Signify Research Show Report from RSNA 2018

December 2018

Signify Research's key takeaways from the 104th Scientific Assembly and Annual Meeting of the Radiological Society of North America (RSNA). Topics covered:


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AI at RSNA – Signs of Maturity, But a Long Way to Go.

Written by Simon Harris

AI was once again the hot topic at this year's RSNA. With close to 60 AI start-ups in the Machine Learning Showcase and most of the incumbent modality and imaging IT vendors marketing AI to varying degrees, the technology was hard to ignore at this year's meeting. Cutting through the inevitable hype, it was clear that vendors are making progress with bringing AI solutions into the daily workflows of radiologists and other imaging specialists. From our discussions with radiologists and from the general buzz on the show floor, it was also evident that the sentiment for AI has progressed from the initial fear and scepticism, to actively engaging with vendors to explore how AI can maximise productivity and lead to better clinical outcomes.

While most now agree that AI is the future of radiology, it's important to remember that we are still in the early stages of technology maturity, both in terms of technology readiness, deployment models and commercial strategies. The table below presents a maturity model for deep learning-based image analysis for medical imaging.

Key Trends Highlighted:

- AI-based diagnostic tools will evolve from point solutions to body area and multi-organ solutions
- Additional functionalities such as decision support, disease characterisation, predictive capabilities and automated diagnosis will be added in the coming years
- Short term growth will be driven by productivity tools with longer term growth driven by quantitative imaging and personalised medicine
- More clinical validation studies are needed to build radiologist confidence and trust in AI
- In the coming years, dedicated AI platforms and AI marketplaces will be the preferred method of AI workflow integration

Product Evolution – Where do we go from Here?

Most of the AI solutions on show at RSNA were essentially detection and/or quantification tools for specific use-cases, e.g. lung nodule detection. Over time, these point solutions will evolve to have broader capabilities. For example, tools that provide automatic feature detection will also provide quantification and characterisation of abnormalities.

	Stage 1 – Research (2015 to 2016)	Stage 2 – Emerging (2017 to 2018)	Stage 3 – Growth (2019 to 2023)	Stage 4 – Institutionalised (2023 onwards)
Product Evolution	1. Algorithms for research use only	1. Regulatory approved algorithms 2. Predominantly software applications 3. Point solutions 4. Mainly detection and quantification with limited decision support 5. Basic lesion characterisation	1. Software applications and embedded solutions 2. Body area solutions 3. Enhanced clinical decision support 4. Predictive capabilities 5. Automated reporting	1. Multi-organ, multi-modality solutions. 2. Whole body analysis 3. Automated diagnosis 4. Advanced decision support with genomics data
Clinical Relevancy	1. Clinical rather than commercial focus	1. Focus on radiologist efficiency and productivity 2. Repetitive, high-volume and time consuming tasks, e.g. cancer screening 3. Triage solutions 4. Quantification	1. 100s of apps for a wide range of clinical use-cases 2. Solutions for rare cases 3. Greater clinical use of imaging biomarkers 4. Personalised treatment decisions	1. Precision medicine 2. Virtual biopsy 3. Imaging AI combined with genomics 4. Imaging AI enables new clinical discoveries
Vendors	1. Medical AI start-ups 2. Academic spinouts 3. Medical image analysis specialists	As Stage 1 plus: 4. Incumbent medical imaging vendors 5. Big tech vendors, e.g. Google, Facebook, etc. 6. Life science companies	As Stage 2 plus: 1. Incumbents acquire successful AI start-ups 2. Start-up failures as VC investment becomes harder to obtain 3. Start-ups become less localised	1. Further market consolidation
Clinical Validation	1. Small-scale reader studies	1. Retrospective and prospective multi-reader studies	1. Large scale multi-site reader studies 2. Continuous learning from solutions deployed in the field 3. Validation by industry bodies, e.g. ACR	As Stage 3
Workflow Integration	1. Standalone workstations	1. Standalone workstations 2. Dedicated cloud-based AI platforms 3. Basic integration with imaging IT (PACS, viewers and AV)	1. Tight (overlay) integration with imaging IT 2. Integration with radiology worklists 3. Integration with EHR and other clinical systems 4. Emergence of edge AI on modalities	1. Single diagnostic platform (clinical, imaging and genomics) with fully integrated AI 2. Edge AI becomes pervasive
Route to Market	1. Direct sales by image analysis vendors 2. Licencing and co-marketing agreements between imaging vendors and medical AI startups	As stage 2 plus: 3. Launch of online medical imaging AI marketplaces	1. AI marketplaces gain traction 2. Basic AI tools are commoditised and become standard features of imaging IT platforms and modalities	1. Further commoditisation
Customer Use	1. Research projects	1. Pilots 2. Single care provider sites	1. Deployed across provider networks in developed healthcare markets around	1. Ubiquitous in developed markets 2. Growing use in emerging markets

There were a handful of solutions of this type on show at RSNA. For example, Koios presented its Decision Support (DS) solution for breast ultrasound that assesses the likelihood of malignancy based on the BI-RADS evaluation scale. Similarly, iCAD's ProFound AI™ for digital breast tomosynthesis (DBT) provides a Case Score on a percentage scale to represents how confident the algorithm is that a case is malignant. In 2019, we expect to see similar solutions for other pathologies, such as lung, liver, prostate and thyroid cancer.

Decision support features will also be added to AI-based diagnostic tools, prviding radiologists with access to automatically registered prior scans and case-relevant patient data from the EHR and other clinical systems, at the point-of-read. Early to market examples on show at RSNA included HealthMyne's QIDS platform, which provides radiologists with a quantitative imaging dashboard including time-sequenced Epic EHR information, and Illumeo from Philips Healthcare. Illumeo is a primary reading tool that automatically adjusts hanging protocols and presents the radiologist with contextual patient information and relevant prior studies. Illumeo also suggests relevant tools and algorithms for the body area being examined. Ultimately, today's image analysis solutions will also provide differential diagnosis, but this is likely a few years away (Stage 4 of the maturity model).

As well as supporting a broader set of functionalities, today's point solutions are also expected to evolve to body area and multi-organ solutions, that can detect, quantify and characterise a variety of abnormalities for entire body areas. While today's point solutions are certainly of value in specific use-cases, particularly for high volume imaging such as cancer screening, they offer limited utility for general radiology as they solve a very small set of problems. To maximise the value of AI in medical image analysis, radiologists require solutions that can detect multiple abnormalities on multi-modality images. Moreover, body area solutions will likely be more cost-effective for care providers than purchasing multiple point solutions.

As point solutions evolve to body area solutions, this will unlock the full potential of AI in medical imaging by further accelerating read times and ensuring that incidental findings are less likely to be missed. For example, an AI-powered analysis of a chest CT ordered for a suspected lung condition may identify incidental cardiac conditions, such as coronary calcifications. The end goal here is an AI solution that can assess multiple anatomical structures from any modality, or even a whole-body scan.

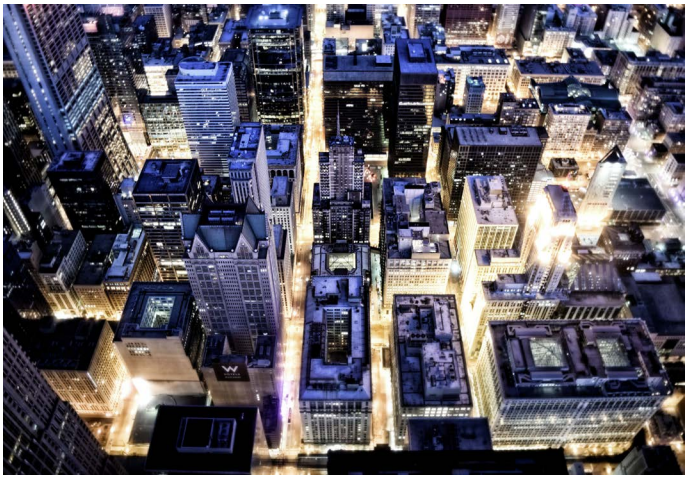
There were several examples of body area AI solutions on show at RSNA. Siemens Healthineers chose RSNA to announce its AI-Rad Companion platform which takes a multi-organ approach to AI-based image analysis. The first application on the new platform will be AI-Rad Companion Chest CT, which identifies and measures organs and lesions on CT images of the thorax, and automatically generates a quantitative report. Another example is Aidoc's body area solutions for acute conditions that detect abnormalities in CT studies and highlight the suspected abnormal cases in the radiology worklist. It currently has solutions for head and cervical spine, abdomen and chest applications. It has received CE Mark for the head and C-spine solution and FDA clearance for its head solution, although this is currently limited to acute intracranial haemorrhage (ICH) cases. An innovative approach to body area image analysis is Change Detector from A.I. Analysis, which detects changes in serial medical imaging studies. The company is preparing an FDA 510(k) application for a head MRI version of Change Detector and it intends to expand its use to support additional areas of the anatomy, for example breast cancer screening, and additional modalities.

Clinical Relevancy – Do We Need an App for That?

AI-based image analysis solutions for a wide range of radiology specialities, from neurology through to musculoskeletal, were on show at this year's RSNA, with a particularly high concentration for lung and breast applications. However, health care budgets are under pressure globally and care providers will need to prioritise their AI investments by initially selecting a shortlist of vendors and algorithms to evaluate. In 2019, we expect to see the strongest market uptake for AI solutions that lead to improved clinical outcomes and deliver a return on investment for providers, either through productivity gains or by enabling more cost-effective diagnosis and treatment pathways. Examples include:

- Solutions for repetitive and high-volume tasks, such as cancer detection in screening programs.
- Triage solutions that prioritise urgent cases in the radiology worklist.
- Tools that provide automatic quantification to replace time consuming (and less repeatable) manual measurements.
- Solutions that facilitate the use of non-invasive imaging techniques, e.g. FFR-CT instead of coronary angiography.

In the short-term, AI tools that make radiologists more efficient and productive will be the low-hanging fruit, but in the longer run, the move to quantitative imaging and the use of imaging biomarkers to predict a patient's response to treatment will become an increasingly attractive market. For example, quantitative data on a tumour's characteristics such as its position in the organ and its heterogeneity, not just its size and shape, will enable more personalised, and potentially cost-effective, treatment planning. Moreover, by reviewing the treatment outcomes of patients who presented with similar disease characteristics, the most effective treatment plan can be selected for each patient. These solutions are likely to appeal to both care providers and payers alike.



Clinical Validation – Not all Algorithms Were Created Equal

There is little to differentiate the underlying deep learning technology behind most of the AI-based image analysis solutions on show at RSNA and it is typically the quality of the training data that dictates the performance of the machine learning model. When evaluating vendor solutions, care providers need to consider both the quantity, diversity (ethnicity, age, co-morbidities, etc.) and the quality of the ground truth data. A lack of images or inconsistent image annotation may compromise the performance of the algorithm during the training process. The approach to image annotation may also have a bearing on the performance of the algorithm, with some vendors using natural language processing (NLP) to mine radiology reports and others investing in more time consuming and expensive manual annotation of the pixel data. One of the most common reasons for a disconnect between the performance of algorithms during development versus deployment in a clinical setting is the quality of the validation dataset. Care providers are encouraged to ask the algorithm developer how the validation dataset was selected and if the data is from the same source/partner as the training data.

In addition, the results obtained from one patient cohort cannot always be generalised to others. For example, will an algorithm trained on data from Chinese patients work as expected on European or American patients, and vice-versa? Similarly, the training data must include images from a variety of modality vendors, scanner models and imaging protocols.

NVIDIA announced two new technologies at RSNA to assist algorithm developers with data curation and annotation - Transfer Learning Toolkit and AI Assisted Annotation SDK for Medical Imaging. The former enables developers to use NVIDIA's pre-trained models with a training workflow to fine-tune and retrain models with their own datasets. The first public release includes a model for 3D MRI brain tumour segmentation. The AI Assisted Annotation SDK helps to automate the process of annotating images. It utilises NVIDIA's Transfer Learning Toolkit to continuously learn by itself, so every new annotated image can be used as training data.

The market for AI-based medical image analysis tools is firmly in the early stages of development and the transition to it becoming a mainstream market is likely a few years away. With hype for AI at an all-time high, vendors need to undertake large-scale clinical validation studies to demonstrate the performance of their solutions in real-world clinical settings and to ascertain if the promise of workflow efficiency lives up to expectations, and by how much. This will boost radiologist trust and confidence in the technology and strengthen the business case for investing in AI solutions. Furthermore, without evidence of a clear ROI, the significant investment in software and the IT infrastructure required to support AI deployments will be hard to justify.

That said, there have been few such studies to date. At RSNA, RADLogics showcased a study from UCLA,

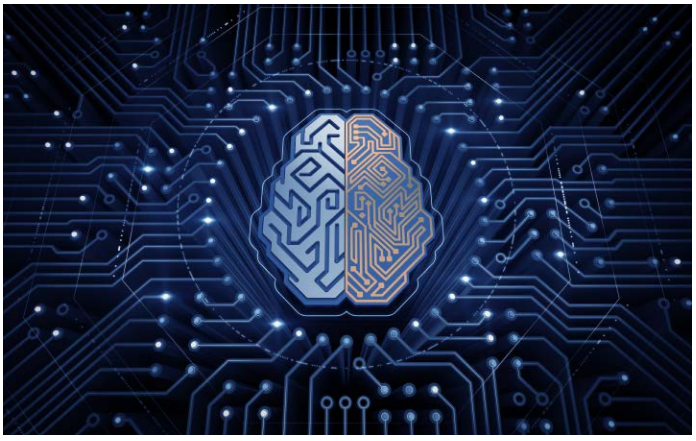
published in Academic Radiology, that evaluated its Virtual Resident software integrated with PACS, configured to automatically incorporate detection and measurement data into a standardised radiology report (Nuance Powerscribe 360). The results indicate that radiologists' time to evaluate a chest CT and create a final report was decreased by up to 44%. The study also found that the overall detection rate of the system was comparable to radiologists who did not use the software and nodule measurement was consistent between the radiologists as well as the software, with a variation of 1mm or less.

iCAD presented the results from a retrospective, fully-crossed, multi-reader, multi-case study that compared the performance of 24 radiologists reading 260 DBT cases both with and without its ProFound AI solution between two separate reading sessions. The findings showed that the concurrent use of ProFound AI improved cancer detection rates, decreased false positive rates and reduced reading time by 52.7% on average.

During RSNA, Aidoc announced a partnership with American College of Radiology (ACR) Data Science Institute, the University of Rochester Medicine and Nuance Healthcare to contribute to the recently launched ACR-DSI ASSESS-AI registry, which aims to provide post-market surveillance and continuous validation of AI performance and impact in real clinical settings.

Workflow Integration – It's a Platform Play

Workflow integration remains one of the biggest challenges with bringing AI-based image analysis tools to market and there were a variety of integration flavours on show at RSNA. These ranged from dedicated AI platforms, both vendor-specific and vendor-neutral, that integrate with diagnostic viewers, workflow platforms and reporting tools, to direct integrations into the primary diagnostic viewing platform itself. While there are pros and cons of each, it's becoming increasingly clear that for AI solutions to enter the mainstream market, they need to be easily accessible and introduce minimal disruption to existing workflows. Radiologists may be willing to accept one more application in the form of a dedicated, multi-vendor AI platform, but it is unrealistic to expect them to use multiple, vendor specific AI platforms. Each time a radiologist comes out of their primary platform to launch a vendor specific AI solution is time lost. This will be particularly hard to justify for AI platforms with a narrow offering of algorithms. Moreover, the huge integration effort associated with individually deploying vendor specific AI products will be prohibitive.



The big three medical imaging vendors – Siemens, Philips and GE - are essentially following the same AI deployment strategy – a dedicated AI platform coupled with an ecosystem of third-party applications. Fujifilm is pursuing the same strategy and Terarecon has the Northstar AI Explorer platform that integrates with its iNtuition AV platform and third-party PACS. Other examples of dedicated AI platforms on show at RSNA were Nuance's AI Marketplace and Blackford Platform from Blackford Analysis. The other PACS and enterprise imaging vendors with AI solutions on show at RSNA typically integrated the algorithms directly into their diagnostic viewing platforms, although some are expected to launch dedicated AI platforms and/or AI marketplaces in the coming years.

Vendor	AI Platform	Ecosystem/ Market Place	Development Platform
Philips Healthcare	Illumeo	Insights Marketplace	HealthSuite Insights
GE Healthcare	Edison		
Siemens Healthineers	AI-Rad Companion AI-Pathway Companion	Digital Ecosystem	
Fujifilm	REiLI		
Terarecon	Northstar AI Explorer	EnvoyAI	
Nuance	AI Marketplace		
Blackford Analysis	Blackford Platform		

The mid-sized imaging IT vendors are likely to use a combination of direct integration of best of breed algorithms into their diagnostic platforms, supported by an AI marketplace for less commonly used algorithms that do not warrant a full integration. Smaller imaging IT vendors lack the resources for multiple direct integrations and will most likely partner with AI marketplaces.

In addition to software applications, there were a handful of examples of embedded AI solutions on show. Samsung showed a digital radiography system (GC85A) with embedded AI for bone suppression and lung nodule

detection (FDA 510(k) pending) alongside its S-Detect™ for Breast, an AI-based software which analyses breast lesions using ultrasound images, which is available on its RS80A ultrasound platform. GE Healthcare once again showed its Critical Care Suite (FDA 510(k) pending) embedded on the Optima XR240amx digital mobile x-ray system. Critical Care Suite automatically detects and prioritizes critical cases, the first example of which is an algorithm for pneumothorax. GE also showed SonoCNS Fetal Brain, a deep learning application that helps to align and display recommended views plus measurements of the foetal brain, on its Voluson E10 ultrasound system and Koios' Decision Support (DS) solution for breast ultrasound embedded on its LOGIQ E10 premium ultrasound platform as a proof of concept.

It was somewhat surprising there were so few edge AI solutions on show at RSNA. Perhaps the modality vendors are keeping their powder dry for ECR? Either way, we expect edge AI to be a major trend in the coming years and across all modalities.

Route to Market – AI Marketplaces an Attractive Proposition

As we mentioned in our RSNA 2017 show report (AI at RSNA – What a Difference a Year Makes), online AI marketplaces provide algorithm developers with workflow integration and a route to market. Despite the accelerated algorithm development times associated with deep learning compared with earlier feature engineering techniques, the cost to develop and commercialise algorithms is high. The commercialisation process is also lengthy due to the stringent regulatory process. For the incumbent imaging IT vendors, AI marketplaces are an effective way to bring a wide selection of AI-based image analysis tools to their customers without incurring high development costs. In the coming years, radiologists will have hundreds of algorithms at their disposal and it's clear that no single vendor can do this on their own. Partnerships are essential. For care providers, AI marketplaces offer a "one-stop-shop" to a pre-vetted, wide range of AI-based tools that integrate directly into their diagnostic viewing or reporting platform.

Enterprise app marketplaces have proved successful outside of healthcare, for example, Salesforce's AppExchange has several thousand enterprise apps and several million installs. Within the healthcare market the concept is also relatively proven, with the major EHR vendors like Epic, Cerner and Allscripts having opened their platforms to third parties and launched app stores. While the concept is yet to be proved in radiology, early customer wins from Nuance, Blackford Analysis and EnvoyAI are encouraging.

In addition to the marketplaces listed below, MDW (Medical Diagnostic Web) announced its medical imaging AI marketplace at RSNA. The MDW platform leverages blockchain technology and enables care providers to purchase algorithms and to monetise their imaging data by making it available to developers as anonymised, annotated datasets for algorithm training and verification. The platform is in beta release with general availability scheduled for Q1 2019.

NVIDIA announced that Ohio State University (OSU) Wexner Medical Center, an academic medical centre and university, is the first US partner to adopt its NVIDIA

Vendor	AI Marketplace	Announced	Number of Developers	Channel Partners	Commercialisation
Siemens Healthineers	Digital Ecosystem	Feb 2017	18	N/A	Not commercially available
Philips Healthcare	Insights Marketplace	March 2018	7 native apps, 3rd party apps to be added in 2019	N/A	Not commercially available
GE Healthcare	Edison	November 2018	Not Disclosed	N/A	Not commercially available
Nuance	AI Marketplace	November 2017	40	N/A	Pilot customers
Blackford Analysis	Blackford Platform	November 2017	1 native app and 8 3rd party developers	eRAD, Intelerad	Commercially available. Flagship customer is RadNet
EnvoyAI	EnvoyAI Platform	November 2017	21	Terarecon, Insignia Medical Systems, Ambra Health	Commercially available. Deployed at around 10 customers
MDW	Medical Diagnostic Web	Q3 2018	Not Disclosed		Beta release

Clara platform to build an in-house AI marketplace to host native applications for clinical imaging. OSU demonstrated models for coronary artery disease and femur fracture on the NVIDIA booth. For care providers, the benefits of a home-grown marketplace are tighter integration into clinical workflows, a sandbox for internal algorithm development projects, ownership of feedback data for continuous learning and transfer learning, and tighter control of the third-party algorithms made available on the platform. We expect other academic hospitals with algorithm development activities to also develop their own marketplaces. Over time, provider owned marketplaces are likely to integrate with third-party marketplaces, such as those in the table above, to give radiologists access to the widest range of AI-based tools as possible.

About the Author

Simon has 25 years of experience in global technology market intelligence, having served as Executive Vice President at IMS Research and Senior Research Director for IHS Inc.'s Technology division. Whilst at IMS Research, he established the InMedica brand of market intelligence for the medical devices industry. Simon is responsible for Signify Research's coverage of the global Medical Imaging market and wrote the 2018 edition of "Machine Learning in Medical Imaging".

Two Key Takeaways from RSNA That Will Shape The Future of Enterprise Imaging

Written by Steve Holloway

As with every year, RSNA provided a glimpse into the future of radiology. Undoubtedly, AI was the most discussed and debated topic, though for imaging informatics there were some other less obvious trends on show that will have a significant bearing on the future of the market. Here's my top two takeaways from the show:

PACS and Enterprise Imaging: The Emperor's New Clothes

One of the most striking observations from wandering the exhibit halls was the almost non-existence of "PACS" and "RIS" in any marketing – "enterprise imaging" has very much taken on "AI" and "VNA" for the most over-used and often under-deserved product title. Does this signal that PACS and RIS has finally been confined to the annals of informatics past? Or is there more to the sudden explosion of enterprise imaging products than meets the eye?

Put simply, PACS is still very much alive and kicking and still forms the core of most imaging informatics platforms that were on show. However, due to increasing integration and cross-over with allied products such as advanced visualisation, universal viewers, VNAs and workflow tools, the definitions between distinct product groups have become blurred. In the North American market as well as other mature international markets, growing demand for enterprise products in the wake of enterprise electronic medical records (EMR) adoption has driven a frenzy for "enterprise" products in imaging informatics. Yet this is not the case when you look at the market data – 86% of

revenues spent on imaging IT worldwide in 2017 were for standalone software modules (such as PACS or RIS), with "enterprise" software only accounting for the remaining 14%. Stronger growth is expected for enterprise products in the coming years, but the imbalance in marketing on show is far removed from the reality of use today.

Most solutions exhibited at the show described as "enterprise imaging" are little more than multi-site PACS systems, or an evolution of multi-site PACS with additional features or partnerships with third parties to support remote viewing (universal viewers) or centralised archiving (usually a DICOM archive or VNA). Very few have the technical maturity to support the reading, management and storage of non-radiology (non-DICOM) images and unstructured or complex clinical content from other departments. This is perhaps exemplified by the level of maturity in integration with different clinical departments of many of these solutions. Take for example the case of breast imaging; digital breast tomosynthesis (DBT) and automated breast ultrasound (ABUS) analysis now make up a significant portion of the adaptive breast screening pathway and have been in regular use for some time, yet still many products marketed as "enterprise imaging" have no capability to manage or integrate native images from these modalities. Nuclear medicine is another common source of imaging that has been overlooked from an integration perspective; the same too can be said of endoscopy and surgical video, point of care ultrasound and digital pathology. Until integration maturity improves to support imaging in these departments, vendors should perhaps stick to a clearer and more consistent name for many of these products, such as "enterprise radiology" rather than "enterprise imaging".

That said, there were positive discussions at many booths around requests from customers to bring a broader set of clinical data into the diagnostic reading environment. Semantic search tools to pull in relevant patient data from the EMR, dependent on the type of scan displayed has already been demonstrated by several vendors utilising AI, with some even enabling access to oncology and pathology reporting within the imaging IT platform, in order to provide a richer diagnostic context for reporting radiologists. This is certainly a positive shift in terms of patient care, though it has a long way to go in terms of implementation. Many radiologists today struggle to handle the vast amount of information provided by today's advanced imaging modalities and are under pressure to read quicker, so information overload is a major concern. Interoperability between the EMR and diagnostic departments such as radiology also remains a barrier – loosening of data protectionism from EMR vendors has certainly helped of late, but there is still a long way to go.

Combined, these factors all suggest that customers and vendors alike should be wary of the broad term of "enterprise imaging", especially when loosely applied to any product that is deployed in a multi-site environment. Instead, the industry needs to better define the maturity of solutions based on their technical capability to both scale and ability to manage imaging and associated clinical content.

Very few health providers or vendors have implemented "true" enterprise imaging in practice today, even if that is their intended direction of long-term development. Instead, "enterprise radiology" would be more apt to depict the capability of solutions in use today, as a stepping stone towards more complex enterprise imaging. If not, many may find that their choice of "enterprise imaging" solutions is akin to the emperor's new clothes for the Danish legend; little more than an enterprise radiology solution in an invisible "enterprise imaging" suit.

Operational Tools for Imaging Will Be Big Business

Health providers are under pressure to deliver high-quality services to more people at lower cost, meaning radiology is increasingly under the microscope as an area for providers to make operational efficiency gains. However, many business intelligence and operational workflow product developments for were not front-and-centre of booths in the exhibition hall – instead they were embedded deep in software version updates of existing imaging IT platforms or positioned as new "add-on" workflow or operational modules.

We can group many of these additional capabilities into the following broad categories:

Radiologist workflow tools: auto-triage, adaptive menus, anatomically adaptive hanging protocols, peer-review and collaboration tools
Operational tools: Case-load balancing, enterprise worklists, smart scheduling, order entry integration, modality fleet management, modality protocol editing, staff resourcing
Business Intelligence & Practice Management: department performance dashboarding, staff and clinical audit, regulatory compliance, finance and billing support, quality and outcome measures

While these tools may not be exclusively used by radiologists, they will all have a significant bearing on patient safety, operational cost and care efficiency. Care provision today is increasingly focused on care quality and efficiency, so the ability of software and services to support ongoing improvements in how radiology departments are run has become as important as diagnostic functionality. Vendors have realised this is an area that so far has been underserved in imaging and offers a significant opportunity to tap into the operational budgets of imaging services at health providers, as opposed to just their IT and informatics budgets.

There were numerous examples on show of improvements in updated platforms. In terms of radiologist workflow tools, multimedia structured reporting, adaptive toolsets and displays (such as anatomical recognition and adaptive menus) and increasingly "smart" worklists are becoming more common. In the business intelligence and practice management segment, performance analytics and dashboarding has becoming increasingly available and specific for the radiology department.

Most progress so far has centralised around a few key areas; staff audit and training, especially related to dose awareness and compliance, are now increasingly integrated and expected from radiology administrators; integration to financial and revenue cycle management has also become more prominent. Other novel features and tools are being released too, such as analytics and dashboarding from basic patient admission information, in order to find patterns or reasons for missed appointments and potentially missed revenue.

These are also being paired with smart scheduling for appointments and follow-up to minimise downtime and reduce patient "no-shows".

In terms of operational workflow, the push from vendors towards enterprise platforms (be they enterprise radiology or enterprise imaging) has also made case-load balancing of enterprise worklists and centralised scheduling more commonly available. Perhaps above all, the leading big-iron modality vendors were all exhibiting some form of modality fleet management. Operational diagnostics and service reminders to support efficiency for CT and MRI have been around for some time, but newer features such as centralised protocol management (as seen in Philips' Healthcare PerformanceBridge module) enable radiology administrators and expert technicians to manage and monitor multiple big-iron modalities from a single central location. Siemens Healthineers was perhaps the most forward in this thinking in terms of fleet management, taking it one step further with their "syngo Virtual Cockpit", a software module that allows a remote expert technician to view (via video feed), assist or manage scan preparation, protocol management and offer real-time support to on-site staff. Initially a concept designed to support advanced scanning in remote locations or emerging markets with limited expert technicians, it is feasible that vendors will also look to offer their own experts to support modality monitoring as a service soon.

About the Author

Steve has over 10 years experience in healthcare technology market intelligence, having served as Senior Analyst at InMedica (part of IMS Research) and Associate Director of IHS Inc.'s Healthcare Technology research practice. Steve's areas of market expertise include Healthcare IT and Medical Imaging.

Advanced Visualisation Back on Track at RSNA?

Written by Ulrik Kristensen

Sidetracked

With healthcare IT becoming increasingly enterprise across departments and sites, Advanced Visualisation (AV) as well as PACS, is commonly a strategic obstacle due to its often standalone workstation-based nature. The wish for diagnostic viewing integrated into the healthcare enterprise with multiple access points, has given new hope for the more lightweight Universal Viewers (UV), and indeed increased demand for UV with diagnostic tools. The UV market is still small compared to the more mature AV market, but after years of relying on superior diagnostic features alone, AV vendors are now realising AV needs to change in order to remain as the primary diagnostic tool. Just like PACS, AV cannot continue to be a disconnected island within hospital informatics. And what do you do when you realise you are being sidetracked? You integrate. RSNA this year testified to this realisation with AV showcases and announcements focusing on AV integrating more tightly in the workflow pre- and post-diagnosis, as well as new developments with AI assisted image analysis.

Upstream Integration

As RSNA President Dr Rao noted in her opening speech about radiology 25 years from now, radiologists will start the day as they do today by clicking through the list of cases. However, AI will have helped prioritising the worklist based on pre-analysis and automatic measurements, and already have pre-diagnosed based on similar cases and supporting clinical information. We can therefore expect worklists to present the results from dynamic imaging IT hubs pulling in information from different clinical sources such as EMR, genomic sequencing, family history etc in order to perform an initial imaging and context analysis, prioritising the cases and presenting them to the radiologist for further analysis using AV if applicable.

Over time, we can expect the current PACS, UV and AV viewers to fuse into one diagnostic viewing platform with accessibility throughout the enterprise, and these viewers will be tightly integrated with the worklist, partly mediated by the underlying AI platform providing pre-analysis for the worklist and visibility in the viewer. The worklist will therefore grow dramatically in importance from the early PACS/RIS worklists and become a cornerstone in clinical enterprise IT. Intelerad's acquisition of the zero-footprint worklist company Clario Medical, announced during RSNA, can therefore be seen as an attempt to build on Intelerad's recent success as an enterprise Imaging vendor and investing that not only in a new tool and local presence in the US, but in a strategy of integrating their solutions deeper in the future radiologist workflow. This follows an ongoing trend of worklist vendors being acquired, or Imaging IT vendors developing own workflow tool modules. Last year Siemens Healthineers completed the Medicalis acquisition, Change Healthcare developed their Workflow Intelligence dynamic worklist, and Mach7 offered their Universal Worklist, amongst others.

Lateral Integration

AI is still very much in the hype phase where everything is possible, and everyone wants to be associated with it. However, there is starting to emerge more pragmatic discussions like "how do we integrate it into the workflow", and "how should radiologists approve, deny or give feedback to the AI generated results", which indicates the technology is maturing and establishing itself in the industry. For years to come AI will most likely be involved in case prioritisation or for routine screening, possibly replacing some of the simpler tasks, but it will not replace the more complex image analysis AV is typically being used for today. AI and AV will therefore need to coexist and complement each other as a natural part of the same workflow.

Most early standalone AI products available today require uploading of images to the cloud for analysis and return a complete quantification report. However, there were also examples on show of partner AI algorithms from vendors such as Koios, Qure.ai, iCAD and HeartFlow being tightly integrated into AV platforms and diagnostic viewers such as Visage7 (Visage Imaging), ResolutionMD (PureWeb), AW (GE Healthcare) and syngo.via (Siemens Healthineers) working side-by-side with the AV clinical tools.

EnvoyAI, following its acquisition by Terarecon, is going for a slightly different approach, using the Northstar AI Explorer for visualisation of AI results from the EnvoyAI marketplace and integrating the Northstar viewer with either third party PACS or Terarecon's own iNtuition AV solution. GE Healthcare announced their new brand name Edison which will include many of their existing clinical AV tools, native AI applications, partnership apps and future imaging analysis and predictive and operational analytics applications, representing an approach similar to other big iron vendors in keeping a centralised AI platform, which then integrates with its AV solution.

Downstream Integration

Many clinical apps on the market have their own reporting tools embedded as part of their solution, however many radiologists use their PACS reporting tools or third-party reporting tools across the different clinical areas for their reporting. As there is much variation in reporting guidelines between countries and clinical areas, some local vendors with structured reporting solutions thrive. However, the market is largely consolidated around a few major players, with Nuance the dominant force in the US market. Philips announced last year a partnership with Nuance for structured reporting in their AI platform Illumeo, and Siemens Healthineers showcased at this year's RSNA how tight integration between Nuance Powerscribe and Siemens syngo.via could create a direct and semi-automated reporting link between the AV platform and the downstream reporting procedure, auto-populating quantifications and observations in the common reporting environment. Additionally, Carestream showcased it's latest multimedia reporting features in Vue Reporting. This suggests that leading vendors in the AV and broader imaging IT industry are becoming increasingly serious about enabling semi-autonomous, structured reporting in radiology.

Tighter Workflow Integration Enables...

The focus on workflow integration and AI were not randomly picked topics to entertain the attendees at RSNA; rather it's part of the overall strategic thinking of AV and medical imaging vendors that they need to integrate AV tightly into the enterprise structures and have continued focus on creating value for their customers, by enabling them to save money on operations, do more diagnoses with fewer resources and improve the standard of care. Streamlining the workflow and incorporating AI for image analysis into AV helps the vendors achieve this goal, while also moving AV from a disconnected island, to a central role in the future of diagnosis.

About the Author

Ulrik joined Signify Research in 2017 with five years' technical and scientific experience from the healthcare technology industry in the fields of genomics, molecular diagnostics and medical devices. Ulrik holds a MSc in Molecular Biology from Aarhus University, and a PhD from University of Strasbourg.

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