Aim": A better patient experience, improved population health, lower costs, and enhanced provider work life.[1] Although originally conceived in the U.S., this aim has been adopted as a set of principles for health system reform by 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). It provides insights from publications and case studies which demonstrate productivity improvements.

---

[1]Bodenheimer T and Sinsky C. Ann Fam Med. 2014; 12: 573-576.

Top three C-level objectives for MRI

A Frost & Sullivan survey of U.S. 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. Because these objectives are tied to the objectives of the Quadruple Aim, they align well with providers' key priorities in the changing healthcare environment.

In order to help us 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.
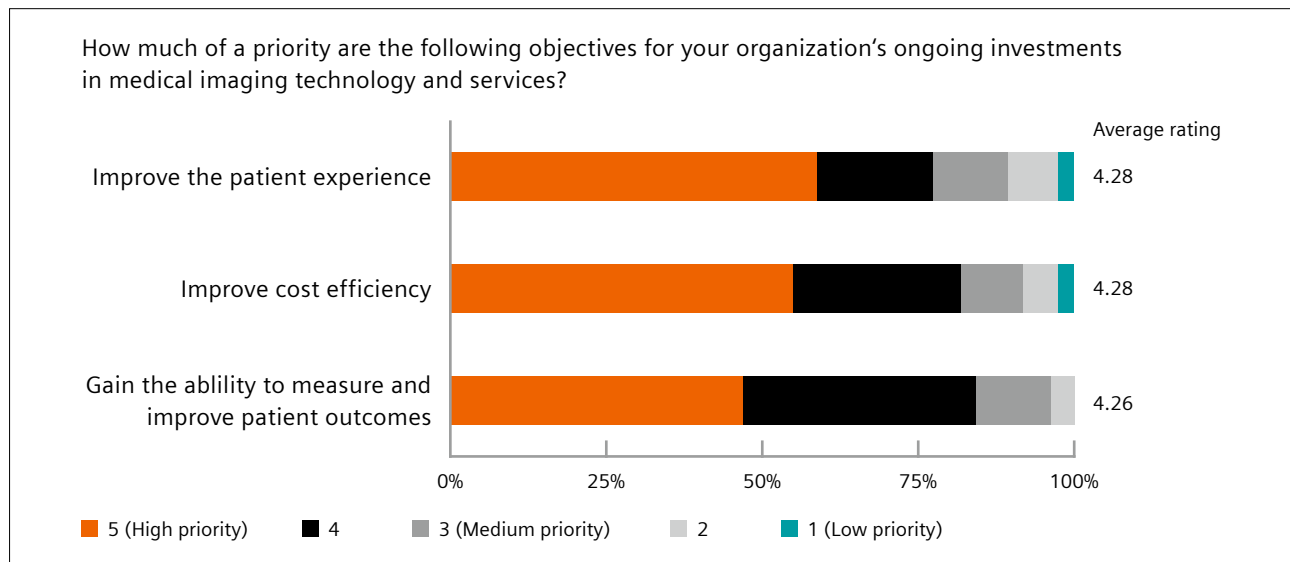

Figure 1: Top three objectives of medical imaging investments in the U.S.

Operational

- Workflow
- Patient throughput
- Exam slot times
- Equipment utilization
- Image consistency

Financial

- Maximizing MRI exam revenue
- Optimizing return on investment for MRI capital equipment
- Optimizing labor costs
- Achieving optimal daily appointment levels

Clinical

- Accurate diagnosis
- Faster scan times
- Reducing artifacts and rescans
- Highest-quality images
- Improved collaboration

Patient

- Experience during exam set-up
- Patient engagement
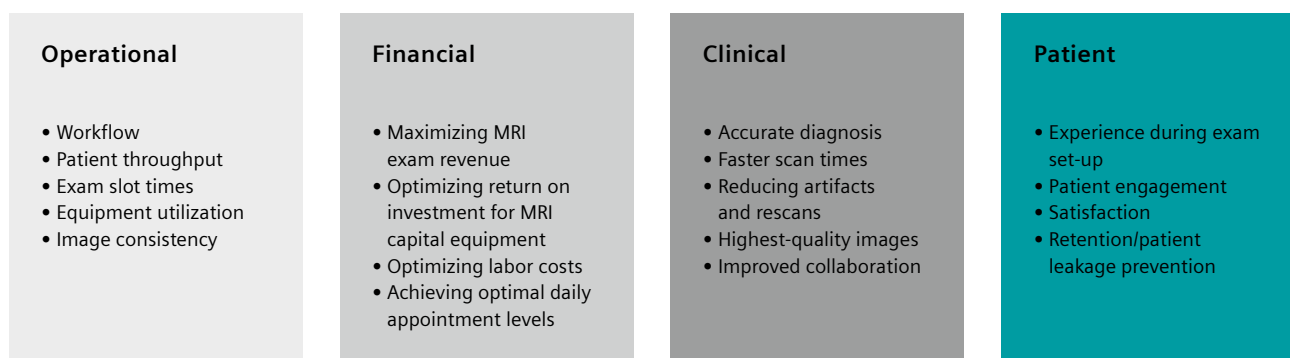- Satisfaction
- Retention/patient leakage prevention

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 is a key area of focus where advances in equipment, software, and protocols can radically change what is possible with an MRI exam.

Given declining reimbursements and shifts in value-based care, maximizing MRI exam productivity is a strategic goal for a healthcare organization to reach its optimal performance. The best way to achieve this goal is with the holistic optimization of the entire imaging value chain: From patient preparation to image acquisition and postprocessing / patient changeover.
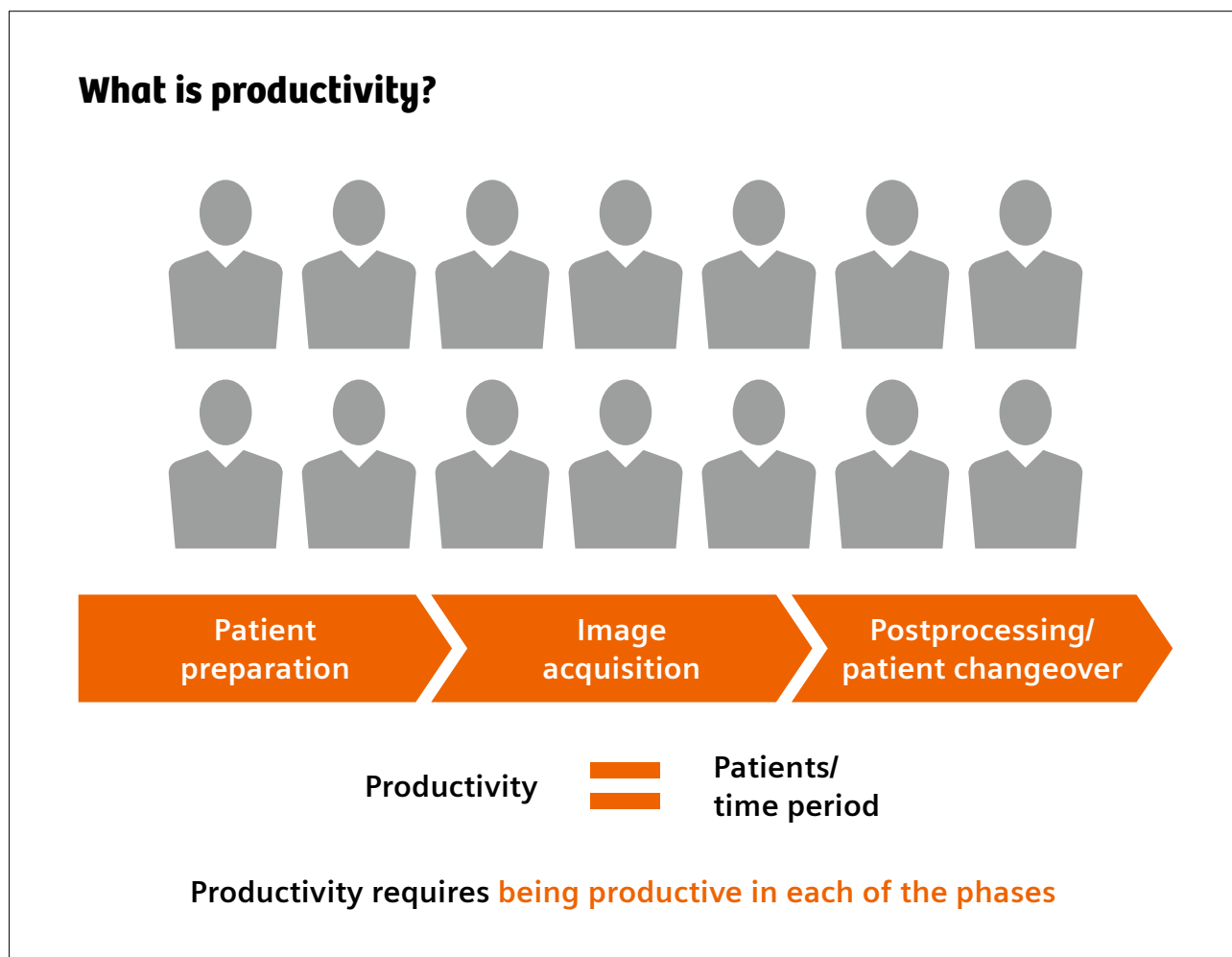
Figure 3: Relevance of MRI workflow phases for productivity

[2]Beker K, et al. AJR Am. J. Roentgenol. 2017; 209: 836-844.

Patient preparation

Patient preparation for 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 during the patient-facing part of the process where a positive patient experience is crucial: One study found that 42 percent of surveyed adults stated they were afraid of undergoing an MRI.[3] The more comfortable the patient and the better their experience during patient set-up 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 do their job.

Figure 4: Focus areas for the patient set-up

Improved workflow

Patient comfort and satisfaction

High-quality images

Consistency

Provider organizations are on the search for innovations that simplify patient set-up (including transport, if necessary), improve consistency, ehance patient comfort to avoid motion and accommodate challenging physiology and anatomy.

For example, some of the most recent innovations are our BioMatrix Sensors and Interfaces, which offer a range of value points that directly benefit the technologist during the exam set-up:

• BioMatrix Sensors anticipate and address motion and alleviate the need for ECG leads or a respiratory belt. 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 technologists position patients faster and avoid repositioning delays – no matter how tall, big, or mobile a patient is.

• BioMatrix Dockable Tables with eDrive allow the 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, thus improving workflow.

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

Proofpoints

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

Powered by
Artificial Intelligence

E.g., **from >7 mins. to <2 mins. turnaround time** with the help of BioMatrix Dockable Tables and room layout optimization. NYU saves up to 73 percent of turnaround time per patient.[5]

With easier set-up and a faster scan time, the technologist can spend more time interacting with the patient, easing their fears, educating them, and ensuring they have the best MRI experience possible.

[4]*Data on file.*
[5]*Recht M, et al.: Optimization of MRI Turnaround Times Through the Use of Dockable Tables and Innovative Architectural Design Strategies. AJR Am. J. Roentgenol. 2019; 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 lack of compliance with instructions significantly affect image quality and lead to approximately $115,000 in additional costs per scanner per year.[6] Exam consistency across multiple scans and follow-ups for the same patient also supports more accurate consultation during the read and more accurate diagnosis. The increased workload, with higher case volume and staffing concerns, is putting further 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 provide benefits such as reducing time spent on the table, easing patient stress, and enabling more patients to benefit from an MRI examination.
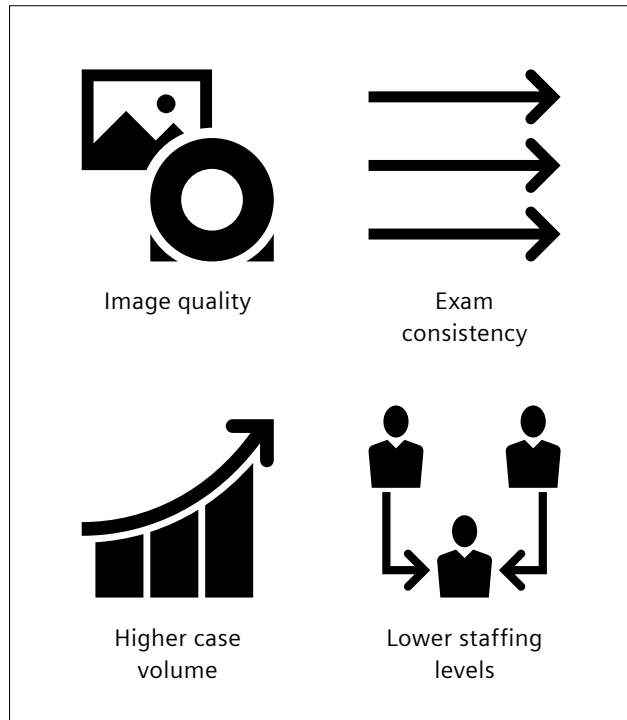

Image quality

Exam consistency

Higher case volume

Lower staffing levels

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 percent of exam types[8], provide an array of protocols that adapt to different patient conditions.

- Accelerated imaging technologies such as Simultaneous Multi-Slice (SMS) and Compressed Sensing (CS) are making image acquisition faster than ever 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 to specific MRI applications for some of the sickest patients.

  - SMS is a revolutionary method designed to significantly reduce imaging times for diffusion, BOLD, DWI, and TSE imaging. SMS can, e.g., reduce scan time by 49 percent for routine diffusion-weighted imaging with RESOLVE, shown in clinical practice to accelerate imaging without compromising 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. CS GRASP-VIBE, allows previously underserved groups, such as pediatric patients and those with limited breath-hold capability, to undergo abdominal imaging while breathing freely. It significantly reduces inadequate or compromised image quality and, hence, non-diagnostic exams.

- BioMatrix Sensors capture physiological characteristics of the patient. The ultra-high density BioMatrix spine coils, for example, utilize seamlessly integrated respiratory sensors to acquire the patient's respiration data. Knowing a patient's breath-hold capability enables the user to choose the right exam strategy.

- Integrated into the BioMatrix Head/Neck coils, CoilShim helps avoid rescans due to significantly improved fat saturation and better DWI quality. SliceAdjust provides reliable and distortion-free whole-body DWI scans.

---

[6]*Val M. Runge et al: Motion in Magnetic Resonance. New Paradigms for Improved Clinical Diagnosis. Investigative Radiology 2019 54:7.*
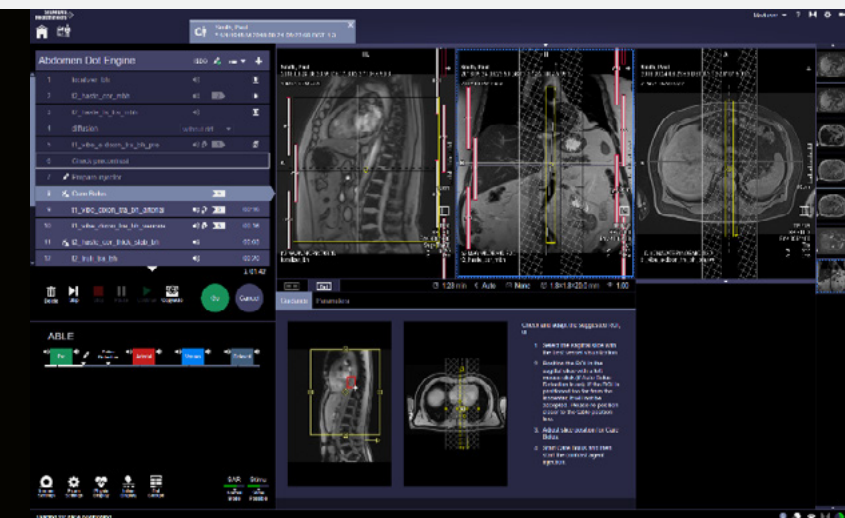[7]*Steve Holloway: MRI 2028: What to expect in the next decade of MRI?. ECR Today on 1 March 2018.*
[8]*Evaluation of 70.5 million MRI exams by Siemens Healthineers, 2017.*
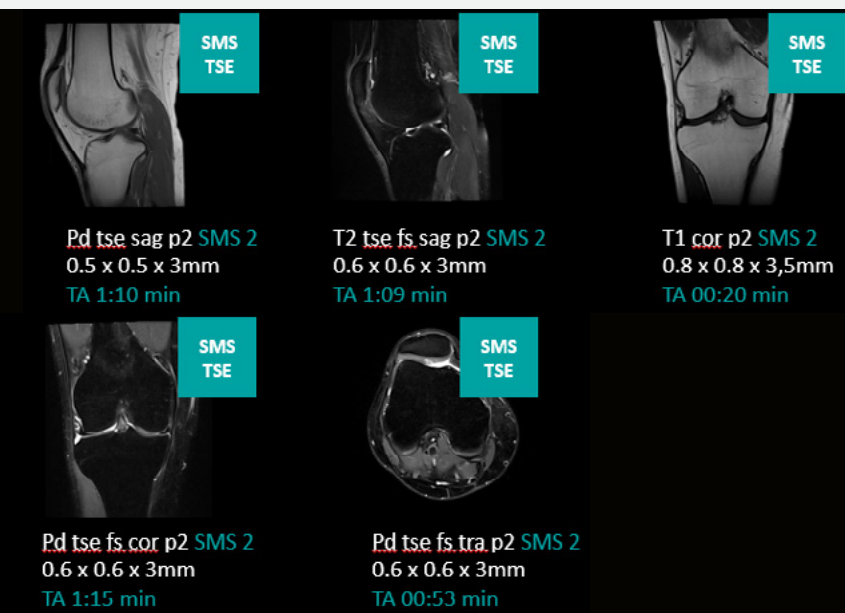[9]*Shown on MAGNETOM Vida, Sola, Lumina, VidaFit, SolaFit.*

Proofpoints

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

Positive results seen with the Brain Dot Engine, for example, included 46 percent lower parameter adjustments and 45 percent fewer tasks for MRI technologists compared to using a non-Siemens Healthineers Dot workflow.[11]

Powered by
Artificial Intelligence

Pd tse sag p2 SMS 2
0.5 x 0.5 x 3mm
TA 1:10 min

T2 tse fs sag p2 SMS 2
0.6 x 0.6 x 3mm
TA 1:09 min

T1 cor p2 SMS 2
0.8 x 0.8 x 3,5mm
TA 00:20 min

Pd tse fs cor p2 SMS 2
0.6 x 0.6 x 3mm
TA 1:15 min

Pd tse fs tra p2 SMS 2
0.6 x 0.6 x 3mm
TA 00:53 min

Study ID: 3aaaa1244

Up to 50 percent time savings with SMS and CS for static 2D and 3D imaging. For example, clinically validated, push-button 2D knee exams performed in 5 minutes instead of the more than 15 minutes required for a 2D knee exam. The underlying GOKnee2D[SMS] was validated by Dr. Jan Fritz from Johns Hopkins University School of Medicine in Baltimore, U.S., and includes multiple orientations and all relevant contrasts.[12]

[10]*Zhongshang Fudan University Hospital, Fudan, CN, Abdomen Dot Engine Workflow Study.*

[11]*Case Study by Prof. Forsting and Prof. Antoch, Department of Diagnostic and Interventional Radiology and Neuroradiology, University Hospital, Essen, Germany.*
The statements by customers of Siemens Healthineers 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.

[12]*Achieved on MAGNETOM Vida with Tx/Rx Knee 15 Coil, data on file.*

Effectively expand the patient population and tackle motion in free-breathing liver imaging with CS GRASP-VIBE. Dr. Yoon et al evaluated the new diagnostic capabilities and clinical performance of CS GRASP-VIBE: "GRASP-[VIBE] was able to consistently provide acceptable arterial phase imaging in patients who exhibited transient motion."[13]

Suboptimal breath-hold

Free-breathing Compressed Sensing GRASP-VIBE

BioMatrix Tuners SliceAdjust and CoilShim **improve image quality.** A study carried out at Universitätsklinikum Tübingen, Germany finds that 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.[14]
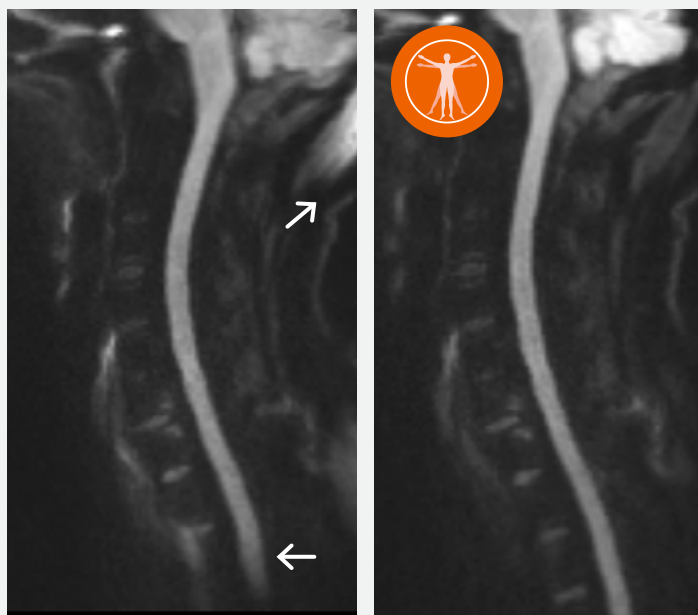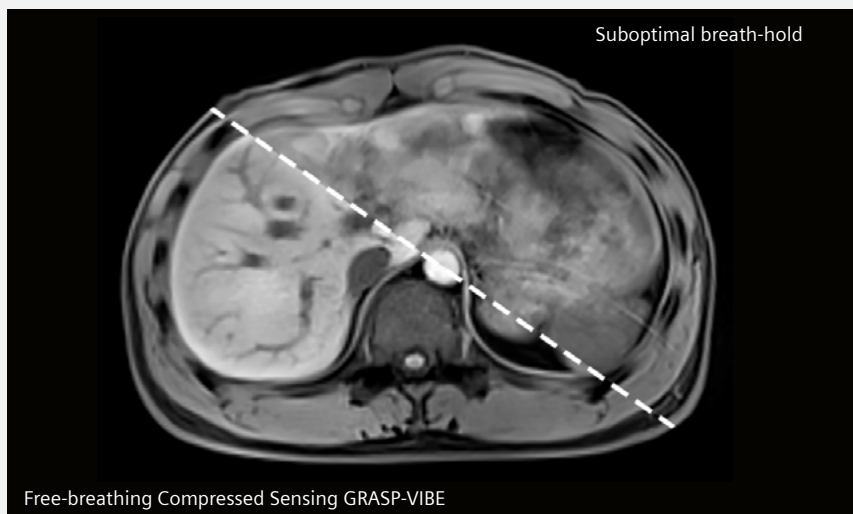
Conventional   CoilShim

---

[13]*Yoon JH et al. Evaluation of Transient Motion During Gadoxetic 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.*
[14]*Walter 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.*

Postprocessing

MRI workflow improvements for postprocessing can benefit healthcare organizations in multiple ways. In many countries, the number of MRI exams is continually on the rise but the number of experts is not keeping pace. As a result, the workload of each radiologist is increasing dramatically. On average, a radiologist interprets one image every 3–4 seconds, 8 hours a day.[15] Software innovations, including leveraging artificial intelligence, allow for faster postprocessing and eliminate errors and inconsistencies.

- Recon&GO features in-line reconstruction and postprocessing of the imaging data, including features such as composing, multiplanar reconstruction, and mathematical operations.

- MR View&GO simplifies image review and analysis. It provides software automation when distributing all necessary results to the PACS and the rest of the 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.[16]

Typically, postprocessing is done in parallel with patient changing and starting the next exam. Efficient changeover times reduce patient stress and allow providers to focus more on patient care. Similar innovations to those described in the chapter "Patient Preparation" can be applied to make the changeover more efficient.

Proofpoints

"Brain Morphometry replaces this guesswork with quantitative and reproducible results to consistently detect changes." [17]

Dr. J. Dehem,
Jan Yperman Ziekenhuis, Belgium

---

[15]*McDonald R, et al. The effects of changes in utilization and technological advancements of cross-sectional imaging on radiologist workload. Acad. Radiol. 22(9): 1191-1198.*

[16]*The 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.*

[17]*The statements by customers of Siemens Healthineers 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 and save 4 mins.[18] per spine exam with Recon&GO for vertebrae labeling in all planes, contrasts, slices, and orientations.
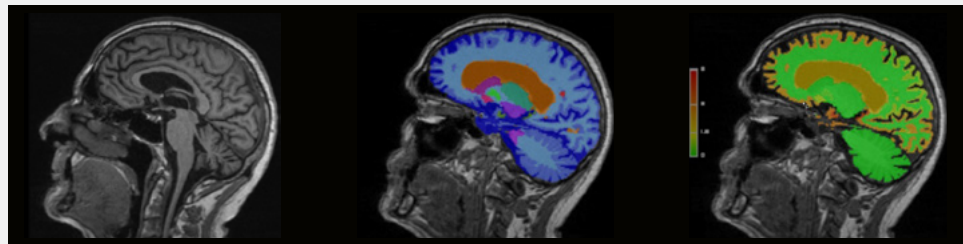
MPRAGE   Label map   Deviation map

Quantitative and reproducible results for consistent detection of changes. AI-Rad Companion Brain MR, for example, can be used for 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

Customer proofpoints showcasing measurable productivity gains

MRI productivity solutions need to demonstrate improvement in day-to-day working practice. 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 the measurable productivity gains achieved by some of our customers by utilizing productivity solutions across the workflow.[19]
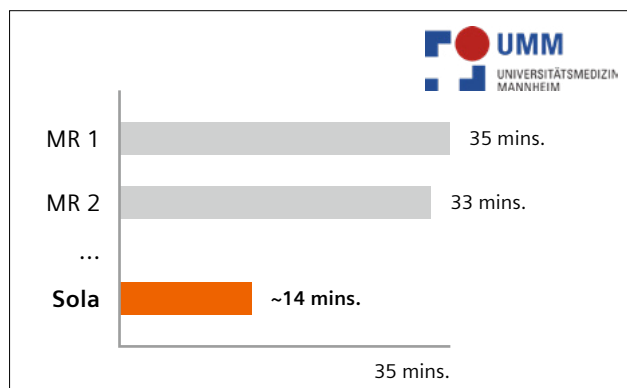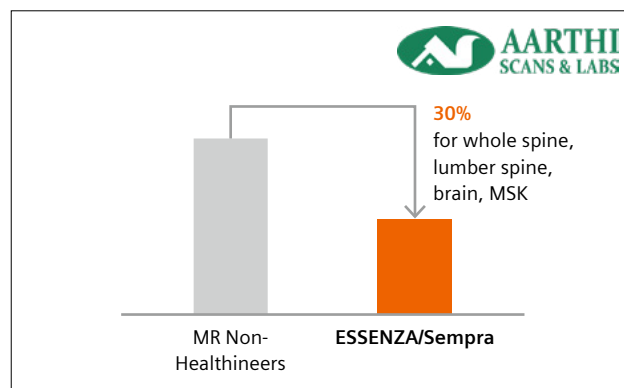

Reducing overall examination times from ~30 mins. to <15 mins. with MAGNETOM Sola[20]
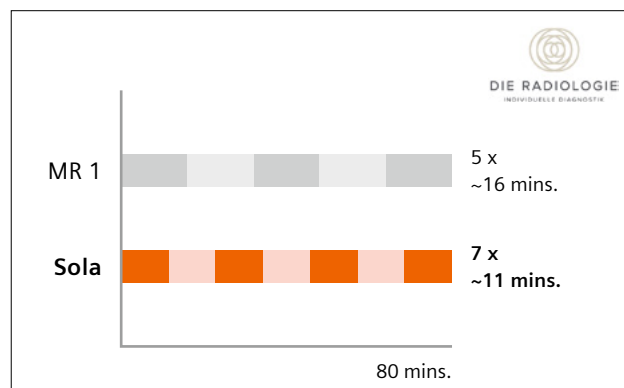
Reducing MSK slot times by 5 mins. with MAGNETOM Sola[21]
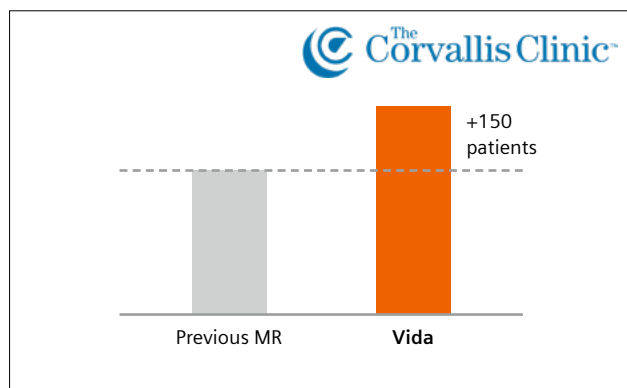
Increasing throughput by 150 patients per month with MAGNETOM Vida[22]

Outperforming competition with MAGNETOM ESSENZA and Sempra by reducing examination times by 30 percent overall[23]

[19]The statements by customers of Siemens Healthineers 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.
[20]Attenberger U, et al. MAGNETOM Sola: Adaptive and anticipatory, predictive and profitable. MAGNETOM Flash (70) 1/2018.
[21]Data on file.
[22]Data on file.
[23]Data 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 also at the enterprise level. Different scanner operating systems cause poor user experience and lead to operational inefficiencies. 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 are able to confidently perform all examinations to the same high standard.

As a result, not all procedures can always be offered at all sites. Protocol management is still largely a manual, 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, which creates a time conflict between protocol updates and patient scans.

Digitalization provides healthcare enterprises with another level of productivity transformation:
The *syngo* MR software provides a common software platform across scanners. Its consistent user experience makes staff rotation easy and scanner operations more intuitive.
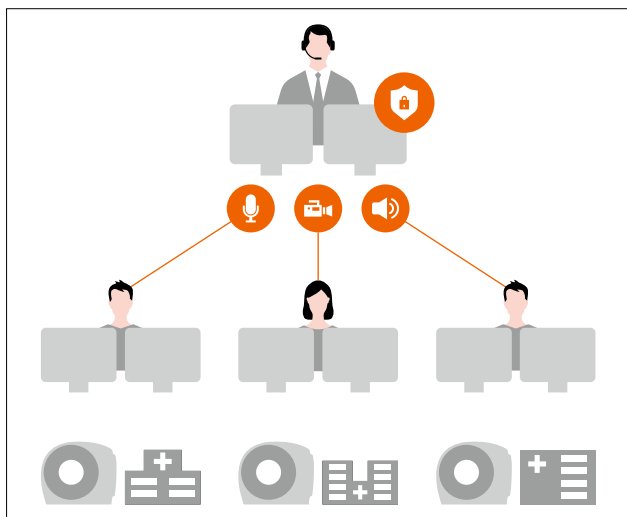
syngo Virtual Cockpit is a software solution for remote scanning assistance. With remote scanning assistance you can connect to MRI scanners in different locations. Experts receive access to the scanner and can support less-experienced technologists via chat, voice, and video. The software enables a higher level of standardization leading to more accurate diagnoses, e.g., for challenging examinations or when facing bottlenecks due to vacation periods, illness, or nightshifts.
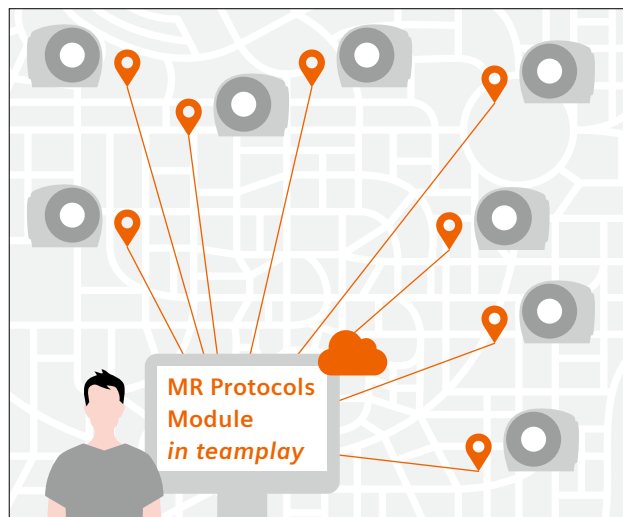
teamplay protocols with the MR Protocols Module allows for better team collaboration and coordination in patient care. teamplay is a secure cloud-based departmental performance management solution that provides protocol management capabilities. The MR Protocols Module enables users to centrally manage all protocols of the MRI scanner fleet,[24] independent of physical location, without interrupting scanning.

---

[24]*The 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 is linked 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. Publications and case studies demonstrate how radiology needs to change practice to manage increasing workload while maximizing value. This is important for creating a stronger continuum of care and thus enhancing MRI in the context of precision medicine, and improving the patient and provider experience.

FROST & SULLIVAN BEST PRACTICES AWARD

PRECISION IMAGING - GLOBAL

Visionary Innovation Leadership 2019

Frost & Sullivan recently recognized the work and leadership of Siemens Healthineers at a best practice level with the 2019 Global Visionary Innovation Award in Precision Imaging. The award showcases the company's influential work and key role in positioning medical imaging in the precision medicine landscape.[25]

---

[25]https://www.siemens-healthineers.com/insights/news/frost-sullivan-award-precision-imaging.html

■ Further reading

- 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 access 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 ■

The information in this document contains general technical descriptions of specifications and options as well as standard and optional features which do not always have to be present in individual cases, and which may not be commercially available in all countries. Due to regulatory reasons their future availability cannot be guaranteed. Please contact your local Siemens Healthineers organization for further details.

Siemens Healthineers reserves the right to modify the design, packaging, specifications, and options described herein without prior notice. Please contact your local Siemens Healthineers sales representative for the most current information.

Note: Any technical data contained in this document may vary within defined tolerances. Original images always lose a certain amount of detail when reproduced.