



CitiusTech White paper

Top Trends in Medical Imaging Technology: Understanding New Developments and Preparing for the Future

Introduction

The healthcare industry has seen a whirlwind of changes in recent years. These changes range from new policies, legislations to novel use cases and innovations in technology. The diagnostic imaging technology market continues to witness a number of trends, which are a move towards patient-centric radiology and value-based imaging. In this white paper, we've listed some of these trends which will have a vital impact on medical imaging, and include new modalities, imaging techniques, information technology, processes and workflows.

Modalities

Mammography

Digital Breast Tomosynthesis (DBT), or 3D mammography with the potential to improve lesion visibility, is the new standard in breast imaging. This method shows significant improvement in the detection of cancer in women. In DBT, a series of images are generated along the breast, which enables a radiologist to view each tissue layer independently instead of a combination of two projections of images. This substantially reduces the number of errors and recalls.^[1] DBT in combination with ultrasound and MRI also enhances diagnostic accuracy. However, numerous attempts will undoubtedly be made in the future to remove radiation from mammography, without compromising the information and image quality.^[2]

Automated Breast Ultrasound (ABUS) is the latest technology being utilized specifically for cancer screening. This technology is primarily employed in cases of asymptomatic patients, where the mammography findings are normal or benign (BI-RADS Assessment Category 1 or 2), with dense breast parenchyma (BI-RADS Composition/Density C or D), and no prior clinical breast intervention.

This year saw noteworthy innovation efforts in mammography. A novel method of noise reduction was tested to improve the clarity of mammo imaging. One of the key research components was to discover new methods to reduce scattered x-rays, using improved monochromatic beams and better spectroscopic detectors. These advances claim to show substantial improvement in contrast and also in the contrast-to-noise ratio.

A new trend in mammography treatment and care cycle stems from the provider market. The provider market is testing collaborative treatment models which can help increase operational efficiency. The live video diagnostics solution is an innovative platform, which improves mammography coverage and workflow by connecting breast imaging physicians, with hospitals' technologists and patients. These collaborative efforts enable real-time communication and provide faster and personalized care when the local onsite imaging physicians are not available.

3D Ultrasonic holography

This technology saw great traction this year and is anticipated to gain widespread acceptance in 2017. Because ultrasonic holography does not use dangerous radiation, it is ideal for preventive and post-operative examinations in breast cancer patients. The resolution of generated images is high in comparison to those of a normal ultrasound. In addition, the images are easily reproducible and allow automated computer-based data interpretation.

Mobile and Internet of Things (IoT)

Mobile technology has made its way into healthcare. While there are large amounts of mobile healthcare applications, the majority are not FDA (Food and Drug Administration) approved. The FDA issued the *Mobile Medical Applications Guidance for Industry and Food and Drug Administration Staff* on September 25, 2013. This guidance explains how the agency identifies

mobile medical apps as devices, and lists regulatory requirements solely for those applications that pose a threat to other medical devices, or those which may present a higher risk to patients, if they do not work as intended.

There are many radiology applications that received 510(k) premarket notification from FDA. Common use cases include: 3D viewing, clinical collaboration, easy Picture Archiving and Communication System (PACS) connectivity, which enable access to radiology reports and referral studies.

IoT, however, has not been as successful in the medical imaging arena. Research has been conducted on leveraging IoT to enhance the workspace experience of a radiologist in a reading room, by controlling the screen brightness and contrast parameters, including the room lighting, depending on the radiologist's choices and reading protocols.

Processes and Workflows

Big data and analytics tools in imaging workflows

Since 2015, big data analytics and medical imaging data have achieved prominence in healthcare. Although imaging data is not analyzed as widely as an independent analytical approach, it is considered part of the care continuum along with other EHR data in context.

The value generated is high and the opportunities are immense with these analyses. From outcomes to reimbursements, protocols to patient experiences, all processes can be optimized to generate great value. For this to be accomplished, a few creative and careful steps should be taken.

1. Identify the measures or reports.
2. Explore how we use this data to modify the processes, infrastructure, personnel or technology to achieve the perceived value. If the steps are unclear, there would be no incentive to enter the data analysis arena.
3. Curate the data. In the imaging workflow, there are several points which are prone to human error and data curation is one of the important tasks to be considered.
4. Present the data to relevant stakeholders. Conventional presentation formats, such as charts or bar graphs, typically are not the most appealing approach to attract patients or other stakeholders. Develop more meaningful and easy-to-understand representations, and always have a clear context in which the said representation is relevant.

Analytics are extensively used to detect specific patterns identified with specific pathology. The imaging algorithms are capable of deriving metrics using intensive analysis of patterns in a given digital image, and output scores that complement the analyses made by the radiologist, which can be useful for quick diagnosis.

With the American College of Radiology's (ACR) Imaging 3.0 initiative and the current focus on value-based healthcare delivery, analytics tools will go well beyond gathering operational metrics.

The future of analytics on diagnostic imaging data is promising. We can look forward to new and interesting features in the Radiology Information System (RIS) and PACS systems, especially those on cloud, which might include analytics and provide impressive reports on operational and clinical data.

Enriched reports

With electronic medical record (EMR) implementations expanding and becoming outcome-based, along with other electronic health record (EHR) data in context, clinical reports are improving in content. This applies to radiology reports too. Patient history which includes snippets from prior images compared to current images is widely used today in radiology reports.

The radiology reports include measurements from 3D analysis software, which now also consist of diagrams with color-coded sections. An example would be a vessel diagram in a cardiovascular CT study.

Enhanced reports provide great insights into patients' progression and help in better diagnoses in the care cycle. On the flip side, not all protocols available today can handle such large, text-rich reports with high-resolution images, which is one of the issues that SMART on FHIR can resolve.

Multi-disciplinary teams

There is an increasing trend of forming cross-sectional teams, which typically comprise a doctor, a technologist, a radiologist and a middle manager, who leverage the acquired data analysis to discuss and approve imaging strategy and treatment. The team can be a care coordination team where a group of specialist clinicians and radiologists work on a historical study, including the planning, diagnosis and treatment approach.

Studies conducted by various organizations in 2016 continue to show tremendous improvement in treatment and outcomes as a result of team collaboration, especially in imaging. Radiologists are

playing key roles in these teams and are empowered to determine a diagnosis strategy and further outcomes.

Patient Health Information (PHI) and Security

Patient data security

Patient data security is the topmost concern in healthcare IT today and is anticipated to remain so for the foreseeable future. Recently at a large health system, hackers stole patient information belonging to millions of accounts through a point-of-sale system (POS) that processes payments, rendering the system vulnerable.

Healthcare records are generally more interesting to hackers compared to credit cards, as they contain demographic information, addresses and social security numbers (SSN) that cannot be easily updated, opening a window for malpractice.

Images also have enough meta-data to cause a PHI breach or a patient safety issue. Radiologists extract images from Vendor Neutral Archives (VNAs) or PACS and post extractions that are vulnerable. Saving these images in local folders for remote reading can expose information to hackers, if enough security measures are not enabled in those systems.

Although VNAs generally seem secure, there are increasing concerns surrounding security in multi-tenant, cloud-based systems. VNAs fall in the category of systems that depend upon a cloud vendor's security measures. When users replicate the images or reports generated with information stored on the cloud, vulnerability opportunities emerge.

New viewing platforms have become the latest trend as IT security policies do not allow installations post-software deployment. If installation is allowed on client workstations, there is a heightened vulnerability to security.

Cloud

Cloud platforms are the obvious choice for healthcare IT applications, considering enormous costs to manage huge infrastructure, analytics data and the storage of priors. Although the pressure is on service vendors to protect the data, the fear of PHI exposure has hampered a major share of healthcare organizations from adopting cloud.

More data breaches occur each year from human errors than breaches on cloud platforms. The key to avoiding breaches is to select the right cloud for the healthcare enterprise. It is important to hire a security

specialist who can assess the security measures and ensure they are sufficient and updated to tackle potential threats. All aspects of security - physical, server, network, application, data, devices and users - along with a well-written Business Associate Agreement (BAA), is important for a successful cloud implementation.

It is time to make the transition to the cloud and leverage its advantages, such as offsite backup, disaster recovery, high resource availability and mobile device security and support.

Interoperability

With Digital Imaging and Communications in Medicine (DICOM) over TCP and HL7 V3 based on XML enabling the exchange, integration, sharing and retrieval of electronic health information, we now have faster and more comprehensive standards at play this year. As expected, these have a web-based and RESTful approach to interoperability.

DICOM's set of public RESTful services are already widely used. STOW (Store Over the Web), QIDO (Query based on ID for DICOM Objects) and WADO (Web Access to DICOM persistent Objects) are being added as features to recent releases in some prominent RIS/ PACS systems. Many systems are still in the process of implementing XDS/XDS-I and XCA.

FHIR (Fast Healthcare Interoperability Resources) is a next-generation standard framework created by HL7 and successor to HL7 v2.x, v3 and CDA.^[3] Given the limitations of previous standards for non-XML segments and esoteric implementations (V2) or complexity of implementation (V3 and CDA), there was a need for a standard which is more structured, standardized and human-readable.

FHIR is a very promising standard, especially due to the ease of learning and excellent support to RESTful and selective retrieval of specific data using JSON, XML, CSV or RSS. It is a practical approach to exposing granular data, saving huge network traffic. The API includes a rich set of vocabularies and data models, allows individual patient and population-wide queries, and is available to a large population of developers.

Vendor Neutral Archives

The VNA market continued to grow this year, especially with key advancements in the cloud offering aspect. On-premise and hybrid offerings of cloud-based VNA are available from major vendors. Its main advantages are attributed to the fact that it can be hosted on cloud and allows full cross-

enterprise document sharing (XDS/XDS-I). The main benefit of the system is that it can store a wide variety of data that are non-DICOM or non-HL7 (videos, PDF, plain text, XML), and still be able to organize and link the data to the corresponding patient or other entities, in a way that it is easily searchable and retrievable.

Another key development in this area is that VNA now not only supports documents from the field of radiology, but also allows artefacts from ophthalmology and oncology. This has permitted applications to retrieve information pertaining to entire patient history, and provide caregivers a broader view of the patient's health. The VNA is now being used as a backup for multiple application databases (which has application-specific information) and as a vendor neutral storage, which is accessible to a PACS workstation to retrieve priors of the patient. This possibility is pushing EHR and PACS workstations

to move toward universal viewing capabilities, where a patient can be viewed comprehensively with data from lab, ambulatory, pathology and other departments along with radiology information. This year, the industry learned that a strong, customizable workflow engine should be at the heart of the VNA and not just as an add-on, without which strong clinical collaboration features seem irrelevant. An external workflow management system could resolve this for a multivendor EHR-PACS-VNA environment, but if the entire interoperability use cases are based on only VNA, a core workflow engine becomes mandatory.

From an end users' perspective, the application should allow a view of all data-related to the patient, presented in context, based on customizable criteria at the point of access. This can be made possible with EHR-RIS-PACS-Workflow-management or by replacing PACS by Vendor Neutral Archive solutions.

References

- [1] [Diagnostic performance of digital versus film mammography for breast-cancer screening](#)
- [2] [Digital Breast Tomosynthesis \(DBT\)](#)
- [3] [FHIR Homepage](#)

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Dhaval has over 16 years of experience in healthcare technology, spanning various domains including healthcare interoperability and enterprise application architecture. At CitiusTech, Dhaval leads strategic partnership management for large healthcare organizations. Prior to CitiusTech, Dhaval worked with leading healthcare organizations and contributed in different roles such as Research Engineer, Lead Engineer and Chief Architect.

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Prasanth has over 13 years of experience in the information technology industry, including a decade of experience in healthcare technology and consulting, primarily focused on provider and ISV segments. Prasanth's core area of expertise includes working with major imaging ISVs in the US and leading large scale product engineering. Prasanth has a Masters in Computer Applications.

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