DIAM

HIMSS SOLUTION

Digital Imaging Adoption Model

Achievement Assessment Report

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Digital Imaging Adoption Model

HIMSS has created the Digital Imaging Adoption Model (DIAM), an eight-stage model to evaluate the maturity of IT supported processes in medical imaging in hospitals around Europe and across the world. This eight-stage (0-7) maturity model drives hospitals' organizational, strategic and tactical alignment towards imaging-IT maturity.

The Digital Imaging Adoption Model for Enterprise Imaging is a progressively sophisticated roadmap enabling quality, safety, and operational efficiency for healthcare providers.

Digital Imaging Adoption Model for Enterprise Imaging structure ensures objectivity:

- Stage 0 indicates low imaging IT maturity; Stage 7 represents an advanced Imaging IT environment with the highest patient safety and work efficiency standards.

- Each DIAM stage has specific requirements and will be considered achieved if at least 70% of those requirements are fulfilled. In addition to the 70% rule some mandatory ('must-have') criteria exist. Organizations not meeting those 'must-haves' will not be able to accomplish certain DIAM stages despite having achieved 70% or more of other stage relevant criteria.

- From Stage 0-4 the model has sequential compliance goals, i.e. organizations need to meet the requirements of lower stages before they are able to move up on the model. Those stages basically describe a hierarchy for planning and implementation of imaging IT.

- Stages 5-7 are non-hierarchical and show different options for making use of advanced software-related features in imaging. To reach Stage 5, an institution is required to achieve at least one of the three possible options (5A, 5B or 5C). Stage 6 requires two out of the three options, while all three must be achieved to reach Stage 7.

Methodology

To be assessed against the DIAM a healthcare organization completes a survey which comprises of a list of criteria statements. The organization completes the survey by selfassessing their performance against each criteria statement (mostly) using the following Likert scale response options:

- **0%**- Not Enabled

- **1-25%**- Minimally Enabled

- **50-75%**- Mostly Enabled

- **76-89%**- Mostly Enabled

- **90-94%**- Mostly Enabled

- **95-100%**- Fully Enabled

Using a proprietary scoring methodology the survey responses are tabulated to derive accomplishment for each stage, each imaging service, and against the overall model. To achieve a given stage an organization must meet a few mandatory criteria AND score 70% or better for overall accomplishment for that stage and all previous stages. This allows flexibility in the model to accommodate different types of organizations, cultures, and approaches to maturity.

Baseline Achievement

Baseline

Stage Achievement	0	Highest Stage Achieved
Overall Compliance	69%	% Accomplishment against DIAM Model
Stage 5c	50%	Not Yet Achieved
Stage 5b	49%	Not Yet Achieved
Stage 5a	60%	Not Yet Achieved
Stage 4	40%	Not Yet Achieved
Stage 3	58%	Not Yet Achieved
Stage 2	50%	Not Yet Achieved
Stage 1	69%	Not Yet Achieved

Gap Assessment

Stage	Enterprise wide	Neurology	Pathology	Urology	Dermatology	Wound Care
Stage Achievement	0	1	1	1	0	1
Overall Compliance	33%	75%	25%	75%	25%	75%
Stage 5c	N/A	59%	59%	40%	61%	45%
Stage 5b	N/A	45%	52%	59%	52%	57%
Stage 5a	N/A	50%	52%	48%	43%	61%
Stage 4	53%	31%	36%	33%	22%	42%
Stage 3	47%	58%	63%	61%	66%	61%
Stage 2	59%	62%	46%	50%	42%	46%
Stage 1	N/A	40%	80%	80%	40%	80%

Stage 1 Criteria Summary

Electronic Image Management Covering Multiple Service Area(s)

To achieve DIAM Stage 1, at least 2 service areas need to have electronic image management (no matter which) with those service areas having 95% of the images captured natively in digital format.

At Stage 1, information systems manage image acquisition (order- or encounter-driven), reports/clinical notes related to medical images, and image archiving. Information systems may also manage supply and inventory where appropriate (e.g. Radiology/Cardiology).

Imaging Service Specific Criteria

DIAM Criteria	Focus Area	Neurology	Pathology	Dermatology	Urology	Wound Care
What percentage of all images (incl. waveforms, photos, slides etc.) in this service area is captured - natively (from the source) - in digital format (i.e. NOT film or paper-based etc.)? E.g. ECGs captured initially on paper and then scanned and attached to the EMR do NOT count as digital files	Image Capture	50-75%	95-100%	50-75%	95-100%	95-100%
if yes, Percentage of authorized users with access/view capability. Based on all potential users with authorization to access within the enterprise	Image Exchange, Data Ingestion & Interoperability	50-95% of all enterprise users	50-95% of all enterprise users	5-49% of all enterprise users	5-49% of all enterprise users	>95% of all enterprise users
What share of imaging related reports/notes are captured in electronic format (vs paper format)?	Image Interpretation & Notes	76-89%	76-89%	76-89%	76-89%	76-89%
When acquiring images the required metadata is automatically associated (for order-based and encounter-based workflows, where applicable). A minimum defined dataset of metadata (patient demographics; acquisition date, time, person, device; body part; laterality; series and study description; procedure code; accession number) is associated with the acquired image, without the need of manual intervention. Data within the minimum defined dataset should not be entered as free text.	Quality Management, Workflow Management & Patient Safety	95-100%	95-100%	90-94%	90-94%	95-100%

Stage 2 Criteria Summary

Electronic Image Management Covering a Variety of Images Across the Enterprise

To achieve DIAM Stage 2, at least 3 service areas need to have electronic image management (representing 80% of all imaging studies). These imaging services should represent at least 2 different 'image usage' categories (diagnostic vs. procedural vs. evidence vs. image-based clinical reports).

At Stage 2, third party image management systems need to be integrated with the Electronic Medical Record (or similar solution), images should be directly accessible, e.g. by single or multiple links, via the EMR (or similar solution), images must have metadata assigned (e.g. MRN, name, description etc.), external images can be imported for clinician access (if policy allows) and measures are in place to ensure the security of protected health information (e.g. malware scans, disablement of downloads to local storage).

Enterprise-Wide Criteria

DIAM Criteria	Focus Area	Technology	Response
All modalities and applications are updated with latest security patches.	Business Continuity, Disaster Recovery & IT Security		50-75%
Procedures are in place to prevent the download of protected health information (PHI) to unencrypted and non-approved devices. This also includes mobile devices.	Business Continuity, Disaster Recovery & IT Security		90-94%
Procedures are in place to scan external media for malware such as USB sticks for vendor software upgrades on modalities.	Business Continuity, Disaster Recovery & IT Security		95-100%
A formalized enterprise imaging roadmap with clear goals and timelines exists	Enterprise Imaging Governance		26-49%
Current Technology Status		Enterprise-wide Image Lifecycle Management	Yes - solution is part of our VNA
Current Technology status		Enterprise-wide Image Acquisition Management/Orchestration	Yes - separate solution(s) which are integrated
Current Technology status		Picture Archiving and Communication System (PACS)	Live and Operational
Current Technology status		Clinical Data Repository/EMR	Live and Operational
Current Technology status		Enterprise Image Repository/Vendor Neutral Archive (VNA)	Live and Operational
Current Technology status		Teleconsultation software (for Clinician-Clinician interaction) (for Imaging)	Live and Operational

Imaging Service Specific Criteria

DIAM Criteria	Focus Area	Neurology	Pathology	Dermatology	Urology	Wound Care
How integrated is this solution with your EMR and other solutions (esp. for orders & distribution)?	Image Capture	95-100%	95-100%	95-100%	95-100%	95-100%
Type of solution used to manage (capture, store, distribute) medical images (by imaging service)	Image Capture	Service-specific	Enterprise-wide	Service-specific	Enterprise-wide	Enterprise-wide
Distinct and clearly outlined interoperability requirements are used during purchasing/procurement process for imaging software.	Image Exchange, Data Ingestion & Interoperability	1-25%	1-25%	1-25%	1-25%	
External images can be ingested directly into the Image Archive (or similar application). e.g. images submitted by patients or received from external referrers on CDs (or other data carriers), such as to be used for second opinion	Image Exchange, Data Ingestion & Interoperability	50-75%	90-94%	50-75%	90-94%	90-94%
if yes, Image access is seamless for the end user. I.e. Users can access the images in the right context (patient-specific) and through their main user interface (i.e. no separate login to another application, e.g. by using the EMR and/or an enterprise viewer)	Image Exchange, Data Ingestion & Interoperability	50-75%	90-94%	50-75%	50-75%	76-89%
if yes, Percentage of authorized users with access/view capability. Based on all potential users with authorization to access within the enterprise	Image Exchange, Data Ingestion & Interoperability	50-95% of all enterprise users	50-95% of all enterprise users	5-49% of all enterprise users	5-49% of all enterprise users	>95% of all enterprise users
Processes are documented and enforced to ensure external imaging data are normalized and indexed. For example to facilitate easy access to images through viewers used in your organization.	Image Exchange, Data Ingestion & Interoperability	90-94%	90-94%	90-94%	90-94%	90-94%
The software environment is standards-compliant enabling the efficient integration of 3rd party products, such as other specialty PACS, viewers, communication tools etc. For example, the organization has rights and access to modify database tables and interfaces to support the integration of other products such as specialty PACS, EMR, ECM etc.	Image Exchange, Data Ingestion & Interoperability	50-75%	26-49%	50-75%	26-49%	26-49%
The imaging service engages in the monitoring of image quality. I.e. a systematic method has to be followed when acquiring and capturing images from a device so that the quality is consistent and meets defined internal standards	Quality Management, Workflow Management & Patient Safety	76-89%	1-25%	1-25%	76-89%	1-25%
What is the level of availability of the imaging solution(s)?	Quality Management, Workflow Management & Patient Safety	High			High	
What is the level of performance/speed when retrieving images?	Quality Management, Workflow Management & Patient Safety	Medium		Medium		

Stage 3 Criteria Summary

Imaging Governance and Strategy; Workflow and Process Safety

To achieve DIAM Stage 3 governance and strategy, workflow process safety, image sharing and accessibility and IT security policies must be in place.

At Stage 3, requirements include:

- Governance and strategy (incl. governing body / oversight) for:
  - Type of imaging solutions/technology, security etc
  - Formalized strategy (addressing the enterprise) and regular vetting
  - Purchases/procurements
- Image Sharing and Accessibility:
  - Clinicians can access all types of images/multimedia through a consolidated viewer; specialists can use specialty viewers on top
  - External referrers can access and view images 'online' (through the organization's network/repository)

- Workflow and process safety:
  - Quality, safety and operational parameters across multiple imaging services are measured and under control
  - Image acquisition workflows across multiple imaging services are formalized, standardized and implemented
  - Status management for imaging studies, reports across multiple imaging services
- IT Security:
  - User Account provisioning
  - Audit trails

Enterprise-Wide Criteria

DIAM Criteria	Focus Area	Technology	Response
What share of all imaging modalities of your organization using radiation send dosage information into the Dose Management System?	All Technology - Standard Qs for Current Installation		95-100%
User/Account provisioning is in place to ensure that user accounts are automatically created, changed, disabled and deleted according to business needs and procedures, e.g. in the context of new hires, promotions or contract terminations.	Business Continuity, Disaster Recovery & IT Security		76-89%
Clinical image acquisition and communication workflows (for all types of images, video, multimedia) are formalized and implemented (either by enterprise governance body or through departmental bodies)	Enterprise Imaging Governance		76-89%
Human and financial resources are allocated to allow the organization to further grow the Enterprise Imaging program	Enterprise Imaging Governance		90-94%
Participation in enterprise imaging governance is multidisciplinary. Participation of stakeholders from various imaging services that have clear responsibility and accountability for imaging-related strategies	Enterprise Imaging Governance		50-75%
The Universal / Enterprise Viewer is deployed in our organization so that it supports basic functions to take measurements, annotate or edit images	Software Capabilities & Acquisition Workflows		76-89%
The Universal / Enterprise Viewer is deployed in our organization so that it provides access to images from multiple imaging specialties	Software Capabilities & Acquisition Workflows		26-49%
The Universal / Enterprise Viewer is deployed in our organization so that it supports multiple formats, incl. DICOM, waveforms, videos, multimedia content	Software Capabilities & Acquisition Workflows		76-89%

Imaging Service Specific Criteria

DIAM Criteria	Focus Area	Neurology	Pathology	Dermatology	Urology	Wound Care
The system provides access to medical image databases/libraries, e.g. to access annotated, indexed and curated imaging studies, diagnosis, patient cases etc. E.g. internal teaching files, open-access database or commercially available services such as STATdx, RADPrimer or others.	Clinical Decision Support	1-25%	1-25%	1-25%	1-25%	1-25%
Type of solution used to manage (capture, store, distribute) medical images (by imaging service)	Image Capture	Service-specific	Enterprise-wide	Service-specific	Enterprise-wide	Enterprise-wide
Authorized users from external organizations (e.g. clinicians from other hospitals, referrers etc.) can access and view images (from this imaging service) over a secured network/connection.	Image Exchange, Data Ingestion & Interoperability	1-25%	1-25%	1-25%	1-25%	90-94%
Imaging specialists from this imaging service can access all types of images/multimedia from their primary system that connects them directly to specialty clinical viewers as needed I.e. no additional log-in needed	Image Viewing	76-89%	76-89%	76-89%	76-89%	76-89%
A formal documented Analytics and/or Business Intelligence strategy exists for this imaging service. The plan has been socialized, endorsed, and supported by appropriate senior management leadership.	Imaging Analytics	76-89%	76-89%	76-89%		76-89%
Data governance is in-place and proactively operating to address data quality and KPI targets related to this imaging service	Imaging Analytics	76-89%	76-89%	76-89%	76-89%	76-89%
Software tools are in use to support Multidisciplinary Team Meetings (MDTs). E.g. for scheduling of meetings, provision of electronic checklists, reporting of outcomes etc.	Multidisciplinary Collaboration	No	Yes - for virtual MDTs	Yes - for virtual MDTs	Yes - for virtual MDTs	No
A formalized and documented quality management (QM) program is in place for this imaging service. This program ensures the identification, measurement, control, and improvement of the various core processes that will ultimately lead to improved medical imaging and operational performance. Please indicate who is responsible for this quality management program (Imaging Service QM vs. consolidated Enterprise-wide QM).	Quality Management, Workflow Management & Patient Safety	Enterprise-wide	Service-specific	Enterprise-wide	Enterprise-wide	Enterprise-wide
Image Lifecycle Management: The lifecycle of images from this service area is actively managed by the use of a dedicated software solution. To reduce the overall cost of retaining images for direct access, while ensuring the long-term retention and retrieval requirements needed for long-term follow-up, retrospective research, and for compliance with legal requirements.	Quality Management, Workflow Management & Patient Safety	1-25%	1-25%	1-25%	1-25%	1-25%
Impact Assessment: Outcomes of IT-supported process improvements are systematically monitored and reported to the appropriate senior management level. E.g. Did the implementation of a new application or process deliver the expected benefits? Are users using new system functions appropriately? etc.	Quality Management, Workflow Management & Patient Safety		90-94%	90-94%		
Medical equipment and applications (such as specialist workstations, imaging modalities/devices as well as related software solutions) is regularly calibrated/serviced/updated in order to ensure that they meet the required quality standards. I.e. medical devices used for imaging are maintained appropriately	Quality Management, Workflow Management & Patient Safety	95-100%	95-100%	76-89%	95-100%	76-89%
Patient identification reconciliation processes/tools are in use I.e. to reduce the occurrence of data loss or patient identification incidents	Quality Management, Workflow Management & Patient Safety	Yes - fully automated	Yes - fully automated	Yes - fully automated	Yes - fully automated	Yes - fully automated
Reported (un)avoidable medical errors are systematically tracked and presented to the appropriate senior management level. E.g. wrong body part scanned, missed examinations, wrong modality/device/contrast agents used etc.	Quality Management, Workflow Management & Patient Safety	26-49%	26-49%	26-49%		26-49%
Status management: The electronic system supports the confirmation of image acquisition/examination completion and automated results delivery to the responsible clinician	Quality Management, Workflow Management & Patient Safety	76-89%	76-89%	76-89%	76-89%	76-89%
Substance administration tracking is supported by the use of a dedicated software solution, i.e. contrast agents and medication	Quality Management, Workflow Management & Patient Safety	90-94%		90-94%	90-94%	
The software supports cumulative Radiation Dose Monitoring I.e. the software automatically checks radiation dosage and monitors that information (can happen in the "background" for medical physicists or "frontend" for ordering physicians, or similar)	Quality Management, Workflow Management & Patient Safety	90-94%	90-94%	90-94%	90-94%	90-94%

Stage 4 Criteria Summary

Fully integrated image management with efficient enterprise-wide image sharing across different service areas

To achieve DIAM Stage 4, the organization must include image management in a fully integrated way while offering image sharing across service areas across the entire enterprise in an efficient way.

At Stage 4, requirements include:

- Enterprise-wide standardized workflows for image/multimedia/metadata capture, storage and sharing

- Use of recognized standards, protocols and/or profiles to support system integration and clinical workflows

- Secure acquisition and easy viewing capabilities for mobile images (mobile platforms, handheld devices)

- Capability to directly ingest external images (incl. associated reports/notes, metadata etc.)

- Remote access to images and reports/notes

- IT Security: Asset and Inventory Management

Enterprise-Wide Criteria

DIAM Criteria	Focus Area	Technology	Response
What share of all imaging modalities of your organization using radiation send dosage information into the Dose Management System?	All Technology - Standard Qs for Current Installation		95-100%
Authorized clinicians and imaging specialists have easy and seamless access to a complete multimedia and image history of their patients, including the ability to make cross-modality comparisons	Software Capabilities & Acquisition Workflows		95-100%
How would you classify the image repository/ies used in your organization?	Software Capabilities & Acquisition Workflows		One-single repository
Surgical and procedural scope images are captured, reviewed, edited, stored - together with the right metadata - in a user-friendly manner and can be presented through the EMR/HIS.	Software Capabilities & Acquisition Workflows		76-89%
Current Technology status		Enterprise-wide Image Lifecycle Management	Yes - solution is part of our VNA
Current Technology status		Enterprise-wide Image Acquisition Management/Orchestration	Yes - separate solution(s) which are integrated

Imaging Service Specific Criteria

DIAM Criteria	Focus Area	Neurology	Pathology	Dermatology	Urology	Wound Care
How integrated is this solution with your EMR and other solutions (esp. for orders & distribution)?	Image Capture	95-100%	95-100%	95-100%	95-100%	95-100%
if yes, Percentage of authorized users with access/view capability. Based on all potential users with authorization to access within the enterprise	Image Exchange, Data Ingestion & Interoperability	50-95% of all enterprise users	50-95% of all enterprise users	5-49% of all enterprise users	5-49% of all enterprise users	>95% of all enterprise users
Recognized, non-proprietary interoperability standards/profiles are in use to manage images and related communication. For example: IHE (XDS, XCA, etc.) or DICOMweb for image exchange and storage; HL7 (HL7 CDA, HL7 V3 etc.) for document exchange; FHIR; RADLEX, LOINC, SNOMED CT etc. for terminology normalization and semantic interoperability	Image Exchange, Data Ingestion & Interoperability	0%	50-75%	0%	50-75%	50-75%
The software environment is standards-compliant enabling the efficient integration of 3rd party products, such as other specialty PACS, viewers, communication tools etc. For example, the organization has rights and access to modify database tables and interfaces to support the integration of other products such as specialty PACS, EMR, ECM etc.	Image Exchange, Data Ingestion & Interoperability	50-75%	26-49%	50-75%	26-49%	26-49%
Notes from technologists/nurses/other supportive staff members are captured in electronic format and are available for the imaging specialists when needed. E.g. to pre-populate reports with measurements or clinically relevant comments	Image Interpretation & Notes	26-49%	1-25%	1-25%	26-49%	1-25%
All images created by this imaging service are viewable through the enterprise viewer	Image Viewing		76-89%		76-89%	76-89%
Clinicians can access images from remote locations through a secure online connection	Image Viewing	1-25%	1-25%	1-25%		
Tele-imaging tools are in use to easily share images for real-time clinician-clinician interaction E.g. for expert review	Multidisciplinary Collaboration	50-75%	50-75%	50-75%	50-75%	50-75%
A communication system for critical and unexpected findings is in use to track compliance for appropriate follow-up action. This system is directly embedded into the electronic workflow. I.e. providing automated alerts for timely and accurate transmission and acknowledgement of critical (e.g. acute bleeding), urgent (e.g. medical evaluation required within 24h), unexpected (e.g. detection of an unexpected lesion/tumor) test results from imaging specialist to clinicians. The communication trail should be consistently tracked in the hospital information system.	Quality Management, Workflow Management & Patient Safety	26-49%	26-49%	26-49%	26-49%	26-49%
Patient consent forms needed in this imaging service are digitally managed and reconciled with patient demographics I.e. consent forms are either digitally captured or scanned into a digital archive so that they can be electronically retrieved/viewed enterprise-wide; can be done by using a centralized or decentralized admission process.	Quality Management, Workflow Management & Patient Safety	95-100%	95-100%	95-100%	95-100%	95-100%
Status management: The electronic system supports the confirmation of image acquisition/examination completion and automated results delivery to the responsible clinician	Quality Management, Workflow Management & Patient Safety	76-89%	76-89%	76-89%	76-89%	76-89%
Substance administration tracking is supported by the use of a dedicated software solution, i.e. contrast agents and medication	Quality Management, Workflow Management & Patient Safety	90-94%		90-94%	90-94%	
The imaging service uses standardized image acquisition protocols for digital photos and point of care ultrasound I.e. ability to securely acquire, label with defined minimum data set, review, edit and present within the EMR/HIS	Quality Management, Workflow Management & Patient Safety	50-75%	76-89%	50-75%	76-89%	76-89%
When acquiring images the required metadata is automatically associated (for order-based and encounter-based workflows, where applicable). A minimum defined dataset of metadata (patient demographics; acquisition date, time, person, device; body part; laterality; series and study description; procedure code; accession number) is associated with the acquired image, without the need of manual intervention. Data within the minimum defined dataset should not be entered as free text.	Quality Management, Workflow Management & Patient Safety	95-100%	95-100%	90-94%	90-94%	95-100%

Stage 5 to 7 Criteria Summary

Imaging Service Specific Criteria

DIAM Criteria	Focus Area	Neurology	Pathology	Dermatology	Urology	Wound Care
Before image capture (e.g during image order, when preparing a modality etc.), the software uses available information from the patient's medical record to actively present alerts or notifications about potential risks, such as relevant patient allergies, modality-dependent concerns or other contra-indications. E.g. patient allergies regarding the use of medication to achieve mydriasis in opthalmology, patient has an implanted insulin pump and cannot perform MRI; patient has allergy to iodinated contrast agents; patient has a history of asthma and cannot perform Cardiac CT, etc.	Clinical Decision Support	90-94%	90-94%	90-94%		90-94%
Computer-aided detection (CAD) or similar tools are in use in order to automatically evaluate/pre-interpret conspicuous structures and sections of medical images (Computer-aided diagnosis, CADx) e.g. cell counts in Digital Pathology, initial diagnosis for specific types of cancer etc.	Clinical Decision Support	90-94%	90-94%	90-94%	90-94%	90-94%
Computer-aided detection (CAD) or similar tools are in use in order to automatically mark conspicuous structures and sections of medical images (Computer-aided detection, CADe). E.g. visualization and quantification of retinal lesions; colonic polyp detection etc.	Clinical Decision Support	90-94%	90-94%	90-94%	90-94%	90-94%
Computer-aided detection (CAD) or similar tools are in use in order to enable smart worklists for automatic assignment and prioritization of studies e.g. to bring in data from EMR and/or use computer-identified abnormalities to prioritize examinations	Clinical Decision Support	90-94%	90-94%	90-94%	90-94%	90-94%
if enabled: These databases/libraries can be accessed directly through the system where the reporting/commenting takes place, i.e. there is no additional log-in process required for the user.	Clinical Decision Support	50-75%	1-25%	1-25%	26-49%	95-100%
Recommendations from Clinical Decision Support (such as the use of appropriateness criteria, best-practice advices, CAD etc.) are monitored in order to analyze clinicians' compliance and/or the validity of the recommendations	Clinical Decision Support	95-100%	95-100%	95-100%	95-100%	95-100%
The system automatically suggests standardized care guidelines / best-practice advices, triggered by keywords from the documentation and/or from the use of Natural Process Language capabilities.	Clinical Decision Support	1-25%	76-89%	1-25%	76-89%	95-100%
The system provides access to medical image databases/libraries, e.g. to access annotated, indexed and curated imaging studies, diagnosis, patient cases etc. E.g. internal teaching files, open-access database or commercially available services such as STATdx, RADPrimer or others.	Clinical Decision Support	1-25%	1-25%	1-25%	1-25%	1-25%
When ordering an image examination, the software provides support to identify the appropriate imaging exam or diagnostic testing needed (depending on patient's symptoms and evidence-based guidelines). This could be integrated with order-entry systems and HIS/EMRs (to ensure appropriateness at Point of Care for the referring physician) and/or a tool for the imaging specialist to help verify incoming orders. Examples for Radiology imaging are "ACR Select" (USA) or ESR iGuide (Europe).	Clinical Decision Support	26-49%	26-49%	26-49%		
Who is responsible for IT strategy, software needs identification and maintenance for this imaging service?	Image Capture	Enterprise-wide	Service-specific	Service-specific	Enterprise-wide	Enterprise-wide
Authorized users from external organizations (e.g. clinicians from other hospitals, referrers etc.) can access and view images (from this imaging service) over a secured network/connection.	Image Exchange, Data Ingestion & Interoperability	1-25%	1-25%	1-25%	1-25%	90-94%
External images are exchanged/shared Country-wide	Image Exchange, Data Ingestion & Interoperability	95-100%	95-100%	95-100%	95-100%	95-100%
External images are exchanged/shared Regionally (e.g. within one or more administrative health regions in a certain country)	Image Exchange, Data Ingestion & Interoperability	90-94%	1-25%	90-94%	1-25%	1-25%
External images are exchanged/shared with Local care community (e.g. with other providers in a geographically limited community)	Image Exchange, Data Ingestion & Interoperability	1-25%	1-25%	1-25%	1-25%	1-25%
Imaging studies are exchanged/shared online (i.e. system-to-system) with organizations of different care types (e.g. Hospital-General Practitioner, Hospital-Rehabilitative Care etc.)	Image Exchange, Data Ingestion & Interoperability	76-89%	76-89%	76-89%	1-25%	0%
Imaging studies are exchanged/shared online (i.e. system-to-system) with organizations of same care type (e.g. Hospital-Hospital, Specialist Center-Specialist Center)	Image Exchange, Data Ingestion & Interoperability	90-94%	90-94%	90-94%	90-94%	90-94%
Measurements from imaging modalities/devices/viewers can be transferred automatically into reports. E.g. for increased efficiency and error reduction associated with manual entry or transcription	Image Interpretation & Notes	95-100%	95-100%	95-100%	95-100%	95-100%
Advanced visualization tools are in use in order to manipulate or enhance medical imaging datasets. This includes procedures such as multi-planar reformatting (MPR), 3D image reconstruction, perfusion maps, procedural planning and navigation tools	Image Viewing	90-94%	90-94%	90-94%		90-94%
During image viewing, related reports/notes - no matter from which service area - are listed and can be directly displayed I.e. no need to actively search and/or login to a second viewer or similar application Examples: dental charting provided with progress note and image; diabetic retinopathy images are provided in combination medical history for interpretation purposes; system informs the imaging specialist if he looks at a primary cancer or a metastasis (secondary cancer) spreading from another body part.	Image Viewing	26-49%	26-49%	26-49%		
During report/note viewing, related reports/notes - no matter from which service area - are listed and can be directly displayed I.e. no need to actively search and/or login to a second viewer a second viewer or similar application	Image Viewing	95-100%	95-100%	95-100%		95-100%
A formal documented Analytics and/or Business Intelligence strategy exists for this imaging service. The plan has been socialized, endorsed, and supported by appropriate senior management leadership.	Imaging Analytics	76-89%	76-89%	76-89%		76-89%
Imaging data - from this imaging service - are used to feed and inform enterprise-wide analytics E.g. care plans are triggered by pressure ulcer progress tracking	Imaging Analytics	95-100%	95-100%	95-100%	95-100%	95-100%
Imaging service uses (digital) information summaries (Dashboards, Scorecards etc.) to improve operational outcomes e.g. systematic tracking and reporting of turnaround times and patient wait times; monitoring of ordering patterns and equipment utilization; monitoring of staff productivity; monitoring of turnaround times etc.	Imaging Analytics	50-75%	76-89%	76-89%	76-89%	50-75%
Imaging service uses (digital) information summaries (Dashboards, Scorecards etc.) to improve patient outcomes e.g. use of radiation dose information from registries for study optimization; biopsy tissue review for radiology-pathology follow-up; tracking wound healing progress, skin lesion growth, macular degeneration, response rate to treatments etc.	Imaging Analytics	76-89%	76-89%	76-89%	76-89%	76-89%
The imaging service is systematically benchmarked with external peers, based on external comparison data/tools I.e. performance indicators from your imaging service are compared with imaging services from external organizations, using an IT-supported, systematic, recurring and standardized approach.	Imaging Analytics	95-100%	95-100%	95-100%	95-100%	95-100%
The imaging service is systematically benchmarked with other departments/units of our organization, based on internal comparison data/tools I.e. performance indicators from your imaging service are compared with another imaging service within your organization, using an IT-supported, systematic, recurring and standardized approach.	Imaging Analytics	1-25%	1-25%	76-89%	76-89%	76-89%
The imaging service participates in Big Data projects to mobilize reservoirs of information in order to make medical imaging more valuable for patients, e.g. by supporting clinical trials or improving diagnostic accuracy.	Imaging Analytics	76-89%	95-100%	76-89%	76-89%	95-100%
The imaging service uses predictive analytics, i.e. using both new and historical data for forecasts, to optimize care provision or the use of resources E.g. to identify cancer spots in a certain geographical area, equipment utilization etc.	Imaging Analytics	90-94%	26-49%	90-94%	26-49%	26-49%
The imaging service uses prescriptive analytics, i.e. making predictions AND providing decision options to take advantage of the predictions, in order to optimize care provision or internal resources E.g. the system provides recommendations on one or more courses of action, including showing the likely outcome of each decision.	Imaging Analytics	95-100%	95-100%	95-100%	95-100%	95-100%
The system can access and meaningfully present epidemiological data related to the patient whose studies are being reported. e.g. when performing calcium scoring to identify patients at cardiac risk, epidemiological data is co-displayed during the time of reporting	Imaging Analytics	1-25%	1-25%	1-25%	1-25%	1-25%

		No	Yes - for virtual MDTs	Yes - for virtual MDTs	Yes - for virtual MDTs	No
Software tools are in use to support Multidisciplinary Team Meetings (MDTs). E.g. for scheduling of meetings, provision of electronic checklists, reporting of outcomes etc.	Multidisciplinary Collaboration					
Tele-imaging tools are in use to easily share images for real-time clinician-patient interaction E.g. telehealth	Multidisciplinary Collaboration	90-94%	90-94%		90-94%	
Patient access to their records is secured E.g. by 2-factor authentication (or similarly secure methods).	Patient Engagement	95-100%	95-100%	95-100%	95-100%	95-100%
Patient satisfaction (about imaging-related service delivery) is measured in a specified, recurrent time interval	Patient Engagement	1-25%	1-25%	1-25%	1-25%	95-100%
Patients can manage access rights to their records and share images with others	Patient Engagement	90-94%	26-49%	90-94%	26-49%	26-49%
Patients can upload images and/or associated reports/notes to their patient record	Patient Engagement	50-75%	50-75%	50-75%	95-100%	95-100%
Patients have online access to educational material specific to their imaging related procedures or problems. For example to inform them about potential risks or benefits of upcoming treatments	Patient Engagement	76-89%	76-89%	76-89%	76-89%	76-89%
Patients have online access to images (all types vs. restricted formats) created in your organization	Patient Engagement	76-89%	76-89%	76-89%	76-89%	76-89%
Patients have online access to reports/notes associated to images created in your organization	Patient Engagement	95-100%	95-100%	95-100%	1-25%	1-25%
Imaging genetics are applied, i.e. the imaging service correlates genetic information from patients with imaging biomarkers in order to optimize the treatment e.g. combining output of the polygenic and neuro-imaging for early detection/prediction of Alzheimer's disease; Radiomics in cancer care to predict disease transformation and drug resistance	Personalized Medicine	50-75%	50-75%	50-75%	90-94%	90-94%
In vivo molecular imaging is in use	Personalized Medicine	26-49%	26-49%	26-49%	26-49%	26-49%
The concept of theranostics is applied, i.e. contrast agents, fluorescent markers, nuclear imaging agents etc. are combined with therapeutic intervention.	Personalized Medicine	95-100%	95-100%	95-100%	95-100%	95-100%
The software in use facilitates access to imaging biobanks which are linked to other genomics, proteomics, lipidomics or similar data	Personalized Medicine	95-100%	50-75%	95-100%	50-75%	50-75%
if yes, Do you exchange (send & receive) information with regional, national or international radiation dose registries?	Quality Management, Workflow Management & Patient Safety	90-94%	95-100%	90-94%	95-100%	95-100%
Impact Assessment: Outcomes of IT-supported process improvements are systematically monitored and reported to the appropriate senior management level. E.g. Did the implementation of a new application or process deliver the expected benefits? Are users using new system functions appropriately? etc.	Quality Management, Workflow Management & Patient Safety		90-94%	90-94%		
The imaging service is quality certified or accredited by a recognized external authority/organization E.g. Governmental bodies, ISO, JCI, QIP, ISAS etc.	Quality Management, Workflow Management & Patient Safety	90-94%	90-94%	90-94%	90-94%	90-94%
The software supports cumulative Radiation Dose Monitoring I.e. the software automatically checks radiation dosage and monitors that information (can happen in the "background" for medical physicists or "frontend" for ordering physicians, or similar)	Quality Management, Workflow Management & Patient Safety	90-94%	90-94%	90-94%	90-94%	90-94%

Stage 5 to 7 Criteria Summary

Advanced Imaging Analytics; Clinical Decision Support and Value-Based Imaging; External Image Exchange and Patient Engagement

Stages 5-7 are non-hierarchical and can be adopted in any order. To reach Stage 7 all three of the Stage 5 through 7 criteria must be met. To reach Stage 6 two-of-three of the Stage 5 through 7 criteria must be met. To reach Stage 5 one-of-three of the Stage 5 through 7 criteria must be met

To achieve the Advanced Imaging Analytics stage, requirements include

- Imaging platform provides infrastructure that enables enterprise data warehouses to use information from images and associated metadata

- Clinical and operational parameters are systematically tracked, benchmarked and can be presented in real-time

- Organizations use and incorporate external data sources

- Examples of using predictive and prescriptive analytics can be presented

- Technology use is captured and analyzed to influence user behavior

To achieve the Clinical Decision Support and Value-Based Imaging stage, requirements include:

- Systems are in place that are capable to provide feedback about the appropriateness to perform an examination, based on patient preconditions, history and approved guidelines

- Organization uses structured reports and/or natural language processing to generate discrete data that can feed algorithms/rules and trigger clinical decision support

- Computer-aided detection and/or computer-aided diagnosis tools are in use (traditional or based on AI/deep learning)

- Best-practice guidelines are directly integrated into the electronic workflow

To achieve the External Image Exchange and Patient Engagement stage, requirements include:

- Exchange of images and reports/notes with care organizations of all types (i.e. primary, secondary, tertiary care etc.) within local care community, region, or even the whole country

- Use of recognized standards (e.g. relevant IHE profiles) for external data exchange

- Patients can make appointments, access their images as well as reports online. Patients are able to upload/download their images and provide access to other care providers of family members

- Patient satisfaction (about services provided) is measured and under control

At DIAM Stage 7, the organization must also:

- Systems are in place that are capable to provide feedback about the appropriateness to perform an examination, based on patient preconditions, history and approved guidelines

- Demonstrate enterprise imaging deployment and use in at least 5 different imaging services (representing 80% or more of all imaging studies created in the organization)

- Employ data-driven decision making for enterprise imaging. Organization must show case studies (with at least 12 months of data history) of how imaging data was leveraged to imporve quality of care, patient safety and care delivery efficiency

- Enforce strong IT governance and management support

- Have in place comprehensive disaster recovery, IT security and business continuity efforts

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