The radiologist's handbook for future excellence 2021

SECTRA

Knowledge and passion

Introduction

In October 2019, Sectra published the e-book "The radiologist's handbook for future excellence 2020". The first edition of the handbook was very well received, and the positive feedback has been overwhelming. It provided radiology professionals with the latest insights and guidance on key technologies within four areas with potential to truly enhance radiologists' skills, scope and ability to cope with future demands. The four areas investigated in the previous edition were:

- Workflow orchestration
- Artificial intelligence
- Multiparametric MRI
- Integrated diagnostics

This 2021 edition of the handbook is divided in two parts. In **Part I**, we give you an update on how the COVID-19 pandemic has impacted radiology overall, and how the four technologies covered in the 2020 edition have evolved during the past year.

In **Part II**, we dive into five new key technology areas to either invest in or keep an eye on during 2021 to stay competitive:

- Smart display protocols
- Optimized diagnostic context
- Streamlined and smart reporting
- End-to-end AI assistance
- Collaboration-enablers for remote reading and distributed workflows

After each section, there is a checklist with the most significant functionalities and prerequisites for you to stay ahead of the curve. In addition, a **bonus chapter** gives advice on two of the most recent and urgent needs we see from a business perspective within radiological IT today—the importance of IT cost-sharing between departments and the need for flexible business models to be able to adjust cost to changing volumes.

Contents

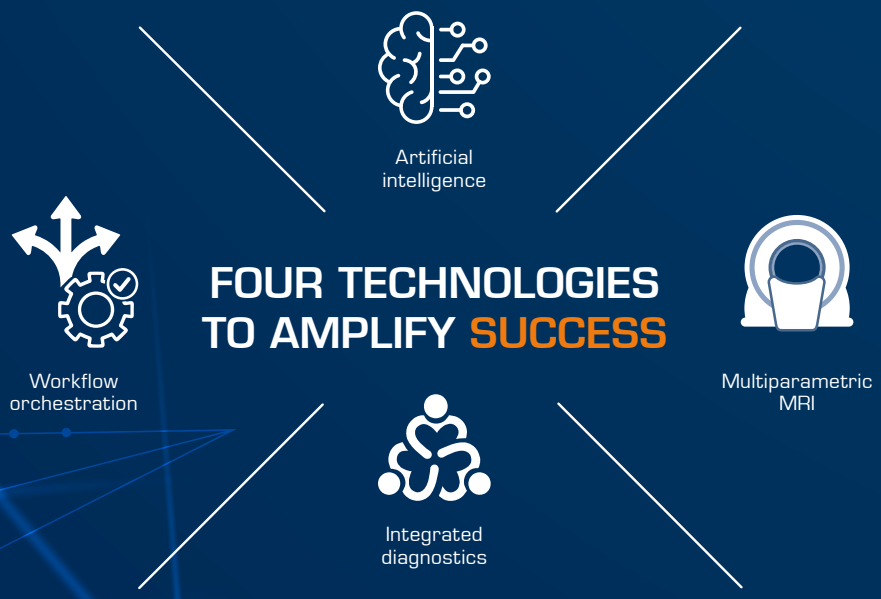
Reading guidance

- Insights and evidence in this report are based on interviews, research, industry articles and market reports
- PACS and enterprise imaging (EI) systems are used as synonyms
- The words "diagnostic application", "workstation" and "client" all refer to the user interface of the PACS/EI system and should be seen as synonyms
- Explanation to the "state and rate of adoption" assessment graphs on pages 8, 22 and 40:
  - Adopt: The industry is already or should be adopting these items
  - Trial: Worth pursuing. It is important to understand how to build up this capability. Try these items on projects that can handle the risk
  - Assess: Worth exploring with the goal of understanding how these items will affect your enterprise
  - Hold: Proceed with caution
- Referencing:
  - . (X). Means the reference "X" adheres to the entire text paragraph before
  - (X). Means the reference "X" only adheres to the latest sentence

Part I: Let's revisit 2020

This 2021 edition of the handbook is divided in two parts. Here in Part I, we give you an update on how the COVID-19 pandemic has impacted radiology overall, and how the four technologies covered in the 2020 edition have evolved during the past year.

Let's get started.



The COVID-19 pandemic and its impact on radiology

Much has happened since we published the last report. The entire healthcare apparatus has been shaken by one of the biggest pandemics of modern times. **Priorities have rapidly changed**, where elective care and preventative tests such as mammography screening have been put on hold. This has led to even greater pressure on radiologists; first to cope with declining volumes and the financial consequences of that, and then to handle the massive increase in the upcoming exams post-COVID. Handling the imaging backlog is a huge challenge for radiology during this second half of 2020.

As mentioned in the handbook last year, **physician burnout** has become a severe issue for radiology according to Medscape's annual report for 2019. Looking into their latest survey published in February 2020, we find that the number of radiologists experiencing burnout has increased from 44% to 46%. Radiology as a specialty has climbed from 12th place to be among the top six specialties when it comes to burnout. The main reason mentioned in the report is spending too much time at work. (1). The financial insecurity, mental burden and looming backlog of cases resulting from the COVID-19 pandemic are not taken into consideration in this data. But we can make a qualified guess that the burnout situation probably has become worse during 2020.

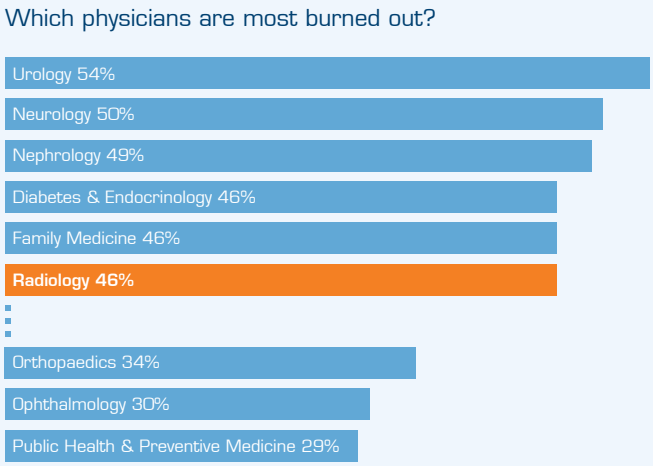


Figure 1. Radiology is among the six specialties feeling most burned out according to Medscape's 2020 annual report (1).

The pandemic has also led to a **workflow shift** when it comes to reading patterns. Working from home has become the new normal, increasing the demands on commu-

nication tools, security and performance of the diagnostic IT system outside of hospital borders. An important question to ask is if radiologists will continue working from home now that benefits such as improved productivity and flexibility have been revealed?

Examples of the imaging backlog due to the COVID-19 pandemic

The Royal College of Radiologists in the U.K. estimates that 850,000 MRI and CT scans need to be carried out in the country because of COVID-19. The NHS would need to increase the number of radiology positions by one-third, which means that the country needs another 1,900 radiologists to work through the backlog from the coronavirus pandemic. (2).

Examples reported from the U.S. in May show similar challenges with large imaging backlogs:

- Henry Ford Health System has a backlog of about 8,000 surgical procedures
- The University of Michigan Health System estimates it has 12,000 delayed surgeries
- Beaumont Health delayed roughly 9,500 imaging procedures, such as CT scans, MRIs and X-rays

Dr. Jeffrey Fischgrund, Chief of Clinical Programs for Beaumont Health, states in the article that it will take many months to clear the backlog: *"I wish I could say it's three months. Realistically, I think it's going to be six months or more."* (3).

With most mammography screening programs completely halted during the pandemic, this area has created huge backlogs in several countries. In the U.S., for example, based on FDA statistics, an estimated 40 million mammography procedures are performed annually. With these programs halted, this equates to nearly 770,000 delayed mammography procedures—every single week. (4).

A study (5) by Dr. Howard Forman and Dr. Joseph Cavallo from the Yale School of Management, published in April in the *Journal of the American College of Radiology*, concludes that the pandemic reduced radiology practices' imaging volumes by 50–70% during a time period of at least 3–4 months. The two authors describe the situation as unique since:

> *"…economic recessions generally tend to result in decreased health care expenditures, radiology groups have never experienced an economic shock that is simultaneously exacerbated by the need to restrict the availability of imaging."*

In May, we heard from several radiology practices that volumes were recovering, although still far from the levels before the crisis. For example, the teleradiology company vRad predicted a gradual recovery during Q2/Q3 2020 and a return to normal procedure volumes in Q4 2020 (see forecast illustrated in Figure 2). Signify Research

reports they are reasonably confident that the huge reductions in diagnostic imaging procedures during the first half of 2020 will lead to a steady recovery in the second half of 2020, and a rapid increase in 2021 as pent-up demand is relieved. (6).

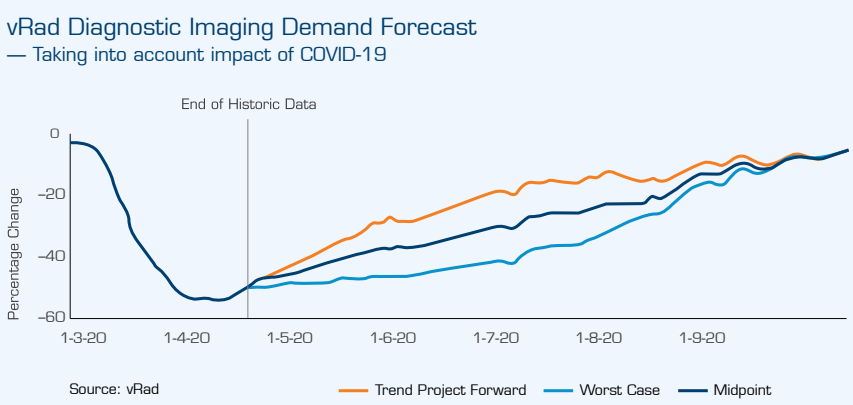


Figure 2. A graph showing three different scenarios on exam volume recovery for the teleradiology service provider vRad's forecast (6).

Radiology's response to the pandemic

On a positive note, these new challenges imposed by the coronavirus have resulted in an increasing speed of adoption for some technologies. From an enterprise imaging perspective, the pandemic has put new demands on your IT systems and the vendors providing them, including new technical functionality for working and collaborating remotely in an efficient, secure way and for handling the post-COVID imaging back-log. But also, the pandemic has shown a need for increased flexibility of the payment model for diagnostic IT systems, to better adjust costs to rapidly changing volumes.

In a survey (7) published by *ITNonline.com*, respondents were asked what the primary method would be to manage the surge in volumes:

- 44% would extend hours of operation
- 29% would create a more efficient workflow
- 1% would utilize a mobile imaging service provider
- 4% would hire more staff
- 15% would do nothing, believing that there will be no surge of outpatient imaging procedures

The fact that almost one third of providers aim to create a more efficient workflow to cope with the imaging backlog highlights the need for utilization of new technologies and functionalities to boost productivity.

The development of the four key technologies of 2020

During the spring of 2020, we conducted comprehensive research by interviewing healthcare professionals, including radiologists and radiology managers, industry experts and health IT vendors. Our aim was to evaluate how the previous year's four key technologies—workflow orchestration, artificial intelligence, multiparametric MRI, and integrated diagnostics—have developed and been adopted in the past year. In addition, we complemented the interviews with some of the latest published research on the selected topics.

Despite the short period of time since our previous radiologist's handbook was published, the COVID-19 pandemic has significantly accelerated the adoption of some technologies, while slowing down others. In this section, we go through the key conclusions of our research in order to provide you, as a radiologist, with insights on these technologies.

Figure 3 illustrates a current state assessment of these four technologies and how quickly they have been adopted by radiology departments.

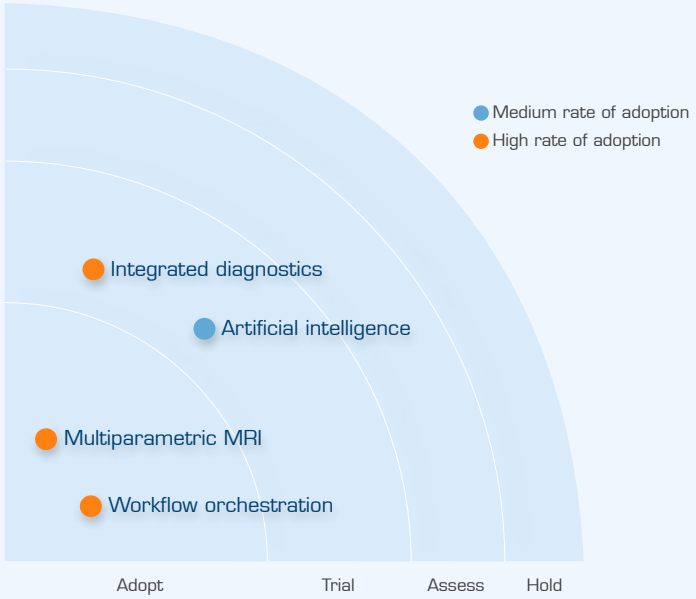


Figure 3. An assessment of the key technologies covered in the previous edition of the handbook. Position indicates current state of adoption, while color indicates adoption rate.

A digest of our findings

Workflow orchestration: The need to manage workflows efficiently has never been greater, and several radiology providers are adopting workflow orchestration solutions as part of their enterprise imaging system. Analytics, feedback and allocation of cases are in the spotlight.

Artificial intelligence: While the AI hype is over and implementations are on the rise, it has not fully taken off during 2020. Continuing to add AI technology that penetrates end-to-end workflows will be key for adoption.

Multiparametric MRI: Adoption of native mpMRI functionality is accelerating, especially for breast. Fast MRI sequences further contribute to strengthening MR adoption in cancer diagnostics.

Integrated diagnostics: A great need for increased sharing of information and collaboration between disciplines might be solved with enterprise imaging and subscription-based models. Some providers have taken the first step to adopt a common platform for radiology and pathology. Shared digital conferences are seen as one of the high points of early achievements, partly driven by the COVID-19 pandemic.

Workflow orchestration

The need to manage workflows efficiently has never been greater, and several radiology providers are adopting workflow orchestration solutions as part of their enterprise imaging system. Analytics, feedback and allocation of cases are in the spotlight.

Workflow is both the magic and the headache of radiology. Orchestrating workflow more efficiently is a win–win for patients, technologists, radiologists and referring physicians. Simply put, patients benefit when the right radiologist is assigned to the right case.

The current need for enhancing workflows

During the last year, we have seen a growing demand for powerful software to facilitate the management of workflows. This is partly driven by the sudden increase in radiologists working from home due to the coronavirus pandemic. In that setting, the need for implementing and efficiently following up on distributed workflows is increasing. The post-COVID volume surge will also put pressure on radiology to handle the sudden increased workload and to share work evenly and fairly between colleagues and sites.

The increased need for workflow orchestration triggered by the pandemic is added on top of other drivers, such as the increased sub-specialization of radiology, tougher service level agreements (SLAs) on radiology services, and the ongoing trend of mergers and acquisitions among healthcare providers. All factors put together, radiology has never had a bigger need for solutions to monitor, manage, and analyze radiology workloads. Providers need to ensure the highest-priority cases are read first—both from a clinical perspective, but also from an SLA point of view. Workflow rules and functionality should also guarantee a fair and balanced workload for all readers.

While many radiology groups today enjoy adequate workflow, most have room for improvement in measuring workloads, managing studies and balancing capacities to boost productivity and prevent physician burnout.

The need for workflow management solutions was highlighted in a poll performed by *Radiology Business Journal* and *RadiologyBusiness.com* in May. The results of the poll concluded that radiology practice leaders' No.1 concern is measuring and managing quality workflow, including load balancing and assigning exams. (8).

Functionality that has turned out to be important

From our interviews, we surmise that the core concept of having **access to an enterprise-wide worklist** was very valuable in managing workflows. An enterprise imaging system that offers transparency allows radiologists to see current workloads at different sites as well as their individual colleagues' assigned cases. As one interviewed radiologist said:

> *"It is really convenient to work with shared worklists driven from the PACS, where I can see which cases other radiologists are working on and we have the possibility to easily share the workload."*
>
> Mattias Mjöman, Radiologist, Region Skåne (Sweden)

There is also a strong trend of using **AI as a pre-reading and triage tool** in workflow orchestration solutions. This is when an AI algorithm detects potential urgent findings so that those cases automatically can be moved to the top of the worklist. Examples of areas where this has been used in clinical practice are breast screening triaging and to detect brain hemorrhage or pneumonia.

Implementing workflow orchestration tools focuses around change management. Creating and analyzing relevant data is paramount to understanding if actions are really leading to a change. Some of the most appreciated features in workflow orchestration software are **easy-to-use analytics and visualization tools**; not only for retrospective analysis, but also real-time information to be able to act here and now. One such example of appreciated real-time data usage is radiologists' ability to see and monitor their own progress in relation to workloads and colleagues, and to act upon the current situation—a kind of "gamification".

Many radiologists have stressed the importance of **transparency**. When done right, transparency takes away suspicion among those dividing up the total amount of work to be done. A transparent workflow management solution with a dashboard providing real-time data can strengthen that trust.

It is not a big surprise to see how much the use of specific tools for **quality assurance (QA)** is appreciated. These tools aim to improve the workflow quality by providing a closed feedback loop between radiologists, or between the radiologist and the technologists. They allow radiologists to flag poor quality of images, wrong hangings, or to handle discrepancies—but also to provide positive feedback to encourage good work among technologists. They also facilitate peer review and learning by following up on findings, which is essential for continuous improvements and skills development. The trend of having pathology in the same enterprise imaging system also allows feedback, comparing image findings with the pathologist's conclusion.

"Previously, technologists and radiologists worked closer together, and radiologists could directly provide their feedback. As we continue to grow our practice, sometimes it is difficult to provide timely face-to-face feedback. The QA feature enables radiologists and technologists to have that feedback loop, which significantly improves learning and the quality of service that we provide."

Rafal Sadowski, Quality and Safety Manager at Midstate Radiology Associates, a Hartford HealthCare partner

A study (9) published in the *Journal of American College of Radiology* in 2018, concluded that implementing a workflow-integrated solution into the diagnostic reading helps radiologists provide feedback to technologists. It will also increase radiologist engagement, and help a practice identify and address ongoing issues.

One of the authors of the study, Shlomit Goldberg-Stein, MD, Albert Einstein College of Medicine in the Bronx, New York, writes: "Consistent diagnostic image quality along with timely and accurate performance of technical and clerical tasks is a requisite for high-level radiology patient care." He stresses the need to enable radiologists to provide input into the process of image acquisition in an easy way in conjunction with the diagnostic procedure.

Large radiology organizations seeking to optimize sub-specialty reading are increasingly adopting capabilities for **automatic case allocation and re-allocation**. Such functionality is realized by creating profiles of individual radiologist's competencies and sub-specialty criteria in the system. Given current scheduling, workload and promised response time, the system then automatically allocates pending cases to the right radiologists. This is something that is time-consuming to do manually and an area with potential for productivity gains.

Automation and rules-based case assignment hinged on available specialists holds strong potential. Both complexity and managing the profiles and rules, together with the cultural and behavioral change for the organization, are barriers that need to be overcome.

Artificial intelligence

While the AI hype is over and implementations are on the rise, it has not fully taken off during 2020. Continuing to add AI technology that penetrates end-to-end workflows will be key for adoption.

The adoption of AI algorithms in radiology to boost productivity in diagnostic reading and workflow management is still prevalent. We now seem to have passed the biggest splash, and it has become obvious that it will take time to implement AI into clinical care. Early signs of the decline in the hype could be seen already at RSNA 2019. Many AI startups faced funding pressure and there was a lower-than-expected attendance in the dedicated AI pavilion.

The perception of what AI can do for radiology short term has matured. The implementation of algorithms into clinical care is still proceeding but is slowed down by a few barriers. We have identified four factors that have had—and still have—a strong impact on the slower pace of AI adoption over the last year:

- The coronavirus pandemic
- The business case and availability of data
- Regulatory approval
- Lack of clinical evidence and reimbursements

The COVID-19 pandemic's impact on AI adoption

During 2020, the coronavirus crisis has slowed down most of the ongoing projects for adopting AI into clinical use—mainly because of a shift in focus of healthcare providers' resources to treat COVID-19 patients. Many providers have become more risk-averse due to financial pressures and have prioritized well-known and trusted technologies before AI. IT staff capacity has also had a negative impact for on-premise AI installations, which today still account for most applications.

It is remarkable how quickly many AI vendors have responded to the new circumstances, shifting their efforts to creating algorithms to assist radiologists in the diagnosis of COVID-19 and its comorbidities. Below are a few examples from the U.S. on how AI algorithms have quickly been developed and used by radiology to assist in COVID-19 care.

One example is algorithms to quickly triage patients with possible COVID-19-induced pneumonia. Albert Hsiao, MD, PhD, Associate Professor of Radiology at University of California San Diego School of Medicine and Radiologist at UC San Diego Health, highlights the benefits they have experienced by using AI-enhanced imaging to fight COVID-19, in a report by HospiMedica (10):

> "We can quickly triage patients to the appropriate level of care, even before a COVID-19 diagnosis is officially confirmed. That's where imaging can play an important role."

A second example is radiologists and physicians at UC San Diego Health who have used AI during the pandemic to enhance their ability to detect pneumonia on chest X-rays. The machine learning algorithm provided color-coded heat maps to indicate the probability of pneumonia. Radiologists could quicker detect pneumonia—and therefore better distinguish between COVID-19 patients likely to need more supportive care in the hospital and those who could be monitored closely at home. (10).

Yet another example is from the department of diagnostic imaging at Rhode Island Hospital. They reported in the journal Radiology that their AI tool improved radiologist accuracy, sensitivity and specificity in identifying patients with COVID-19 pneumonia on CT scans. The authors report that this can be particularly helpful in differentiating COVID-19 pneumonia and pneumonia of other origins, which has been a major hurdle in controlling the pandemic. (11).

Although the coronavirus pandemic has slowed down most of the previously ongoing AI projects, new applications have quickly been developed where cases match current needs—a match that previously has been missing. These examples show proof of a capability among AI vendors to quickly refocus, and it also justifies the value of adopting AI applications through marketplaces. These platforms allow you to use newly released apps developed by a range of AI vendors without having to wait for an upgrade of your EI system.

The business case and availability of data

The financing of AI algorithms remains an issue. Most current AI applications are very specific and made for narrow use cases. We have not yet seen a broadscale implementation of such applications. In addition, most available use cases are being driven by data availability, not by where the biggest needs are for AI augmentation. Narrow use cases, together with a mismatch between available solutions and needs, lead to **difficulties to justify the price per analysis**. The business case does not add up. This is something that needs to be solved, most likely by bringing many different specific AI algorithms together and allowing them to penetrate the entire workflow, showing workflow-wide productivity gains—something we dig deeper into in Part II of this handbook.

Regulatory approval

Another factor impacting adoption is the regulatory component. Since 2018, the U.S. Food and Drug Administration (FDA) has cleared over 50 AI-based medical imaging applications for sale and a higher number have received a CE Mark (12).

In an article (13) published in *RadiologyToday*, Dr. Bradley J. Erickson (MD, PhD), Associate Professor of Biochemistry and Molecular Biology at the Mayo Clinic College of Medicine in Rochester, MN, predicts that AI-assisted work efficiencies will be the most immediate benefit and first to be adopted, mainly because they will not require FDA clearance. He believes that the next wave will be the diagnostic tools. (13). His perception is in line with what we have heard in our interviews: first, we expect to see a larger increase in AI strengthening workflows, whereas AI targeting diagnostic reading has a longer maturity cycle. When AI penetrates the entire reading process, we can expect substantial gains and solid justification for the business case.

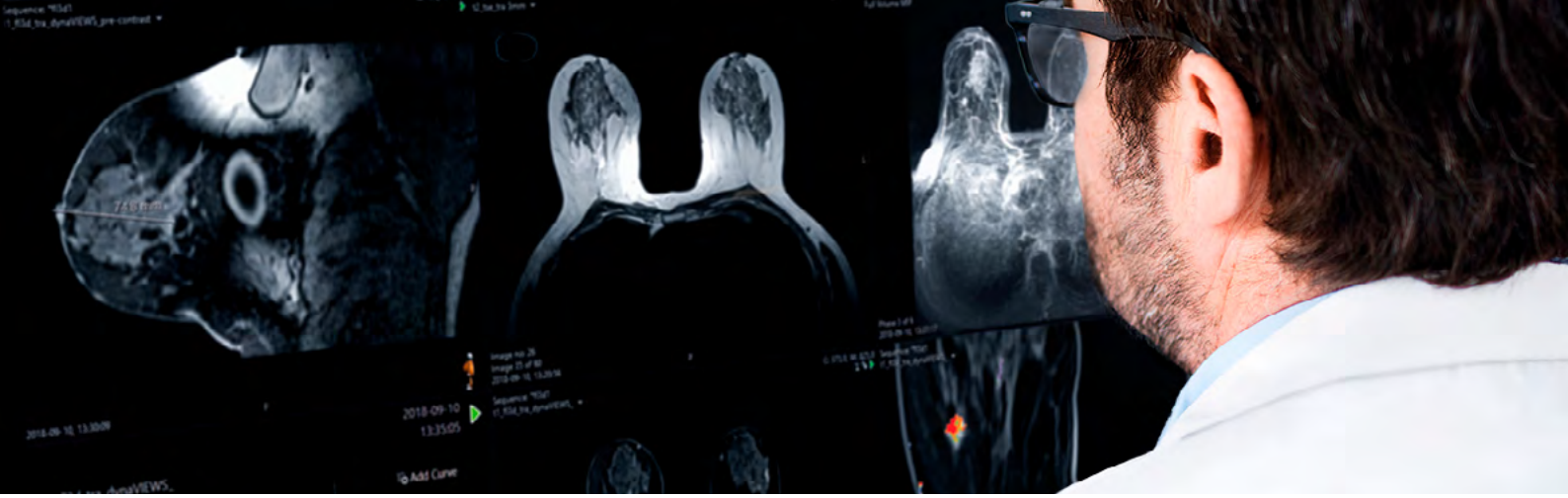
Lack of clinical evidence and reimbursements

Clinical evidence and economic studies to demonstrate the health economic benefits of AI take investment and time, which is why initially, start-ups rarely have the capacity to conduct them. More studies are required to build the customer confidence needed for most health providers to invest. Investment in AI-based clinical applications for radiological medical imaging is currently not considered a high priority. The lack of reimbursement for AI-based clinical applications is another major barrier that can only be solved with clinical evidence in place. This evidence will come, but it will take some time.

AI is slowly getting there

Despite the above-mentioned barriers that are slowing down the adoption of AI, we see many signs that AI is indeed making it into radiologists' workflows. AI adoption will most likely start accelerating once the coronavirus pandemic has passed, and the main conclusion to be made is that AI needs to penetrate the entire reading process to provide true efficiency gains to radiology.

Another conclusion is that the perception of how AI should be integrated into clinical workflows seems to have harmonized in the past year: there will be **an orchestrating "middle layer" in terms of a marketplace** that brings various AI applications together, enables a smooth integration into clinical workflows, and offers one contracting party and one point of installation. Whether those platforms will be provided by the vendors offering pure marketplaces, PACS/EI vendors, or modality vendors is yet to be determined. Based on our interviews, healthcare providers seem to lean towards the two latter groups.



Multiparametric MRI

Adoption of native mpMRI functionality is accelerating, especially for breast. Fast MRI sequences further contribute to strengthening MR adoption in cancer diagnostics.

Many radiologists are still complaining about poor integrations between the EI system and third-party applications to handle multiparametric MRI (mpMRI) examinations. This has been especially prevalent for breast examinations, mainly because of an increased use of mpMRI in breast imaging over the last few years.

Poor integrations drive native mpMRI applications

In the research we have conducted, we have been told several remarkable stories about poor access to mpMRI tools—not only examples of poor integrations, but also cases where these special applications have even been installed on completely separate workstations located in other rooms. The result is inefficiencies and frustration among already overloaded radiologists. And should lack of integrated tools prevent radiologists from utilizing mpMRI for diagnosis, there are clearly lost clinical benefits for the patient.

The situation, however, is changing. We see a clear trend in more EI and PACS vendors natively incorporating mpMRI functionality into their own systems instead of integrating with third-party applications. This shift has been highly appreciated by users as it removes integration issues and gives immediate access to the necessary tools without having to switch windows or context. In our interviews, we also found that users tend to prefer easy-to-use solutions with access focused on the most common tasks in lieu of highly advanced features. Speed and ease of use is paramount.

Adoption of mpMRI applications for breast is prevalent

Looking into which areas of mpMRI have garnished the highest user satisfaction, breast is prevalent. The mpMRI functionality for other exam types, such as prostate, liver and female pelvis, have also been appreciated by users, but not to the same extent as breast.

For prostate, there are still a few unmet demands and room for improvements in the solutions currently available on the market. For example, physicians using mpMRI for prostate also want integrated tools for reporting, such as automated population of volume measurements. Tools for segmentation of lesions in the prostate, and for sending these segmentations to the ultrasound for the biopsy planning, are highly requested. Few, if any, vendors today can offer such a complete set of functionalities integrated with the reading workflow.

Shorter MRI protocols lead to new demands for MRI tools

In addition to tools for mpMRI, the more frequent use of shorter MRI protocols increases the need for other advanced MRI functionality natively in the EI system, such as post-processing software. The adoption of shorter MRI protocols is one of the fields where AI has been truly valuable. AI has contributed to the advancement of abbreviated and ultrafast MRI protocols to save time in the camera, fueled by the growing volumes of using MRI in diagnostics, screening and treatment, combined with the need to lower cost and reduce patient wait times.

> For example, GE Healthcare recently received a U.S. FDA clearance for a scanner using deep learning for that purpose, driven by the need to handle the backlog of five million MRI examinations due to the coronavirus pandemic. (14).

There are many studies currently ongoing for using shorter MRI protocols, primarily driven by the proven benefits of using MRI for breast cancer screening, which requires shorter protocols (15). A common way to accomplish shorter MRI protocols is to reduce the number of sequences or to run the dynamic sequence in a different way.

All in all, the adoption of tools for post-processing due to shorter MRI sequences, together with native tools for mpMRI, are two trends that we most likely will see more of in the coming years.

Integrated diagnostics

A great need for increased sharing of information and collaboration between disciplines might be solved with enterprise imaging and subscription-based models. Some providers have taken the first step to adopt a common platform for radiology and pathology. Shared digital conferences are seen as one of the high points of early achievements, partly driven by the COVID-19 pandemic.

The need to break down the silos to enable a tighter collaboration between radiology, pathology and other disciplines keeps growing. In addition to the fundamental drivers —such as an increased complexity of diagnosis and treatments spanning over several ologies, and the quality benefits of cross-discipline collaborations—the COVID-19 situation has further added to this need. Over the past year, ICU departments have been required to interact in a more frequent and closer way with radiologists, especially for diagnosis and follow-up of patients with COVID-19-induced pneumonia. This has created a need for workflows that existing IT systems have rarely been able to provide.

Managing the diseases for leading cause of death requires cross-discipline collaboration

The rising costs from the leading causes of death, such as cardiovascular diseases, cancer and infectious disorders, fuel the need for more integrated care. This was especially highlighted in a study (16) published in the scientific journal *Biochemia Medica* in February 2020, which summarizes the latest advancements in integrated diagnostics and how to overcome the barriers. It particularly highlights the importance of getting up to speed in implementing integrated diagnostics between lab medicine, radiology and pathology to manage the costs associated with diseases for leading cause of death.

The authors write that integrated diagnostics "has an enormous potential for revolutionizing diagnosis and therapeutic management of human diseases, including those causing the largest number of worldwide deaths". In addition, there are many diseases and conditions that may benefit from convergence and full integration of laboratory medicine, diagnostic imaging and pathology. (16).

The findings from their study are well aligned with the outcome of our interviews, where many radiologists stressed the need to share information and communicate between radiology, pathology and lab medicine more easily. A first step, such as giving access to each other's reports and images, can create significant value.

Even if the benefits of establishing integrated workflows are fairly obvious, it often drills down to overcoming the barriers for enabling cross-discipline collaboration.

Barriers and how to overcome them

The previously mentioned study (16) investigated the main barriers for implementing integrated diagnostics and found that insufficient IT infrastructure, costs and the enormous volume of different information to be integrated were the main three hurdles. They also provided potential solutions shown in Figure 4.

Drawbacks and potential solutions in integrated diagnostics

Drawbacks	Potential solutions
Infrastructure of information technology	Integrate existing information systems Develop new integrated information systems Combine bioinformatics and imaging informatics
Costs	Health Technology Assessment
Enormous volume of different information	Include (increase) expert comments in integrated reports Develop and use expert systems and neural networks Overcome cultural and political boundaries Create multidisciplinary teams Introduce integrated diagnostic algorithms

Figure 4. Drawbacks and potential solutions of adopting integrated diagnostics (16).

Similar barriers of achieving integrated diagnostics were mentioned in our interviews. We found that the integration between IT systems is still the main hurdle, creating inefficiencies and dissatisfaction as users must log on to several different systems in order to access data from other disciplines.

However, many radiologists seem hopeful, as more and more providers are adopting new consolidated IT systems to reduce the number of integration points and facilitate integrated care. These enterprise imaging (EI) systems are now being widely adopted, although few have yet achieved their full potential. EI systems as an enabler for integrated diagnostics was also confirmed in the study (16) previously mentioned.

Enterprise imaging—the highway to integrated diagnostics

The early adopters of EI have confirmed that these systems will diminish barriers of integrations, costs and volume of data. One platform being used by many different ologies can facilitate the sharing of images and reports and the creation of joint workflows between disciplines, reduce the need to integrate systems and handle the various elements of images and data.

Ensuring security and conformance is also a major IT upside for consolidated systems. It is very difficult to ensure that ten systems from different vendors with various technologies adhere to strict security standards. Importantly, EI systems allow radiology departments to share IT costs with other departments—a key to allowing investment in new technology despite the financial impact of the coronavirus pandemic where radiology volumes and profits have suffered.

In an article (17) published in *Applied Radiology*, Rasu Shrestha, MD, MBA, Chief Strategy Officer and Executive Vice President at Atrium Health, states: "Centrally managed storage solutions have been shown to lead to reduced total cost of ownership in a relatively short time". In the same article (17), he describes the benefits of sharing IT costs associated with enterprise imaging by using the term "we-conomy":

> *"The new reality is what can be called the 'we-conomy'—where it makes more economic sense to contemplate managing larger entities across the enterprise vs departmental solutions in a one-off manner."*

Subscription-based payment models to facilitate expansion to other ologies

In addition to the IT infrastructure itself, we see a wider adoption of **subscription-based payment models**, facilitating the shift towards enterprise imaging. The reasons are three-fold:

First and foremost, pricing schemes based on the utilization of the system, instead of a fixed upfront license fee and concurring service fees, reduce the need for big capital investments and offer higher flexibility to adjust cost to volumes. This creates reduced risk and makes it easier for radiology departments to gain approval on EI investments from hospital management.

Secondly, subscription-based pricing schemes allow for a much easier expansion of the system into other ologies since no extra licenses are needed, just an upgrade by the model, enabling cross-disciplinary sharing of images and data.

Similarly, the third benefit is the easier expansion of the health system when acquiring new hospitals or hospital groups.

While integrated diagnostics holds the promise of great benefits, the adoption is still slow. However, the ongoing transition from departmental PACS to EI systems is the most prevalent step we see in this direction, and it is most likely a trend that will keep growing over the coming years. Having access to each other's images and reports together with shared digital conferences are two high points of early achievements.

Part II: Technologies and functionality ahead

In this second part of the handbook, we present five areas of technology that contain sets of functionality that are pivotal for future radiology success—some already available, and some to keep on your radar to ensure they are part of your imaging vendor's long-term plans.

In addition, we have put together a bonus chapter with advice on two of the most recent and urgent needs we see within radiological medical imaging today from a business perspective: the importance of IT cost-sharing between departments and the need for flexible business models to be able to adjust cost to changing volumes.

Let's continue.

FIVE TECHNOLOGIES TO AMPLIFY SUCCESS

Smart display protocols

Optimized diagnostic context

Streamlined & smart reporting

End-to-end AI assistance

Collaboration-enablers

Five key technologies for radiology longevity in 2021

As the technologies covered in the 2020 edition of the handbook have harmonized and evolved during the past year, we now have a better understanding of where and how they will play a pivotal role in the radiologist's toolkit. The five new areas of technology we will detail in this chapter are:

- Smart display protocols
- Optimized diagnostic context
- Streamlined and smart reporting
- End-to-end AI assistance
- Collaboration-enablers for remote reading and distributed workflows

Figure 5 represents an assessment of where these are in the state of adoption, and the rate at which they are currently being adopted.

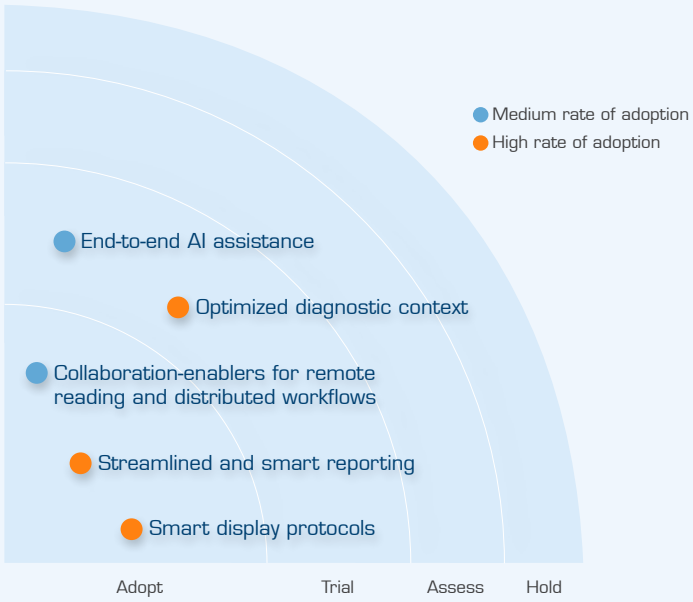


Figure 5. Assessment of this year's selected technology areas and their respective phase of being adopted by radiology. Position indicates current state of adoption, while color indicates adoption rate.

Smart display protocols

Efficient display protocols have been a burning topic within radiology since the introduction of PACS, mainly due to their importance for productivity. To cover and support a wide variety of examinations and modalities, automatic presentation and layout of the display is, by its nature, a complex and time-consuming task, both for radiologists, administrators and vendors.

A rigid rules-based display system may not properly handle scenarios when examination protocols are not as expected. This fuels the need for adding "smartness" into display protocols, which can come both in the form of automation and AI, including assisting tools to quickly adjust to a user's preference.

> An article published in 2020 in the *Society for Imaging Informatics of Medicine* highlights the need for display protocols to allow for a standardized, systematic and efficient way of reviewing complex exams. The authors write that the use of a dedicated display protocol has the potential to improve efficiency of workflows and consistency between readings. They also mention that the display protocol should be able to support the radiologist in making a visual screening to ensure all the intended imaging sequences were acquired. The article also found that display protocols play a crucial part in the educational process of trainees, creating a consistent set-up between exams to support efficient training. (18).

Enabling efficient display protocols is about finding a balance between providing a good first hanging, and the ease of quickly changing the set-up to suit personal preferences or to fit the specific patient context and case. Speed is absolutely essential. It ought to be up to each radiology provider to decide if the first hanging suggestion presented by the system (for a specific exam and modality type) should be standardized across all radiologists, or should take individual preferences into consideration and be customized thereafter.

Finding the balance between standardization and customization

When it comes to the initially presented display protocol, the suitable level of standardization versus customization varies significantly between clinical scenarios. Highly standardized procedures, such as breast screening and plain film exams, are well suited to static and standardized protocols, whereas highly complex scenarios, such as oncology follow-up examinations with a wide range of CT and MR examinations, require a much higher degree of customization.

In addition, the ongoing consolidation where radiology groups merge and are being acquired increases the need for standardizing display protocols within the network, as initial hangings must work and look similar across all sites. This is often more easily

said than done and the further standardization goes, the more important it becomes that the system offers high flexibility for each individual to be able to quickly adjust the first suggested hanging.

A good first hanging enhanced by "smartness"

At its core, the initial hanging suggestion is often based on parameters such as anatomy and examination data. Going further towards customization, an initial hanging can also consider configurations made by a specific user and remember earlier set-ups to become more personalized.

Display protocols that can remember personal set-ups and behaviors—also called "smart" display protocols—have been discussed for more than a decade. However, it is not until the use of machine learning increased that we have witnessed the implementation of true "smartness" that actually works.

The primary aim for including "smartness" into applications is to make radiologists more efficient, which, in the case of display protocols, means reducing the effort to get to the most preferable hanging for a specific exam. This also includes reducing the workload for administrators and super users while assisting them in the ideal preparation of the exams.

However, even the most powerful AI algorithms may face challenges in providing a suitable first hanging for large and complex cases. As a result, intuitive tools for adjusting the initial hanging are also important.

Ease of adjusting display protocols

To provide an efficient reading process, display protocols should be easy and quick to change, with minimal effort. Ease of changing display protocols depends on the design being supportive and giving access to the right tools within three main areas:

- Image presentation—to assist in getting the right images in the right places on the screen
- Navigation—to assist in the changing of series and comparison of exams
- Visualization—to assist in the overview to ensure that all series which need to be reviewed, are indeed reviewed

A system that can provide tools for quickly adjusting the image presentation, navigation and visualization in the initial hanging will deliver an efficient reading workflow, despite a high level of standardization that may not provide a "perfect" initial hanging. This leads us to the topic of making sure display protocols are "forgiving".

Making the display protocols more "forgiving"

Smart display protocols are not just about providing a first good hanging and tools to be able to adjust them. It is also about the EI system offering a framework of tools that can make the display protocols more forgiving. This set of tools can be used to meet different needs without having to modify the existing display protocols.

One example is to make it easier to adjust the presentation by navigational tools, such as quickly changing to another prior, another series, or use 4D navigation to find a specific phase. Another example is to include visualization of the series you have already reviewed to better guide you through the reading process. This functionality makes display protocols more forgiving, reducing the need for "perfect" display protocols—thereby also reducing the time required to configure them.

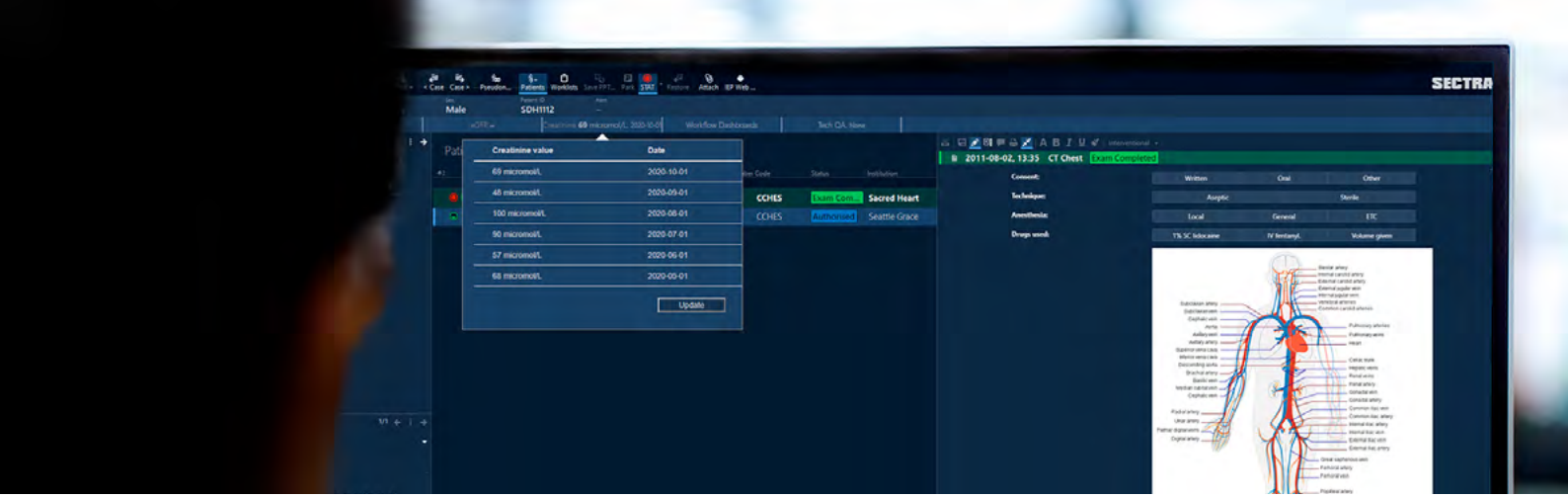
The essence of a long-term plan

The management of display protocols should be robust. Display protocol capabilities should be resilient to changes in exam protocols over time. Also, as display protocols are essential to everyday work, it is important that improvements are provided non-disruptively by the vendor, allowing you to adopt them at your own pace.

All in all, this ties back to the vendor having a robust long-term roadmap and strategy for its display protocols. New enhancements should be released iteratively, providing continuous value with every release instead of one Big Bang that will force you to adopt and reconfigure all protocols at once. You should ask for and scrutinize the vendor's roadmap to assure they have a long-term plan for display protocols to ensure consistency.

Smart display protocols—The checklist

- ☑ Efficient display protocols are about reducing the effort of getting to the most preferable hanging for a specific exam. This also includes minimizing the effort for users and administrators to set them up.
- ☑ The initial hanging suggestion should at least be based on generic parameters, such as anatomy and examination data.
- ☑ Going further towards customization, the initial hanging should consider configurations made by a specific user and remember earlier set-ups to become more personalized.
- ☑ Display protocols should be easy and quick to change, with minimal effort.
- ☑ You should quickly be able to adjust the image presentation, navigation and visualization of the initial hanging. Despite a high level of robustness, a "perfect" initial hanging may not be available for your specific case.
- ☑ You should have access to a framework of tools that can make display protocols more forgiving, i.e. tools that can be used to meet different needs without having to modify the existing display protocols.
- ☑ Display protocol capabilities should be available long-term and be resilient to changes in exam protocols over time.
- ☑ As display protocols are essential to everyday work, it is important that improvements are provided non-disruptively by the vendor, allowing you to adopt them at your own pace.
- ☑ You should ask for and scrutinize your vendor's roadmap to assure they have a long-term plan for display protocols to meet future needs.



Optimized diagnostic context

An optimized diagnostic context means that you, as a radiologist, have all the clinical information you need to diagnose and create the best possible report for the patient, without having to switch applications or look into the electronic medical record (EMR). Every context switch takes time and risks a loss of focus. It is vital that your EI system shows the information you need based on the current exam. This requires an efficient exchange of data between the EI system and the EMR.

Overcome the IT legacy

The EMR has historically been an additional system that exists outside of the PACS or EI system—in many cases developed and implemented separately from and after the PACS. This is one of the reasons why radiologists must turn away from the PACS to obtain clinical data from the EMR. Often this involves launching the EMR (possibly on a separate workstation), logging in to the EMR, and then manually transcribing the medical record number of the patient of interest.

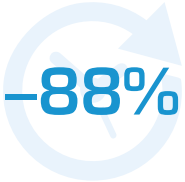
Although the integrations have improved for many radiologists during the past few years, a lot remains to be done within this field to boost productivity. Most EMRs still do not have the ability to synchronize the currently selected study or patient. So, an essential first step is to ensure context synchronization and single sign-on are in place. This will make a substantial difference in time savings and will ensure a consistent patient context across the diagnostic application.

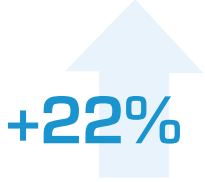
"In the best of all possible worlds, I would never have to log in to the EMR again. I want everything in the PACS."

Radiologist at a major U.S. multi-hospital health system

Quantitative benefits of a well-integrated EMR

In a study (19) from 2018 published in the *Journal of Digital Imaging*, a research team objectively quantified the impact of implementing a PACS–EMR integration. To do that, they identified the exams in which the radiologists accessed the EMR to obtain additional clinical data and measured the time before and after the integration was implemented. Their conclusion was that **the time to access the EMR decreased** from 52 to 6 seconds ($p < 0.001$), which is approximately 12% of the time.





Due to easier access, the utilization of clinical information to perform the diagnosis also increased. **The proportion of studies with EMR access increased** from 36.7% (10,175/27,773) to 44.9% (10,843/24,153) after integration ($p < 0.001$), which is an increase of 22%.

In total, this proves that integrating PACS and the EMR substantially decreases the time to access the EMR and is associated with a significant increase in the proportion of studies for which radiologists obtain additional clinical data. (19).

The authors of the study (19) concluded that:

"… PACS–EMR integration is about much more for radiologists than being 'a matter of convenience'—it truly improves patient care and helps specialists demonstrate their value."

Success factors to establish a tight EMR integration

As a radiologist, a tight EMR integration should enable you to minimize the need for switching between different IT systems. Data exchange ideally allows all relevant clinical information to be shown within the diagnostic application, preferably adjusted to the type of exam currently being reviewed and the patient anamnesis. For example, if the patient is allergic to specific contrast agents, this information should be visible. It is also important that the data is up to date. A real-time exchange, for instance using the standard HL7 FHIR, allows the applications to exchange information that does not necessarily need to fit the data model of each application.

There must also be tools available to query more data about the patient without having to go to the EMR, such as when the referral is poorly written and more patient information is required. This is an added benefit of using a PACS–EMR integration built on HL7 FHIR.

Another critical aspect is the importance of an efficient data exchange back to the EMR. This is essential from several perspectives, such as flagging high priority and critical cases to the referring physician based on radiology findings. Other examples are communicating structured lesion data to the EMR required for the reporting scheme or providing the referring physician with image links and tables to make the reports richer and easier to interpret.

As you can see, there is a wide range of demands when it comes to EMR integrations. To meet all various needs, it is important that the EI system not only can exchange the right data, but also can make the data useful. This can be achieved by adding user-friendly and custom-made apps, which can make data usable and present it intuitively. Applications that can be "plugged in" to the EI system to present data have been much appreciated and bring flexibility to tailor the workstation to meet specific needs.

Optimized diagnostic context—The checklist

- ☑ Getting to the right context means an efficient exchange of data between the EI system and the EMR so that you can maximize the time spent in a single application, avoiding costly context switches to the EMR.
- ☑ Most EMRs still do not have the ability to synchronize the currently selected study or patient. An essential first step is therefore to ensure context synchronization and single sign-on, which will result in significant time savings.
- ☑ All relevant clinical information should preferably be visible directly in the diagnostic application.
- ☑ The integration should be built on a standard, such as HL7 FHIR, that allows for providing real-time and up-to-date information.
- ☑ There must be tools available to query more data about the patient, without having to access the EMR.
- ☑ Efficient data exchange back to the EMR is important to enable flagging of critical results, communicating structured lesion data, or providing the referring physician with image links and tables to make the reports richer and easily understandable.
- ☑ The EI system should not only be able to exchange the right data with surrounding systems, but also needs to work as a platform to integrate custom-made apps that can make data usable and present it in an intuitive way.

Streamlined and smart reporting

The report is the end-product of all the effort you put into your work as a radiologist and what provides value to the referring physician and the patient. When talking about productivity, it often refers to creating a high-quality, meaningful and easy-to-interpret report in the shortest time possible.

Radiologists spend a lot of time on reporting. A study made by Canterbury District Health in Christchurch, New Zealand, developed a transparent and robust method of measuring radiologists' workload. They used observations, timing and data from the IT system to conclude that **35% of a radiologist's time is spent on diagnostic reporting** (see Figure 6) (20). The 35% found in this study from 2013 might sound low, and things might have changed. However, 35% still is a significant amount of time in a radiologist's day, involving the entire process from worklists, selecting a case, reading the patient history, doing the diagnostic review, checking comparisons and finally doing the report.

Every percentage that can be saved in the reporting process becomes enormously valuable. This drives the need for the system to provide a streamlined, smart and intuitive reporting process with minimal context switches.

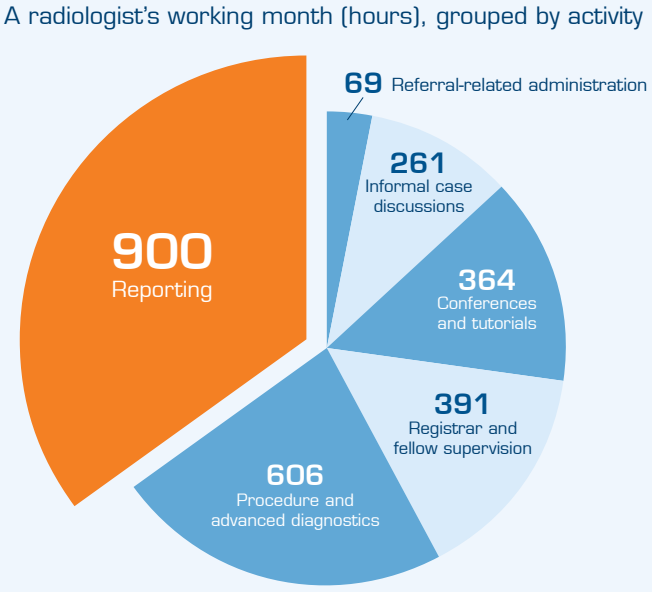


Figure 6. Time allocation of a radiologist's working month. Total clinical hours per month: 2,591. (20).

A single integrated diagnostic application

One of the biggest time inefficiencies in reporting—and diagnostics in general—is switching contexts. This occurs when you use several separate applications for diagnostic reading, advanced visualization and reporting. The heterogeneity of such an environment forces the user to switch windows to add text, perform measurements and annotations, or collect information—creating a loss of focus and other inefficiencies.

Substantial time savings can be recognized by working in as few systems as possible. This would mean all reporting should be performed in a single diagnostic application. Striving for a single integrated view is the main reason behind more and more reporting components being moved from separate reporting systems or RIS, into the PACS/EI system.

In addition, one common solution for diagnostics and reporting ties the reporting closer to image-generated data into one end-product. With a closer connection between images and the report, you can create so called rich reports, which provide additional value and clarity to referring physicians. Examples include inserting measurements or links to images into the report.

AI-enhanced structured reporting

Another benefit of bringing images closer to the report by using one application is that it allows for the use of structured reports in combination with AI-assisted data field population. Historically, structured reports have been criticized as being too "clicky" and static. But combined with smart, AI-based tools, they can automatically suggest measurements to be added to a structured form or perform automatic comparisons, such as tumor progression. The important point is that the AI technology should let you, the radiologist, approve or reject suggestions to be added. In other words, the radiologist must be in the driver's seat. We have talked to several health providers who also use AI-enhanced structured reports utilized by technologists at the modality level to pre-populate fields and prepare the report to minimize time-consuming tasks for the radiologists.

From another perspective, functionality for structured reports also adds benefits for decision support and compliance with standardized disease workflows or reporting schemes. These templates can guide you through which measurements are compulsory for a specific disease according to standardized guidelines. At the same time, they can provide you with decision support on the recommended treatment or required additional exams based on findings made.

We are seeing a significant increase in the number of structured reporting schemes and standardized workflows being introduced, such as PI-RADS, BI-RADS, RECIST, etc. In addition, there is a steadily growing number of reporting schemes being introduced

related to immunotherapies, companion diagnostics and specific diseases. One current example is that many radiology providers have incorporated structured reporting templates for COVID-19.

During spring 2020, the Dutch Radiologist Association, NVVR, published a recommendation on how to report COVID-19 CT chest scans through structured templates. As a result, a number of Dutch radiology providers, together with Sectra, developed a visual structured reporting template, completely integrated with the PACS reporting module (see Figure 7). The structured reporting template was then tailored to fit the guidelines for the U.K., U.S. and Germany. This example highlights the importance of the PACS/EI system in providing a standardized way to quickly incorporate new structured templates into reporting modules as clinical guidelines change.

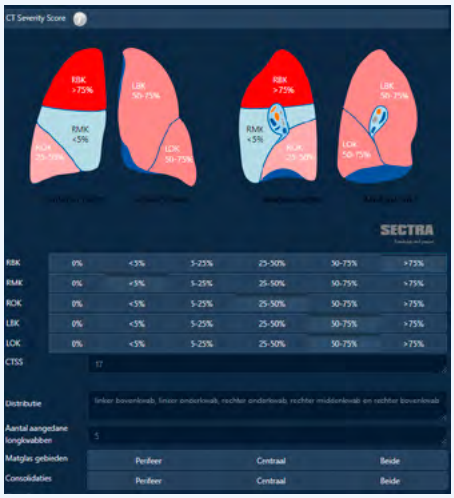


Figure 7. Screenshot of the COVID-19 structured reporting template in the Sectra PACS/EI system, developed in the Netherlands.

Altogether, the complexity and variety of reporting will increase the need for efficient reporting tools in the future. In short, guiding structured reporting functionality can help you follow the standardized protocols without having to spend time looking in guidance protocols, provide you with instant decision support, and assist in adding measurements and comparisons to the report automatically.

As there is a continuous change in standardized reporting schemes and how structured data should be exchanged with different systems, the EI system needs to be flexible. New structured reporting templates and workflows should be easy to add, and the system needs to support a standardized way of interchanging structured data with the EMR. Healthcare providers should be able to decide on the design themselves and add the suitable forms they want to increase efficiency in their respective reporting workflow.

Streamlined and smart reporting—The checklist

- ☑ Context switches should be minimized. All reporting should be performed in a single diagnostic application.
- ☑ Move reporting into the PACS/EI system, instead of using a separate reporting system or the RIS.
- ☑ The system should support inserting measurements and links to images into the report to tie the report closer to the images.
- ☑ The system should support AI-enhanced structured reports to assist with measurements and comparisons to be added to the report.
- ☑ The integrated structured reports should provide decision support and assist you in compliance with standardized disease workflows or reporting schemes.
- ☑ The EI system needs to be flexible and new structured reporting templates and workflows should be easy to add. It also needs to support a standardized way of interchanging structured data with the EMR.

End-to-end AI assistance

As previously concluded, one key to facilitate AI adoption is to be equipped with a marketplace platform that can provide a broad set of AI applications to improve the various parts of your workflow—including triage, diagnostics and reporting. The marketplace and the EI system must together provide a **completely seamless integration of the AI applications throughout the entire workflow**. Otherwise, the effect of AI in radiology will be limited and the business case hard to justify.

The role of the marketplace

Many of the AI-based radiology applications available today are targeted at improving workflow efficiency, but the biggest impact will arguably come from solutions that have both a workflow (productivity) and a clinical (quality) value proposition. Comparable solutions will save radiologists time and enable both more clinically effective and more cost-effective diagnostics.

Using a marketplace as an orchestrating "middle layer" between the portfolio of AI applications and the diagnostic system will be the most cost-efficient way of adopting AI-based tools. For example, AI marketplaces were mentioned in a report (21) published by Signify Research in October 2019 as offering "a unified approach to deploying AI in medical imaging" instead of buying and integrating various AI applications from several different vendors.

In the long run, the marketplace you select needs to provide a broad portfolio of quality-assured applications from many different vendors, while offering one contracting party and a single point of installation. A marketplace should provide you with an opportunity to mix and match algorithms from various vendors and should take away the need to upgrade the diagnostic system as soon as you want to use a new AI application. Furthermore, it must bring these applications together into an efficient workflow through tight integration with the EI system.

Seamless integration with the EI system

The EI system together with the marketplace should offer radiologists an end-to-end solution. That means that the AI applications you choose to utilize are completely embedded into the workflow, without the need to launch separate windows. One of the main reasons why most enterprise imaging vendors that offer marketplaces only provide them to existing customers is to guarantee such end-to-end solutions.

The importance of the tight EI system–marketplace integration was highlighted in the guide "A Buyer's Checklist for AI in Health and Care", published in May 2020 by the NHSX, who are responsible for delivering the U.K. Health Secretary's Tech Vision, building on the NHS Long Term Plan (22). In their ninth statement of the checklist they write:

"New technology needs to work alongside existing systems, to ensure both safety and efficiency. Back-end integrations are essential for ensuring a clear and reliable workflow. […] A reliable workflow is even more important when multiple organisations are involved in caring for people."

Watching a demo of the EI system and how AI algorithms selected from the marketplace interact with the workflow is usually enough to evaluate the integration. Also, bear in mind to ask how new applications become available to you as an end user, and the time normally required for this. To facilitate new integrations to be established, the enterprise imaging vendor should allow for a standard-based way of integrating AI applications from the marketplace.

A broad portfolio of AI applications to support end-to-end workflows

The range of available applications should assist you not only in the diagnostic parts—such as detection, quantification and classification—but also in workflow orchestration including triage, exam and resource allocation. In addition, AI should assist in reporting, for instance pre-populating structured reports with measurements and comparisons. Only when AI spans the entire process will it make workflows more efficient and the business case affordable. It will also then be possible to measure the true quality benefits by measuring its end-to-end impact.

Using AI applications for lung cancer screening as an example, the first generation of AI-based clinical applications provided diagnostic support by detecting, quantifying and classifying lung nodules, often generated as a separate report or series in the EI system. The next generation covers the entire workflow, where structured data of external observations automatically populates the report and comparison with prior exams is automated. Solutions in the near future are expected to also provide classification and triage for acute lung conditions and will be added with incidental findings. The key point here is that such an end-to-end solution can only be provided by a marketplace tightly integrated with the EI system spanning the entire diagnostic process.

Establish an internal AI group

Having the right technology in place will not be enough. The adoption of AI in radiology requires efforts from various parts of the organization and, not least, projects need to be prioritized and followed up on. The advice is to establish a project group responsible for this, involving various roles including radiologists, IT, administrators, managers, etc. This group should create processes and rules for how AI applications are validated and added to the workflow, manage prioritizations, and handle the dialogue between users and the vendors.

End-to-end AI assistance—The checklist

- ☑ Be equipped with a marketplace platform that can provide a broad set of AI applications to improve the various parts of the workflow, such as triage, diagnostic support (detection, quantification, classification) and reporting.
- ☑ The marketplace and the EI system must together provide a completely seamless integration of the AI applications throughout the entire workflow.
- ☑ The AI applications should follow integration standards and not use proprietary ways of presenting results nor use their own viewers. In the same way, the EI vendor should allow for a standard-based way of integrating AI applications from the marketplace.
- ☑ For accessing new AI-assisted workflows available in the marketplace, the EI system might have to be upgraded. But this should not be a requirement for each single AI application you want to add.
- ☑ The marketplace should provide a broad portfolio of quality-assured applications from many different vendors, while offering one contracting party and one point of installation.
- ☑ Talk with the marketplace vendor about how they look at workflows and ensure they can provide a seamless end-to-end solution with tight integrations with the apps they offer.
- ☑ Request a demo to evaluate their integration capabilities and ask how quickly new applications can be available to end users.
- ☑ Establish a project group responsible for the roll-out of AI applications and for handling the dialogue with users as well as vendors. This group should include all the necessary roles, including radiologists, IT, administrators, managers, etc.

Collaboration-enablers for remote reading and distributed workflows

Consolidation is everywhere. Not only have hospitals, imaging centers and radiology groups consolidated on a massive scale, but organizations have also embarked on initiatives to simplify and merge their many PACS into a single solution for the enterprise. This fuels a need for IT tools to support distributed workflows across many different sites and organizations.

In addition, the coronavirus pandemic has rapidly changed the working situation for many radiologists, requiring reading from home and collaborating with colleagues remotely. This shift, while initially viewed as negative, has shed light on the many productivity benefits of working from home undisrupted, performing remote teaching and being independent of a specific work location.

These two trends increase the need for the EI system to live up to its name. It must offer true “enterprise-grade” functionality for orchestrating the workflow over many different sites and skillsets, provide integrated tools to facilitate remote collaboration and home reading, and enable participation in virtual MDTs and teaching.

Remote reading

One thing that became obvious during the rapid, global spread of COVID-19 was the benefit of using a single integrated application for diagnostics, workflow, reporting and advanced tools such as mpMRI. Covering all needs in one client reduces the requirements to install many various applications on all workstations you might use. One application for all needs allows you to work remotely with a single installation—something that proved advantageous as many radiologists worked from home during the spring of 2020.

From the same perspective, it is also important to make sure the PACS/EI system is “forgiving” when it comes to the variety of hardware devices such as keypads, monitors etc. Too strict requirements would lead to a very cumbersome, slow and expensive process of distributing standardized workstation set-ups to all radiologists to make them “home-compatible”. With a single solution and reasonable hardware flexibility, you will be able to work remotely with the same productivity as working onsite.

Another key aspect for efficient remote reading is having a system optimized for handling high latency and suboptimal internet conditions, using strategies such as caching, streaming or progressive image transfers. Regardless of the choice of technology, the important thing is that remote reading can be done with sustained excellent performance. An EI system optimized for distributed work can compensate for a home Wi-Fi that is not as stable or high-speed as the cable connection at work.

Tightly integrated tools for efficient communication are important in order to make remote reading as efficient as being onsite. This could be chat functionality for quick

questions or asking for a second opinion by sending links to images, or instant communication with technologists. Another tool for efficient remote reading and teaching is screen-sharing capabilities, which in real time allow you to point out specific areas to facilitate collegial discussion. The key is to make sure these communication tools are embedded and do not require a context switch.

We must also bring up the importance of high security. Without security, the coronavirus crisis can easily become a ransomware crisis. You must be able to securely connect to the EI system, which requires secure communication and encryption. The system should provide security mechanisms such as client-based certificates for secure home reading in cases where connection via VPN is not possible or permitted.

Distributed workflows

With radiologists working from home, managers cannot get the same overview of who is working in what room and location. This fuels the need for analytics dashboards to create a holistic overview of exam distribution and performance, and to quickly identify bottlenecks via alarms. The key with dashboards is that they should only show what is relevant for each differing role and they need to be tailored to show different metrics for radiologists, radiology managers, administrators and technologists.

Your workflow orchestration software should ensure reading of exams based on current workloads by the most appropriate radiologists within or outside the hospital network—evenly and fairly. It is important that workflow orchestration tools take into consideration various kinds of data, such as exam types, competence profiles and feedback functionality. To also allow for reallocation functionality, integration with the scheduling system is necessary.

> *"These [workflow orchestration] tools have enabled us to much better understand our business. We have learned about radiologists' reading patterns and exam distribution and been able to train staff where it is most needed."*
>
> Beverly Rosipko, Director of Radiology Informatics at University Hospitals in Cleveland, OH

Not to forget, working over large, distributed networks highlights the importance of speed. As with remote reporting, the EI system needs to be designed and optimized for delivering high performance at the home workstation, at the most rural clinic, as well as at the central hospital. The system should be capable of delivering at amazing speed, independent of modality type, the amount of studies or their sizes. Whether users connect locally or remotely, via the LAN or WAN, the image viewing performance should largely be equivalent and fast on connections as low as a few Mbps. To make sure you are equipped with a system that will not force you to wait for loading images or slow scrolling of image stacks, it needs to build on a modern technology platform. For example, a good system should pre-load cases on low bandwidth lines to ensure a satisfactory user experience. This platform should contain all technology and applications natively, so that you can perform your diagnostics in one workflow without having to switch context.

Collaboration-enablers for remote reading and distributed workflows—The checklist

- ☑ Strive to use as few IT systems as possible. A single integrated application for diagnostics, workflow, reporting and advanced tools such as mpMRI reduces the requirements to install many various applications on all work-stations you might use.
- ☑ Make sure your PACS/EI system is flexible to the variety of hardware devices. Too strict requirements lead to a slow and expensive process of shipping out standardized workstation set-ups to all radiologists to make them "home-compatible".
- ☑ The system should be optimized for handling high latency and suboptimal network conditions.
- ☑ Your EI system should be equipped with embedded tools for efficient communication, such as a built-in chat functionality, to make remote reading as efficient as being onsite.
- ☑ Ensure that your IT system can offer high security. You should be able to securely connect to the EI system, which requires secure communication and encryption, such as VPN or preferably client-based certificates.
- ☑ You should be equipped with an analytics dashboard to create a holistic overview of exam distribution and performance, and to quickly identify bottlenecks via alarms.
- ☑ The dashboard needs to be tailored to only show relevant metrics for each differing role.
- ☑ The workflow orchestration solution should be able to distribute exams based on current workloads to the most appropriate radiologists within or outside the hospital network—evenly and fairly.

Urgent business needs to address: IT cost-sharing and more flexible business models

Radiology has faced declining reimbursements for a long time. The consequences have been severe, but most providers have been able to compensate by driving higher volumes, enabled by the use of more efficient IT tools and spending more hours at work. Some have also tried to create additional revenue sources by offering extra services such as patient portals or patient-friendly reports, but few have truly succeeded.

As already covered in Part I, radiology has faced a large drop in volumes during the coronavirus pandemic, leading to severe financial complications. The rapid decline in volumes has forced providers to take radical actions, such as lowering radiology salaries. Many practices will look back at 2020 as a year where they lost millions, but some will emerge more successful and stronger from this crisis. Those are the ones that have been able to adapt their business and adjust their cost base with declining volumes, while also keeping the capacity to be able to scale up again to manage the post-pandemic surge in imaging volumes. These providers will be able to keep investing in new technologies and software to succeed in the future.

We have identified two key strategies for how to successfully adapt your business to handle the consequences of the crisis:

- Sharing IT costs with other departments
- Adopting flexible business models where the cost for software is linked to volumes

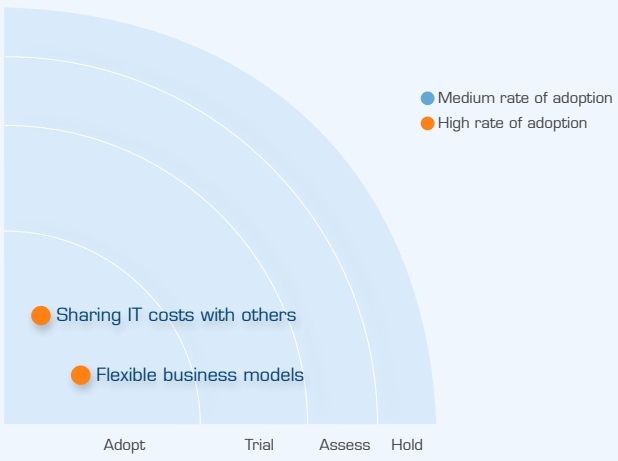


Figure 8. Assessment of two strategies to adopt to emerge stronger from the coronavirus crisis.

Sharing IT costs with other departments

Getting approval for investment in new radiology IT, such as EI systems, is key for acquiring new functionality and increasing productivity. But because of the COVID-19 situation, getting approval for new investment will be tough if you cannot prove a beneficial ROI. According to the report "Vendor Performance in Response to the COVID-19 Crisis" (23), published by KLAS Research, 81% of the interviewed leaders of provider organizations report significant budget cuts. However, of this group, 74% will invest in more technology moving forward (23).

> *"All of our IT purchases have been put on hold besides the expansion of our Zoom licenses. We are bleeding lots of money. Once things calm down, we will have to evaluate what purchases to proceed with."*
>
> One of the interviewed healthcare professionals in the KLAS Research report (23)

Generally, the money for radiology IT investments in the U.S. rarely comes from the radiology department, but rather derived from health system. As long as volumes are down and reimbursements are still on the decline, systems will make budget cuts to survive. Hence, the size of IT investments for radiology will be directly correlated to the size of its profit contribution to the health system.

However, the current adoption of EI systems instead of departmental PACS provides an opportunity to share IT investments with other departments and show a positive ROI. Modern EI systems will replace PACS systems for radiology, pathology, cardiology, and more—and with a common VNA backbone, both software costs and hardware can be shared. Showing a business case where the total IT cost for all imaging departments will be substantially reduced opens for new investment decisions to be made.

For example, a report (17) published in *Applied Radiology* investigated the benefits of sharing IT costs across disciplines. The author mentions that a unified and streamlined management of images and related content reduces costs by eliminating or mitigating data migrations and limiting the number of interfaces required to image-enable the EMR. From this, they conclude that "centrally managed storage solutions have been shown to lead to reduced total cost of ownership in a relatively short time". They also point out that this is especially true when looking at needs not just across one specialty, such as radiology, but across multiple specialties throughout the enterprise.

Another study (24) published as a *HIMSS–SIIM* collaborative paper in 2019 lists some of the various areas where enterprise imaging could save costs. Some of the examples mentioned are:

- Unnecessary duplicative imaging procedures
- Duplicative imaging infrastructure in departments using imaging (examples such as GI, dermatology, wound care, pulmonology)
- Optimal use of resources across the enterprise (e.g. a global worklist for all radiologists in the enterprise)
- Centralized image storage infrastructure instead of a costly distributed infrastructure
- Centralized maintenance of unified imaging IT infrastructure

Looking at quantitative cost savings, a study (25) published in the *Journal of Digital Imaging* in 2019 performed a post-implementation evaluation of a health system's shift to enterprise imaging. At the time of writing, the case in this study, University Hospitals in Cleveland, OH, included 54 radiology and 26 cardiology sites affiliated with the health system and they commenced the EI system shift in 2015. The main conclusions were:

"This process was associated with more than 10% cost savings, 30% reduction in storage costs, superior support for disaster recovery, and 80% decrease in unscheduled outages. All these were achieved despite a 120% increase in archive retrieval needs and a 40% growth in image production."

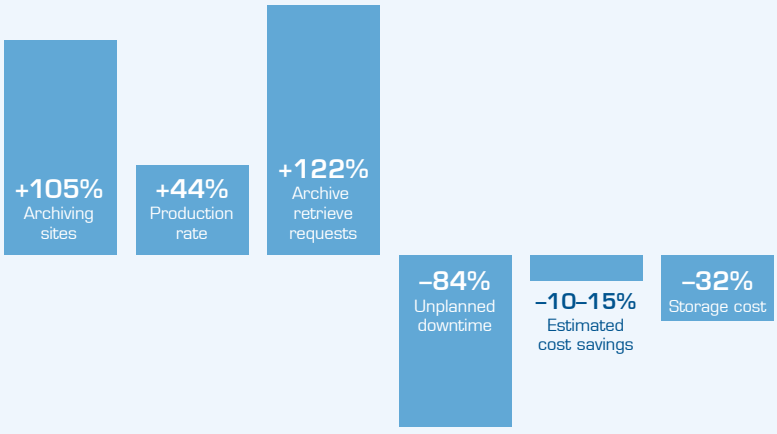


Figure 9. Post-implementation vs. pre-implementation status of the image management system at the University Hospitals health network (25).

The study (25) concluded that the financial ROI will take only 2.5 years to recoup the overall imaging costs. This, together with the benefit for radiology being able to share costs with other departments, will equip you with powerful arguments to proceed with the investment in enterprise imaging.

Flexible business models

To stay profitable, the coronavirus pandemic has showed that it is necessary to adjust IT costs to changing volumes. That is one of the main reasons why many radiology practices are leaving the traditional business model for IT systems consisting of an upfront license fee together with a fixed service fee, in favor of a more agile software subscription model. The subscription model offers a more flexible growth scenario with costs directly linked to the utilization of the IT system, i.e. a predetermined price per exam. That allows for financial resiliency during periods of shifts in volumes.

Subscription models are also a powerful tool to help convince decision-makers to consider new investments as it involves a lower risk with lower capital investment. With costs based on volumes, the result is greater risk sharing between you and the vendor. Most subscription models involve a beforehand commitment to a minimum volume, which is far more cost-effective in a growth scenario than the license-based model. The higher minimum volume commitment you make, the lower the price per exam. But even if you select a risk-averse model at a lower volume commitment, you pay less for the number of exams exceeding that minimum level.

The subscription model can also help when expanding from one or many departmental PACS to enterprise imaging. It allows other clinical disciplines to be added without the need to negotiate and acquire new licenses. All it requires is an upgrade of the subscription tier. This facilitates the process of sharing IT costs with other departments, as previously discussed.

In addition, subscriptions allow for a faster adoption of new functionality provided by the vendor, as these become available as part of the package without need for a license upgrade.

In total, adopting a subscription-based model for enterprise imaging will leave you better equipped to handle future changes in volumes and ensure quick access to the latest technologies.

Cost-sharing and flexible business models—The checklist

- ☑ The radiology providers that will emerge stronger from the coronavirus pandemic are the ones that keep investing in new technologies and software to succeed in the future.

- ☑ There are two key strategies that have proven to help providers manage the crisis:
  - Sharing IT costs with other departments.
  - Adopting flexible business models where the cost for software is linked to volumes, such as subscription-based models.

- ☑ The current adoption of enterprise imaging provides an opportunity to share IT costs with other departments. Showing decision-makers a business case where the total IT cost for all imaging departments will be reduced opens up for new investment decisions.

- ☑ The subscription model links costs to the utilization of the IT system, i.e. the volumes, and makes your practice more resilient against shifts in volumes. At the same time, it makes it easier to get approval for new investments being made.

Handbook summary—what to adopt and what to put on your radar

In Part I of this year's handbook, we have provided you with an update of the 2020 edition's four technologies and how they have evolved and been adopted—especially in light of the rapidly changed circumstances due to the COVID-19 pandemic. In Part II, we explored five new areas of technology that are expected to play a pivotal role in your daily work to achieve success in the future.

For a complete overview of all of these technologies, together with the urgent business needs presented in the last chapter, see the summarizing tables below. All areas have been categorized based on whether you should consider adopting them as soon as possible, or instead have them on your radar and trial them. We also provide an assessment of their current rate of adoption and their impact on productivity as the most important determinator for future success.

Adopt now

Technology or business need	High current rate of adoption	High short-term impact on productivity
Workflow orchestration	●	●
Multiparametric MRI	●	●
Smart display protocols	●	●
Streamlined and smart reporting	●	●
Collaboration-enablers for remote reading and distributed workflows		●
Sharing IT costs with others	●	●
Flexible business models		●

Trial now

Technology or business need	High current rate of adoption	High short-term impact on productivity
Integrated diagnostics	●	
Artificial intelligence		
Optimized diagnostic context	●	●
End-to-end AI assistance		

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