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Diagnostic Imaging:

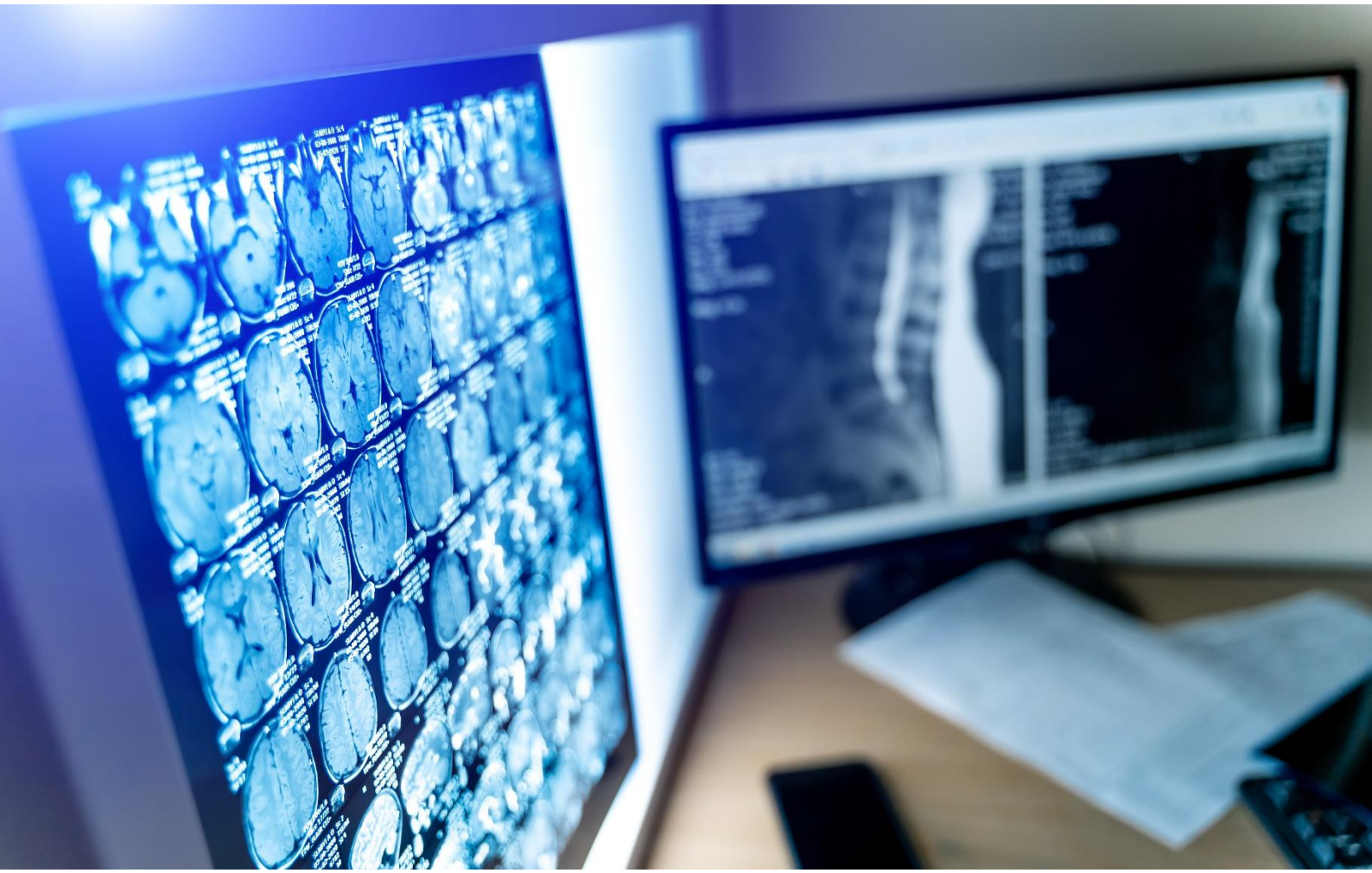
Understanding 6 Key Areas of Investment

Table of Contents

Abstract

As medical technology advances, the market for Diagnostic Imaging continues to evolve fueling the growing demand for patient-centric healthcare. It is safe to predict that new market segments, based on modality, geography, and end-users, are likely to show excellent potential for future growth. It is imperative that the industry focuses on critical R&D investments to adapt to constant changes while fulfilling customer needs.

This paper aims to highlight the outcomes of a changing market, tackling three important questions concerning technology and R&D investments. It discusses the latest trends in the industry and presents six potential opportunities, which are Large untapped datasets, Developing workflow management, Strengthening patient data security, Improving accessibility, Service maintenance, and Improving image quality, for the manufacturers to explore. Each opportunity is followed by a real-world example where a novel solution is implemented by manufacturers as part their strategic investment.



Introduction

With the advent of novel technologies and rapid digitalization, the global medical devices industry is jumping leaps and bounds in growth and development. From new and emerging business models to accelerated innovation in many areas of diagnostics, care delivery, connected health, data security, supply chain, and process automation, etc., the landscape of healthcare seems to be hovering around the idea of disruptive possibilities owing to several trends. There is a significant shift in R&D spending patterns and talent trends, collaborations with start-ups, tech. giants, and service providers, and an overall emphasis on digital and connected health.

Medical imaging is one such segment of the MedTech industry that has significantly benefited from the trends mentioned above. This steadily growing segment is projected to reach US$ 52 billion by 2025 at a CAGR (2021-2025) of 4.35%.

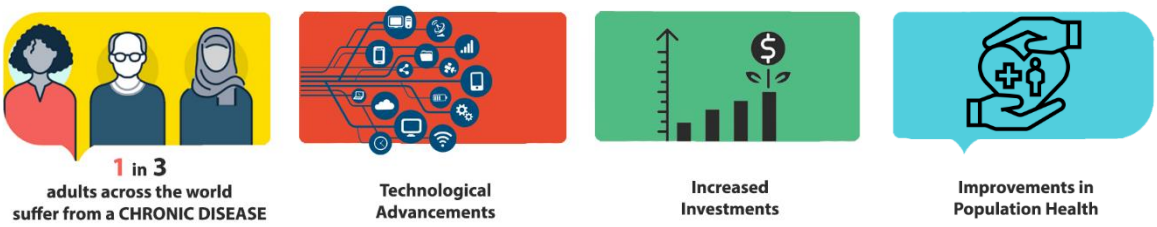


Figure 1: Factors driving growth in Medical Imaging

The root cause for the upsurge in demand is the primary need for early diagnosis. The ever-growing incidence of chronic diseases worldwide, an aging population, rising awareness, and priority to health are increasing the need for early diagnosis. An additional factor relevant in today's scenario is the predominant use of X-ray and CT systems to diagnose Covid-19 cases across the world. Along with the need for early diagnosis, factors such as technological advancements in various applications, massive spending in product R&D, growing investments in healthcare infrastructure, and the need for visible improvements in population health are driving the growth in medical imaging technologies.

To meet rising demand, companies strive to attain market equilibrium by investing in technology. From a macroeconomic standpoint, suitable investments are proven to bear fruit to all stakeholders in such ecosystems.

Medical Imaging Overview

Medical imaging is the use of technology to produce internal images of the body for clinical analysis or medical intervention in a non-invasive manner. To gain an in-depth understanding of the impact of medical imaging on healthcare, it is ideal to first understand its composition.

Upon analysis of various parameters, the medical imaging market can be divided into segments in terms of geography, end-user, and modality incorporating both product and application. The framework of segmentation gives us the following insights about the market:

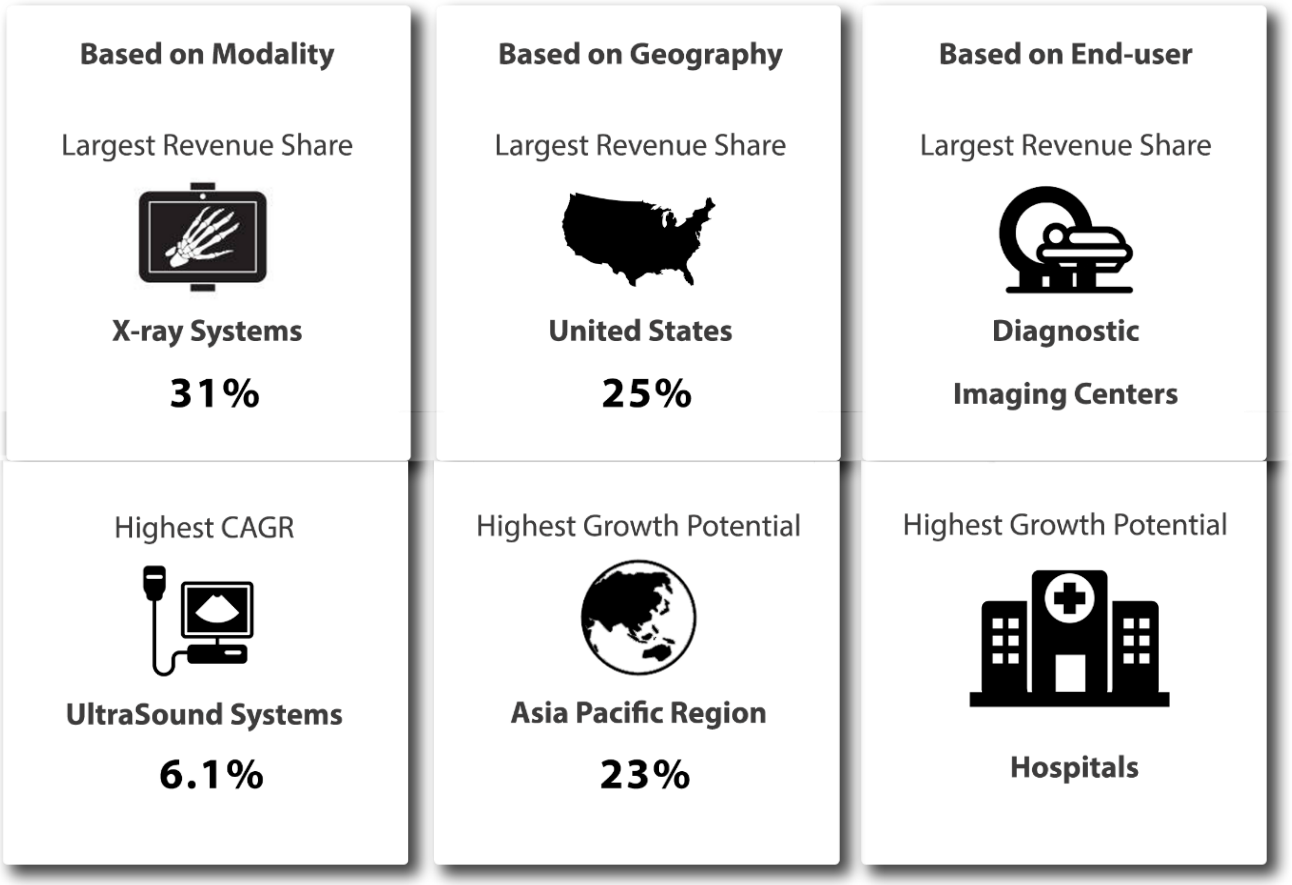


Figure 2: Key insights from market segmentation

Source: Statista, 2021

Note: Revenue and growth rate calculations use 2020 as the base year through a forecast period till 2025

Considering the tremendous potential in the diagnostic imaging market, making suitable investments at the right time in the right technology is critical for manufacturers. Any market player considering a strategic investment in this sector would be well-advised to ponder the following questions and their answers.

Q.1. Why technology should be prioritized for strategic investments?

Q.2. What are the major growth driving factors?

Q.3. What should be the key areas of investment?

Why technology should be prioritized for strategic investments?

Clarity of purpose is of course fundamental to any enterprise, but often hard to articulate with precision. It is interesting to note that diagnostic imaging firms are elucidating their focus and providing their customers with quality service and diagnosis by factoring in the latest innovations and developments in technology.

According to Deloitte's digital transformation study, companies that apply 'digital pivots', a term they coined to describe technology-related capabilities and assets across a wide range, tend to achieve better financial results and several application-based benefits. Digital pivots include flexible and secure infrastructure, mastering data, open talent networks, ecosystem engagement, intelligent workflows, unified customer experience, and business model adaptability, all of which align with the opportunities in medical imaging.

Over hundreds of start-ups are active members in the space of cost-efficient technology deployment. From AI in radiology to blockchain integration and data-driven decision support systems, the potential in the medical imaging space is enormous. Embracing technology-related change is a positive outlook from an industry-wide perspective as the avenues for precision imaging are clearer than ever before. This allows medical imaging to play a more important role in the wider paradigm of precision medicine.

What are the major growth driving factors?

Among the many reasons for growth in the medical imaging market, it is fascinating to understand how technical drivers have played an important role in boosting growth. A study by *JACR in collaboration with McKinsey* found that three factors were driving the immense current growth in the medical imaging market.

- First and foremost, the medical imaging domain generates large and extensive datasets. The development of deep learning technologies and advanced analytical tools has given businesses new ways of employing datasets for decision support and early diagnostics.

- Secondly, technological advances have made it easier to select the right combination of imaging hardware and software providers. This in turn leads to better image quality, lesser processing time, and greater efficiency in maintenance.

- The third is due to changing provider perspectives, and a shift in focus to a more patient-centric approach. Technology is becoming essential for improving workflows, strengthening patient data security, enabling remote accessibility, and quality imaging.

Figure 3: Technological drivers of growth in medical imaging

Source: JACR, 2018

What should be the key areas of investment?

Listed below are six potential opportunities where diagnostic imaging equipment manufacturers should focus on in terms of R&D spending, to create robust, patient-centric, accurate, and efficient solutions.

Opportunity 01 – Large Untapped Datasets

Statistics show that each year, close to 600 million imaging procedures are carried out in the US. The immense amount of data derived from these procedures has the potential to generate patient-centric and clinically pertinent insights utilizing big data science. This prospect influences decision-making that goes far beyond the current scenario of image diagnosis and clinical information.

Leveraging Image Big Data Analytics

Medical images take up one-third of global data storage. By analyzing thousands of images through big data, algorithms will help physicians identify patterns in images and patient data, and share this in real-time for sophisticated diagnosis and decision support. This will increase efficiency, improve accuracy, reduce cost and time, and ultimately deliver better recommendations for clinical treatment.

Frost & Sullivan predicted that data analytics tools and data management would help expand the US market for medical imaging at a staggering 16% CAGR from 2014 to 2019. Big Data technologies today are far more superior due to the latest advancements in IT infrastructure capable of handling unstructured, high volume data of varied forms generated at rapid speeds.

Case: Zebra Medical Vision is an Israeli start-up that uses big data to perform clinical research and analyze millions of imaging records, assisting practitioners in delivering patient care and detecting anomalies.

Opportunity 02 – Developing Workflow Management

The explosive surge in tasks, datasets, and complexity in handling patient information has made it difficult for radiologists and practitioners to operate without compromising on providing quality care. The healthcare industry is grappling with an array of issues such as a crippling shortage of healthcare workers, coping with an aging patient population, and providers facing ever-increasing costs and operational inefficiencies in the process of decision-making. By augmenting workflows, artificial intelligence may prove to be the answer to many issues.

Using AI for Improving Operational Performance and Efficiency

Integrating AI into medical imaging workflows helps in generating insights from large volumes of clustered data that is stored with the healthcare providers. The providers can then improve operational performance and efficiency, drive productivity, and optimize resources at hand while saving time and costs.

How can manufacturers improve performance?

The use of algorithms and AI engines to sift through extensive data will save time, effort and increase overall productivity. The staff's non-value-added tasks can be eliminated, and resources can be optimally utilized. Amongst many, AI can make a difference in the following functional areas:

- Systematic patient scheduling
- Managing referrals
- Exam preparations and adjustments to imaging protocols
- Maximising scanner utilisation
- Obtaining full knowledge of patient history through tracked reports

Various applications of AI can be used to enable an end-to-end platform for workflow solutions as shown in the figure below:

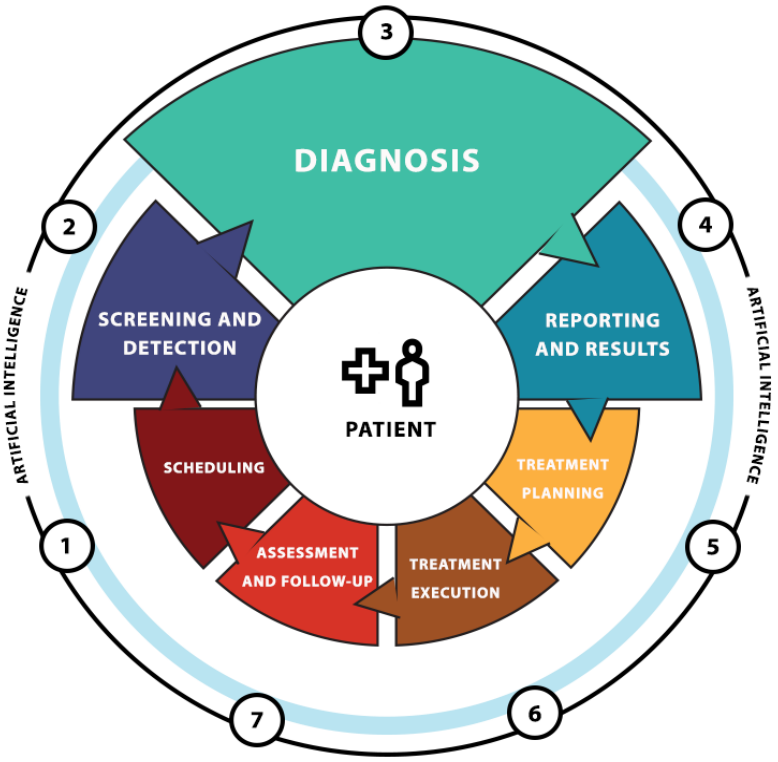


Figure 4: Pictorial representation of an AI based end-to-end platform for workflow solutions

Each stage of this workflow is augmented by the use of AI to deliver direct or indirect improvements in performance, all the while keeping the patient at the center of attention. Using such a platform also paves way for better collaboration and the creation of multi-disciplinary teams. For example, stages 1 to 4 involve seamless interactions between the reception, technicians who operate devices, physicians and pathologists for diagnosis, and radiologists for reporting the results.

Figure 5: Benefits of using AI to improve workflow

Unfortunately, as per the radiology business, a study conducted by ACR Data Science Institute shows that only 30 percent of radiologists use AI in practice. Innovation followed by acceptance should soon see a change in this trend.

Case

1. DeKalb Medical partnered with GE Healthcare to implement GE's Centricity RIS-IC as a part of its enterprise imaging plan. It successfully converted a three-hospital healthcare system into an advanced RIS, improving patient care and helping DeKalb stay relevant in the competition.
2. Intel developed a deep learning toolkit known as OpenVINO. It helps X-rays conduct pneumothorax inferencing 3.3 times faster than without it.

Opportunity 03 – Strengthening Patient Data Security

Just as integrating healthcare to the Internet has brought numerous positive developments, it has also given rise to severe risks to cybersecurity. Patient data is of utmost concern to healthcare IT today as it stores important information about the patient such as details regarding demographic, location/address, social security numbers, etc. According to a Trustwave report, healthcare data is valued almost 50 times higher than the next highest value in the eyes of the perpetrator and/or hacker. Hence, the greater the incentive for hackers to breach, the greater the threat that providers will have to deal with. Medical images in specific pose a dangerous risk as it contains enough metadata to create a breach or safety issue.

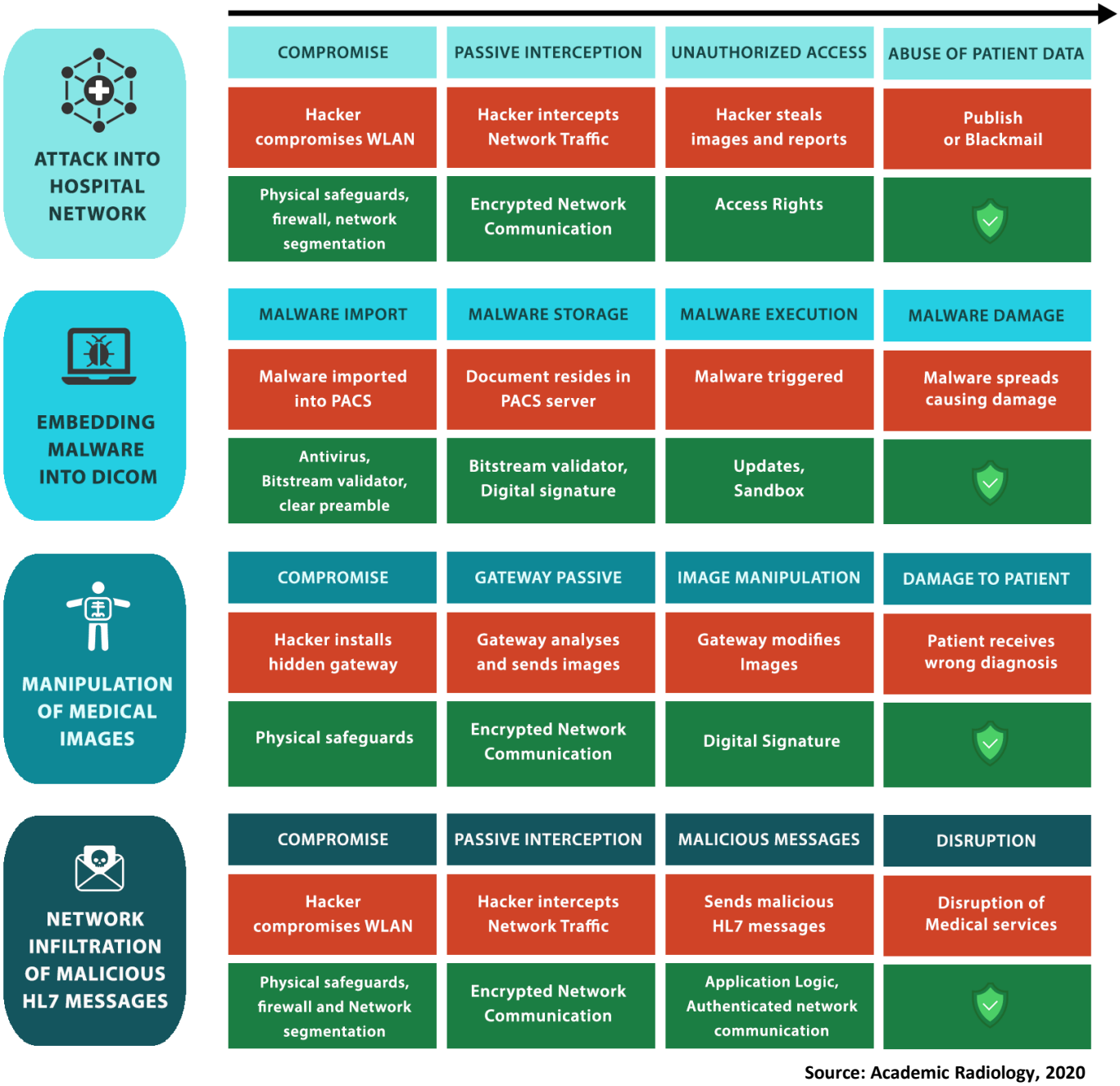
Case

1. In 2019, several attacks against medical protocols and file formats had taken place. Important examples in the context of PACS and medical imaging are – embedding malware in a DICOM image and the use of AI techniques to falsify medical images.
2. Greenbone Networks, a Germany-based security firm, found close to 24 million patient exams that stored more than 720 million images exposed in 187 insecure servers in the US. Two months after this discovery, the number of exposed servers doubled, posing a severe violation of privacy.
3. The US government fined several medical imaging companies, one of which was a Tennessee-based company having to pay US $3 million for accidentally exposing a server holding more than 300,000 patient data.

Prevention and Mitigation Measures

Mitigating risks in health data security requires very diligent and structured efforts. It is also important to understand that health data security is the responsibility of every stakeholder working in the healthcare ecosystem. Thus, it is vital to implement cybersecurity plans for prevention and mitigation purposes. This may involve regular monitoring of networks or current capability assessments and, most importantly, building a culture for dynamic security.

To further emphasize the importance of prevention and mitigation, below is a diagram that shows a series of four cyberattacks in congruence to the attacks in 2019. Each row from top to bottom represents the scenario, attack, and remedial measure respectively in four steps leading to the next.



Source: Academic Radiology, 2020

Figure 6: Series of four cyberattacks and respective mitigation techniques

Opportunity 04 – Improving Accessibility in Radiology

According to ITN editors, insights from RSNA 2020 indicate that radiology exams (with increased modalities) have increased by 43%, contributing to an increase in overall data collected, which is expected to reach 2000 exabytes. As the global healthcare system struggles with a shortage of care providers and ever-increasing costs, teleradiology may prove to be a pivotal solution to optimizing existing resources, supporting radiology departments, improving accuracy while reducing time for image interpretation, and making diagnostic imaging more accessible to stakeholders involved. Some would say that teleradiology came into existence due to the imbalance between the demand and supply of diagnostic services. Teleradiology is expected to overcome this deficiency in timely diagnosis and improve patient care, as it sets out to grow at a CAGR of 20%, valued at over US$ 13 billion as per ITN and Future Market Insights.

Teleradiology

Teleradiology serves as a means to connect radiologists from far and wide to patients in places unreachable for quality care and effective symptom control. This method is often outsourced and thus helps the provider save costs and optimize the use of resources. Teleradiology proves to be helpful in emergency cases when it is critical to provide quick diagnostic services.

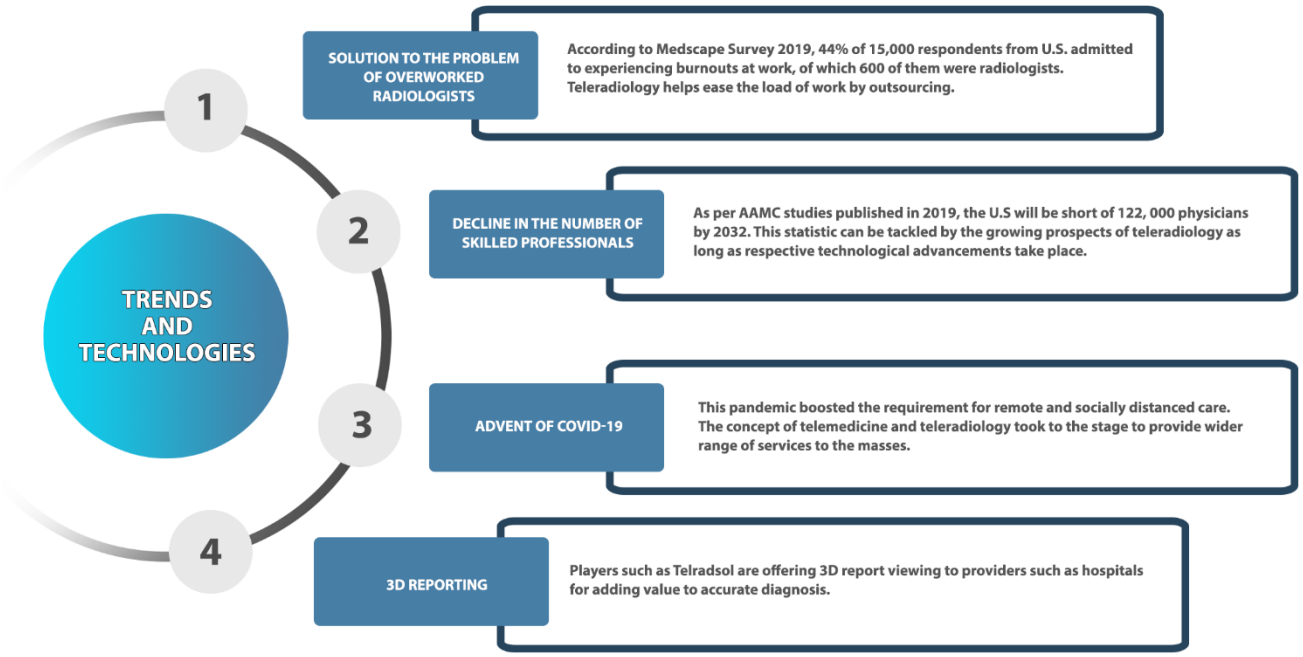


Figure 7: Trends and technologies prevailing in teleradiology

Benefits to patients and providers:

- Resources and infrastructure can be efficiently utilized
- Cost and time savings
- Access to improved care
- Round the clock services

Case

1. Philips acquires a US-based Direct Radiology's teleradiology platform, business operations, and employees. The organization was providing services to more than 300 hospitals, imaging centers, and others in the U.S. This step was taken to expand the scale of teleradiology to the world.
2. BEFUND24 is a teleradiology solution introduced by Siemens Healthineers to manage data transfer, financial and administrative processes. It provides access to a network of subspecialists in times of staff shortage.

Opportunity 05 – Service Maintenance

Availing quality services for software maintenance is an essential step in delivering patient care in this industry, for example, by increasing system uptime or smooth running of equipment. Subpar maintenance can lead to incorrect diagnoses, interrupted patient care, and increased expenses. Time is wasted while waiting for scheduling, detection, rectification, and re-operation in the traditional manner of servicing and hence, the need for 'remote services'.

Remote Services

The concept of remote services has gradually developed over time by using various methodologies to deliver improved performance and faster system up-time. Today, technology has aided this service line in taking maintenance a step further by incorporating the following:

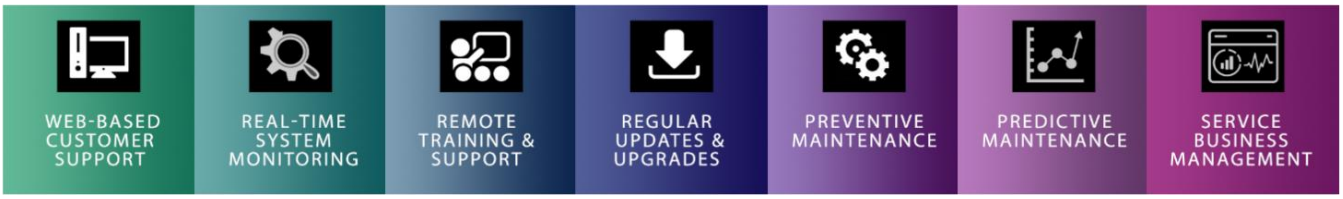


Figure 8: Modern traits of remote servicing

Predictive maintenance is a significant application of big data analytics that helps providers in proactively diagnosing the problems, thus reducing the probability of unexpected system failures and saving time, resources, and money in the process.

Case

1. Hitachi Healthcare addressed the issue of maintenance of superconducting MRI systems by studying their breakdown. They analyzed 100 MRI systems that had almost three years' worth of data to detect any patterns. Using machine learning and analytics, they found that signs of failure can be seen months in advance. By scheduling timely and appropriate maintenance, the company reduced system failures by 16.3%.

2. The top players in this industry like Philips, GE, and Siemens, have all jumped in on this bandwagon and enjoy the benefits of the same. GE Medical Systems Inc. even patented a breakthrough technique for medical equipment predictive maintenance as a method that lasts till 2023.

Opportunity 06 – Image Quality

As medical imaging continues to grow and develop, it is vital to consider the idea of image quality which directly impacts the decision made by physicians/ practitioners. Several human factors play a role in the analysis and interpretation of an image, and thus, it is vital in maximizing visual quality.

3D Technology

3D imaging allows practitioners to view images from different angles and helps develop an overall understanding of the case. This form of imaging has proven to produce high-quality images in terms of volume, clarity, and crisp visualization.

Figure 9: Five areas of medical imaging impacted by 3D technology

AI plays a significant role in improving efficiency in quality images and shortens the acquisition time thus, enabling quick and effective diagnosis. With 3D imaging and AI facilitating SIFTing (scale-invariant feature transform) through extensive data, radiologists can now spot information from images that cannot be detected by a human eye.

4D Technology

4D medical imaging has advanced the level of performance of volumetric imaging techniques by integrating time information to incredible heights. This line of technology is applicable and highly useful for monitoring fetal heartbeats, detecting cancerous tumors, and visualizing blood flow.

Case: According to statistics, an estimated 95,000 people each year in the United States have their heart valves replaced. 4D MRI is a method used to measure and visualize blood flow in arteries in a non-invasive manner. The future of 4D technology carries huge potential as experts believe it will expand into visualizing and monitoring other systems in the body.

Apart from those stated above, there are several other advancements in imaging that make diagnosis easier and accurate. Some of these image processing techniques are:

1. Needle navigation: Defined needle pathway that provides 3D visualization of needle positions during an interventional procedure to assist physicians in terms of accuracy, dosage reduction, and provision of optimal workflow for needle interventions, thereby enabling better patient outcomes.
2. Metal artifact reduction: Automatic detection of metallic objects (implants) and artifacts for introducing correction factors that allow clinicians to get a clearer view of blurred anatomical features closer to the metallic object/ implant.
3. Stent visualization: A visualization tool for stent positioning and deployment that suits the needs of cath lab workflow as it automatically improves the image quality of stents from cine X-ray acquisitions.

Conclusion

The medical imaging market is growing at a steady pace as both demand and supply are well backed by the need and investment. Spending patterns show a positive outlook for medical imaging as more and more companies have started to make future R&D investments in hindsight of optimistic technological results. As long as technology advances, so will be medical imaging in providing patients the top-most care they need. The six areas of interest discussed in this paper can prove to be significant in delivering better performance, improved workflow and efficiency, enhanced accuracy, increased accessibility, remote service maintenance, and AI-based decision support for diagnostics, especially in dire times such as COVID-19. The importance of this change that is set to take the course is re-emphasized by the fact that the landscape of healthcare is indeed disrupting thanks to many factors, of which one is undoubtedly, Medical Imaging.

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TATA ELXSI

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