Innovations in Cancer Screening

How advances in imaging technology and the use of artificial intelligence and analytics are improving the accuracy and cost of medical imaging for early cancer diagnosis, and increasing confidence in vital preventive screening programs.

Presented by Median Technologies, The Imaging Phenomics Company®

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Despite decades of research, cancer continues to be the healthcare crisis of this generation. Cancer is now the second leading cause of death globally according to the World Health Organization (WHO) accounting for one in six deaths globally[i]. As global populations age, and chronic diseases become more prevalent in emerging economies, these numbers are expected to soar to nearly 21.7 million new cases and 13 million deaths by 2030[ii].

That's the bad news.

The good news is that oncology experts have made tremendous progress in recent years in both the diagnosis and treatment of many forms of cancer. These diagnostic improvements include advanced medical imaging technologies, including digital mammography and computer-aided detection (CAD) technologies that use artificial intelligence, and specifically deep learning, to automatically recognize patterns in images that suggest a tumor or lesion.

Part 1:

Why we screen

Early cancer screening

Early cancer screening has long been used to identify people with abnormalities suggestive of a specific cancer or pre-cancer who have not yet developed any symptoms. Screening is a vital component of cancer treatment as these screens enable prompt detection without invasive procedures.

When identified early, cancer is more likely to respond to effective treatment and can result in a greater probability of survival, less morbidity, and less expensive treatment. Significant improvements can be made in the lives of people by detecting cancer early and avoiding delays in care. In absence of early diagnosis, people are diagnosed at later stages when curative treatment may be less effective, more invasive, costly and time-consuming – or it can occur too late for treatment to deliver any benefits.

Benefits of early detection

The benefits of early detection through cancer screening programs is well documented. A 2015 analysis, published by the British Medical Journal, shows the overall survival among women with breast cancer is longer when their cancer is detected before the cancer spreads to the lymph nodes[iii]. The authors of the study concluded: "Diagnosis of breast cancer at an early tumor stage remains vital."[iv] A similar study showed that 70% of lung cancer patients survive for at least a year if diagnosed at the earliest stage, compared to just 14% of patients who survive a year when diagnosed at the most advanced stage of this disease[v].

The benefits of early diagnosis are so well established, that the World Health Organization encourages healthcare professionals to educate patients about the value of early diagnosis and screening, and has stated that "early detection of cancer greatly increases the chances for successful treatment." [vi]

How we screen

There are two primary applications of medical imaging for cancer diagnosis and treatment:

Screening
Screening is a preventive step to identify people with abnormalities suggestive of a cancer or pre-cancerous growth who have not yet developed any symptoms. Screening programs can be effective for identifying cancers early and getting patients into treatment when positive outcomes are more attainable. Many global healthcare organizations and regulatory bodies encourage early and regular screening as a key component of preventive care programs.

Monitoring
Monitoring is the observation of a disease, condition, or one or several medical parameters over time. For malignant cancers, medical imaging can be used to track the progress of the diseases and the outcome of various treatments. Such monitoring can be a valuable component of the care paradigm as it is an easy and non-invasive way to determine if a treatment is having the desired effect, and if not, how the care plan can be adapted.

Medical imaging can also be used to track the development of benign tumors, which while not cancerous, can become a medical concern if they press on vital structures such as blood vessels or nerves. In most cases, the monitoring of patients over time is key to determining the progression of benign tumors, determine the possibilities of benign tumors turning malignant, or find malignant cancers. Both screening and monitoring are vital tools in the cancer treatment journey.

> “ Early detection of cancer greatly increases the chances for successful treatment.”

Part 2:

Artificial intelligence in medical imaging

The benefits of early screening and advances in screening technologies to make earlier detection possible are important trends in oncology. However, the high rate of inaccuracies in reading these screens has been a deterrent for effective roll out of preventive screening programs as further explained in the next section.

The effect of false positives

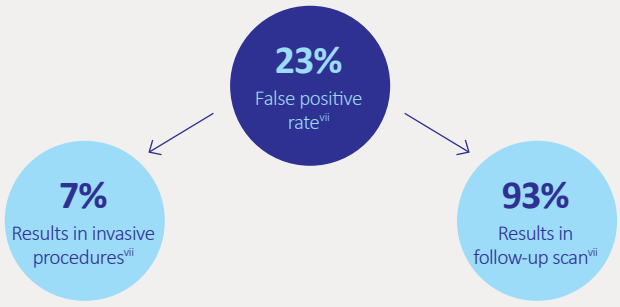
Recent studies show that almost one in four (23%) patients experience false positives on image readings for certain cancer screenings . This high rate of false positives often leads to unnecessary invasive procedures and follow-up scans that add tremendous cost and anxiety for patients. A 2015 study, published by Health Affairs magazine found that the national expenditure for false-positive mammograms and breast cancer over-diagnoses is estimated at $4 billion a year in the US alone.[ix]

Along with the expense and stress, the high rate of false positives has created a culture of wariness toward some cancer screening programs. News stories questioning the value of early screenings and healthcare professionals voicing skepticism about the benefits versus the risks of early screening have led some healthcare organizations to shift their messaging about early screening programs. In 2015, a US Preventive Services Task Force declined to recommend bi-annual mammograms for women in their 40s, despite adequate evidence that mammography screening reduces breast cancer mortality in women ages 40 to 74 years. They advised instead that women in their 40s make individual decisions about whether to be screened based on their own health history and perceived benefits. The Task Force cited the frequency of false-positive test results as a primary factor in this decision.[xi]

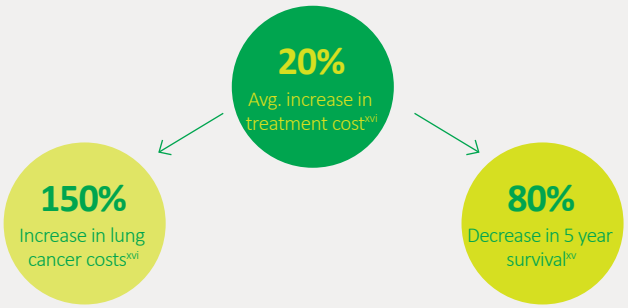
When patients receive such conflicting guidance on when and whether to pursue cancer screenings, they may be less likely to take advantage of these early diagnostic tools.

The high rate of false positives in cancer screenings is due in part to the way images are evaluated. Traditionally, medical images are read visually by radiologists who are often overly cautious for fear of missing something. They may only spend a few minutes looking at each image to determine whether an unusual pattern suggests cancer. And while radiologists have extensive training in how to read these scans, a single reading of an isolated image can be time-consuming, difficult, and can result in a high rate of false positives. As more medical imaging tests are conducted, and demand for radiologists out-strips supply, the pressure they face will only increase, forcing them to read more images in less time.

False Positives: Costly, unnecessary follow-ups



False Negatives: Decreased survival and increased treatment costs



Data-driven solutions improve accuracy

Fortunately, advances in artificial intelligence (AI) and analytics in the medical imaging space offer solutions to these challenges, and provide radiologists with a valuable support system to validate their assessments and create efficiencies in their workflow, so they can help more patients.

Since the first x-ray in 1895, radiology has been at the forefront of medical innovation. The ability to use imaging technology to non-invasively identify tumors, injuries, and other anomalies transformed the way we diagnose an array of conditions, cutting cost and risk from the medical care process.

This field continues to evolve today with recent advances in both medical imaging and the analysis of these screens. The latest generation of imaging technology captures digital images, and uses highly sensitive software technology to detect smaller abnormalities and enable earlier diagnoses. For example, 3-D digital breast tomosynthesis (DBT) has dramatically improved the ability to spot smaller lesions for earlier cancer detection.[xii]

Sophisticated Computer Aided Detection (CAD) tools are also transforming the screening landscape. These tools use AI and specifically deep learning algorithms to automatically identify tumors or suspicious lesions in images. Their highly reliable algorithms can reduce time to evaluate a screen and help reduce the rate of false negatives, allowing patients to be accurately diagnosed earlier, reducing mortality and decreasing treatment costs.

These precision technologies can also be used to track imaging biomarkers to quantitatively evaluate disease evolution, including changes in the shape, size or volume of a lesion or tumor. These advances are expanding the use of images for clinical trial enrollment criteria, and for tracking the population outcome trends in drug development trials and wide-scale healthcare programs. As imaging capabilities become more sensitive, they will continue to enable earlier diagnosis by identifying small variances that might not be easily spotted by the human eye.

CAD systems are able to deliver more consistent analyses than visual assessments alone, which has an immediate impact on accuracy and health outcomes. The algorithms are trained to identify anomalies by reviewing thousands of labeled images and data to understand when a screen has an abnormality that requires further review. When a new image is submitted, the algorithm applies its training to differentiate normal vs. abnormal structures (e.g., benign/malignant).

3-D digital breast tomosynthesis (DBT) has dramatically improved the ability to spot smaller lesions for earlier cancer detection.[xiii]

Proven results

By leveraging the combined benefits of algorithmic image processing, advanced image visualization, and cloud-based imaging systems that allow radiologists to capture and store vastly more images at less cost, radiologists can speed the image reading process, and gain valuable data-driven insights to support their own conclusions. This can help them drive efficiencies into the diagnostic process tasks and reduce risks and errors.

Robust reporting with lesion tracking and snapshots over time promotes further accuracy, transparency and collaboration across the care team through the patient's care. Another study, published in Annals of Oncology found a global decrease in colorectal, breast, and uterine cancers in high income countries is most likely due to screening and access to treatment.[xiv]

These efficiencies are becoming more important as medical imaging becomes more prevalent. Improved imaging capabilities and reduced cost of screening, coupled with the rising rate of cancer and other chronic diseases in aging populations, are driving up the use of medical imaging in ambulatory care and hospital environments around the world. Recent studies show steady increases in the number of computed tomography (CT), magnetic resonance imaging (MRI), and positron emission tomography (PET) scans performed in North America, Europe and Asia. Developed nations show the largest use of these scanning technologies, though the large population and aging demographics in Asia Pacific along with their growing investment in healthcare will drive up use of these innovative imaging solutions in this region in the years to come.[xxi]

Increased 5- Year Survival

Type of Cancer	5-Year Survival – Early Stage Dx	5-Year Survival – Late Stage Dx
Lung[xv]	70%	14%
Ovarian[xv]	90%	5%
Liver[xviii]	31%	3%

Decreased Treatment Costs

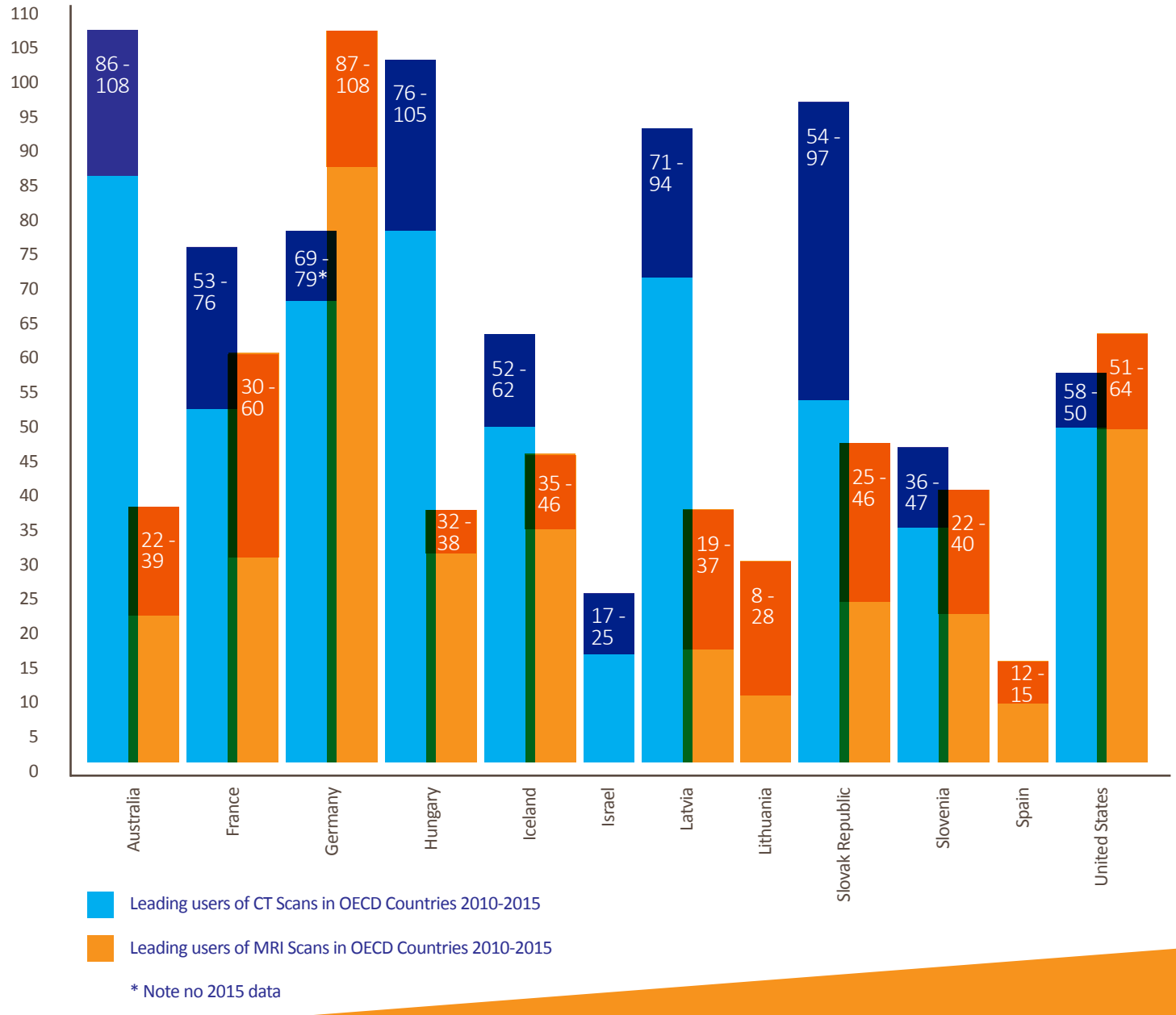
~17% Reduction in total costs with early diagnosis (stage I/II vs III/IV)[xvi]

50-60% Cost reduction for certain cancers[xvi,xvii]

61% savings	Lung cancer
35% savings	Ovarian cancer
27% savings	Colon cancer

The data demonstrates that improved imaging technology, advances in analytics and AI capabilities, and the increasing use of medical imaging is saving lives and resources across the globe. Medical imaging systems with analytics capabilities allow healthcare professionals to make faster and more data-driven diagnoses using non-invasive solutions. This reduces the time, cost and stress related to medical care, and puts patients on a faster track to wellness.

Past studies have shown that prudent use of imaging can reduce the time and cost of hospital stays and avoid unnecessary invasive procedures. For example, since 1998, CT scans have been found to significantly reduce the negative appendectomy rate and the number of unnecessary hospital admissions, saving $447 per patient[xxii]; while a 2007 study found that increased multi-slice coronary computed tomography could save up to $1.2 billion annually in the treatment of stroke patients[xxiii].



The future of medical imaging

AI, cloud based storage, and mobile digital scanning tools will dominate trends in medical imaging in the coming years. Together these technologies enable smarter, cheaper and more efficient scanning to be conducted in even the most remote medical settings. By harnessing big data and analytics capabilities, these systems will continue to provide targeted, data-driven analyses, reducing time and errors, and providing radiologists with a valuable tool to diagnose patients. In the coming years, we expect CAD systems and cloud based solutions to continue to deliver new features and more precise imaging functionality to support patient care and clinical research efforts.

However, as these trends evolve there will be obstacles. On the technology side, the biggest is training the algorithms to identify anomalies in medical images with precision. The AI healthcare market is expected to grow more than 10x in the next five years.[xxiv] That suggests exciting innovations to come – but also portends a growing talent gap that could stymie progress. The workplace indeed saw a 500% increase in the number of AI related job postings from 2015-2017, and the talent that is available are scoring huge salaries and their choice of jobs across many sectors.[xxv] This may force new partnerships and collaborations between healthcare and technology companies to fill the talent gap, and drive progress in this space.

Growth in AI driven medical imaging will also be tempered by regulators' approval process. To win approval Medical Imaging Technology developers must be able to demonstrate that they can deliver results as accurately, or more accurately, than a human analysis. These imaging solutions have only just begun winning approval by FDA and other regulatory bodies, however a recent spate of approvals suggests that the marketplace will see continued AI driven innovation in the years to come.

The radiology sector is in a state of transformation. Advances in AI, specifically deep learning, and digital imaging make it possible for hospitals and medical care facilities to more rapidly and accurately assess patients' conditions, and to craft a care journey that will deliver the best possible outcomes. It is an exciting evolution, and we are eager to transition the next generations of these tools to market to the benefit of patients, providers, payers, and global healthcare community.

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About Median Technologies

Since 2002, Median has been doing one thing and one thing only - expanding the boundaries of the identification, interpretation, analysis and reporting of imaging data in the medical world. Median is at the heart of innovative imaging solutions to advance healthcare for everyone. As The Imaging Phenomics Company®, Median provides insights into novel therapies and treatment strategies. Our unique solutions, MediScan® for patient care, iSee® for clinical trials, and iBiopsy® for imaging diagnostics, together with our global team of experts, are advancing the development of new drugs and diagnostic tools to monitor disease and assess response to therapy.

Median Technologies supports bio pharmaceutical sponsors and healthcare professionals around the world in bringing new and targeted treatments to patients in need with an eye on reducing overall costs. This is how we are helping to create a healthier world.

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