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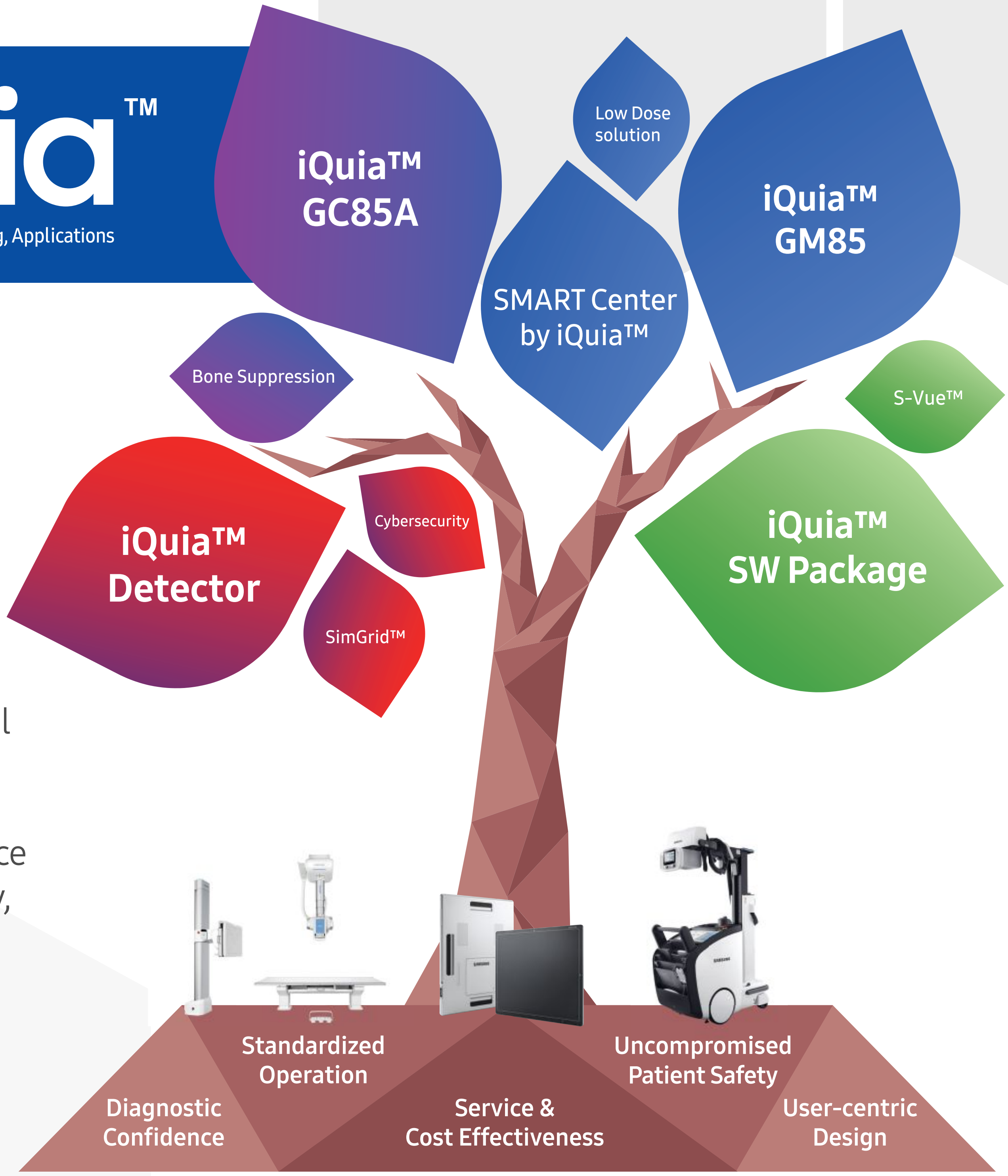

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Monitoring Radiation in the Workplace

By Mukta Acharya

Doctors and technicians are exposed to on-the-job radiation often on a daily basis. It is critical to be aware of how much radiation the clinician is being exposed to, and some of the best methods of monitoring that exposure.

Everyone is exposed to radiation from benign sources such as cosmic rays, radon, microwaves and cell phones. However, higher-energy short-wave radiation in many occupational sources can penetrate and disrupt living cells and increase cancer risk, so exposure must be monitored. The risk of cancer from radiation exposure reportedly increases as the dose of radiation increases. Anyone who works in a setting with a known radiation source is at risk.

Any amount of radiation can be harmful in theory, but it's generally accepted that low exposures carry low risk. When it comes to chronic radiation, however, experts don't always agree on a safe level. This is especially true since some radiation effects, including cancer, may not show for years or decades after an individual has stopped being exposed. The Occupational Safety and Health Administration (OSHA) does have published standards, but they don't answer the question of what is too much for each person.

What is Dosimetry?

Dosimetry is the calculation of the absorbed dose in tissue resulting from exposure to ionizing radiation. Dosimetry monitoring is the practice of wearing personal radiation measurement badges (dosimeters) to measure the amount of dose exposure. These badges provide readings about the dose of ionizing radiation an individual receives. Dose measurements and history are captured and stored. These dose reports help to monitor the safety of the workers and the workplace.

Dosimetry monitoring services enable customers to monitor and track individual radiation dose in compliance with radiation safety regulations. Most services also include compliance, recordkeeping and reporting capabilities that help manage an efficient safety program. Typically, technicians wear badges for a period of time and at the end of the wear period, they ship them to the service provider to be read. Staff typically receive replacement badges prior to the end of the wear period so there is no gap in dose monitoring. The dose data and dose reports are calculated by the dosimetry service provider and are made available to the customers, usually through an online portal.

Providing customers dose data to help protect employees from potentially harmful radiation is the most important reason for dosimetry services. Accreditations and regulations across industries at state, federal and government levels internationally also place certain radiation monitoring requirements on organizations with ionizing radiation sources. Having a dosimetry service program provides data that can be used to identify situations of overexposure and take corrective actions to minimize radiation exposure in the future. It helps improve safety and provide peace of mind to the customer that their workplace and employees are safe.

Many organizations institute radiation safety programs with dose monitoring services as a protection from future litigation. While the health risk of radiation exposure is purportedly low, the fact that it's still a possibility creates a liability risk for employers. Consider cancer; for men there is a 39.66 percent probability they'll develop cancer in their lifetime. With such a high probability, it would be wise to understand exactly how much exposure each employee has — if any — and to document that measurement systematically to show it never exceeded thresholds. This would be valuable information in any future legal discovery.

Recommended Frequency

Frequency of radiation monitoring can vary based on the work environment and the needs of the facilty. Dosimeters can be read daily, weekly, monthly or quarterly, and the customer will usually work with the dosimetry service provider to select the desired frequency of reads.

Radiation dose monitoring strategies and tracking can be overwhelming, especially for smaller offices and practices that don't have the dedicated resources for managing such a program. It requires due diligence with a clear process for long-term documentation and recordkeeping, along with an understanding of the required compliance. It often requires dedicated resources, and can also get complex and expensive. The good news is that there are simple and cost-effective dosimetry monitoring services available to organizations of all sizes that simplify radiation safety with a streamlined process. When organizations outsource the process, they gain freedom from the radiation dose tracking burden and overhead and can instead focus on their core competency.

Wearing personal radiation measurement badges to measure dose exposure is crucial.

Service Providers

When researching service providers, consider the technology and types of dosimeters offered, as well as accreditations and certifications, the access you will have to radiation consultants, ease of access to the dose reports and any type of hidden fees that could evolve. Also consider the provider's experience in dosimetry, ability to provide expert technical support and customer service. itn

Mukta Acharya is director of marketing, field and safety instruments, for Thermo Fisher Scientific.

Participants

Agfa
www.global.agfahealthcare.com/us/enterprise-imaging/dose-monitoring/

Bayer
www.radiologysolutions.bayer.com

Bracco
www.bracco.com

Canon
www.us.medical.canon

Fujifilm
www.fujimed.com

GE Healthcare
www.gehealthcare.com

Guerbet
www.guerbet-us.com

Imalogix
www.imalogix.com

Infinitt
www.infinittna.com

Medic Vision
www.medicvision.com

MedSquare
www.medsquare.com/en/

Mirion
www.mirion.com

MyXrayDose
www.myxraydose.com

PACS Health
www.dosemonitor.com

Philips Healthcare
www.medical.philips.com

Qaelum
www.qaelum.com

Sectra
www.sectra.se

Scranton Gillette Communications obtained the product specifications from the manufacturers.

Comparison chart compiled by Imaging Technology News

Scranton Gillette Communications assumes no responsibility or liability for any errors or omissions in this chart.

Thinking beyond transactions. Designing the future of pediatric care.

Making a first-time right diagnosis is a challenge in healthcare. At Phoenix Children's Hospital, technology is helping to raise all boats while writing the future of pediatric care.

In the past three decades, pediatric radiology has been transformed by imaging technology. More simplicity, speed and accuracy have allowed improved workflows, more accurate measurements and faster clinical decisions, but likely nothing has opened up as many new opportunities as the transition from 2D to 3D imaging.

Phoenix Children's Hospital, the sixth largest children's hospital in the US, has been using 3D imaging for several years, and incorporated it into several areas of the hospital's patient care, such as preoperative planning, research and education, and patient and family support, including for its pediatric patients.

"We process the images in radiology, reconstruct and segment the anatomy, and then send them electronically to our Cardiac 3D Print Lab. If it's necessary for the surgeon or patient-family to better understand the anatomy, we can make a 3D printed image of the heart and we can allow a doctor or a patient-family to hold a heart in the palms of their hands," says Justin Ryan, Research Scientist of the Cardiac 3D Print Lab at Phoenix Children's.

Partnering to "raise all boats"

About 10 years ago, Phoenix Children's began a long-term relationship with Philips that expanded in early 2017 to become an enduring strategic partnership. This new 15-year agreement is a first-of-its-kind partnership for Philips with a stand-alone children's hospital system, and includes imaging systems, patient monitoring, clinical informatics, and a comprehensive range of clinical and business consulting services.

In part, the particular needs of the pediatric healthcare market mean Phoenix Children's looks for an overarching goal from its technology supplier which is "beyond transactional thinking." The long-term partnership aim is to "raise all boats" to the same level as Phoenix Children's diagnostic imaging.

"The way that children are cared for can affect the adult world, and having a broad and global view means Philips can see the world for all of its parts, not just as one particular market," says David Higginson, Chief Information Officer at Phoenix Children's Hospital. "We actually want to do things with technology that are going to make an impact on a child's life. We're not really tied up in the baggage of the past...what we're doing now is we're writing our future and the future of care for children in Arizona."

If you want to learn more from Phoenix Children's Hospital go to **philips.com/nobounds**

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Comparison Chart **Radiation Dose Management**

Company name	Agfa Healthcare	Bayer Healthcare LLC	Bracco Diagnostics	Canon Medical		Fujifilm Medical Systems U.S.A. Inc.		GE Healthcare		Guerbet LLC	Imalogix
Product name	Enterprise Dose Management (powered by DoseMonitor)	Radimetrics Enterprise Platform	Nexo[Dose]	Dose Tracking System	Spot Fluoroscopy	FDX Console (common acquisition workstation for all Fujifilm DR portable and room solutions)	Aspire AWS Console (common acquisition workstation for all Fujifilm mammography solutions)	DoseWatch	DoseWatch Explore	Dose&Care	Imalogix
FDA cleared, year	Yes, 2012	2013	FDA Class I 2012	Yes, 2013	Yes, 2011	Yes, 2017 (most recent)	Yes, 2014 (for current mammography system)	N/A, not a medical device	N/A	2015	Registered as a Class 1 medical device under FDA 2014
CE mark approval, year	2013	2013	CE mark 2013	Yes, 2014	Yes, 2014	Yes	Yes, 2013 (for current mammography system)	CE mark date: 2011	N/A	2012	N/S
Briefly explain what the software monitors, reports	Automated ionizing dose data collection, reporting and analysis solution	The Radimetrics Enterprise Platform by Bayer is a solution for integrated radiation and contrast dose management; integrating seamlessly with radiology workflow and hospital IT infrastructure	Fully automated, enterprise level dose data collection, reporting and analysis solution; Nexo[Dose] is fully Joint Commission compliant with both CT and XA requirements	DTS provides a virtual patient dose map with real time tracking of estimated peak skin dose during an interventional procedure	Using spot fluorscopy the radiologist is able to reduce the area of anatomy exposed to radiation for live fluoroscopy while still maintaining a LIH image in the background	International standard (IEC 62494-1) exposure/deviation index; Fujifilm proprietary exposure indices; dose area product (DAP); radiation dose structured report-ing (RDSR)	Fujifilm proprietary exposure indices; mean glandular dose (MGD); entrance skin exposure (ESE); kVp, mA, time, mAs, compression thickness, compression force, target/filter combination, dose mode	Enterprise-wide dose management solution that captures, tracks, alerts and reports on patient radiation dose and contrast agent injection; analytics assist in quality control and dose optimization	Introductory dose management solution compatible w/ select GE CT devices; this cloud-deployed Web application provides detailed exam-level dose and protocol info, analytics, reporting	Software solution for collecting, controlling and analyzing radiation dose delivered to patients during medical imaging examinations., compatible with all types of imaging modalities from all manufacturers	Imalogix puts the cloud, deep learning and AI to work to turn enterprise-wide imaging data into actionable information that can help improve clinical practice and healthcare operations
At what level is dose monitored and analyzed (e.g., patient, study, department, site)	Dose levels are monitored and analyzed at the patient, study, modality, department, facility and enterprise level	Patient, study, acquisition, injection, organ, modality, enterprise, site, equipment, staff, protocol	All levels, including patient, protocol study, modality, operator and facility	Patient, study	Patient, study	Dose monitoring and analysis is performed at both the patient and study level	Dose monitoring and analysis is performed at both the patient and study level	Site; department; patient; study; series	Series-level dose and protocol details for connected GE CTs, excludes directly identifiable patient information	All including: patient, study, modality, staff, operator, physician, medical indication, department, site	Acquisition, study, location(s), manufacturer, size, age, sex, protocol, time, technologist, physician
What modalities can be monitored	CT, XA, CR, DR, NM, PET, mammo, MR, US	CT, CT/PET, PET, CR/DR, MG, angiography/interventional/cardiovascular/fluoroscopy, MRI	CT, XA, DR, CR, MG, NM, PET, MR	Angiography	Angiography	Digital radiography and computed radiography	Digital mammography and breast tomosynthesis	CT, CM, CV/IR or XA, MG, DR, RF, NM, SPECT-CT, PET, PET-CT	GE Healthcare CT systems	CR, DX, RF, XA, CT, CB/CT, MG, PET/CT, SPECT/CT, SPECT, C-Arm, DXA, external ionization chamber	CT, fluoroscopy (cardiovascular, IR, XA and RF), molecular imaging, mammo, CR/DX, contrast
Does the system support diagnostic reference levels (DRLs) set locally, by registries or by regulatory bodies	Yes, DRLs may be set according to ACR guidelines, or facility preference	Patient, exam, acquisition DRLs, set locally based on standards from registries and regulatory bodies	Yes, the application has full DRL comparison functionality; users can input (or bulk upload) DRLs, choose to apply them or not, and run reports including a graphical display; DRLs can be contributed from any source	N/A	N/A	Yes; the system can be configured to support site specific DRLs, as well as those recommended by registries or regulatory bodies	Yes, MQSA compliant	Yes, DRLs from regulatory bodies (regional, national; 30 different countries), from registries (ACR) and set locally (custom/load local DRLs) are supported	Manual upper threshold entry only	Yes for all; especially on procedure, protocol, acquisition protocol, targeted anatomical region	DRLs can be evaluated while considering patient age, sex and/or size; DRLs can be assessed at the acquisition, exam and patient cumulative dose levels
What differentiates your software from competitors	Rapid implementation, standards based, intuitive and straightforward to use; membership in the global dose registry is included	Vendor neutral, multi-modality software for integrated radiation/contrast dose management; supports historical data migration; dynamic analytics; advancing trending analysis; protocol management tool	Advanced feature set (NCICT organ dose, peak skin dose, global dose registry), ease of use, low IT effort for implementation, reasonable cost	Utilizes actual estimated skin dose to the patients body based on body type and detector angle in both field of view maximums and procedure maximums	Conventional collimation prevents the interventionalist from seeing outside of the collimated area, and the patient input dose may be increased as the system compensates for the reduced amount of scatter radiation	Feature analysis-based image processing, alerts to technologist for over/under exposure and patient motion	Feature analysis-based AEC, feature analysis-based image processing, user-selectable dose modes	Facilitation of compliance (DRLs & national export to authorities for 30; adverse events annotation for reporting); personalized and automated patient dose features set	Cloud-deployed web application, without any IT integration required and no required hardware; automatically retrieves, tracks and reports radiation dose for GE CT devices	Vendor neutral, user-friendly interface customizable by account and user profile, multimod, hybrid mode connection to PACS for new equipment and connection directly to modalities for old technologies	Focus is on acting on insights to improve quality, safety and efficiency versus managing IT installations or sifting through data

MODALITIES TRACKED / METHODS SUPPORTED

Company name	Agfa Healthcare	Bayer Healthcare LLC	Bracco Diagnostics	Canon Medical		Fujifilm Medical Systems U.S.A. Inc.		GE Healthcare		Guerbet LLC	Imalogix
Dosimetric information	mSv, mGy, collim single, collima width, convol kernel, CTDIvol max, CTDIvol min, data source, distance to detector, distance to patient, DLP, effective dose, effective dose (k), effective dose (NCICT), effective dose (virtual dose), effective dose factor	CTDIvol/DLP/SSDE/ICRP/cumulative/exam/series/organ	All parameters delivered from the modality are stored within the database including CTDIvol, DLP, technique, demographics, etc.	Not supported on CT	Not supported on CT	N/S	N/S	At study level: CTDIvol max, DLP, effective dose, fetal dose; at series level: CTDIvol, DLP, effective dose, SSDE, water-equivalent SSDE, organ dose, fetal dose; at patient level: cumulative DLP	series number, CTDIvol, DLP, series type, scan length	DLP, CTDIvol, SSDE, organ dose, fetal dose, effective dose	DLP, CTDIvol, SSDE, effective, organ, cumulative
Protocol parameters	All	Customizable	Nexo[Dose] stores all protocol data at the series level	Not supported on CT	Not supported on CT	N/S	N/S	All available in DICOM	Series number, series description, kV, auto mA, mA, max mA, mAs, exposure time, rotation time, pitch, single coll; width, total coll., noise index, % iterative recon	Yes, D&C collects all information for each protocol	All

MAMMOGRAPHY

Company name	Agfa Healthcare	Bayer Healthcare LLC	Bracco Diagnostics	Canon Medical		Fujifilm Medical Systems U.S.A. Inc.		GE Healthcare		Guerbet LLC	Imalogix
Dosimetric information: organ dose (mean glandular dose); entrance skin dose	Yes, fully supported	Compression force, entrance dose, image count, kVp, mAs, mean glandular dose (total, left, right)	Yes, all mammo parameters are supported including MGD, entrance skin dose	Not supported on mammography	Not supported on mammography	N/S	Mean glandular dose, entrance skin exposure	Study: total AGD, AGD by laterality, entrance exposure by laterality, number of exposures by laterality; series: AGD, laterality, entrance exposure, total number of exposures, effective dose, breast glandularity	N/A	Entrance dose, mean glandular dose (total, left, right)	Entrance dose and glandular dose

Comparison Chart Compiled by Imaging Technology News

Scranton Gillette Communications assumes no responsibility or liability for any errors or omissions in this chart.

Editor's Note: Additional submitted information also appears on our website at **www.ITNonline.com**.

N/A = Not applicable N/S = Not specified

Infinitt Healthcare	Medic Vision Imaging Solutions Ltd.		Medsquare	Mirion Technologies		MyXrayDose Ltd.	PHS Technologies Group, LLC (PACSHealth, LLC)	Philips	Qaelum	Sectra Inc.
DoseM	SafeCT	SafeCT-29	Radiation Dose Monitor (RDM)	Instadose+ Dosimeter	Instadose Dosimeter	MyXrayDose	DoseMonitor, NexoDose, NovaDose, Radiation Dose Monitoring by Agfa	DoseWise Portal	Dose	Sectra DoseTrack
FDA Class 1, 2015	2011	2016	2015	N/A	N/A	Class 1 device	Yes, 2012	N/A, this is a Class 1 medical device	Yes, 2016	2013
CE Class 1, 2016	2011	N/A	2012	N/A	N/A	Commercial release 2014	2013	2016	Yes, 2012 CE class IIB	2013
DoseM, abbreviated from Dose Management, extracts radiation dose information from the image data and stores it in a web-based system	Enabling the use of low-dose protocols using iterative image reconstruction technology	XR-29 dose check and RDSR functions; monitors the estimated dose prior to the scan; reports actual dose after the scan	RDM is a software solution for collecting, controlling and analyzing radiation doses delivered to patients during medical imaging examinations	The Instadose+ dosimeter is a digital radiation monitoring device and wireless system that captures, transmits, measures, analyzes and reports staff radiation dose exposure anytime, as often as needed	The Instadose dosimeter is a digital radiation monitoring device that provides immediate dose readings for occupationally-exposed staff using any internet-enabled computer	Cloud-based solution for monitoring clinical image quality and patient X-ray dose; analytical software automatically evaluates image quality and records technique and dose for every patient	Automated ionizing dose data collection, reporting and analysis solution	Vendor-agnostic and multi-mod web-based sol that collects, measures, analyzes, reports patient and staff radiation exposure, assisting healthcare providers to take control of quality of care, efficiency, patient and staff safety	Dose management solution that automatically monitors, evaluates and helps to optimize the radiation dose that patients receive for multi-facility, multi-modality and multi-vendor imaging environments	Complete solution to automatically collect, store and monitor radiation dose delivered to patients from imaging procedures; allows in depth ad-hoc and automatic reporting to patients, physicians and dept managers
Dose is monitored and analyzed at the following levels: patient, study/series, protocol, device model, gender, age, examination room, institution, operator, body part, exam type, device manufacturer	Series, study	Series, study, patient, protocol, scanner, department, site, organization	All including: patient, study, modality, staff, operator, physician, medical indication, department, site	At the wearer level	At the wearer level	Series, study/patient, protocol, equipment; flexible analytical tools are available to allow users to filter, group, display and analyze data in multiple ways	Dose levels are monitored and analyzed at the patient, study, modality, department, facility and enterprise level	Patient dose is monitored directly from the imaging modalities to capture all exposure events, not just those sent to PACS	Series, study, patient, device, hospital/department, institution	Series, study, patient, room department, site, hospital, region, operator, equipment make, model, type
CT, CR, DR, DX, XA, MG, RF, portable, NM, BMD (DICOM header, DICOM SR , DICOM MPPS, OCR capture image, DAP meter interface)	CT	CT	CR, DX, RF, XA, CT, CB/CT, MG, PET/CT, SPECT/CT, SPECT, C-Arm, DXA, external ionization chamber	Used by occupationally exposed individuals working with photon or X-ray radiation emitting modalities; Instadose+ dosimeters are not sensitive to beta-, proton- or neutron-emitting sources	Used by occupationally exposed individuals working with photon or X-ray radiation emitting modalities; Instadose+ dosimeters are not sensitive to beta-, proton- or neutron-emitting sources	CT, XA, RF, DR, MG, NM, PET, any DICOM modality that generates diagnostic images and reports X-ray dose metrics	CT, XA, CR, DR, NM, PET, mammo, MR, US	All X-ray modalities can be monitored including CT, fluoroscopy, DR and mammography and angio	CR, CT, CBCT, DR, DX, MG, MR, NM, RF, US, XA; contrast media usage data is also collected and analyzed	Any modality: CR, DX, RF, XA, CT, NM, MG
Yes, DoseM provides DRLs set according to national guidelines; in countries without national guidelines, the user can configure local DRLs for the hospital	Locally	DRLs set locally, by registries or by regulatory bodies	Yes for all, especially on procedure, protocol, acquisition protocol, targeted anatomical region	N/A	N/A	Yes, published DRLs are available and organizations can establish their own DRLs; DRLs are also calculated from industry statistics for specific study, series and patient size	Yes, DRLs may be set according to ACR guidelines, or facility preference	Yes, has the capability to set custom DRLs at the exam level	Yes, the system allows setting legal and cutomized DRLs (static levels) as well as local ones calculated with own data from the hospital (dynamic levels)	Set locally, by exam type, adult/peds, and body habitus; the system also allows national and dynamic DRL calculations to occur
Integrated monitoring; tracking with DRL; researching tool; big data centralization/management for large hospital group	Better or as good as the OEM solutions (demonstrated by dozens of clinical studies); supports all CT vendors and models; enterprise solution; reference sites	Only 3rd party XR-29 solution that does not infringe other party's IP rights; recommended by CT OEMs; reference sites	Vendor neutral, user-friendly interface customizable by account and user profile, multimodality, hybrid mode connection to PACS for new equipment and connection directly to modalities for old technologies	Only Instadose+ dosimeters enable daily and on-demand, electr dose reads and alerts vs traditional period based reads (quarterly), enabling staff to quickly pinpoint high dose exposures for occupationally exposed workers	Only Instadose+ dosimeters enable daily and on-demand, electr dose reads and alerts vs traditional period based reads (quarterly), enabling staff to quickly pinpoint high dose exposures for occupationally exposed workers	Quantitatively monitors clinical image quality; from this, able to keep diagnostic accuracy in its proper place as the primary objective of a radiology exam with dose minimization as an important but secondary obj	Rapid implementation, standards based, Intuitive and straightforward to use; membership in the Global Dose Registry is included	Combines real-time staff radiation exposure and patient data by integr w/ DoseAware personal dosimeters; DoseWise Portal is integr into the Philips IntelliSpace PACS and also the Philips IntelliBridge Enterprise offering HL7 functionality	Dose is more than a dose registration system; starting from the idea that dose registration is actually a part of a task to come to a wider target Dose tries to collect more information than the dose related values	Effective method to interrogate the data at a high and low level with ease; the solution is SaaS based model and allows customers to come and go and scale up and down in a real time reflection of their business needs
CTDIvol, DLP, SSDE, effective dose, organ dose, contrast media	Yes	Yes	DLP, CTDIvol, SSDE, organ dose, fetal dose, effective dose	N/A	N/A	SSDE, DLP, CTDI, effective dose	mSv, mGy, collimation single, collimation width, convol kernel, CTDIvol max, CTDIvol mean, CTDIvol min, data source, dist to detector; dist to patient, DLP, effective dose, effective dose (k), effective dose (NCICT), effective dose (VirtualDose), effective dose factor	The DoseWise Portal can capture CTDIvol, DLP, calculate SSDE from the scout image, calculate effective dose (mSv), and calculate peak skin dose from fluoroscopy	CTDI per acquisition, max CTDIvol, weighted CTDIvol, DLP, SSDE, effective dose, cumulative dose, organ dose, SSDE, SSDE_WED, reference phantom used by the CT for dose calculation	Yes, as well as organ specific dose calculations.
kVp, mAs, scan length, exposure time, phantom, pitch, water equivalent diameter (cm), effective diameter (cm), isocenter (cm)	Yes	Yes	Yes, RDM collects all information for each protocol	N/A	N/A	All parameters reported in DICOM public tags	All	All CT machine DICOM outputs such as kV, effective mAs, pitch, width, etc.	Yes, all protocol parameters used during exam are visualized; comparison of parameters with those from default protocols available	Yes
AGD, effective dose	N/A	N/A	Entrance dose, mean glandular dose (total, left, right)	N/A	N/A	Organ dose, entrance skin dose	Yes, fully supported	Yes	Organ dose if sent by modality and AGD, entrance dose, breast density if integrated with external volumetric breast density systems (ex. Volpara, Fujifilm); calculated effective dose	Yes

Comparison Chart **Radiation Dose Management**

Company name	Agfa Healthcare	Bayer Healthcare LLC	Bracco Diagnostics	Canon Medical		Fujifilm Medical Systems U.S.A. Inc.		GE Healthcare		Guerbet LLC	Imalogix
Data collection method	RDSR, DICOM header, OCR, manual entry, HL7	PACS and/or device integration; data from available DICOM headers; supports historical data migration via PACS	DICOM/MPPS	Not supported on mammography	Not supported on mammography	N/S	Full integration with mammography gantry including transfer of calculated, calibrated dose values	Many data collection options: DICOM from device (image header, MPPS, RDSR), DICOM from PACS, optical character recognition (OCR), EMR/RIS integration via HL7, proprietary connections with device	N/A	DICOM RDSR (radiation dose structured report); DICOM header; DICOM MPPS (modality performed procedure step)	PACS/scanner direct; DICOM, RDSR, Smart OCR; all images within a study are processed for a complete picture
RADIOGRAPHY / FLUOROSCOPY (X-RAY)											
Dosimetric information: DAP	Yes	Deviation/exposure index, entrance dose, DAP, ref. point	All dose data including DAP, SID, kVp, Mas and any information provided from the modality	Not supported on XR	Not supported on XR	N/S	N/S	At study level: DAP, entrance dose, effective dose; at series level: DAP, entrance dose; at patient level: cumulative DAP, cumulative entrance dose	N/S	DAP, air kerma	Entrance dose, DAP, exp index, relative exp count
Protocol parameters	All	Customizable	All are supported	Not supported on XR	Not supported on XR	For integrated systems, may include: kVp, mA, time, mAs, SID, collimation	N/S	All available in DICOM	N/S	Yes D&C collects all information for each protocol	All
Data collection method	RDSR, DICOM header, OCR, manual entry, HL7	PACS and/or device integration; data from available DICOM headers, RDSR, MPPS and dose sheet OCR	RDSR, MPPS, DICOM header	Not supported on XR	Not supported on XR	2-way integration with X-ray generator	N/S	Many data collection options: DICOM from device, DICOM from PACS, optical character recognition (OCR), EMR / RIS integration via HL7, proprietary connections with device	N/S	DICOM RDSR; DICOM header; DICOM MPPS (modality performed procedure step); DICOM secondary capture (ORC: optical recognition character)	PACS/scanner direct; DICOM, RDSR, smart OCR; all images within a study are processed for a complete picture
IMPLEMENTATION PROCESS											
What is the implementation process	DoseMonitor software is installed remotely via VPN connection	Initiate, build, test, deploy, train, enhance	Nexo[Dose] is implemented using ITIL implementation methodologies, utilizing professional radiology informatics resources that are dedicated to the project	This technology is added to existing systems through software upload and callibration	This technology is added to existing systems through software upload and callibration	Pre-installation consultation, installation, end-user training	Pre-installation consultation, installation, end-user training	Customized and built based on customer expectations	User completes Web registration and is granted access to product	Three phases: 1) Pre-study phase: site visit and assessment of the installed base and infrastructure; 2) Deployment phase: installation of physical or virtual server and connection with the different equipment; 3) Training and support	Installation of edge server, configure PACS or scanner to auto-forward
What is the training process	Remote training is delivered via WebEx, unless on-site is purchased	Onsite and remote scoped per client needs/goals	Training is accomplished via multiple online or on-site sessions (customer preference)	On the job training by Canon applications team; additional applications support is available at Canon training facility or on site as structured by the customer	On the job training by Canon applications team; additional applications support is available at Canon training facility or on site as structured by the customer	Post-installation applications training for all end users; virtual library for ongoing training initiatives	Post-installation applications training for all end users; virtual library for ongoing training initiatives	GE clinical education specialist provides on site and remote training; physicist, physician, technologist dedicated training and site specific education program	User manual and training guide embedded, webinars available	Training dedicated for physicians, technologist, medical physicist, head of department, radiation safety officer	Unlimited virtual training, webinars, release notes
What is the support process	24 x 7 x 365 telephone support, email or interactive help desk	Scoped per client/24 x 7 for contracted customers	24 x 7 x 365 telephone support is standard	24/7 assist support is available during product warranty and service agreement periods	24/7 assist support is available during product warranty and service agreement periods	Technical assistance center, remote access, field service dispatch	Technical assistance center, remote access, field service dispatch	Service contract provides onsite and remote support	Support services thru the service contract on the GE CT	Full technical and clinical support - ISO 9001	Direct
DOSE DATA											
What parameters are used to record dose and set alerts	Customer can set alerts on any system parameter	Customized per client's preference; variety of parameters available for thresholds and alerts	All parameters supplied by a modality can be recorded and an alert created	Alerts based on configurable peak skin dose thresholds	N/S	International standard (IEC 62494-1) exposure/deviation index; Fujifilm proprietary exposure indices	N/A	Dose metrics, protocol parameters, medical staff performing the exam, patient criteria impacting on dose	DLP, CTDIvol, mA, kV, scan length, pitch, noise index, % iterative recon, etc; DLP, CTDIvol, number irrad events for alerts	CT: Effective Dose, DLP, CTDI, Nb of irradiation event, SSDE, scanning length; XA, RF, DX, CR : DAP, Air Kerma, time of fluoroscopy, Nb of radiographic frames, SPECT, SPECT-CT, PET-CT: radionuclide dose	Dose metrics, scanner, location, physician, technologist, scan length, size, age, sex, etc.
IT QUESTIONS											
Is the footprint of the server and client software	Server typically VM, Windows/MS SQL	Dependent on study volumes	Server is HP DL380 equivalent or VM. No client, application is displayed in a browser	No server is needed or requested; the client software resides in the equipment room which the dimensions are available via the IPM	N/S	SQL server and client combination deployed individually	SQL server and client combination deployed individually	Server and zero-footprint web client	Zero-footprint, cloud-based solution	Zero-footprint because it's a web based solution	Onsite server included; all modern browsers
Is the solution centrally hosted or on locally deployed hardware	On-premise or hosted, customer choice	Solution will be deployed on customer IT infrastructure, either physical or virtual environment	Single on-premise or Microsoft Azure hosted database	Locally	N/S	Locally deployed hardware	Locally deployed hardware	Customer hosted physical server or virtual server	Virtual server hosted by GEHC	Both according to customer's choice	Imalogix is a cloud-based solution
What are the general server specifications	DL380 or equivalent 2 CPU/16 GB RAM, 1 TB HDD	Volume dependent; min <100,000 studies/yr 100 GB LinuxOS/DB mount/200 GB Radimetrics software mount/4 Virtual CPUs/16 GB RAM	HP DL380 equivalent/ 16 GB RAM/250 GB HDD/SSD	No server required	N/S	N/A	N/A	Windows Server 2008/2012, 64-bit or later	GE provided	8 GB RAM - 4 CPU Processor - 500 GB virtual disk (depending of the number of modalities)	Provided

Comparison Chart Compiled by Imaging Technology News

Scranton Gillette Communications assumes no responsibility or liability for any errors or omissions in this chart.

Editor's Note: Additional submitted information also appears on our website at **www.ITNonline.com.**

N/A = Not applicable   N/S = Not specified

Infinitt Healthcare	Medic Vision Imaging Solutions Ltd.		Medsquare	Mirion Technologies		MyXrayDose Ltd.	PHS Technologies Group, LLC (PACSHealth, LLC)	Philips	Qaelum	Sectra Inc.
Dose report OCR, RDSR, MPPS, DICOM header	N/A	N/A	DICOM RDSR (radiation dose structured report); DICOM header; DICOM MPPS (modality performed procedure step)	N/A	N/A	Data extraction from DICOM image header, RDSR	RDSR, DICOM header, OCR, manual entry, HL7	Data is collected directly from the machine via RDSR, MPPS, OCR image capture and may be collected remotely via the EMR/PACS	DICOM RDSR, DICOM header analysis, MPPS, HL7, dose report secondary capture	DICOM Dose SR, MPPS, OCR, HL7, PACS Q/R integration, manual entry
DAP, effective dose	N/A	N/A	DAP, Air Kerma	N/A	N/A	DAP, Reference point air Kerma, kV, target/filtration type	Yes	Yes, DAP is captured by the DoseWise Portal via the machine	DAP, fluoro time, entrance dose, number of exposures, exposure index, deviation EI, target EI, vendor specific exposure index, effective dose	Yes
kVp, mAs, fluoro time, air kerma, filter type, filter material, filter thickness	N/A	N/A	Yes, RDM collects all information for each protocol	N/A	N/A	All parameters reported in DICOM public tags	All	Yes, all machine operating parameters are collected via DICOM such as collimators and mA at the event level	Yes, all parameters provided by the modality are visualized	Yes
Dose report OCR, RDSR, MPPS, DICOM header, DAP meter interface	N/A	N/A	DICOM RDSR (radiation dose structured report); DICOM header; DICOM MPPS (modality performed procedure step); DICOM secondary capture	N/A	N/A	Data extraction from DICOM Image header, RDSR, MPPS	RDSR, DICOM Header, OCR, manual entry, HL7	Data is collected directly from the machine via RDSR, MPPS, OCR image capture and may be collected remotely via the EMR/PACS	DICOM RDSR, DICOM header analysis, MPPS, HL7, dose report secondary capture	DICOM Dose SR, MPPS, OCR, HL7, PACS Q/R integration, manual entry
Pre-survey modality information and user requirements for project management; total inspection of the modalities to interface with DoseM; build system and interface with modalities; DoseM running test; education and Go-live	Standard; one day	Standard; one day	Three phases pre-study phase: site visit and assessment of the installed base and infrastructure; deployment phase: installation of physical or virtual server and connection with the different equipment; training and support	An onboarding appointment is scheduled with the customer to walk thru the account set-up and badge initialization process; orientation of the Instadose custmer portal to manage the account, incl online badge assign and generating electr reports, is also provided	An onboarding appointment is scheduled with the customer to walk thru the account set-up and badge initialization process; orientation of the Instadose custmer portal to manage the account, incl online badge assign and generating electr reports, is also provided	Installation of DoseNode(s) on the customer's network; config of the customer on www.MyXrayDose.com; configuration of auto-transfer by PACS, equipment vendors to DoseNode; create mappings for study and series to the standardized coding system	DoseMonitor software is installed remotely via VPN connection	The Philips DoseWise Portal will be remotely installed at the customer site and field engineers will make the modality connections via DICOM nodes under the direction of the project manager	Project manager performs kickoff meeting, involving all major stakeholders; once agreed on technical details and timelines, the project will start w/ the creation of the hardware and the estab of a remote network, which will be used to install the syst	Services provided from remote; customer will interact with Sectra staff to coordinate connections via the desired data collection method
On-site education (application specialist); training video; web education; annual collective training upon user's request	Included in the implementation	Included in the implementation	Training dedicated for physicians, technologist, medical physicist, head of department, radiation safety officer	Training consists of the initial onboarding session, follow-up with a client support representative, and access to printed and video tutorials	Training consists of the initial onboarding session, follow-up with a client support representative, and access to printed and video tutorials	Local administrator, advanced user, general user, provided by WebEx; onsite at time of commissioning and additional onsite training may be purchased	Remote training is delivered via WebEx, unless on-site is purchased	Philips will provide on-site user training and product configuration post installation using our team of clinical applications specialists and physicists	The application specialist will provide training sessions dedicated to the different user roles; these sessions can be on site or via videoconference	Video, WebEx, Onsite
Technical engineer/ application specialist/ developer supports contracted customer on-site and remote	Remote access	Remote access	Full technical and clinical support - ISO 9001	Client services representatives are available Monday-Friday from 6 am to 4 pm PST	Client services representatives are available Monday-Friday from 6 am to 4 pm PST	Remote technical support, email, phone, screen share; onsite if support contract	24 x 7 x 365 telephone support, email or interactive help desk	Philips will provide remote technical support as needed from 8 am to 5 pm EST	Qaelum has a ticketing system, but emails or phone calls to our support are also an option	Call center with remote access
All parameters prov by the modality can be used to record dose info, inclu patient demogr info, examination parameters and absorbed dose info	CTDIvol, DLP	CTDIvol, DLP	CT: Effective Dose, DLP, CTDI, Nb of irradiation event, SSDE, scanning length; XA, RF, DX, CR : DAP, Air Kerma, time of fluoroscopy, Nb of radiographic frames, SPECT, SPECT-CT, PET-CT: radionuclide dose; MG	N/A	N/A	Cumulative dose at the reference point, DAP, DLP, SSDE, CTDI, mSv	Customer can set alerts on any system parameter	Yes, common dose attributes may be used to record dose and set alerts such as DLP, SSDE (WED), CTDIvol, DAP, CAK, EDE, etc.	All parameters coming from the modality can be used to record dose and they all can be used to set alerts on; we even have the possibility to script alerts like: when study description is coronary CT and pitch > 2, send alert	Any field in the database is able to be used by the system to create an alert; therefore it is possible to use visit frequency as an example to alert as well as the dose
Server, zero-footprint web client	Server	PC	Zero-footprint because it's a web-based solution	N/A	N/A	Virtual machine or local server for image analysis and dose data extraction; zero-footprint cloud-based web client for user access	Server typically VM, Windows/MS SQL	DoseWise Portal is software only solution uses a virtual machine server supplied by the customer in most scenarios	Installed in one or more virtual machines running all components; users don't need to install anything	With the exception of a small onsite communication appliance (proxy/gateway), all infrastructure is hosted
Customer-hosted physical hardware	Centrally hosted	Local PC	Both according to customer's choice	Centrally hosted by Mirion Technologies Dosimetry Services Division (DSD); relay devices feed raw data to a web service	Centrally hosted by Mirion Technologies Dosimetry Services Division (DSD)	Centrally hosted cloud-based solution	On-premise or hosted, customer choice	Locally hosted physical or virtual machine, may be configured for department-wide or enterprise-wide service	Dose is normally hosted in the hospital's premises but a cloud solution may be evaluated	Centrally hosted
Windows server 2008 R2, 64 bit or higher	2U/4U rack mounted, Dual Intel Xeon, 1 TB DDR, redundant power supplies, GPUs	N/A	8 GB RAM - 4 CPU processor - 500 GB virtual disk (depending of the number of modalities)	N/A	N/A	DoseNode - Windows server 2012 64 bit, Quad Core 32 GB RAM 400 GB SSD, GBps network	DL380 or equivalent 2 CPU/16 GB RAM, 1 TB HDD	Quad-core or 4 vCPU equivalent (2.8 GHz; AMD Operton 4,133 equivalent), 16 GB RAM minimum,	Server spec depend on the size of the installation and on the existing architecture (e.g. single PACS vs multiple PACS): a customized project proposal will be provided	The gateway needs 2 CPUs, 4 GB RAM and 200 GB disk

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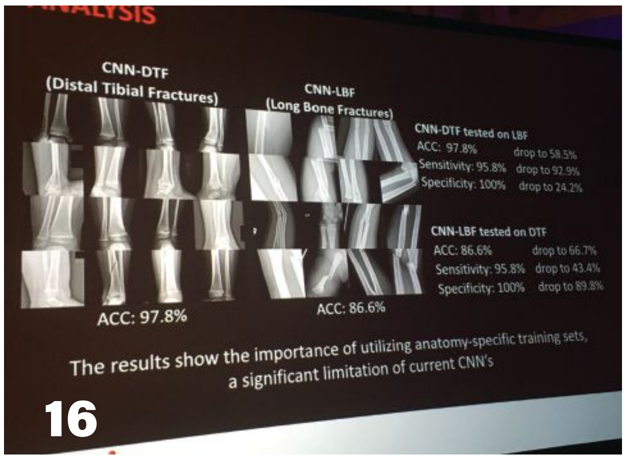

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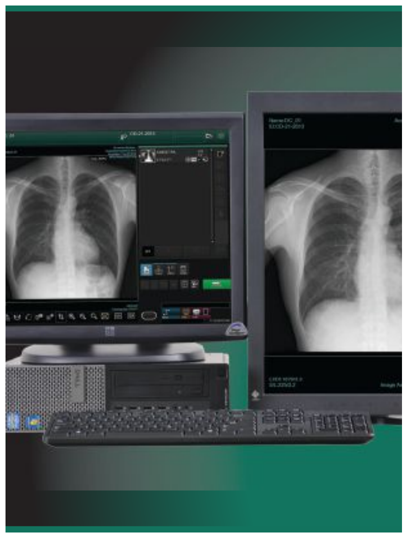

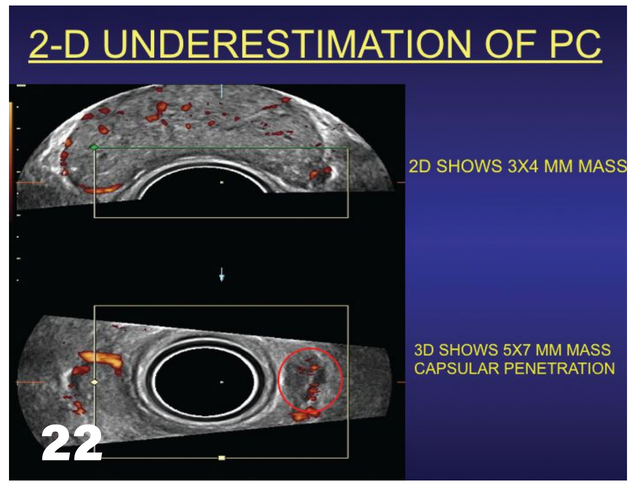

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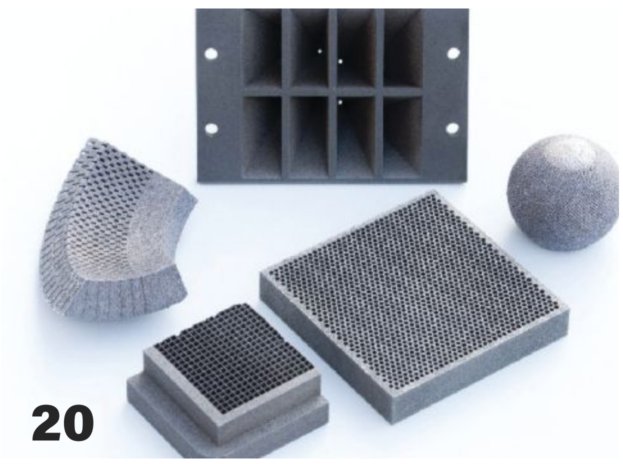

WOLFMET

About the cover

The FDX Console represents the culmination of Fujifilm's extensive experience in image and information processing. Its sophisticated interface is intuitive and customizable, and enables fast, easy exam completion and image optimization.

GREG FREIHERR

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From Your Editor

When Change is Constant

Melinda Taschetta-Millane

http://www.linkedin.com/home?trk=hb_tab_home

Imaging Technology News

@itnEditor

"Change is the only constant in life."

— *Heraclitus of Ephesus, pre-Socratic Greek philosopher*

Radiology's history dates back to 1895 when Wilhelm Roentgen discovered X-rays. The very first image taken was of his wife's hand; the "x" originally stood for "unknown." So much was unknown back then, yet this was the impetus that would start the evolution of change.

Quickly, progress and developing technology ensued. From George Eastman introducing radiographic film in 1918, to William Nelson Beck inventing ultrasound while conducting an experiment with a scanner in 1957, to Godfrey Hounsfield creating the prototype for the CT scanner in 1968, and the list goes on and on.

Fast-forward to today.

Artificial intelligence (AI) is, by true definition, artificial. We know that it can't take the place of people, but it can help radiologists more accurately get the information they need, and augment patient care. "This is about making life easier for the radiologist and staff, it's not replacing anybody," said Sham Sokka, VP and head of radiology solutions for Philips Healthcare, in an *itnTV* interview.

Scientists at Dana-Farber Cancer Institute recently demonstrated that an AI tool can perform as well as human reviewers — and much more rapidly — in extracting clinical information regarding changes in tumors from unstructured radiology reports for patients with lung cancer. In fact, the AI tool performed comparably to trained human curators in detecting the presence of cancer, and whether it was responding to treatment interventions, stable or worsening.

Researchers compared human and computer measurements of outcomes such as disease-free survival, progression-free survival, and time to improvement or response, and found that the AI algorithm could replicate human assessment of these outcomes. The deep learning algorithms were then applied to annotate another 15,000 reports for 1,294 patients whose records had not been manually reviewed. The authors found that computer outcome measurements among these patients predicted survival with similar accuracy to human assessments among the manually reviewed patients.

But this is just one example of how AI has interwoven itself into the world of radiology. AI has the potential to have a substantial effect on the practice of medicine, and even transform the role of the radiologist by automating routine and time-consuming practices. And with this time savings, physicians have more time to interact with patients.

AI may have a substantial effect on the practice of medicine, so much so that it transforms the role of radiologists. The technology has the potential to make the practice of medicine faster by automating routine and time-consuming practices. However, the overarching promise of AI is to provide more time for physicians to interact with patients. Let's keep this momentum of change rolling.

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We welcome your comments on the topics found in *Imaging Technology News*. Please send your thoughts to *mtaschetta-millane@sgcmail.com*

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A Study of Breast Biopsy at Jefferson Radiology

How the Affirm® prone breast biopsy system transformed a once-dreaded procedure for patients and physicians

At Jefferson Radiology in Hartford, CT, patients and physicians are finding breast biopsy procedures are no longer as intimidating and dreaded as they once were. Jean M. Weigert, MD, explains how the Hologic Affirm® prone breast biopsy system has played a key role in increasing patient comfort, improving throughput and more for this high-volume facility and its patients.

Jean M. Weigert, MD
Jefferson Radiology,
Hartford Hospital

Biopsy Images that 'Pop'

A successful breast biopsy procedure hinges on being able to quickly and accurately identify, target and access lesions, including challenging low-contrast distortions and faint calcifications. This can be difficult without the high-quality imaging of the Affirm® prone system.

"Honestly, I used to dread doing stereos. Because I was never sure if I would see the calcium. And now, the calcium pops."

That's because the Affirm® prone system is driven by powerful imaging technology and a field of view that's more than 6.5 times larger than previous generations of prone biopsy systems to allow for easy targeting.[i,iii] With these advancements, the system helps clinicians to pinpoint those hard-to-find lesions that might not be visible with older technology.[ii]

Thanks to this exceptional imaging, Dr. Weigert is confident she can identify and target lesions. In fact, she's had a change of heart over breast biopsy procedures. "I love biopsies now. I look forward to them."

And that confidence has even helped Dr. Weigert reduce unnecessary biopsies. While reflecting on prior procedures, she recalled several instances where she accurately identified purported calcifications as milk of calcium thanks to the Affirm® prone system. This has prompted her to redirect patients, including for additional imaging that ultimately confirmed her diagnosis and bypassed the unneeded biopsy.

Other times Dr. Weigert has brought her targeted calcification into focus on the Affirm® prone system and the superior imaging revealed additional clusters that didn't appear on the original mammogram. She can think of at least three cases in which these clusters she wasn't intending to target turned out to be abnormal.

A More Comfortable Biopsy

It's an unfortunate reality that core-needle breast biopsies are, and continue to be, a relatively uncomfortable, and sometimes even scary, experience for patients. Thankfully, things have dramatically improved.

> "I love biopsies now. I look forward to them."

"[The Affirm prone system] is a lot more comfortable than our old machine. Starting from square one, getting patients to be relaxed and comfortable is so much easier."

Thanks to ergonomically-designed memory foam cushion, the Affirm® prone system provides custom, targeted pressure-point support suitable for most body types, helping to eliminate motion and keep patients comfortable.

Often Dr. Weigert and her colleagues hear back from patients who are happy to share that their procedures weren't as bad as they thought they would be.

It's a common refrain heard by facilities with the Affirm® prone system. In fact, more than 95 percent of patients reported their Affirm® prone biopsy procedure was faster, more comfortable and less painful than expected.

In Dr. Weigert's experience, the improvement is especially pronounced for patients who previously had procedures done on the facility's old system and later on their Affirm® prone system. "They are definitely more comfortable on this system," confirmed Dr. Weigert. "The patient seems to be much more relaxed."

And the benefits extend beyond patient comfort to also include ease of access to the breast. Dr. Weigert is particularly fond of the system's arm-through procedure accessories, which she has found can make this type of procedure easier to execute while also more comfortable for her patients. The arm-through procedure accessories make access, even to challenging posterior lesions, fast and easy.

Increased Biopsy Speed

Procedure speed is multifaceted, impacting a facility's throughput, patient experience and more. In the past, stereotactic biopsies could take upwards of 30-45 minutes. Thanks to newer systems and technologies, that doesn't have to be the case.

And at Jefferson Radiology, where Dr. Weigert and her colleagues complete four to five tomosynthesis-guided biopsies daily, quick and efficient procedures are essential.

Part of the speed equation includes ease of targeting. Dr. Weigert has found that the exceptional 3D™ images produced by the Affirm® prone system help her to quickly and easily identify how to access lesions.

"You know immediately, when panning through the images, whether or not you're lateral or medial, because you see how far you're going through," explained Dr. Weigert. "It's much easier to tell where we are and to make a correction. Once you've got the right spot, we're done in five minutes."

Additionally, when using 3D™ technology, the Affirm® prone system combines steps that were once required by standard 2D biopsy procedures, which can lead to fewer exposures, a faster procedure, and up to 50 percent lower radiation dose for patients.[iv,v]

"It improves our throughput and it improves patient comfort, because they're not in compression for as long. It just goes so quickly."

Ultimately, the Affirm® prone breast biopsy system has won the acclaim of Dr. Weigert, Jefferson Radiology and its patients. The system has truly changed minds about what a biopsy procedure can – and should – look like.

Opinions expressed are solely those of the participants.
[i] Compared to existing dedicated prone biopsy systems. [ii] Compared to the MultiCare® Platinum system. [iii] Based on a survey of 165 patients post-procedure at 3 hospitals. [iv] 3D™ Breast Biopsy option. [v] Compared to a standard 2D stereotactic procedure.

Using Artificial Intelligence to Deliver Personalized Radiation Therapy

New Cleveland Clinic-led research shows that artificial intelligence (AI) can use medical scans and health records to personalize the dose of radiation therapy used to treat cancer patients.

Published in *The Lancet Digital Health*, the research team developed an AI framework based on patient computerized tomography (CT) scans and electronic health records. This new AI framework is the first to use medical scans to inform radiation dosage, moving the field forward from using generic dose prescriptions to more individualized treatments.

Currently, radiation therapy is delivered uniformly. The dose delivered does not reflect differences in individual tumor characteristics or patient-specific factors that may affect treatment success. The AI framework begins to account for this variability and provides individualized radiation doses that can reduce the treatment failure probability to less than 5 percent.

"While highly effective in many clinical settings, radiotherapy can greatly benefit from dose optimization capabilities," said lead author Mohamed Abazeed, M.D., Ph.D., a radiation oncologist at Cleveland Clinic's Taussig Cancer Institute and a researcher at the Lerner Research Institute. "This framework will help physicians develop data-driven, personalized dosage schedules that can maximize the likelihood of treatment success and mitigate radiation side effects for patients."

The framework was built using CT scans and the electronic health records of 944 lung cancer patients treated with high-dose radiation. Pre-treatment scans were input into a deep-learning model, which analyzed the scans to create an image signature that predicts treatment outcomes. Using sophisticated mathematical modeling, this image signature was combined with data from patient health records — which describe clinical risk factors — to generate a personalized radiation dose.

"The development and validation of this image-based, deep-learning framework is exciting because not only is it the first to use medical images to inform radiation dose prescriptions, but it also has the potential to directly impact patient care," said Abazeed. " The framework can ultimately be used to deliver radiation therapy tailored to individual patients in everyday clinical practices."

There are several other factors that set this first-of-its-kind framework apart from other similar clinical machine learning algorithms and approaches. The technology developed by the team uses an artificial neural network that merges classical approaches of machine learning with the power of a modern neural network. The network determines how much prior knowledge to use to guide predictions about treatment failure. The extent that prior knowledge informs the model is tunable by the network. This hybrid approach is ideal for clinical applications since most clinical datasets in individual hospitals are more modest in sample size compared to non-clinical datasets used to make other well-known AI predictions (i.e. online shopping or ride-sharing).

Additionally, this framework was built using one of the largest datasets for patients receiving lung radiotherapy, rendering greater accuracy and limiting false findings. Lastly, each clinical center can utilize their own CT datasets to customize the framework and tailor it to its specific patient population.

"Machine learning tools, including deep learning, are poised to play an important role in healthcare," said Abazeed. "This image-based information platform can provide the ability to individualize multiple cancer therapies but more immediately is a leap forward in radiation precision medicine."

ACR NAMES NEW OFFICERS


D. MONTICCIOLO

The American College of Radiology (ACR) Council recently elected Debra L. Monticciolo, M.D., FACR, of Temple, Texas, president of the American College of Radiology (ACR) at ACR 2019 — the ACR annual meeting in Washington, D.C. Katarzyna J. Macura, M.D., Ph.D., FACR, of Baltimore, Md., was elected ACR vice president.

ICAD APPOINTS CFO


R. S. AREGLADO

iCAD, Inc. appointed R. Scott Areglado as chief financial officer. Areglado has been serving as interim chief financial officer since December 2018, and previously held the role of corporate controller at iCAD since May 2011.

SIR GOLD MEDALISTS

The Society of Interventional Radiology (SIR) presented its highest honor, the SIR Gold Medal, to Alan H. Matsumoto, M.D., FSIR; Daniel Picus, M.D., FSIR; and James B. Spies, M.D., M.Ph., FSIR, during its Annual Scientific Meeting in Austin, Texas. These awards acknowledge distinguished and extraordinary service to SIR or to the discipline of interventional radiology. Matsumoto is professor and chair of the department of radiology and medical imaging at the University of Virginia, Charlottesville. Picus is a professor of radiology and surgery at the Mallinckrodt Institute of Radiology (MIR) at Washington University School of Medicine, St. Louis. There he established the interventional radiology section, serving as its first chief from 1987–2000.

SIR 2019–2020 PRESIDENT


L. FINDEISS

Laura Findeiss, M.D., FSIR, an interventional radiologist and chief of service for the department of radiology at Grady Memorial Hospital, Emory University School of Medicine, Atlanta, assumed the office of president of the Society of Interventional Radiology (SIR) on March 26, during the society's Annual Scientific Meeting in Austin, Texas. In addition to Findeiss, other incoming officers of SIR's 2019–20 Executive Council include President-elect Michael D. Dake, M.D., FSIR, University of Arizona Health Sciences, Tucson, Ariz.; Secretary Matthew S. Johnson, M.D., FSIR, Indiana University School of Medicine, Indianapolis; and Immediate past-president M. Victoria Marx, M.D., FSIR, Keck Medicine of USC, Los Angeles.

The Challenge of Pediatric Radiation Dose Management

Diagnosing an adult is different than a child and there is increased concern about radiation exposure

Radiation dose management is central to child patient safety. Medical imaging plays an increasing role in the accurate diagnosis and treatment of numerous medical conditions. The speed, accuracy and noninvasiveness of medical imaging have also contributed to a sharp increase in the number of imaging procedures.

In the U.S., the use of computed tomography (CT) scans nearly tripled, from 52 scans per 1,000 patients to 149 scans per 1,000 patients between 1996 and 2010.[1] According to the American College of Radiology (ACR), nearly 68 million CT scans are performed annually in the U.S. today. Japan, the United States and Australia lead the world in number of CT scanners per head of the population, with 64, 26 and 18 scanners per million citizens respectively.[2]

Above: Diagnostic CT equipment has special pediatric features, and includes a range of dose management settings that can be calibrated for safe use on infants, children and adolescents.

Top right: The CT scanner might not come with protocols that are adequate for each hospital situation, so at Phoenix Children's Hospital they designed their own protocols, said Dianna Bardo, M.D., director of body MR and co-director of the 3-D Innovation Lab at Phoenix Children's.

Dosing in Pediatrics

Diagnosing an adult is different than a child. As the number of procedures has increased, so too has concern about exposure to radiation. Children are more radiosensitive: Their organs and cells are growing faster and therefore could be potentially damaged by ionizing radiation.

"Everybody cares about radiation dose, but the most sensitive to radiation are children, because they're growing," said Richard Towbin, M.D., chief of radiology at Phoenix Children's Hospital. "We have to relate our dose choices and our protocols for imaging to the group of problems we're trying to solve."

The range of ages and disease types in a pediatric hospital such as Phoenix Children's is vast — on one day a radiologist could be conducting a magnetic resonance imaging (MRI) scan on a fetus, on another it could be a CT scan on an 18-year-old, 220-pound football player. Whether it is a baby or a teenager, the aim is the same — to provide safety and comfort for the patient and their family throughout the entire imaging procedure.

"Children have different types of cancers and different types of heart disease, and different types of neurologic diseases than an adult might," said Dianna Bardo, M.D., director of body MR and co-director of the 3-D Innovation Lab at Phoenix Children's. "An adult might have a longer time to develop an injury or to develop a disease process, so we're looking at things in earlier stages, maybe more subtle stages in a child than we are in an adult."

Maintaining Image Quality

There are many modalities of medical imaging procedures in Phoenix Children's, each of which uses different technologies and techniques, and uses ionizing radiation to generate images of the body. Radiation doses for imaging procedures such as a CT, X-ray or fluoroscopy are set according to the child's body size and the disease type.

Diagnostic equipment has special pediatric features, and includes a range of dose management settings that can be calibrated for safe use on infants, children and adolescents.

Recently there has been an increase of new healthcare technology to manage radiation dose for patients without losing image quality. Not long ago dose reduction in diagnostic imaging would lead to poorer images; now technology has put more tools into the hands of radiologists, enabling them to make adjustments based on the patient need, without sacrificing on the quality of the image.

Designing Imaging Protocols

Establishing protocols saves time and means radiologists can assess each patient and decide which protocol will suit the procedure. Pediatrics has a lot of nuances and complexity compared to an adult hospital, which requires close collaboration between hospital and technology partner.

As part of its partnership with Philips, Phoenix Children's has collaborated in designing and testing new protocols in its imaging equipment that is child-sized and appropriate for particular age groups or a particular organ.

"The CT scanner might not come with protocols that are adequate for each hospital situation. We've designed our own protocols to do that, and we've shared those with Philips. So, they're out there in the world, freely available to Philips users," Bardo said. "If the child comes in and they're 6 feet 2 inches tall and 180 pounds, then I know that I can choose the correct protocol on the fly, just visually knowing that I've got the right thing. That's very important."

Results are specific to the institution where they were obtained and may not reflect the results achievable at other institutions.

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For More Information: www.philips.com/nobounds

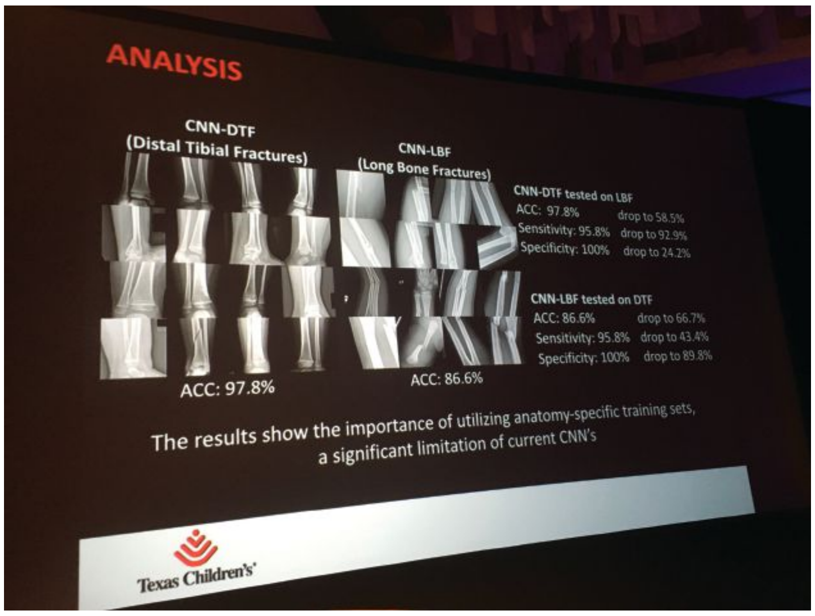
Can Artificial Intelligence Help Pediatric Radiologist Burnout?

A new study reveals high levels of job dissatisfaction among pediatric radiologists, and some suggest AI can help streamline workflow to alleviate workload burdens

By Jeff Zagoudis

Burnout has become a popular buzzword in today's business world, meant to describe prolonged periods of stress in the workplace leading to feelings of depression and dissatisfaction with one's occupation. The topic has become so pervasive that the World Health Organization (WHO) addressed it at its 2019 World Health Assembly in Geneva in May, adding burnout to the 11th revision of the International Classification of Diseases (ICD-11) — although classifying it as an "occupational phenomenon" rather than a medical condition.

Healthcare itself is not immune to burnout, and a recent study in *Journal of the American College of Radiology* demonstrates it is taking a toll on pediatric radiologists in particular. The study surveyed Society of Pediatric Radiology (SPR) members and found nearly two-thirds expressed at least one symptom of burnout. While burnout is a complicated phenomenon and no two people experience it the same way, a commentary on the study suggests artificial intelligence (AI) could help alleviate some of the difficulties that can lead to burnout.



SUDHEN DESAI, M.D.

Artificial intelligence can help ease pediatric radiology's workload by speeding up diagnostic image interpretation, as demonstrated here with leg bone fractures.

Defining Burnout

Rama S. Ayyala, M.D., is a pediatric radiologist with the Department of Diagnostic Imaging at Rhode Island Hospital-Hasbro Children's Hospital and Warren Alpert Medical School of Brown University. She wanted to study burnout because she had been interacting with a lot of people in her field who were experiencing it. "A lot of them were leaving medicine and some were even having mental health issues," she said.

This sentiment was also born out in the most recent edition of the *National Physician Burnout, Depression and Suicide Report*, published by *Medscape*. The report ranks medical subspecialties by the percentage of clinicians reporting feelings of burnout. Radiology ranked seventh in the 2018 *Medscape* survey — alarming enough by itself, but even more so because it jumped from 18th place in the previous edition.[1]

Ayyala's research team surveyed SPR members on their feelings of burnout according to the three components of the Maslach Burnout Inventory (MBI), originally published in 1981:

- Emotional exhaustion (feeling overextended and depleted);
- Depersonalization (a sense of cynicism, and/or a detached or callous attitude toward your job); and
- Lack of personal accomplishment (perceived incompetence with capabilities in the job).

A total of 460 clinicians returned responses out of the 1,453 who were sent the survey, a 32 percent response rate. The prevalence rate for emotional exhaustion

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"People feel like they've lost their sense of control," said Ayyala.

The survey included additional questions to gather more information about the roles and job characteristics of pediatric radiologists, including:

- Gender;
- Full- or part-time employment status;
- How long they have been practicing;
- Practice type;
- Total number of pediatric radiologists in the practice; and
- On-call status and frequency of being on-call.

Out of all the job characteristics surveyed, on-call status seemed to have the single greatest association with increased feelings of burnout. "Many children's hospitals currently struggle with how to provide 24-hour radiology coverage," Ayyala stated.

AI Making Way Into Pediatric Imaging

Technology has dramatically changed the way radiologists practice, as remote viewing systems, the evolution of picture archiving and communication systems (PACS) and mobile devices allow them to read images from essentially anywhere. For some radiologists who feel burned out due to their workload, however, technology may be able to help alleviate some of their burden — specifically artificial intelligence (AI).

Michael J. Callahan, M.D., who is the director, computed tomography; division chief, abdominal imaging; medical director, ultrasound; and staff radiologist in the Department of Radiology at Boston Children's Hospital, wrote a commentary for *Pediatric Radiology* on Ayyala's study. The topic of burnout has become a point of focus at recent SPR meetings, and the society is working to find possible solutions to help its members. According to Callahan, AI has been discussed as one approach to help improve efficiency in image interpretation. "Although theoretical solutions exist for a multitude of problems, steps to moderate and manage the effects and consequences of burnout in pediatric radiologists will undoubtedly require in-depth discussions at future SPR meetings," he wrote.

The use of AI has exploded in radiology as a whole in recent years, with vendors and clinicians exploring its use for everything from image interpretation to worklist sorting and more. Despite the immense interest, AI is taking slightly longer making its way to clinical use in the subspecialty of pediatric radiology. This is largely due to the need for large volumes of data to train algorithms, a feat which is difficult with the generally lower volumes of pediatric imaging, according to Sudhen Desai, M.D., an interventional radiologist at Texas Children's Hospital.

"A system like Texas Children's, which has a good amount of inpatient and outpatient volume, has available to itself the ability to create datasets to train models from. That's one of our luxuries," he said. "However, there are smaller pediatric institutions that suffer from lack of available data."

Part of the problem, according to Desai, is that the need for larger volumes of data runs counter to the long-standing protocol of limiting the exposure of children to radiation, advanced through national initiatives such as Image Wisely. While this has placed limitations on the adoption of AI in pediatric radiology, the technology itself may also offer a way forward. Desai said that work is ongoing to train the algorithms with lower numbers of radiographs or cross-sectional imaging. With this information, algorithm architects can employ methods such as feedback learning (teaching the computer to take actions in an environment so as to maximize the concept of a cumulative reward) and transfer learning (using the knowledge gained from one application and applying it to a different but related problem). "So we're trying to use various tricks and techniques to train our models in a more efficient fashion so that we don't need tens of thousands of datasets but … maybe hundreds of datasets, that would allow us to do the work," Desai said.

Using AI to Combat Burnout

As suggested by Callahan, the role of AI in combating pediatric radiologist burnout may be in streamlining and/or automating some of the processes and tasks that entail a heavy workload burden. Several practitioners are already exploring the use of AI in a clinical pediatric imaging setting, offering many promising applications.

Bone age detection. Bone age evaluation is one of the most common practices in pediatric radiology. Radiologists examine series of hand radiographs to evaluate a patient's growth and diagnose developmental disorders. The Radiological Society of North America (RSNA) made this the focus of its first annual Machine Learning Challenge in 2017. Teams of researchers were encouraged to develop their own algorithms for automating bone age detection by using a dataset of hand radiographs compiled from various leading U.S. research institutions. Participants in the challenge were judged on how well the bone age evaluations produced by their algorithms agreed with the expert observers' notated evaluations. The winning algorithm is now available through the EnvoyAI Exchange platform.

Safwan Halabi, M.D., a clinical associate professor of radiology – pediatric radiology at Stanford Children's Health, has been using the bone age algorithm in his clinical research. He is currently collaborating with researchers at nine other institutions to validate the algorithm "and it's looking really good," he said. "We could eliminate some of our mundane things that we measure [because they] can be automated and sent directly to the electronic health record."

Pneumonia detection. Halabi's Stanford colleague Matthew Lungren, M.D., an assistant professor of radiology (pediatric radiology) is part of a group developing an AI algorithm to improve pneumonia detection on chest X-rays. Their model is trained on a National Institutes of Health (NIH) dataset consisting of 112,120 frontal view chest X-rays from 30,805 unique patients. In a preliminary paper published in 2017, the algorithm was found to exceed the performance of an average radiologist in detecting pneumonia.[2]

Pneumonia detection was the focus of the 2018 RSNA Machine Learning Challenge.

Interpreting tubes and catheters in pediatric X-rays. Another challenge in the world of pediatric imaging is the fact that many of the smallest, sickest patients have a large number of tubes and other apparatus attached to them — feeding tubes, catheters, ECG leads and more. When these patients need to be imaged, the radiologist will typically have to go through each image and identify artifacts that are external to the patient.

Desai stated that research is currently being done to train AI to identify and classify these outside objects in an X-ray. Using adult chest radiographs, the research group added markers for lines and tubes, and that information was fed back into the AI model. The model was then applied to pediatric radiographs, and it was able to identify lines, tubes and other objects "on the order of about 80 percent," Desai said. The ultimate goal is for the computer to recognize catheters or tubes that are out of position and alert the radiologist.[3]

Human Element Still Required

These and other applications offer hope for artificial intelligence to act as a workflow organizer for pediatric radiologists experiencing burnout from an intense workload. But while the technology continues to mature, it is critical for the people guiding the technology to carefully consider its application.

"Burnout is a very large term for a lot of different causes," said Stacey Funt, M.D. Funt previously worked as a full-time body radiologist in New York before her own experiences with burnout caused her to reorder her priorities. She now works in radiology part-time while speaking across the U.S. as a health and wellness coach for healthcare providers through her own company, Lifestyle Health LLC. Funt's experience with burnout stemmed from a perceived loss of connection with other doctors and her patients. Ultimately, she believes that the most helpful technological solutions are those that can help improve communication across the healthcare continuum. This could be especially helpful for the subset of radiologists who identified being on-call as a potential source of burnout. "I think a lot of things that place stress on radiologists, especially those on-call, is when you need to contact referring physicians or when you need to relay information and you can't find people. So it all depends on the issues for each person, and that's variable," she concluded. itn

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First Clinical Experience With the RayCare OIS

Iridium Cancer Network consists of all seven hospitals in the Antwerp region, closely collaborating regarding radiation oncology. The network acts as a single radiation therapy department, making it the largest in Belgium with its annual 5,300 patients. Iridium was first to use the RayCare* oncology information system (OIS) clinically, only two months after it was released from RaySearch.

Iridium Cancer Network became a RaySearch customer in 2015 when choosing RayStation for its treatment planning. Iridium quickly appeared as an obvious choice of clinical partner to develop RayCare, the next-generation OIS, as the department spreads over seven hospitals. This, combined with a strong interest for clinical innovation, made the network a very attractive partner to develop aspects of RayCare related to coordinating cancer care efforts between institutions.

It made perfect sense to help RaySearch develop such an OIS, said Piet Dirix, radiation oncologist at Iridium.

"For me, the partnership with RaySearch was an absolute no-brainer. We needed to have an OIS that we could trust and that would help us tremendously with our workflow. Hearing that RaySearch was developing such an OIS and that they were actually looking for clinical partners to develop it with them, I became incredibly enthusiastic and we really wanted to participate in that," he said.

Seamless Integration With RayStation

Iridium became a clinical partner to RaySearch in late 2015 and has since made a strong contribution to develop RayCare, especially with features that will support coordinated activities between different institutions. The first steps of the clinical use were done with a focus on planning workflow support and image management using RayPACS, a picture archiving and communication system (PACS) that makes it fast and easy to retrieve and share images.

"With RayCare, we can just label an image in RayPACS and then the system handles the import from RayPACS to RayStation. When launching RayStation, the patient information is there, your CT is there and you can start work directly with your patient. This is a big improvement," Gert De Kerf, medical physics expert, said.

The tight integration between RayCare and RayStation simplifies the teamwork between clinicians, especially when different clinicians can be working on a single patient at different steps of the treatment process.

"Here at Iridium we work as a team to treat the patients. So, it is possible that I delineate a CT scan, that my colleague approves a plan, and another revises the adjustments that are made to the plan. In that way, RayCare is very crucial to the way we work," said Carole Mercier, radiation oncologist.

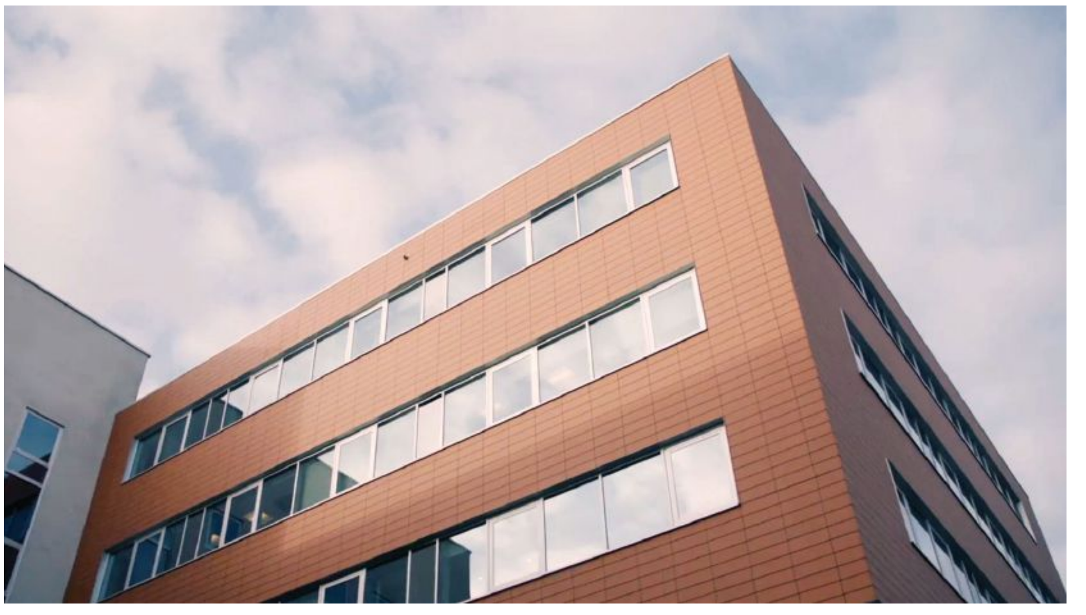
"Before the implementation of RayCare we had some problems with commenting when a plan was rejected. Now, thanks to RayCare and the feedback loops, this is simplified," De Kerf said.

The seamless integration between the systems is great, said Dirix.

"What I am most satisfied with is the close interaction with RayStation. When I push on a certain task in RayCare, RayStation immediately opens at the right patient, in the right time of his or her workflow. This really saves time," he said.

After a few months of using the RayCare OIS they can already note some efficiency improvements. RayCare and RayStation are used together on one Linac at Iridium, which is actually the linac with the shortest waiting time within the network, according to Dirix.

"There are now around three days wait at the machine where we have RayCare and RayStation, compared to around 21 days at the other linacs. This shows you how powerful the combination is," Piet said.



ABOVE: Iridium Kankernetwerk consists of all seven hospitals in the Antwerp region

RIGHT: Piet Dirix, radiation oncologist at Iridium.

Simplified Workflow

On top of the close interaction with RayStation, RayCare provides other valuable advantages. It has simplified the patient intake consultation process and reduced issues from 25 to 5 percent. RayCare's schedule automation feature made it much simpler to find the optimal treatment date, eliminating the delays that could result from the complexity of the manual scheduling.

RayCare has been developed by RaySearch to meet the ends of the needs of diverse cancer centers to enable them to give the best possible care to their patients. Therefore, in RayCare digital workflows tailored to the clinic's needs can be created. The workflows are designed to be highly configurable and tasks for specific staff members can be created automatically, triggered by defined events.

The workflows used at Iridium are custom made and set up in collaboration between Iridium and RaySearch. Six workflows for five tumor groups were specified to Iridium's needs, with a focus on automation and optimization.

"On the stereotactic treatments we treat five different tumor groups and for these patients six workflows were created. They were all made to our specific needs; for example, we needed an anchor date for an MRI. RayCare now has an anchor date for the MRI," said Mercier.

Comprehensive Cancer Care is the Future

Centers today often use multiple software systems, including systems for radiation oncology, medical oncology and surgical oncology. The aim with RayCare is to combine these into a single, harmonized system to manage the patient's entire oncology treatment — from scheduling through treatment delivery and follow-up.

Iridium shares that same ultimate vision of a borderless oncology environment and the future results of the partnerships look very promising.

"I think the future of cancer care will be comprehensive. I think we have to break down the walls between radiation oncology, medical oncology, surgery and especially pathology. These need to be incorporated into a single OIS, and that is exactly what RayCare allows you to do," said Dirix.

** Subject to regulatory clearance in some markets.*

For More Information: www.raysearchlabs.com

The Development of Tungsten Collimators May Advance Medical Imaging

3-D print allows a new method to shape the extremely hard material

By Steve Jeffery

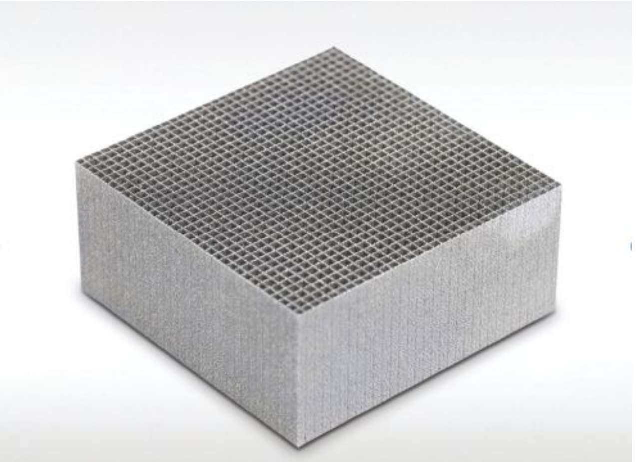
In molecular radiotherapy (MRT) treatment of the thyroid, existing single photon emission computed tomography (SPECT) imaging systems are unable to accurately measure radiation absorbed by patients during and after treatment. As a consequence, only limited information regarding the success of radiotherapy treatment has been available.

For the last six years, teams from the University of Liverpool's Department of Physics and The Royal Marsden and Royal Liverpool University Hospitals have been working to develop an imaging system (known as DEPICT) that would better measure the absorbed radiation dosimetry. The aim is to provide a more accurate treatment and diagnosis of patients.

Central to the imaging system's scanner is a collimator. This is a device which aligns the beams of radiation emitted from the patient so that they are directed onto a detector. The radioactive iodine is ingested by the patient in liquid or capsule form, and then gamma rays are emitted in all directions through the patient, yet only the rays which are aligned with the collimator holes will make it through to the detector. The data received can then be converted into an image on a computer screen.

Previously, lead was the preferred material for collimators. However, tungsten is much more efficient than lead at screening unwanted gamma beams. Additive manufacturing now allows the collimators to be made in tungsten, resulting in much clearer images of the radiation dose received by the patient.

A critical part of the new imaging system is the use of a direct-digital conversion, cadmium-zinc-telluride (CZT) detector. This part is used in conjunction with a parallel hole collimator with an active area comprising an array of 0.6 mm holes. Traditionally made of lead, collimators on the market were not up to the task of supporting the new DEPICT system, because it required a very intricate design that was not possible to create from this relatively soft material. Researchers hit on the idea that high-density tungsten could be the ideal material if they could find a way shape it into the required collimator.

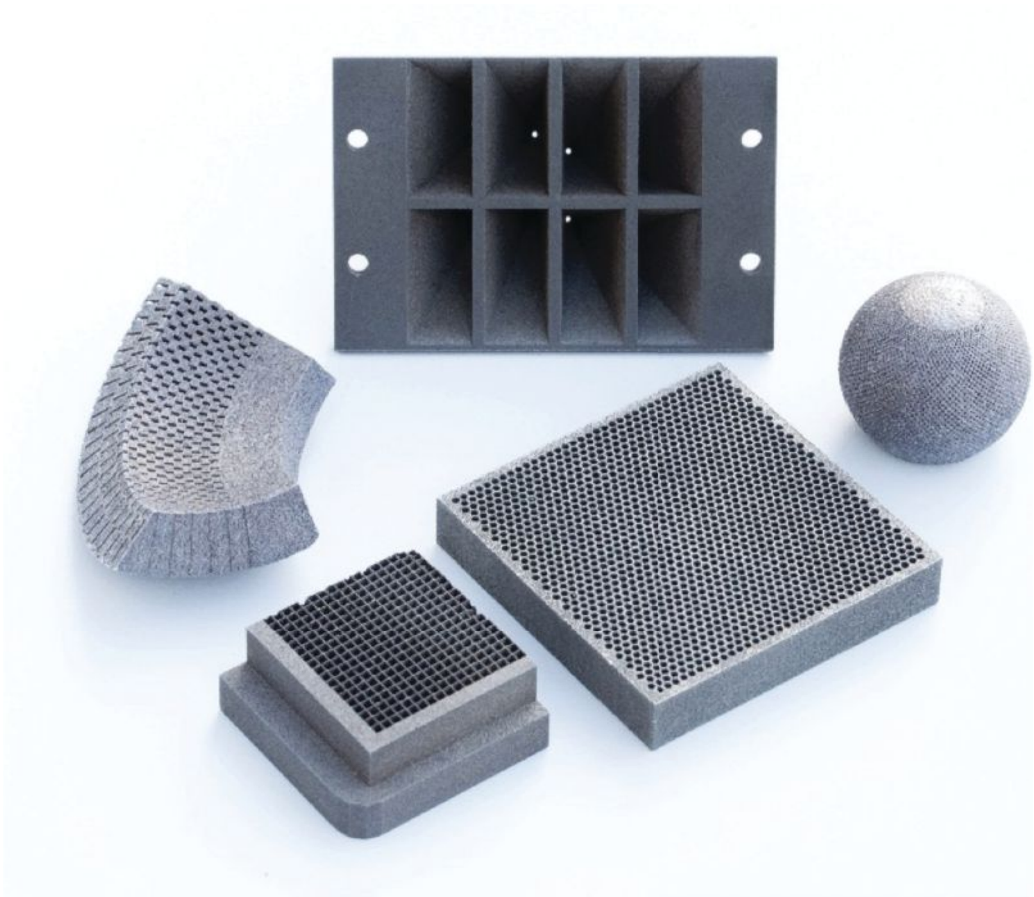

WOLFMET

A 3-D printed tungsten pre-clinical X-ray system collimator.

Tungsten Difficult to Use But Ideal

Tungsten's density is around 1.7 times that of lead traditionally used in collimators, but it is difficult to work with because it has the highest boiling and melting points of any element known to man. It also means there is no other material in the world capable of holding tungsten as a molten liquid, so it cannot be cast into high precision shapes in the manner of iron, aluminum and other common metals. That is until now.

A group of experts in the U.K. recently began 3-D printing of intricate geometrical shapes from tungsten alloy powder as a new



WOLFMET

Examples of complex 3-D tungsten shapes formed by additive manufacturing techniques. The tungsten alloy powder is printed into the form desired and is laser fused so it can be machined and finished. Previously, making collimators from Tungsten was labor intensive because it required working with sheets of the metal to create the collimator matrix.

method to work with material. A team from Wolfmet, a company that makes components for automotive and aerospace, developed this highly specialized additive manufacturing metallurgy process, essentially fusing the tungsten alloy powder together. A high-powered laser is applied to fuse successive layers of pure tungsten powder until a complex component is built. Once fused, the powder is pressed into parts, sintered and then machined into the desired form.

The Wolfmet tungsten team has developed a highly specialized metallurgy process, essentially fusing successive layers of tungsten powder to build a finished component.

The method is ideal for the manufacture of high-precision components such as collimators and radiation shields in CT, SPECT, MR and X-ray imaging systems. Furthermore, the technique allows components to be produced cost effectively in days and weeks rather than months.

> With its excellent attenuation properties, a tungsten collimator significantly reduces septal penetration in comparison with the same collimator made from lead, resulting in much improved image quality.

The technique, also called selective laser melting (SLM) or direct metal laser sintering (DMLS), is an additive manufacturing technique which, for the first time, enables the production of individual metal components with complex geometries without the need for part-specific tooling. The additive manufacturing process uses the high energy laser to shape the layers of metallic powders to form three-dimensional components.

The geometries that can be achieved are not possible using traditional machining, otherwise known as subtractive manufacturing. By removing this design limitation, the possibilities are almost endless. When tungsten's excellent radiation absorption combined with good thermal resistance is added into the mix, the possibilities become genuinely exciting.

The end material is an alloy, of 90-97 percent tungsten depending on the grade. This material retains the unique density and radiation shielding capabilities of pure tungsten however, for the first time, it can also be machined to tight tolerances.

Creating a 3-D Printed Collimator

The team at Wolfmet helped create the world's first collimator of its kind for the DEPICT system. After undergoing recent trials, the group reported great success. With its excellent attenuation properties, a tungsten collimator significantly reduces septal penetration in comparison with the same collimator made from lead, resulting in much improved image quality.

"The final product shows great potential to enable better radiotherapy treatment monitoring," said Samantha Colosimo, Ph.D., project manager, Optimization of Medical Accelerators (OMA) Project, University of Liverpool.

The team working on the project is hopeful that the DEPICT imaging system will be available commercially in the next three years.

The implications could be significant; the ability to individualize treatments is expected to reduce healthcare costs by providing speedier and more efficient treatments. Importantly, it is hoped that this development will increase rates of successful cancer treatment, leading to improved quality of life and health for those patients.

Applications Outside of Healthcare

The same principals of 3-D printing tungsten could mean huge advances in other sectors outside of healthcare.

Airport and cargo scanners used to examine the contents of transport containers could be upgraded in the same way using tungsten collimators. The scanners often have tungsten grids that screen out stray X-ray beams to give a more accurate image. These grids are currently built up manually from many individual tungsten sheets, but could soon be replaced by monolithic SLM parts.

The application of the metallurgy process allows these complex parts to be manufactured as a single component. This results in a much shorter delivery time and eliminates a lot of costly hand assembly work.

The geometrical detail, which can be incorporated into the tungsten, could now mean that increasingly complex components can be created. In the future this means it may be possible to provide handheld, lightweight medical scanners that can be used to home in on individual organs while producing similarly accurate images.

Tungsten properties are well known, but only now can they be harnessed more fully through this new manufacturing method. **itn**

Steve Jeffery is the business development manager for Wolfmet's 3-D printed tungsten components division.

4-D Guided Prostate Treatment: The Future of OIM-directed Therapies

New information management technologies advance image guided treatment since tumor volume, capsular margins and aggression parameters are quantifiably evaluated before, during and after therapy in 3-D

By Robert Bard, M.D., DABR, FASLM

Extracapsular extension (ECE) is a major clinical indicator for brachytherapy or external beam treatment of prostate cancer. The prostatic capsule is a thin layer of compressed fibrous tissue and ultrasound imaging depicts the pericapsular fat as a strongly echogenic structure while magnetic resonance imaging (MRI) demonstrates a dark envelope. The capsule tends to be incomplete around the apex accounting for greater extraprostatic spread from apical tumors. Applying standard diagnostic criteria, capsular erosion must appear in two orthogonal views or in multiplanar 3-D volumetric sonography 2/3 planes. Unlike standard ultrasound where the operator moves the probe, volumetric 3-D transducers are stationary as 200-300 images are captured in 10 seconds, removing the problem of operator dependency and allowing rapid review and accurate comparison of pathology in subsequent studies. (See **Figure 1.**)

Capsular invasion occurs with infiltration of the cancer into the fibrous capsule. Capsular penetration is tumor invasion extending beyond the capsule that produces bulging, irregularity of the capsule and gross tumor noted invading the fascial planes, rectal serosa or levator sling muscles. Perineural invasion, a microscopic diagnosis, cannot be inferred from diagnostic imaging at this time. However, the nerve supply of the gland tends to follow the major arterial network and is imaged with color Doppler sonography (CDS) or power Doppler sono-angiography (PDS). Capsular lateral wall erosion is often best imaged in the coronal view on 3-D PDS, while posterior erosion usually is best depicted on the transverse 3-D PDS. MRI, with its inferior capsular resolution (including endorectal coil scans) may not always confirm extracapsular disease clearly exhibited on high-resolution sonography.[1-7] During examination of a suspicious capsule finding, the real time 4-D mode might be used to target the anomaly and better image the full anatomic extent of penetration with curvilinear probes.

Quantifiable Digital Scanning Versus Biopsy

The new optical dermatologic modalities of reflectance confocal microscopy (RCM) and optical coherence tomography (OCT) are highly accurate in detecting malignant capsular penetration and are used in other solid organ tumors such as breast, thyroid and prostate tumors with great accuracy, but limited depth penetration. Highly suspect areas are then checked for spread to the seminal vesicles, and a search is performed for lymphadenopathy to verify the disease is locoregionally confined and surgical intervention is unlikely at this time. Patients are reassured since they simultaneously see the 3-D picture as the real time exam proceeds in thoroughly logical, systematic staging. Four-dimensional sequencing (real time 3-D) permits image-guided biopsy of the most virulent area of the tumor and allows the pathologist to focus on strongly suspicious regions of the lymph node mass excised during prostatectomy. Similarly, during examination the patient may personally visualize extraprostatic disease or seminal vesical invasion so plans for radiation or other therapies may be initiated in a timely manner.

Digital Imaging Reduces Complications

Fear of complications deters patients from seeking medical intervention so many opt for noninvasive diagnostic options. Cancer treatment effectiveness depends on the precise tumor volume and depth penetration measurements. However, many cancers provoke a benign local immune response or there may be co-existant inflammatory reaction that simulates a larger area of malignancy, such as cicatrix formation accompanying chronic prostatitis, that is indistinguishable on MRI from a stone or malignancy. Imaging highlights the true border of the tumor, optimizing targeting for healthy tissue sparing and resulting in a narrower treatment zone and lesser side effects.

Doppler Applications

Blood vessel mapping using the various Doppler modalities is routinely used in both cancer treatment and reconstructive preoperative planning. In cancer radiation, the presence of aberrant large veins or significant arteries in the treatment field may allow post-treatment vasculitis to be minimized. Advanced 3-D Doppler systems allow for histogram vessel density measurement of neoplastic angiogenesis. (See **Figure 2**.) This baseline of neovascularity is used worldwide as a reliable treatment parameter and serves as an accurate surrogate endpoint.[8-22]

Low grade prostate cancer identified by 4-D volumetrics clearly delimited by the capsule and of low tumor vessel density is followed serially in 6-month intervals. Subsequent capsular invasion or increase in vessel density by histogram analysis requires urologic or oncologic measures. Primary bladder cancer or extracapsular extension into the bladder is evaluated concomitantly with the prostate and neovascularity and wall invasion noted before surgical referral. Rectal and bladder post-radiation effects may be moderated by pretreatment placement of tissue buffering devices under ultrasound image guidance.

Contrast Enhanced Ultrasound (CEUS)

In 1990 Rodolfo Campani, M.D., director of the University of Pavia Radiology Department, developed ultrasound contrast-enhanced cancer imaging for liver tumors followed by David Cosgrove, M.D. (London), Nathalie Lassau, M.D. (Paris) and Carlo Catalano, M.D. (Naples), for breast, prostate and melanoma respectively. CEUS is currently used worldwide, but not fully FDA-approved in the United States. Microbubble media show tumor neovascularity with exquisite detail, evaluating therapeutic response in solid organs. This distinction is important since the international response assessment in solid tumors (RECIST) studies demonstrated tumor enlargement during treatment may be related to apoptotic cell death with cystic degeneration or immune cell infiltration destroying malignant tissue while

> The new optical dermatologic modalities of reflectance confocal microscopy (RCM) and optical coherence tomography (OCT) are highly accurate in detecting malignant capsular penetration, and are used in other solid organ tumors such as breast, thyroid and prostate tumors with great accuracy but limited depth penetration.

increasing the visualized tumor volume. Doppler ultrasound or CEUS reliably verifies decreased malignant angiogenesis in these cases instead of using biopsy, contrast computed tomography (CT) or DCE-MRI for confirmation. Thermal treatments such as cryotherapy, high-intensity focused ultrasound (HIFU) or laser ablation are designated complete when penetrating cancer arteries are no longer detectable. It must be noted that prostatitis and post-treatment changes by radiation or other therapies distorts the expected imaging anatomy by most modalities, and the true evaluation of recurrence is best determined by functional vascular perfusion studies that are superior surrogate tumor markers to other clinical indicators. A recently recognized immuno-oncologic response limiting positron emission tomography (PET)/CT accuracy is termed "pseudo-progression" demonstrating overall tumor burden increases during successful therapy. Shrinking tumors may likewise be biologically viable as is occasionally seen from the aggressive desmoplastic reaction to certain high-grade breast cancers. Post radiotherapy imaging in successful cases may show decrease in tumor neovascularity in as short a time period as 1-2 weeks, suggesting short interval neovascular evaluation as a better indicator of effective response than standard protocols. In the future, ionizing treatments may be considered effective when tumor vessel perfusion has completely ceased at a 3-month scan interval and further biopsies possibly obviated. Post-radiation prostate-specific antigen (PSA) spikes are quickly shown to be false positives due to prostatitis or bone metastases rather than actual recurrence in the treatment glandular area.

Margin Delineation

Advances in laser/optical devices allow near microscopic tissue analysis of the cells by noninvasive testing. Real time microscopy during surgery verifies the tumor border is clear in cases of skin cancer, and future use in breast and prostate cancer treatment is under clinical study. In true capsular penetration, radiation treatment becomes a prime clinical option. Since the 18 MHz probe is directly in contact with the capsule, the resolution is five times greater than MRI capability. DCE-MRI is routinely used to verify malignant lymphadenopathy or bone metastases, and has been highly successful after 3-D/4-D imaging has ascertained and localized the extraprostatic disease.[23] Another potential use of margin neovascularity is the problem with anatomic pathologists seeing biopsy specimens that appear malignant but not being able to assess if the microscopically abnormal cells are biologically active. Some of the newer optical applications image capillary blood flows, meaning the total absence of microcirculation may signify a treated tumor under the microscope may look active, but be functionally inactive at this time.

Autoimmune Disease, Toxic Exposure and Cancer

Abnormal immune responses that initially appear in the skin are associated with increased multiorgan cancer incidence including breast and prostate disorders. Inflammatory vessels in psoriasis and infection are visibly observed and quantifiably cataloged since successful treatment is calibrated by measured decrease in the number and type of abnormal vessels. High vascular immune vessel density is proportional to increased risk of future neoplastic tissue proliferation. Many arthritic conditions have coexistent dermal manifestations alerting us to the probability of more extensive subclinical joint involvement. Thus patients with proven collagen disorders, contact dermatitis of unknown etiology or overexposure to toxins as we see in the 9/11 first responders are candidates for cancer screening at 6 month intervals. The statistics from the cancer organizations monitoring the World Trade Center disaster have found the incidence of skin cancers to be highest followed by bladder and prostate cancer. The general public is sensitized to the fact that our contaminated food supply, medicines and overall environment has increased our risk and are demanding more accurate cancer detection options.[24] A study by William Oh, M.D., reported in *Business Insider*, June 2019, done at Mt Sinai on the firefighters showed a surprising result that toxic dust inhalation produced more prostate cancers than lung cancers in the Ground Zero responders.[25] Clearly more attention needs to be paid to environmental carcinogens and increased cancer screening will discover more disease at a lower stage, improving overall survival.

Since 1974, Robert L. Bard, M.D., PC, DABR, FASLMS, has pioneered noninvasive digital imaging technologies as alternatives to radiation-producing diagnostic systems for evaluating solid organ neoplastic disease. He is internationally recognized as a leader in the field of 21st century 3-D ultrasonographic volumetric Doppler imaging. He specializes in advanced 3-D sonography to detect cancers in numerous organs including the breast, prostate, skin, thyroid, melanoma and other areas. His images are used to accurately guide biopsies, target therapy and provide focused follow-up after treatment.

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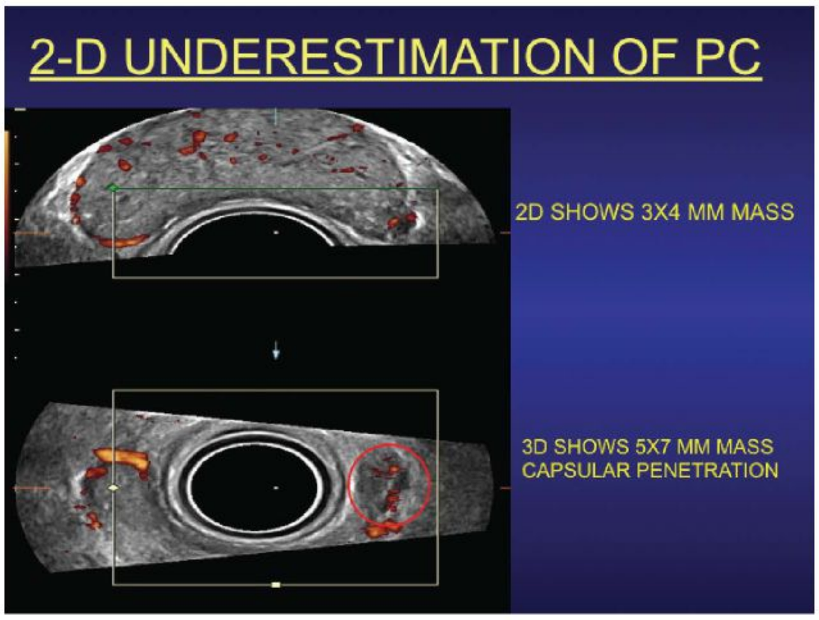

Figure 1. 2-D (top) vs 3-D (bottom). The irregularly marginated left tumor mass that bulges the lateral capsule appears three times the volume on the multiplanar 3-D/4-D image reconstruction and shows complete extraprostatic extension. ***Note:*** This anterolateral lesion is not clinically palpable.

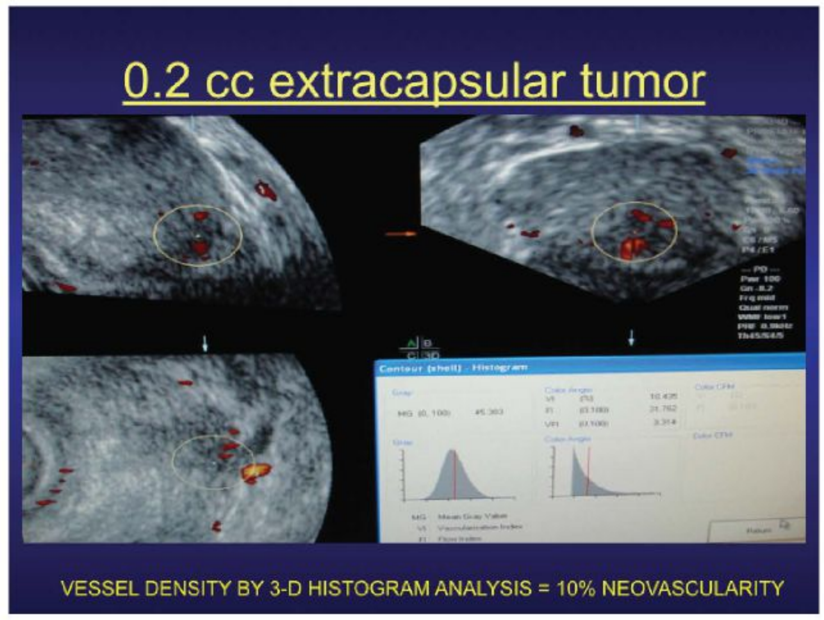

Figure 2. Histogram-volumetric study shows extracapsular tumor has a 10 percent malignant vessel density, which can be used as a reference measurement to assess treatment effect on serial scans.

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This device is intended for retrospective and statistical data management and visualization. It is not intended for real time data visualization, diagnostic applications or for any other use for which the device is not indicated. This device is only to be operated by and under quasi-continuous supervision of qualified and trained staff in an appropriate licensed health care facility.

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Bracco Injeneering S.A., located in Lausanne, Switzerland, is the most recently added Business Unit of Bracco Imaging. Bracco Injeneering is committed to develop the best-in-class integrated injection solutions with a strong heritage in research and innovation. It provides quality solutions for state-of-the-art radiology centers, offering proven injection technology, built on Bracco Imaging's expertise.

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CONTRAST MEDIA AND

The global rise in chronic disease has significantly increased demand for diagnostic imaging procedures, and in turn, contrast media to enhance those images. More than 30 million imaging procedures are performed each year in the U.S., and 60 percent of contrast imaging agents sold are iodinated contrast agents.[1] Although considered safe for the general population, iodinated contrast agents may place patients at an increased risk for nephrotoxicity, especially those with certain risk factors undergoing cardiac interventional procedures. Renal function impairment due to nephrotoxicity can be temporary or permanent, with potentially life-threatening complications requiring rehospitalization or dialysis — or even resulting in death.

Acute deterioration of renal function shortly after administration of iodinated contrast material is known as contrast-induced acute kidney injury (CI-AKI). It occurs most frequently following coronary angiography, percutaneous coronary intervention and contrast-enhanced computed tomography, especially in patients where advanced age, diabetes or heart failure increases renal injury risk.[2] With more than 50 perecent of cardiovascular imaging procedures being performed on patients 65 and older, CI-AKI is an issue with broad visibility.[3]

Although the Acute Kidney Injury Network (AKIN) has standardized criteria for diagnosis of CI-AKI, there is no consensus on the serum creatinine level or eGFR beyond which a patient's risk should contraindicate contrast media use. Without specific guidelines, management of at-risk patients varies and is driven mostly by clinicians' individual judgment.

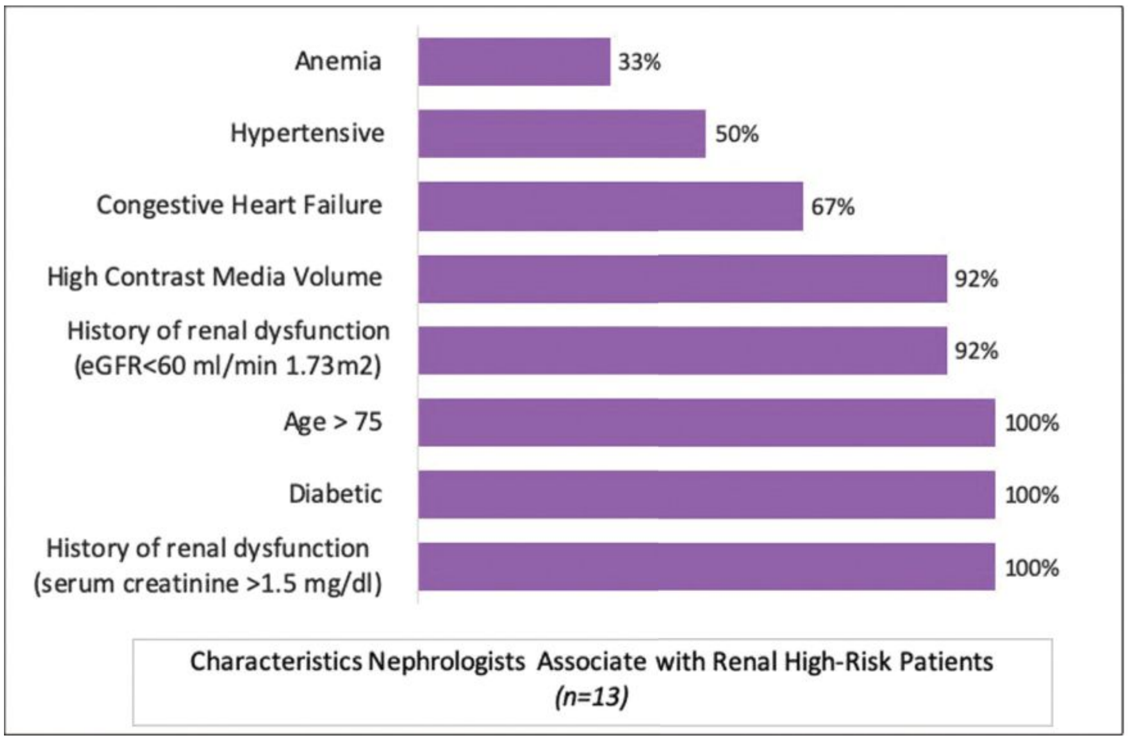
Physicians Want A Safer Contrast Media Option

A recent survey of 63 hospital specialists involved in contrast-enhanced angiography was fielded to understand their concerns and decision-making in selecting contrast agents.[4] Results were presented at FASEB-AKI in July 2019. As specialists with input or decision-making roles in contrast selection — radiologists, interventional cardiologists, radiopharmacists or nephrologists — all respondents were familiar with current contrast agent options, including iohexol and iodixanol.

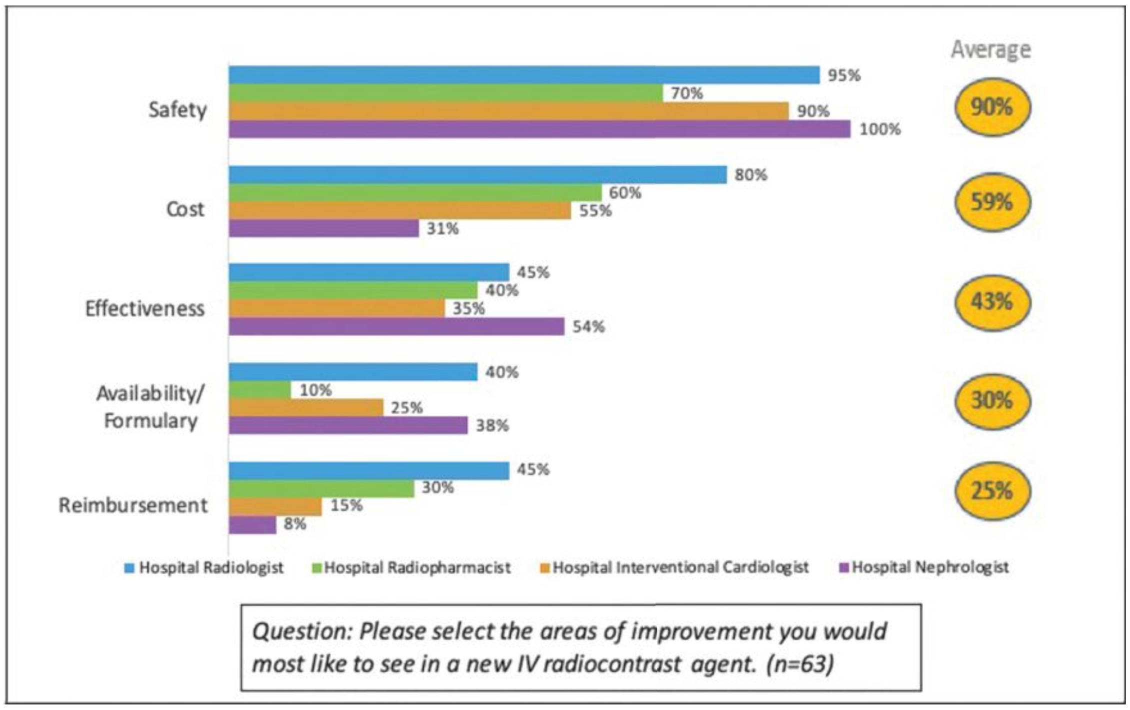
The need for safer contrast agents emerged as a common theme.

Ninety-eight percent of survey respondents reported pre-screening prospective patients for elevated renal risk. Nephrologists estimate 23 percent of patients have elevated risk, with associated conditions ranging from anemia and hypertension, to diabetes and history of renal dysfunction.

Fully 90 percent of responding clinicians reported deferring patients from contrast imaging because of



Characteristics nephrologists associate with renal high-risk patients. (n=13)



Increased safety in general was the most desired improvement for IV contrast agents, followed by reduced cost and effectiveness.

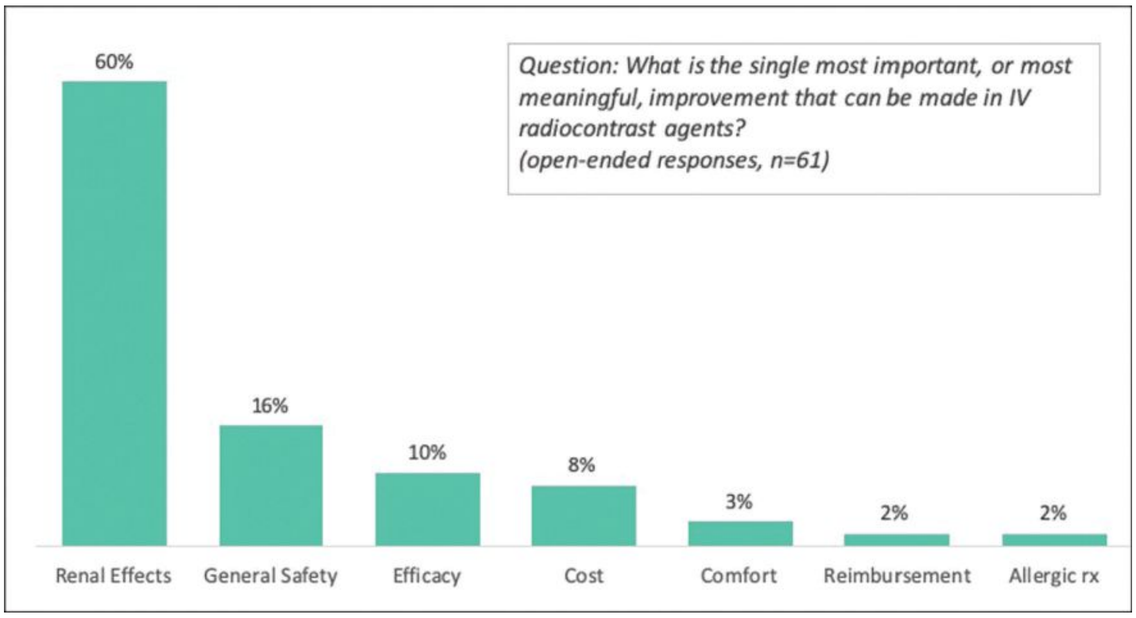
RENAL RISK MITIGATION

renal risk with, on average, 12 percent of all patients being deferred. Not surprisingly, nephrologists defer considerably more patients than do other specialties (18 percent vs. ≈11 percent).

When risk mitigation measures are employed for high risk patients, on average 86 percent of physicians reported using hydration protocols, 82 percent use reduced contrast agent volume/reduced repeat dosing and 72 percent use alternative contrast agents.

Increased safety in general was the most desired improvement for IV contrast agents, followed by reduced cost, and effectiveness.

Renal toxicity reduction, specifically, was identified as the single most important improvement needed with contrast agents.



Renal toxicity reduction, specifically, was identified as the single most important improvement needed with contrast agents.

The Need for Renal Safe Contrast Agents

Iodinated contrast agents are highly water-soluble and carbon-based, with the most common types used today either low-osmolar nonionic monomers (iohexol, iomeprol, iopamidol and others) or iso-osmolar iodixanol. It is thought that the higher the osmolality or particle concentration in the contrast solution, the greater the vascular symptoms of warmth or pain during injection, as well as risk of CI-AKI.[5] After completed IV procedures, there may be stasis of contrast within the kidneys, and nephrograms have shown contrast media in the kidneys of CKD and diabetes patients up to eight days after it was administered.[6]

The primary strategies for reducing this risk for patients are to select less toxic iodinated contrast agents and to use doses as low as reasonably achievable. But in patients with high-risk profiles, there is no absolute safe limit of contrast dosage. In a 2016 study, it was reported there were no adjunctive pharmaceuticals proven effective at preventing or treating CI-AKI.[7]

The Development of Captisol-enabled Iohexol

With this in mind, a team of scientists at Verrow Pharmaceuticals (acquired by Ligand Pharmaceuticals in January 2018) studied the effects of reformulating iohexol (the most widely used iodinated contrast agent) with Ligand's Captisol, a patent-protected, chemically modified cyclodextrin (sulfobutylether-β-cyclodextrin, or SBECD). Captisol solubilizes insoluble drugs for IV injections and improves stability, bioavailability and dosing of active pharmaceutical ingredients.

Preclinical studies demonstrated that when Captisol is added to iohexol and administered to rodents, significant reductions occur in tubular dilation, vacuolization and loss of brush border.[8] Serum creatinine levels in mice were observed to increase after contrast administration and were then mitigated by addition of Captisol. Rats did not show the same increase in serum creatinine, but did show significant functional benefit of Captisol and survival was increased from 50 percent to 88 percent. Iohexol with Captisol showed reduced kidney injury to rodents from contrast doses similar to those used in clinical human settings. The addition of SBECD showed no adverse effects, instead acting protectively and blocking damage to the kidney.

In July 2019, Ligand announced positive top line results from a Phase 1 clinical trial of its Captisol-enabled (CE) iohexol program.[9] Based on top line data, the trial achieved the primary endpoint demonstrating pharmacokinetic bioequivalence between CE-Iohexol injection and a reference Iohexol injection (OMNIPAQUE) after IV administration in healthy adults. CE-Iohexol injection was safe and well tolerated, and adverse events were in line with the known safety profile of OMNIPAQUE. Details and data from the Phase 1 trial have been submitted for presentation at future scientific conferences.

With a large potential market and lack of viable alternative options for reducing the risk for CI-AKI, Captisol-enabled iohexol is anticipated to potentially establish a new safety standard in the clinical use of iodinated contrast agents.

About Ligand Pharmaceuticals

Ligand develops or acquires technologies that help pharmaceutical companies discover and develop medicines. The company creates value for stockholders through a diversified portfolio of biotech and pharmaceutical product revenue streams, supported by an efficient and low corporate cost structure. Ligand offers investors an opportunity to participate in the promise of the biotech industry in a profitable business with lower risk than is typical in the industry.

Ligand's business model is based on doing what they do best — drug discovery, early-stage drug development, product reformulation — and partnering with other pharmaceutical companies to leverage what they do best — late-stage development, regulatory management and commercialization. Ligand has established multiple alliances, licenses and other business relationships with the world's leading pharmaceutical companies including Amgen, Merck, Pfizer, Celgene, Gilead, Janssen, Baxter International and Eli Lilly.

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SIIM 2019 Shines Light on AI, Cybersecurity

Pragmatism reigns while cloud technologies rise at the Society of Imaging Informatics in Medicine meeting

By Greg Freiherr

Philips and Fujifilm booths at SIIM 2019.

Photo by Greg Freiherr

Pragmatism from cybersecurity to enterprise imaging was in vogue at the 2019 meeting of the Society of Imaging Informatics in Medicine (SIIM). Not unexpectedly, artificial intelligence accounted for much discussion amid telltale cracks in its hype.

Exerting pressure was an undercurrent of practicality, bubbling up in session talks by key opinion leaders (KOLs) and from the exhibit floor, where some company representatives spoke of the continuing need for artificial intelligence (AI) to demonstrate an ROI (return on investment).

This doff of the hat to practicality could be seen in the format of scientific sessions, which were kicked off by luminary speakers providing the context in which to understand research data presented in follow-on talks. Among the takeaways were that:

- Natural language processing (NLP) can extract information from the free text of radiology reports;
- Smart algorithms might provide a safety net for patients and providers by keeping track of important follow-up recommendations in radiology reports;
- Simple neural networks can be better than a complex one; and
- Smart software can improve the performance of resident radiologists to the expert level. (Some evidence shows that, even on its own, the software can outperform non-expert radiologists.)

Other sessions featured faculty, as in the case of one about cybersecurity hosted by J. Anthony Seibert, Ph.D., an imaging physicist on the radiology faculty of the University of California in Davis.

Security Attracts

Just being aware of the security threat posed by hackers is an important first step forward, Seibert said. Easy to do and low-cost follow-on steps can go a long way toward keeping hackers away, he said. These include backing up disks, encrypting laptops and patching known shortcomings in software.

Security was on the mind of Woojin Kim, M.D., chief medical imaging information officer for Nuance Communications, when he spoke about the significance of blockchain in medical imaging. Formerly a practicing radiologist at the University of Pennsylvania Health System, Kim sought to "demystify" blockchain technology, describing what it is and how it is relevant to medical imaging. Increased security, a result of blockchain's inherent design, was one of its advantages, he said.

Enterprise Imaging Architect Matthew Hayes, MBA, CIIP, spoke on ways to fix a floundering enterprise imaging network. Hayes described how to clean up problem areas in the session titled "Tidying Up."

AI Attracts Attention

Surprising no one, SIIM 2019's buzz acronym was AI. But speakers, including Charles E. Kahn, Jr., M.D., FACR, professor of radiology at the Hospital of the University of Pennsylvania and vice chair of the department of radiology at the University of Pennsylvania, and company reps on the exhibit floor offered it up with pragmatic aplomb. At the Dwyer Lecture, Kahn described how to make AI safe, effective — and humane. (To be humane, AI must show that it can improve "the care of our patients" while preserving the "dignity, beneficence and autonomy" of physicians, according to Kahn.)

KOLs and company reps lauded AI for its potential, but said smart algorithms have to prove their value. A luminary presenter at one session, Stephen B. Hobbs, M.D., medical director of imaging informatics at the University of Kentucky, said there are some excellent use cases for AI — but "we will find some cases where (AI) does not really work the way we need it to — at least not until a long time down the road."

Greg's Journal

Day One: Tuesday

9:45 p.m. (SIIM time, aka Mountain Daylight) — Land at Denver Airport. The wait for a hotel shuttle takes a lot longer than the ride to the hotel 7 miles away.

Day Two: Wednesday

9:02 a.m. — Take Lyft to conference. New construction punctuates light traffic — traveling miles in just minutes; love the commute.

9:30 a.m. — Pick up badge; take a hike — a long one — to exhibit floor. Browse booths; speak with sales reps.

10:07 a.m. — GE is decidedly old school from its messaging ("Elevating Radiology") to its (mostly) blue-colored booth. Collaboration plays a prominent role. Centricity Solution for Enterprise Imaging is grounded in data management and sharing. The objective? Increased efficiency. Depending on the radiologist this can translate into more time for academic pursuits, diagnosing tougher cases or participating on the patient care team.

10:32 a.m. — IBM's booth runs the gamut from Watson Health to interoperability to functionalities that ingest, manage, store, view, share and exchange medical images. All are mixed in with history going back to Merge Healthcare (the formerly standalone PACS and services vendor acquired in 2015 by IBM).

10:43 a.m. — Multimodality display screens dominate Eizo's SIIM booth.

11:01 a.m. — Ambra's message: stop using CDs to transfer patient images; next-generation image management tools make more sense. Cloud-based technologies are better suited to the future management, uploading and sharing of images.

11:17 a.m. — Barco launches a remote reading solution built around its eGFX graphics box, which securely drives medical-grade displays. Supporting the launch are the growth of teleradiology and the need of prospective employers to meet the expectations of young radiologists to strike a 21st century life-work balance. The technology is designed to give radiology employers an advantage by providing a secure and uniform work environment regardless of location — be it in a hospital, clinic or home. (Automated QA and calibration remove the challenges of managing medical workstations across multiple locations, according to the company.)

11:30 a.m. — Konica Minolta Healthcare frames its Exa platform as providing secure access across the enterprise. But the technology can be more narrowly focused as a radiology PACS or RIS (radiology information system); for a single purpose, for example, to support radiology billing; or for image archival and retrieval in mammography, orthopedics or cardiology.

1:15 p.m. — Luminary speaker Curtis Langlotz, a professor of radiology at Stanford University where he researches machine learning technologies, opens a session on natural language processing (NLP). Waxing nostalgic about how language has evolved, Langlotz describes how words contained in radiology reports today might serve as "vectors" that AI can use to process text. SIIM presenters later in the session describe how NLP might be built into smart algorithms. In the role of spotting incidental findings that need follow-up, these algorithms could serve as safety nets to catch radiologist recommendations that might otherwise fall through cracks.

Vital Images features optical camera as important part of enterprise imaging.

Photo by Greg Freiherr

Aidoc algorithms cover key regions of the body. They can be "always on" thanks to AI Orchestrator.

Photo by Greg Freiherr

Day Three: Thursday

8:01 a.m. — University of Kentucky Medical Informatics Director Hobbs starts a session on machine learning in chest imaging. Afterward, he says metaphorically, "some fruit can be picked with relative ease," for example, pneumonia, lung nodules and cancers. Whereas others, such as interstitial lung disease, COPD and diffuse pulmonary disease, are "considerably more challenging." Artificial intelligence is in its infancy, but it will gain traction over time, he predicts.

11:02 a.m. — Aidoc's smart software can be "always on," and "comprehensive," according to a rep at the company's SIIM booth. Integrated into clinical workflows through Aidoc's "AI orchestrator," FDA-cleared algorithms can evaluate imaging results for intracranial hemorrhage, fractures of the spinal vertebrae, and pulmonary embolism. The software might then notify radiologists of anomalies. Aidoc algorithms have "critical impact as opposed to being scientific only," a company rep tells me.

11:30 a.m. — Carestream and Philips are just an aisle apart on the exhibit floor. But the juxtaposition is coincidental despite the two being in the midst of a planned merger. Neither could say much about the pending deal (gag rules are in effect) except the reasons behind the merger, reasons that have already been well publicized (e.g., the complementary nature of product lines; the compatibility of corporate cultures, etc). But the two companies address points not directly involved in the prospective merger: Carestream insists its X-ray modality is going strong; Philips argues against "best of breed" solutions. Philips' long-standing contention is that, although best of breed components can be optimized for specific solutions, they do not necessarily deliver optimal results as a system. Doing so hinges on enablement — does the whole system satisfy clinical needs? Or do interoperability issues get in the way? Will Carestream's Vue products be integrated with Philips' IntelliSpace? (We'll have to wait to find out.)

12:12 p.m. — Siemens promotes the operational aspects of its hardware. Digitalization is the common thread; analytics the critical fiber. Artificial intelligence is part of the solution, a company rep tells me — but only a part. Making that point is cloud-based TeamPlay, which the company describes as a network for imaging departments. TeamPlay -- which does not involve AI — takes center stage at the Siemens booth for its critical role in evaluating the use of imaging devices. (Through this network, imaging departments can assess scanner utilization, workflow performance, and patient exams, according to the company, the data available to compare to those of other imaging departments so as to help make clinical, financial or operational decisions.) The point is to ensure an ROI that can be measured instead of hoped for, a Siemens rep tells me. Doing otherwise risks overpromising; the development of expectations that can't be realized; and disappointment.

12:46 p.m. — TeraRecon features "a workflow enhancement" that strips off patient health information (PHI) before clinical data are sent through the cloud for interpretation by smart algorithms. Interpretations can then be sent back to the clinical sites, a rep tells me. This allows the clinical sites to control PHI, while still allowing AI interpretation through the cloud.

12:53 p.m. — Vital Images (which has joined Canon Medical) features an optical camera designed specifically for enterprise imaging. The camera downloads patient data either from the patient wristband or a computer work list, associating those data with the appropriate patient record and treatment information. It also measures automatically the distance from camera to subject — for example, a pressure ulcer of the skin — adjusting the image to ensure an "apples to apples" comparison of prior and current images. This helps the physician determine if the wound is getting larger or smaller over time, a rep told me.

1:16 p.m. — Nuance Communications wants to make it clear to visitors that its PowerScribe One does more than dictation. Booth placards attribute the use of PowerScribe to a 94 percent reduction in radiology report turnaround time; an 82 percent increase in follow up tracking; a 42 percent reduction in duplicate imaging studies; and an 87 percent drop in phone interruptions. Helping make these possible are text-aware, language-understanding algorithms that convert speech into structured data in radiology reports. More can be found in the Nuance white paper titled "In Your Words: How AI is advancing the impact of radiology in healthcare," copies of which were available at the Nuance booth.

1:48 p.m. — Beneath the multi-faceted umbrella of the Fujifilm booth is information about the company's 3-D and advanced visualization. Artificial intelligence offerings are built on the company's proprietary platform, called REiLI (a Japanese word that, according to the company, connotes intelligence and resourcefulness). PACS and enterprise imaging (including a physician portal and other information systems) are built on the Synapse platform, which the company frames as able to handle radiological as well as optical images, the latter being an integral part of its enterprise imaging platform.

1:57 p.m. — An acquaintance stops me on the exhibit floor; time to catch up — and hear about his new employer Qure.ai. Based in India, the company focuses on smart algorithms that produce "real outcomes that our customers need," he told me. That need may be efficiency. Or it may be improved diagnoses. It depends on the market. Efficiency matters more in developed nations, where physicians are relatively plentiful, than in emerging ones, where they are in short supply. Consequently, emerging markets need something to magnify the presence of physicians, whereas developed markets need efficiency. AI can satisfy both; Qure.AI can do the tailoring.

2:15 p.m. — Walk down "Start-up Street," the SIIM low-rent district of the exhibit hall. AI Analysis grabs my attention with its "Change Detector," which color codes the differences between old and new images. The Detector helps radiologists see what might otherwise escape them, say the firm's entrepreneurs, who are preparing an application for FDA clearance of the software. They claim the detector might help spot changes months earlier than traditional inspection; it might also accelerate the comparison process. Their hope? Better patient care — and more revenue for users.

Day Four: Friday

8 a.m. — Attend scientific session on neuro machine learning. Luminary speaker Luciano Prevedello, M.D., MPh, chief of the Ohio State University division of imaging informatics casts AI as "getting a lot of attention lately" thanks to the performance of smart algorithms. Talks that follow his remarks fan the flames. One shows evidence that AI can boost the performance of radiology residents well above their pay grade.

1:10 p.m. — Chill at the Fairfield Hotel. Women's soccer on TV; mentally chanting: USA ... USA ... USA. (Nationalism ... inescapable.)

6:10 p.m. — Leave hotel for Denver Airport. Walk serpentine to the TSA scanners. No metal; no problem. Go to gate; airborne soon after. Psyched to return for AHRA 2019. **itn**

Greg Freiherr is a contributing editor to Imaging Technology News (ITN). Over the past three decades, he has served as business and technology editor for publications in medical imaging, as well as consulted for vendors, professional organizations, academia, and financial institutions.

AI Algorithm Detects Breast Cancer in MR Images

Presentation at breast imaging symposium demonstrates potential of deep learning

By Greg Freiherr

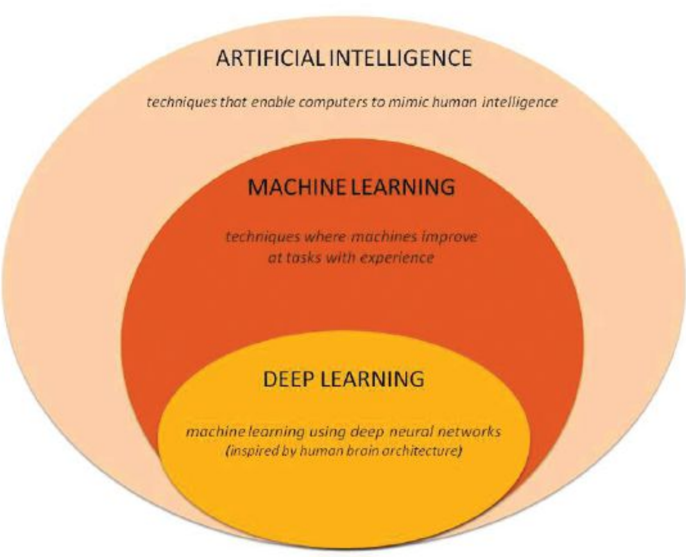
The use of smart algorithms has the potential to make healthcare more efficient. Sarah Eskreis-Winkler, M.D., presented data that such an algorithm — trained using deep learning (DL), a type of artificial intelligence (AI) — can reliably identify breast tumors in magnetic resonance (MR) images. In doing so, the algorithm has the potential to make radiology more efficient.

On April 4, at the Society for Breast Imaging (SBI)/American College of Radiology (ACR) Breast Imaging Symposium, Eskreis-Winkler stated that the algorithm, which was trained to identify tumors in breast MR images, could save time without compromising accuracy. Deep learning, she explained in her talk, is a subset of machine learning, which is part of artificial intelligence.

"Deep learning is a new powerful technology that has the potential to help us with a wide range of imaging tasks," said Eskreis-Winkler, radiology resident from Weill Cornell Medicine/New York-Presbyterian Hospital. In her talk at the SBI symposium, she said DL has been "shown to meet and in some cases exceed human-level performance."

How The DL Algorithm Was Developed

Eskreis-Winkler and her colleagues used a neural network to classify segments of the MR image and to extract features. The algorithm learned to do this on its own. The use of DL eliminated the need to explicitly tell the computer exactly what to look for, she said during the presentation: "We just feed the entire image into the neural network, and the computer figures out which parts are important all by itself."



Sarah Eskreis-Winkler, M.D.

A smart algorithm has been trained on a neural network to recognize the appearance of breast cancer in MR images. The algorithm, described at the SBI/ACR Breast Imaging Symposium, used deep learning, a form of machine learning, which is a type of artificial intelligence.

Eskreis-Winkler, who is working toward a doctorate in MRI physics "interspersed with the residency," outlined the development of a deep learning tool for clinical use. Initially, many batches of labeled images are fed into the neural network. When training begins, the network weights, which are used to make decisions, are randomly initialized. "So network accuracy is about as good as a coin toss," she said.

The network, however, learns from its mistakes using a process called backpropagation, whereby wrongly categorized image results are fed backwards through the network and the decision weights are adjusted. "So the next time the network is fed a similar case, it has learned from its mistake and it gets the answer right," said Eskreis-Winkler, who plans to be a breast imaging fellow at Memorial Sloan Kettering Cancer Center (MSKCC) after completing her Ph.D. and residency in June 2019. Work on the project was done at MSKCC, she said, with Harini Veeraraghavan, Natsuko Onishi, Shreena Shah, Meredith Sadinski, Danny Martinez, Yi Wang, Elizabeth Morris and Elizabeth Sutton.

After her symposium talk, Eskreis-Winkler told *Imaging Technology News* that, if integrated into the clinical workflow, the algorithm has the potential to improve the efficiency of the radiologist, "so that the tumor pops up when you open a case on PACS."

Its use might also save time during tumor boards, she said, by automatically scrolling to breast MRI slices that show cancer lesions. This would eliminate the time otherwise spent manually scrolling to these slices.

DL Algorithm Scores in the '90s

The algorithm that she described at the SBI symposium processed MR images from 277 women, classifying segments within these images as either showing or not showing tumor. The algorithm achieved an accuracy of 93 percent on a test set. Sensitivity and specificity for tumor detection were 94 percent and 92 percent, respectively.

She described the results as "promising, because the dataset size we were using — about 6,000 slices — wasn't even so big by deep learning standards. Going forward we should be able to improve our results by increasing the size of our dataset."

DL works best when using at least 20,000 slices, Eskreis-Winkler said.

Deep learning will not provide the whole solution, she cautioned. People have to work with DL algorithms to achieve their potential.

"The way in which AI tools will be integrated into our daily practice is still uncertain," she said in her SBI presentation. "So there is a big opportunity for us to be creative and to be proactive, to come up with ways to harness the power of AI to make us better radiologists and to better serve our patients."

Machines make diagnostic errors, as do radiologists, Eskreis-Winkler asserted. "But they don't make the same kinds of errors," she told *ITN*. "So one of the really exciting areas is to figure out how to best combine the power of humans and machines, to push our diagnostic performance to new heights. This is an initial step in that direction." **itn**

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Ask What AI Can Do For You — And Your Patient

“It’s tough to make predictions, especially about the future.”
— Yogi Berra

Greg Freiherr has reported on developments in radiology since 1983. He runs the consulting service, The Freiherr Group.

Yogi was right. Cars didn’t fly (at least not en masse). And space stations didn’t rotate (at least not on purpose). And these are just a couple examples of technologies that didn’t happen when they were supposed to.

That doesn’t mean, however, accurate predictions couldn’t have been made. The fundamental problem was in misreading conditions.

The race to the moon in the sixties, for example, was a logical result of the Cold War. Unfortunately, politicians, astronauts — and those who wrote about them — swaddled this race in grand phrases (e.g.: “man’s reach for the stars”), raising expectations that simply couldn’t be met. This is why in 1975 the Apollo capsule rendezvoused in earth orbit with a Soyuz capsule — as a political symbol of détente between the U.S. and Soviet Union.

The second act of the space race featured space trucks — a Soviet military spacecraft called Buran and the U.S. Space Shuttle, which hauled military and nonmilitary cargoes into orbit. Buran flew once; America’s shuttles flew for decades until two were destroyed during flight and the others were hung in museums, after failing (miserably) to meet economic expectations.

How Not To Repeat History

America’s misadventures in space provide a lesson about why it is so important that we don’t expect too much from artificial intelligence. Being realistic has the power to moderate expectations. Unfortunately, realism can change. Consider the test for machine intelligence devised 70 years ago by Alan Turing, a pioneer of modern computing. Dubbed the Turing test, it contends that a computer is intelligent when interaction with that computer cannot be distinguished from interaction with a person.

Plenty of computers today could pass that test. Notably, chatbots routinely fill in for people in “customer service.” And their use could accelerate.

Does that mean that at least some of today’s computers are “intelligent?” The answer is moot.

Radiology — A Frontier For AI

“AI is here to stay for a while; maybe forever,” said Siemens’ Wesley Gilson, Ph.D., speaking to attendees of a Siemens-sponsored presentation on artificial intelligence at the AHRA meeting in mid-July.

So what is it that makes AI appealing? According to Gilson, artificial intelligence lead for Siemens Healthineers, it’s what AI might do for radiologists and patients.

Radiology already is being challenged by the accumulation of data. Fast-growing workloads are reducing the time for interpretations, raising the potential for error. AI algorithms might help radiologists stay on top of data, he said, just as their analyses might improve disease surveillance and — ultimately — patient outcomes.

AI radiology assistants could help quantify these data and make critical measurements that improve the detection and diagnosis of disease. They might even “drive clinical treatment decisions,” said Peter Shen, vice president of business development at Siemens Healthineers. Built into machines, AI algorithms might automate workflow and accelerate the reconstruction of images.

“We want to take all this data and do something practical with it,” said Shen, who during his AHRA presentation used efforts at weather prediction to drive home the need for practicality in the analysis of healthcare data. In regard to weather forecasts, he opined that people are less interested in knowing the exact temperature than “whether they should wear flip-flops or bring an umbrella.”

“Similarly (in radiology), if we want to manage dose, we are less concerned if (a single exposure) is precisely 1.0 or 1.1 mGy,” Shen said. Operative practicality comes from changing the parameters of a CT scanner, he said, so patients get consistently less dose over time.

Gilson described how AI might automate patient positioning in CT, MRI, even mobile C-arms. Automated positioning could reduce radiation dose and enhance images, as well as save time and labor, thereby boosting productivity and reproducibility.

AI algorithms may also help radiologists and other physicians make sense of data coming from multiple sources — not only images, but laboratory and genomic information, for example. With the help of these algorithms, multiple pieces of information might be put into a customized and personalized treatment plan.

“That is where we see a lot of potential,” Shen told me after the presentation. “How can I use artificial intelligence to assess all these data and figure out how to best treat (the) individual patient?”

Eventually the data specific to a patient might be built into a “digital twin,” which could serve as a patient simulator for testing the effectiveness and safety of different treatments before deciding finally on one to prescribe. That, however, is still a long ways away, Gilson said.

Improvement Through Imprecision

The most advanced AI algorithms, the ones that come from deep learning (DL), are not mathematical constructs. Therefore, they should not be accorded the same precision as mathematics.

They get their smarts from “trial-and-error” learning, achieved often through hundreds or thousands of forays into datasets. In short, DL algorithms learn by being wrong; their experiences establish the basis for “understanding.”

While they may lack mathematical precision, they can go far beyond what can be defined purely by mathematics. This is the imprecise nature of tomorrow’s artificial intelligence, which — ironically — is modeled on human learning. It is what makes DL algorithms so potentially powerful — and potentially scary.

Some pundits have worried that smart algorithms might eventually conclude on their own that their intelligence is better than that of people. To their fear, I say poppycock … it’s like asking whether bicycles will one day outpace people in races.

Bicycles do not race. Bicyclists do. These are people who depend on machines to enhance their performance.

Similarly, machine intelligence might factor into the future of radiology … if we have realistic expectations.