



Setting up a regional or national radiology digital teaching archive

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Foreword

A picture is worth a thousand words.

Nostalgic for the 'good old days' when radiologists collected diagnostic gems for teaching purposes and then handed on their film collection for posterity? Readily anonymised, easily portable to different locations and of variable quality and preservation, these collections were often accompanied by a distinctive aroma but supported the training and assessment of many generations of trainee radiologists, medical students and colleagues. Ready access to picture archiving and communication systems (PACS) images enables the development of individual teaching archives on local systems but does not facilitate networked regional or national teaching, network or national discussion of discrepancies or excellent diagnoses of anonymised cases at regular learning meetings or the easy submission of de-identified images for research purposes.

This document provides expert guidance on the technical requirements for individual radiologists and the PACS industry to facilitate and improve the connectivity and simplify submission of anonymised annotated cases between PACS and a digital archive whether local, regional or national, for teaching or research purposes.

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1. Background

As professionals, radiologists across the UK need to participate in teaching, training and research. A current frustration is the lack of technological capability to send anonymised (de-identified) images and studies to regional or national teaching archives directly from PACS workstations. Teaching cases, such as those published in The Royal College of Radiologists' *Radiology Events and Discrepancies (READ)* newsletter, are widely used by radiologists around the country as they are of high educational value, especially for radiologists who have already achieved Fellowship of The Royal College of Radiologists (FRCR). Regional and national teaching databases are needed for developing the knowledge and skills of radiology trainees, but would benefit trained radiologists and other professionals too.

Currently, if a radiologist wants to contribute teaching cases to READ or any national/regional teaching archive, the process is laborious at a time when radiologist resource is scarce. Breaking down the technological barriers to contributing imaging studies directly from a PACS viewer to a teaching archive or a research database would make teaching and research in the NHS much more efficient and more accurate (as the number of cases would increase substantially).

It has been reported that the anonymisation (de-identification) of images and transfer of cases to a compact disk (CD) for onward dissemination by post can take hours. This time requirement is no different whether entering cases onto a teaching archive or submitting cases for research. With local pressures of reporting workloads, contribution to teaching, training and research becomes almost impossible for many radiologists. Currently all cases need data upload and manual de-identification to be ready for use as a resource. De-identification is also required for submitting cases for discussion at learning from discrepancy meetings (LDMs).

This issue becomes all the more important with the implementation of the General Data Protection Regulations (GDPR) and other similar data protection legislation.¹ This legislation requires data processors to use measures such as anonymisation, pseudonymisation and encryption to facilitate the use of patient data in the context of research, ensuring that all identifiable data – including digital imaging and communications in medicine (DICOM) metadata – has been removed before use (European Society of Radiology [ESR], 2017).²

2. Purpose

This document provides guidance to both the PACS industry and radiologists about the technical requirements to facilitate and improve connectivity between PACS and digital teaching archives, whether local, regional or national. To address this issue it is essential that all PACS vendors support the teaching files and clinical trials export profile (TCE profile) of Integrating the Healthcare Enterprise (IHE). In order to submit cases for teaching or trials efficiently, a user must be able to:

- Flag appropriate images and add supplemental information
 - Anonymise image studies, there may be a need for using reversible anonymisation (pseudonymisation) in research trials
 - Route the study to the appropriate destination (a teaching file system or clinical trial repository). TCE profile defines how this can be done by PACS vendors efficiently to support the users.
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IHE has published the specification for this profile which is available online:
https://wiki.ihe.net/index.php/Teaching_File_and_Clinical_Trial_Export

3. Application

There are two fundamental requirements for successful teaching and training archive set-up: ease of use and ease of contribution. Ease of use relates to the teaching archive functionality. Ease of contribution relates to the ability of the local PACS system to anonymise data and seamlessly connect with teaching archives regardless of vendor.

The key criteria for ease of use are:

- Ability to organise the teaching archive into personal and shared folders
- Search and display functionality within the teaching archive
- Exporting/migrating/sharing teaching cases from one teaching archive to another, and also to programmes such as Microsoft PowerPoint, email, social media and other applications
- End of contract teaching archive data migration.

Appendix A is a functional specification to ensure ease of use within teaching archive functionality.

Trust PACS functionality

The key criteria for ease of contribution are:

- Seamless connection between any vendor's PACS systems to a regional or national teaching or research archive
- Ability to undertake complete anonymisation/de-identification by the sending institution, particularly cognisant to the requirements for treatment of personal data under the GDPR and other similar legislation.¹

Appendix B is a PACS specification to support creation of teaching files.

This document was approved by the Clinical Radiology Professional Support and Standards Board on: 10 May 2018.

4. References and glossary of terms

References

1. <https://www.eugdpr.org/> (last accessed 26/6/2018)
2. European Society of Radiology (ESR). The new EU General Data Protection Regulation: what the radiologist should know. *Insights Imaging* 2017; **8**: 295–299.
3. <http://dicom.nema.org/medical/dicom/current/output/html/part15.html> (last accessed 26/6/18)

Glossary of terms:

- **IHE:** Integrating the Healthcare Enterprise (IHE) is a non-profit organisation based in the United States (US). It sponsors an initiative by the healthcare industry to improve the way computer systems share information. IHE was established in 1998 by a consortium of radiologists and information technology (IT) experts. It develops and documents standards-based solutions (called IHE profiles) to real world problems. It also organises testing and education to foster their adoption.
 - **TCE:** Teaching file and clinical trial export profile is an IHE profile which lets users send images and related information for automatic routing to teaching file authoring or clinical trials management systems.
 - **GDPR:** The General Data Protection Regulation (GDPR) (EU) 2016/679 is a regulation in EU law on data protection and privacy for all individuals within the European Union.¹
 - **SNOMED CT:** SNOMED CT is a structured clinical vocabulary for use in an electronic health record.
 - **ICD:** International Classification of Diseases of World Health Organization.
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Appendix A. Teaching image archive functionality specification – ease of use

1. The teaching archive MUST support the TCE profile of IHE as a receiver actor to ensure that it is interoperable with any vendor's PACS (see Appendix B).
 2. It must be possible to customise the teaching archive database into different folders which may be used for different purposes for example, user's personal folder for their personal cases, LDM folders, exam teaching folder for FRCR 2B, public folder and so on.
 3. When a user account is created, it must automatically create a 'personal folder' for them.
 4. Users of the system must be able to create new sub-folders. Once a new folder is created by the user, they must be able to share it with others who may be given editing or viewing rights for the folder. The person who has editing rights must also be able to restrict who can send them information (using General Medical Council [GMC] number or equivalent for identifying the sender).
 5. It must be able to receive the following information from PACS (described above):
 - a. Sender information (contributor) – name and GMC number or equivalent (unique ID of the sender)
 - b. Intended recipient – which may be an individual user folder or a group folder (for example, LDMdated9/10/16 and so on)
 - c. Images – individual images, series or study as sent by the PACS
 - d. Subject header information – (for example 'Interesting case of hepatoma for teaching')
 - e. Coded entry for key words (such as ICD, SNOMED CT codes and so on)
 - f. Free-text information – for example describing the referral information on request card, unique characteristics on images, histology if available and the learning points from the case. This may include:
 - Clinical history
 - Findings
 - Diagnosis
 - Discussion/learning points.
 6. It must receive images into the 'intended recipient's folder' within the teaching archive – some folders will be private for named individuals and others may be shared and used for specific purposes – for example LDMdated12/10/16, FRCR Part 2B teaching and so on.
 7. Folder restrictions – it must be possible to restrict each folder with who can send images to it, who can edit it and who can view it.
 8. Users working on the teaching archive must be able to edit and organise the information received from the PACS into customisable database fields within the teaching archive that allow for teaching, training or holding LDMs.
 9. It must be possible to initially receive the images (directly from PACS) into a 'personal folder' of the radiologist – as the radiologist may identify themselves as the 'intended recipient'. The radiologist may then modify (crop images, change and save default windows and so on) and save the content at a later stage. The radiologist may even
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wish to send a copy to another folder, for example exam folder or LDM folder, for consideration by the person who has editing rights on the exam folder and so on.

10. There must be standard DICOM data field columns such as national procedure code for the exam and modality type.
11. There must be options for coded data fields – it must be possible to add international classification of diseases (ICD), especially if a final histological diagnosis has been made (<http://apps.who.int/classifications/icd10/browse/2016/en> or SNOMED CT codes or American College of Radiology [ACR] codes and so on). This needs to be an optional field, which can be left blank if data is not available.
12. It must be possible to have five to ten customisable data fields which are used for cataloguing by the editor of each folder – for example diagnosis, body part, disease type, taxonomy and so on. Depending on the folder use, customisable fields could be used for various purposes, for example:
 - a. For an LDM folder – date of LDM, error type and so on
 - b. For exam folder it may be date of exam, subtype of exam and so on
 - c. Personal folders – users may wish to use their own cataloguing process which helps them use it for their various teaching – for example sonographer teaching, ophthalmology juniors teaching and so on.
13. Free-text fields must be available for editing by the owner and editors of the folder (those who have editing rights). These may include:
 - a. Title/subject
 - b. Clinical history
 - c. Findings
 - d. Diagnosis
 - e. Discussion.

This must be populated from the information sent from the PACS, but allow the person/s with editing rights on the folder to modify the content.

14. It must also allow for tagging of keywords to be added for ease of searching.
15. It must be possible to easily search the teaching archive folders. It must be possible to search both free text, keywords or coded database content.
16. The viewer for display of images must be a standard DICOM viewer – with windowing, pan zoom and so on. The teaching archive must support the basic image review profile of IHE.
17. Ideally it should be a zero footprint DICOM viewer so that it works over a standard browser.
18. It must be possible to set up quizzes and self-testing exams (with a two monitor display) so that the answers can be visible to the examiner but not the examinee. Examiner can see some data fields but hide them from the examinee (for example PowerPoint presenter display and so on).
19. It should be possible to add JPEG images of histology or PDF documents from literature searches and so on.
20. Users must be able to export cases to PowerPoint presentations, JPEGs, AVI files and so on.

21. Users must be able to share and publish anonymised teaching cases with others – via email, social media and so on. All information including the sender/GMC or other ID number must be removed for public sharing or publishing.
22. Users must be able to export cases from one teaching archive to another teaching archive (similar to forwarding an email).
23. At the end of the contract, the customer must be able to migrate the teaching archive content to another vendor's teaching archive. Hence, the teaching archive must also support export selector and export manager of the TCE profile.
24. It must be possible for users to 'like' a case within the teaching archive.
25. It must be possible for system administrators to define storage limits to individual folders – for example 100 gigabytes (GB) for a personal folder, 200 GB to an exam folder and so on. If the storage limit is exceeded, an email should be sent to the 'owner of the folder' advising them to manage the folder or buy more storage.

Appendix B. PACS contract wording

1. Digital imaging and communications in medicine (DICOM) destination configuration:

Picture archive and communication systems (PACS) system administrators must be able to configure one or more teaching archives as DICOM destinations within their PACS.

2. DICOM objects:

PACS must use the DICOM C-STORE or STOW mechanisms to send the following to the **teaching archive destination**:

- The de-identified images
- Associated non-image objects such as DICOM presentation states
- A DICOM manifest – also called key object selection document (KOS object) to define the list of images and some basic information about the submission
- A DICOM structured report (conforming to the additional teaching file information [ATFI] template) to describe the teaching aspects of the case for teaching cases (may be used for research cases as well).

3. Image selection on PACS display

User must be able to select images from one or more series, full study or images from one or more studies for that patient from the PACS display and send it to a teaching/research archive with ease (for example one to two mouse clicks). This functionality must be directly supported by the PACS. In Integrating the Healthcare Enterprise (IHE) terms, this means that the image display actor must be grouped with an export selector.

4. Additional teaching information (DICOM SR) added:

An important function of the export selector is the creation of the **ATFI** document which allows users to add information to the teaching archive along with the selected images as defined above, and this too must be easily populated by the user from their normal PACS workstation (viewer).

The IHE specification for teaching files and clinical trials export profile (TCE) provides a template for the ATFI, but makes it clear that the specifiers of a system should define their own exact rules for its content. The RCR proposes the following template for a teaching archive template (NB: a different template may be required for a research project).

- Sender/author information – name of the sender which is transmitted to the receiving system. This would allow the case to go directly to the author's personal folder within the teaching archive. This must be a mandatory field (TCE 101 IHERADTF 'Author').
- Subject heading or title or abstract – must be **free text** so that users are not restricted and can use subject matters as they wish – for example 'missed lung cancer' (if wishing to contribute to an learning from discrepancies meeting [LDM] folder), 'Interesting case of pneumoconiosis' (if contributing to an interesting cases folder) and so on. This must be a **mandatory field** (TCE 104 IHERADTF 'Abstract').
- Free-text information (these are **optional fields**)
 1. Clinical history (121060 DCM 'History')
 2. Findings (121071 DCM 'Findings')

3. Diagnosis/conclusion/impression (111023DCM 'Differential diagnosis/impression')
4. Discussion/learning points (TCE106 IHERADTF 'Discussion')
5. Keywords (TCE 105 'Keywords')

Table 1: Additional teaching file information TCE template (UK) (DICOM SR TEMPLATE FOR TCE ATFI)

	NL	Rel with parent	Value type	Concept name	VM	Req type
1			CONTAINER	EV (TCE006, IHERADTF, "Additional Teaching File Information")	1	M
2	>	CONTAINS	TEXT	EV (TCE101, IHERADTF, "Author") ** see note	1	M
3	>>	HAS PROPERTIES	TEXT	EV (TCE102, IHERADTF, "Affiliation")	1	U
4	>>	HAS PROPERTIES	TEXT	EV (TCE103, IHERADTF, "Contact")	1	U
5	>	CONTAINS	TEXT	EV (TCE104, IHERADTF, "Abstract")	1	M
6	>	CONTAINS	TEXT	EV (TCE105, IHERADTF, "Keywords")	1-n	U
7	>	CONTAINS	TEXT	EV (121060, DCM, "History")	1-n	U
8	>	CONTAINS	TEXT	EV (121071, DCM, "Finding")	1-n	U
9	>	CONTAINS	TEXT	EV (TCE106, IHERADTF, "Discussion")	1-n	U
10	>	CONTAINS	TEXT	(111023, DCM, "Differential Diagnosis/Impression")	1-n	U
11	>	CONTAINS	TEXT	EV (TCE107, IHERADTF, "Diagnosis")	1-n	U

**Note: The fifth (final suffix) component of the name should be a unique identifier for the author. For doctors this should be their General Medical Council (GMC) number in the form GMCxxxxxx.

5. De-identification or anonymisation of images:

This is very important and must happen within the firewall of the sending institution before data is transferred to the teaching archive.

- **Export manager actor of TCE:** Patient-identifiable data, visit and institutional data, physician-identifiable data and equipment data within DICOM headers must be fully anonymised. Users must have confidence that data transferred will be anonymised by the **source institution**, before it leaves the trust firewalls. *Before sending images to a teaching archive, users must be able to preview the images to ensure that patient demographics are not embedded in the pixel data – possibly using a user prompt.* The export manager actor in IHE performs the de-identification function. The export manager actor function could be fulfilled by an image manager actor (which can either be a PACS or even a vendor-neutral archive [VNA]), but could be a stand-alone system if the PACS/VNA are not able to support this functionality. This will ensure that anonymisation/de-identification of DICOM data happens at source (within the firewall) – **before** it reaches the teaching archive.
- **Basic application level confidentiality profile:** For proper de-identification of data, the IHE export manager actor must comply with DICOM PS3.15 Annex E.2 basic application level confidentiality profile.³ This profile is intended for use in clinical trials and other scenarios in which de-identification may be required, such as creation of teaching files and other types of publication, as well as submission of images and associated information to registries such as oncology or radiation dose registries. This basic application level confidentiality profile defines an extremely conservative approach that removes all information in the non-pixel data attributes, including graphics or overlays related to:
 - The identity and demographic characteristics of the patient
 - The identity of any responsible parties or family members
 - The identity of any personnel involved in the procedure
 - The identity of the organisations involved in ordering or performing the procedure
 - Additional information that could be used to match instances if given access to the originals, such as user identification numbers (UIDs), dates and times
 - Unsafe private attributes.
- **Retain patient characteristics option**

This retains age, sex and weight information in a way which is extremely unlikely to compromise anonymity and which is useful for teaching purposes (for example age of patient at the time of study acquisition may be useful for teaching).
- **Retain longitudinal temporal information with modified dates option**

This retains relationships between dates of images in study in a way which is extremely unlikely to compromise anonymity and which is useful for teaching purposes.
- **Clean pixel data option support**

The basic application level confidentiality profile on its own would not require any changes to the pixel data, even when that contains 'burnt-in' patient information as is common in ultrasound and so on. It is important that the export manager must be specified to support the 'clean pixel data option' of the basic confidentiality profile, which requires it to ensure that such information is also removed from the pixel data. The mechanisms by which this is achieved are not specified in the standard and could

include combinations of heuristics, optical character recognition or even human intervention/checking.

- **Pseudo-anonymisation log-file**

The export manager must keep a log-file of all study UIDs of the examination sent and also the unique ID assigned by it on its outward journey to the teaching archive. This is important especially if there is a need to re-identify the patient in exceptional circumstances and also when the archive is used for research.

- **Retain safe private option**

This allows a restricted set of private attributes which are important for research use to be maintained without risking leakage of personal information.

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