# Imaging Data Anonymisation Guideline

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Revision History

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# 1. Introduction

## 1.1 Purpose

The purpose of this guideline is to define the minimum anonymisation standards for DICOM imaging data shared externally via a secure, governed research environment (SGRE). This document aims to ensure all shared clinical trial imaging data complies with privacy regulations and ethical standards, thereby protecting the identities of clinical trial participants. It is intended for people involved in data processing, anonymisation, and external collaborations, as well as for external researchers who will access this anonymised data.

## 1.2 Scope

This guideline applies to all DICOM imaging data prepared for sharing with third-party researchers on an SGRE. While the primary focus is on DICOM data, the principles outlined may also inform anonymisation practices for other types of imaging data when applicable.

## 1.3 Secure, governed research environment (SGRE)

A secure, governed research environment (SGRE) is any controlled environment designed to support privacy-preserving access to research data.

This anonymisation guidance assumes that anonymised imaging data will be shared only within an SGRE that adheres to established principles for responsible data access. A commonly referenced model is the Five Safes framework, developed by the UK Office for National Statistics, which is widely used for enabling privacy-preserving research. The framework ensures:

- Safe People (only trained and authorised users may access the data)
- Safe Projects (research is ethically and scientifically justified)
- Safe Data (data is appropriately anonymised and prepared to minimise identification risk)
- Safe Settings (data can only be accessed within secure, technically controlled environments)
- Safe Outputs (all results leaving the environment undergo disclosure review).

Together, these safeguards ensure data can be used for meaningful research while maintaining privacy, confidentiality and public trust.

# 2. DICOM standard overview

DICOM (Digital Imaging and Communications in Medicine) is the internationally recognised standard format for storing, transmitting and managing medical imaging data developed and maintained by the National Electrical Manufacturers Association (NEMA). A DICOM file encapsulates both the medical image itself (pixel data) and a rich set of metadata that describes the image and its clinical context. This standardised structure supports interoperability across imaging devices, clinical systems and research platforms.

Due to its structural complexity and extensibility, the DICOM format has the potential to store personal data, including sensitive health data, across both metadata and pixel data, including nested sequences and vendor-specific fields.

The following overview focuses only on key, foundational aspects of the DICOM standard that are most relevant to anonymisation and external data sharing. It is not intended to be a comprehensive treatment of the full specification. For full technical details, implementers should consult the authoritative NEMA DICOM standard documentation ((NEMA), Digital Imaging and Communications in Medicine (DICOM) standard, 2025).

## 2.1 Metadata

DICOM metadata is a structured collection of **attributes** (also called "tags") that describe aspects of the imaging study ((NEMA), PS3.5 2025c - Data Structures and Encoding, 2025). Each attribute is uniquely identified by a tag in the form (group, element) – for example, (0010,0010) for Patient Name.

Each tag has a defined **value representation (VR)**, which specifies the data type and format of the values. VRs play a critical role in health data risk assessment by indicating the likelihood of a data element containing personal data. Please find the VR types, descriptions and health data risk assessment in Appendix A.

The importance and required presence of the attributes are defined in the Information Object Definitions (IODs) through a **Type system**:

- Type 1: Required and must have a valid, non-empty value
- Type 2: Required but may have an empty value
- Type 3: Optional attributes

### 2.1.1. Standard tags

Standard tags are defined in the DICOM standard and are consistent across vendors and systems ((NEMA), PS3.6 2025c - Data Dictionary, 2025). They include essential information required for interpretation, storage and clinical integration of imaging data. Many of these tags contain patient-related or study-specific data that may be considered personal data and require anonymisation.

### 2.1.2. Private tags

Private tags are non-standard attributes reserved for modality vendors, PACS systems, or institutions to store proprietary information not defined in the public DICOM dictionary. They occupy odd-numbered groups (e.g. 0019,xxxx or 0029,xxxx) and are organised into blocks allocated by a private creator element (e.g. (0019,0010)), which is a vendor-chosen label that declares ownership of the subsequent private elements and ensures different vendors do not collide when storing their custom metadata.

Because private tags are flexible by design, their **internal structure varies widely:** many use standard VRs such as LO, DS, IS or FD, but others contain complex or opaque content including binary arrays, mixed binary-text structures, proprietary encoded tables, XML or JSON fragments, or large textual blobs. Siemens CSA headers, GE ExamInfo structures and Philips private dictionaries are typical examples of where metadata may be embedded in formats that are not human-readable without vendor-specific parsers. **The type of information** stored in these private tags ranges from highly technical acquisition and reconstruction parameters to workflow-derived clinical or operational details. Scientifically useful content is common, especially in MRI and PET, because not all acquisition parameters are captured in standard DICOM attributes. Many advanced or experimental protocols also encode their internal sequence descriptors, reconstruction modes, or software versioning in private metadata. Some of these parameters might be essential for accurate preprocessing and reproducibility in quantitative pipelines.

However, private tags also carry **substantial re-identification risk** because vendors and workflow systems often copy clinical or operational details into these fields. They may include patient identifiers, accession numbers, operator or technologist names, site or department names, and precise acquisition timestamps. Free-text protocol notes, encoded binary structures and device-specific identifiers such as scanner serial numbers can also embed personal information or quasi-identifiers in ways that are difficult to detect without fully decoding the private metadata.

#### 2.1.3. Sequences and nested elements

DICOM supports complex data structures through **sequences** (VR 'SQ'). A sequence tag contains a list of items, each of which is a nested set of DICOM attributes. Sequences are used to encode repeating or hierarchical information. Personal data can be present at any level of the sequence hierarchy. For example, a sequence may contain nested patient names referring to physician details, or institution identifiers.

#### 2.1.4. Other structural considerations

In addition to tags and sequences, DICOM files may include:

- **Overlay and graphic data:** Elements such as (6000,3000), which may be used to annotate images with text or graphical content, potentially containing identifiers.
- **Encapsulated documents:** PDF or CDA documents embedded in tags such as (0042,0011), which may include clinical notes or identifiable content.
- **DICOM structured reports (SRs):** Specialised DICOM objects that encode clinical information – such as measurements, observations, interpretations and annotations – in a structured, machine-readable format. Unlike free-text narrative reports, SRs use a hierarchical data model built from coded entries and nested sequences, enabling both human readability and automated processing.
- **Waveform data:** For modalities such as ECG or EEG, PHI can be embedded in waveform annotation sequences or headers.
- **Radiation therapy objects (RTSTRUCT, RTPLAN, RTDOSE):** Radiation Therapy Structure Sets, Plans, and Dose objects may contain patient identifiers, anatomical labels, physician names, timestamps, and treatment-related annotations that require full review and anonymisation.
- **Presentation states (PRs):** Presentation state objects control visualisation parameters (e.g. windowing, overlays, annotations) and may contain burned-in text, labels, or graphical overlays that include PHI.
- **Segmentation objects (SEGs):** Segmentation objects encode derived mask data and may contain identifying labels, structure names, timestamps, and references to source images that require anonymisation.
- **CT dose reports:** For CT scans, dose report objects or secondary capture images may include displayed patient names, dates, institution identifiers, and operator information rendered directly into the image pixels.

### 2.2 Pixel data

Pixel data represents the raw image content, such as grayscale intensities in an MRI slice or coloured values in ultrasound. It is stored in tag (7FE0,0010) and is distinct from metadata. Pixel data is often large and can contain sensitive information embedded directly into the image.

Common forms of sensitive content within pixel data include:

- **Burned-in annotations:** These are alphanumeric characters or graphics permanently overlaid onto the image pixels, often by the imaging device or PACS system. They may include patient names, IDs, dates of birth, examination dates or institutional information. Burned-in annotations can appear in a variety of image types, particularly those that are non-volumetric, secondary or presentation-focused.
- **Identifiable anatomy:** Certain modalities, especially structural head imaging such as MRI or CT, capture detailed facial features or cranial geometry. These anatomical structures can be used to reconstruct a 3D facial surface or be matched with external photographs, making them a risk for biometric re-identification.

## 3. Anonymisation overview

### 3.1 Definitions

The terms de-identification, pseudonymisation and anonymisation are often used interchangeably in clinical research and data sharing, but they reflect different levels and approaches to reducing the risk of re-identifying individuals. Understanding these distinctions is essential, especially when working with sensitive imaging data.

- **De-identification** typically refers to the process of removing or masking direct identifiers (such as names, IDs and dates) to reduce the risk of re-identification. However, re-identification remains theoretically possible under certain conditions (e.g. via dataset linkage or background knowledge).

- **Pseudonymisation** involves replacing identifiable information (e.g. patient ID) with artificial identifiers (pseudonyms), while maintaining a reversible mapping (often stored separately and securely). This approach does not count as anonymisation under most privacy laws, as re-identification remains possible by those holding the key.

- **Anonymisation** is the process of transforming data so that individuals cannot be identified, either directly or indirectly, using any information that is reasonably available. It involves permanently removing or altering personal identifiers in a way that prevents reconstruction or linkage back to a specific person. Proper anonymisation preserves the usefulness of the dataset for analysis while ensuring no individual can be re-identified.

Below is a simplified comparison:

| Aspect | De-identification | Pseudonymisation | Anonymisation |
|---|---|---|---|
| **Goal** | Minimise risk of re-identification | Mask direct identifiers, enable controlled linkage | Eliminate re-identification risk |
| **Re-identification** | Possible under certain conditions | Possible by trusted party with mapping key | Not reasonably possible |
| **Identifiers** | Removed or obfuscated | Replaced with pseudonyms | Removed or irreversibly transformed |
| **Linkability** | Partially retained | Retained via mapping | Lost |
| **Scientific utility** | Preserved | Preserved | May be partially reduced |
| **Imaging challenges** | May skip pixel or file-level identifiers | Same as de-id; mapping must be protected | Requires full metadata, pixel, and structure review |

As such, the workstream's recommendation aligns more closely with the **anonymisation standard**, aiming to eliminate personal data to protect patient privacy while preserving the scientific utility of imaging data.

## 3.2 Regulatory standards: HIPAA, GDPR and cross-jurisdictional applicability

Two widely recognised frameworks govern anonymisation practices:

- **HIPAA (US): Safe Harbor and Expert Determination**
  Under the Health Insurance Portability and Accountability Act (HIPAA), two primary methods are recognised for de-identifying protected health information (PHI):
  - **Safe Harbor method:** This approach requires removing 18 specific identifiers from PHI. These include direct and indirect identifiers such as:
    - Names
    - All geographic subdivisions smaller than a state, including street address, city, county, precinct, ZIP code, and their equivalent geocodes, except for the initial three digits of the ZIP code if, according to the current publicly available data from the Bureau of the Census:
    - The geographic unit formed by combining all ZIP codes with the same three initial digits contains more than 20,000 people
    - The initial three digits of a ZIP code for all such geographic units containing 20,000 or fewer people is changed to 000.
    - All elements of dates (except year) for dates that are directly related to an individual, including birth date, admission date, discharge date, death date, and all ages over 89 and all elements of dates (including year) indicative of such age, except that such ages and elements may be aggregated into a single category of age 90 or older
    - Telephone numbers
    - Vehicle identifiers and serial numbers, including licence plate numbers
    - Fax numbers
    - Device identifiers and serial numbers
    - Email addresses
    - Web universal resource locators (URLs)
    - Social security numbers
    - Internet protocol (IP) addresses
    - Medical record numbers
    - Biometric identifiers, including finger and voice prints
    - Health plan beneficiary numbers
    - Full-face photographs and any comparable images
    - Account numbers

- Any other unique identifying number, characteristic or code
- Certificate/licence numbers.

If these elements are removed, and no actual knowledge of re-identification risk remains, the dataset is considered de-identified (Malin, 2010).

- **Expert Determination method**: In this approach, a qualified statistical or scientific expert applies formal risk assessment techniques and determines that the risk of re-identification is very small, even if some elements not permitted under Safe Harbor are retained.

Neither method provides a foolproof, zero-risk de-identification solution. Rather, they represent pragmatic frameworks designed to enable the creation and sharing of healthcare information with a sufficiently low and manageable risk of re-identification.

- **GDPR (EU)**
  The General Data Protection Regulation (GDPR) defines anonymisation more stringently. Anonymised data must be irreversibly stripped of personal identifiers, such that no individual can be re-identified by any means reasonably likely to be used. This does not require absolute impossibility of re-identification, but rather that the risk is no longer reasonably plausible. Pseudonymised data – where identifiers are replaced by codes, but re-identification is still possible through a key – is not considered anonymous under the GDPR (University College of London, 2025) (Sharp Cookie Advisors, 2020).

While the HIPAA and the GDPR provide important reference points for health data de-identification and anonymisation, they should not be treated as universal substitutes for jurisdiction-specific legal review. Other privacy and health data frameworks may apply depending on the country or region of data origin, the location of the data controller or processor, the recipient institution, and the intended data-sharing pathway. Examples include Canada's Personal Information Protection and Electronic Documents Act (PIPEDA) and provincial health privacy laws, Japan's Act on the Protection of Personal Information (APPI), the UK GDPR and Data Protection Act, Australia's Privacy Act, Singapore's Personal Data Protection Act (PDPA), Brazil's Lei Geral de Proteção de Dados (LGPD), China's Personal Information Protection Law (PIPL), South Korea's Personal Information Protection Act (PIPA), and India's Digital Personal Data Protection Act (DPDP Act).

Although these frameworks generally share a common concern with whether an individual remains identifiable, directly or indirectly, they differ in terminology, legal thresholds, treatment of pseudonymised data, research-use conditions, and cross-border transfer requirements. For example, under HIPAA, de-identification may be achieved through the Safe Harbor or Expert Determination methods, whereas GDPR distinguishes anonymous data from pseudonymised personal data, with pseudonymised data generally remaining within the scope of data protection law if re-identification is possible using additional information. Canadian and Japanese frameworks also use jurisdiction-specific concepts of de-identification, anonymisation and pseudonymisation. Therefore, these guidelines use HIPAA and GDPR as benchmark frameworks, while recognising that international medical imaging data sharing may require additional jurisdiction-specific review.

For medical imaging data specifically, legal requirements should be applied together with imaging-specific technical standards such as DICOM/NEMA PS3.15. DICOM/NEMA provides the operational framework for addressing imaging-specific identifiers, including DICOM attributes, private tags, dates, UIDs, descriptors, structured content, burned-in annotations, and pixel data. However, DICOM/NEMA conformance alone does not determine whether a dataset is legally anonymised under every applicable jurisdiction. The final anonymisation assessment should consider both technical de-identification completeness and the applicable legal standard for identifiability.

## 3.3 Imaging data anonymisation standards

Imaging data anonymisation presents unique challenges due to its dual structure: metadata (tags) and pixel data (the image itself), both of which can contain personal data. For this reason, the medical imaging industry refers to established de-identification standards, notably the **NEMA DICOM de-identification standard** ((NEMA), PS3.15 E Attribute Confidentiality Profiles (Normative), 2025).

This standard outlines multiple 'de-identification profiles', each specifying which DICOM attributes should be removed, retained, replaced or blanked, depending on the intended use case. For example:

- **The Basic Profile** removes all directly identifying attributes and generalises or removes potentially identifying metadata.
- **The Retain Safe Private Option** allows some private attributes to remain, if they have been reviewed and deemed non-identifiable.
- **The Clean Descriptors Option** addresses descriptions that may inadvertently reveal identity, such as body part labels including patient names.

These profiles help ensure a consistent, auditable and standards-based approach to anonymising DICOM files, especially when sharing imaging data across institutions, countries, or with external researchers.

In addition to the NEMA standard, **The Cancer Imaging Archive (TCIA)** provides publicly available imaging datasets that follow strict de-identification procedures aligned with DICOM PS3.15, including detailed documentation of removed, retained and sanitised attributes; TCIA also maintains a comprehensive *Private Tag Dictionary* that helps identify risky vendor-specific metadata. Similarly, the **Radiological Society of North America (RSNA)** promotes best practices for imaging de-identification through initiatives such as the RSNA Clinical Trials Processor, educational resources, and guidelines that emphasise personal information removal, safe handling of DICOM metadata, and robust anonymisation workflows for multi-institutional research.

Despite the availability of established standards and reference practices, there remain significant challenges in defining explicit

anonymisation criteria and developing fully standardised, practical guidelines that address the complete spectrum of risks associated with DICOM anonymisation for clinical data sharing. As a result, organisations still face ambiguities when operationalising these standards – particularly when balancing regulatory compliance, scientific usability and interoperability across external collaborators. Continued harmonisation efforts and clearer consensus on operational best practices are therefore needed to support consistent, safe and effective anonymisation of imaging data in real-world clinical and research environments.

## 4. Anonymisation criteria

The workstream has conducted a comprehensive review of current anonymisation and de-identification standards, including the DICOM standard as maintained by NEMA, HIPAA Privacy Rule requirements, GDPR definitions of personal data and anonymisation, and practical frameworks adopted across leading research institutions such as RSNA guidance on imaging de-identification and the operational approaches implemented by TCIA, which provides large-scale, publicly accessible imaging datasets anonymised according to rigorous, transparent procedures.

Building on this foundation, the workstream has developed and continues to refine a unified set of imaging data anonymisation guidelines and workflow procedures that address the full range of challenges inherent to DICOM metadata and pixel data. This criteria provides clear, practical rules for removing, transforming and retaining information in a manner that maintains scientific and clinical utility while meeting the compliance expectations outlined earlier in this document.

To support consistency, traceability and scalability, our recommended approach incorporates automated detection, transformation and auditing of both metadata and pixel data, enabling reliable application of anonymisation rules across diverse modalities, vendors and study contexts. By grounding the anonymisation workflow in established regulatory, technical and community standards, the strategy provides a strong and defensible foundation for compliant and interoperable clinical data sharing with external collaborators.

### 4.1 Consistency across clinical and imaging data

Clinical and demographic data are essential complements to imaging datasets, and imaging data likewise provides critical context for clinical analyses. When these two data types are shared together, they must be anonymised using **harmonised transformation rules** to ensure both analytic consistency and protection against re-identification. Divergent anonymisation approaches can introduce inconsistencies, break linkages, or inadvertently expose personal data when the two datasets are joined.

To prevent these issues, the same anonymisation logic must be applied across all datasets intended for joint analysis, including:

- **Direct identifiers** (e.g. names, medical record numbers, full dates of birth, contact information, addresses) must be **removed from both clinical and imaging datasets without exception**, as their presence in either domain would re-identify the joined dataset.
- **Quasi-identifiers** (e.g. demographic attributes, temporal information, geographic descriptors, institutional identifiers) may be retained only when supported by a documented risk assessment demonstrating that their inclusion does not meaningfully increase re-identification likelihood. When quasi-identifiers are scientifically relevant, they should follow an aligned transformation logic across datasets (consistent date shifting, age banding, or controlled vocabulary harmonisation, etc.).

For certain demographic elements that are not required for imaging-based analyses but may be relevant to clinical or epidemiological research (e.g. race, ethnicity, nationality, or county of residence), it may be appropriate to **retain these fields in the clinical dataset while omitting them from the imaging metadata.** This approach minimises exposure of sensitive attributes to the more broadly distributed imaging files while preserving information needed for clinical analyses conducted under stricter governance.

Consistent cross-dataset anonymisation ensures clinical and imaging data remain accurately joinable, analytically coherent, and privacy-preserving, enabling integrated research without introducing avoidable re-identification risks.

### 4.2 Metadata anonymisation

#### 4.2.1. Standard tags

As part of the anonymisation workflow development, we have conducted a structured review of standard DICOM attributes to identify elements that may contain personal data or pose a re-identification risk. Based on this analysis, we have compiled a **detailed list of DICOM tags, along with the required anonymisation actions**, grounded in the NEMA DICOM standard and further informed by practical guidance from TCIA and RSNA. This tag-action mapping serves as the foundation of our pipeline and addresses both commonly used and less visible metadata elements (see Appendix C).

Below are several key attributes and the corresponding anonymisation strategies we suggest:

- **Patient ID:** Replace with an anonymised identifier generated using a salted cryptographic hash function. SHA-256 is recommended due to its strong collision resistance and wide adoption. A randomly generated salt is combined with the original identifier prior to hashing to prevent guessing or reconstruction. The resulting identifier should remain consistent for each participant across all imaging sessions to enable linkage within the dataset without retaining any real-world identifying information. The salt or any identifier mapping enabling re-identification must not be shared with data recipients, thereby preserving external anonymisation. However, such mappings may be retained internally under strict access controls, separate from the released dataset, to support an institutional crosswalk for operational purposes.

- **Person name (PN) attributes:** All VR 'PN' attributes should be cleared or removed, since names are direct identifiers and are unnecessary for image interpretation or research workflows.
    - Exception: **Patient name:** Replace with anonymised Patient ID value, providing internal dataset linkage while removing all name-related information.
- **Patient's birth date and age:** Patient Birth Date (0010,0030) is classified as a direct identifier and must be removed or replaced with a zero-length or placeholder value (e.g. "00000000"). DOB must not be date-shifted or replaced with a surrogate date, as doing so may still permit inference of the true age. Instead, age information may be retained in Patient's Age (0010,1010), provided it is generalised to prevent re-identification. Recommended generalisation rules are:
    - *Participants ≥90 years:* age aggregated into a single category (e.g. "90+" for clinical data, "090Y" for the Age tag) per Safe Harbor.
    - *All other participants (<90 years)*: the degree of age rounding or dynamic banding (e.g. monthly bins for infants, broader bands for minors, or 5–10-year bands for adults) should be determined through a risk assessment that considers cohort size, study population characteristics, rarity of condition and other factors (Kniola, 2016).

These rules ensure DICOM objects retain clinically meaningful demographics while preventing reconstruction or inference of the original birth date.

- **Demographic fields:** Retain only demographic attributes needed for imaging analysis. Sex, weight and size may be kept when scientifically required. Remove race, ethnicity, nationality and country values, as they increase re-identification risk and are not needed for image interpretation. For any field considered for retention, ensure consistency with the clinical dataset and document a risk assessment justifying its inclusion.
- **Patient information (group 0010):** contains demographic and identity-related attributes, most of which are direct identifiers or high-risk quasi-identifiers. Aside from the fields explicitly addressed above, all other attributes in this group should be removed. These include patient address, telephone numbers, ethnic group, occupation, comments, and other descriptive fields that may reveal personal or contextual information about the subject.
- **Site ID:** When present (typically stored under the Clinical Trial Site ID (0012,0030) tag), replace with an anonymised site identifier generated using the same salted-hash logic applied to Patient ID. The resulting value should be irreversible and consistent for each site across the dataset.
- **Unique identifiers (UIDs)** (e.g. Study Instance UID, Series Instance UID, SOP Instance UID): Replace with newly generated, DICOM-compliant UIDs using a deterministic method to preserve linkages between related objects. New UIDs should be constructed under a valid, registered UID root, with a reproducible hashed or mapped suffix derived from the original UID. This prevents linkage to source systems while maintaining consistent associations within the anonymised dataset. SOP Instance UID (0008,0018) must be unique across the dataset.
- **Dates:** Apply a subject-specific date offset, determined from the anonymised Patient ID, and use it consistently across all imaging exams and visits to preserve temporal relationships while masking true calendar dates. All retained DA and DT attributes should be shifted by the same offset within a subject, using a random value constrained to a ±30-day window to ensure both privacy protection and longitudinal consistency.
- **Time:** Time-of-day fields associated with patient workflow events (e.g. Study Time, Series Time, Acquisition Time) should be removed or zeroed, consistent with the DICOM Basic Application Confidentiality Profile, as they may enable linkage to operational logs. Technical timing parameters (e.g. TE, TR, TI, frame timing) that do not represent real-world clock times may be retained. For DT attributes, the date component must be shifted, and the time component removed or retained based on whether it contains identifying information.
- **Accession number and medical record numbers:** Remove or replace with non-identifiable placeholders, as they are direct patient or workflow identifiers and can be used to link imaging exam back to the originating clinical system.
- **Institution and device information fields:** Remove or replace with non-identifiable placeholders, as these attributes reveal the originating site, scanner location, or specific device hardware and can enable linkage back to the hospital or acquisition environment.
- **Free-text fields** (VRs LO, LT, SH, ST, UT): Free-text attributes pose a high risk of containing PHI, including manually entered names, initials, dates, site identifiers, or workflow comments. Because some free-text fields may also contain information useful for downstream scientific analysis, these attributes should undergo a tiered evaluation process:
    1. Apply automated detection using pattern-matching (e.g. regular expressions for dates, names, IDs), NLP-based PHI detection, and OCR when text is embedded in images or burned-in overlays.
    2. Apply targeted Manual Review only for fields marked as potentially retainable after automated analysis.
    3. Retain only when the field contains scientifically necessary information and is verified to be free of personal information.

Otherwise, remove the field or replace its content with a standardised, non-identifiable placeholder.

- **De-identification disclosure attributes:** Retain or populate these attributes to document that anonymisation was performed and to specify the methods applied. These fields contain no personal data and are recommended for transparency, reproducibility and regulatory compliance:
    - Patient Identity Removed (0012,0062)

- De-identification Method (0012,0063)
- De-identification Method Code Sequence (0012,0064)

DICOM Attribute Groups with higher risk of personal data disclosure:

- Group 0010 (Patient Information): Contains direct identifiers such as Patient Name, Patient ID, Birth Date, Sex, Weight/Size and patient comments.
- Group 0012 (Clinical Trial Attributes): Includes protocol IDs, site IDs, sponsor information, coordinating centre details and trial-specific subject identifiers.
- Group 0008 (General Study and Series Information): Often contains institution and department names, accession numbers, descriptions, operator and physician names, workflow timestamps, and protocol text.
- Group 0032 (Study Scheduling and Request Information): Includes requesting physician/service, procedure step IDs, request numbers and workflow-related timestamps.
- Group 0040 (Procedure and Observation Workflow): Contains performed procedure details, observer names, report timestamps, coded observations and free-text descriptions.
- Group 0020 (Study/Series/Image Identification): May include Study ID, frame-of-reference identifiers, referencing relationships, and vendor-specific IDs linking back to source systems.

#### 4.2.2. Private tags

As mentioned in Section 2.1.2, DICOM private attributes allow modality vendors, PACS systems and software tools to store proprietary metadata that is not defined in the public DICOM dictionary. Because these attributes are flexible by design, vendors may encode information using standard text-based VRs or more complex formats such as binary arrays, mixed binary/text structures, nested sequences, or proprietary encoded tables. These structures are often undocumented and difficult to interpret without vendor-specific knowledge, and some can contain deeply embedded information not visible in simple header inspection.

Private tags frequently include workflow-related and operational details that may replicate personal information already present in standard tags. Examples include patient or operator names, accession numbers, internal identifiers, timestamps, device serial numbers, institutional descriptors, or free-text protocol comments. In addition, some private blocks mirror standard fields with personal information for internal workflow compatibility, meaning personal data can appear redundantly or in modified form. Because of this variability, lack of transparency and the possibility of encoded personal information, automated sanitisation is unreliable, and thorough manual decoding may not be feasible. For these reasons, **the default recommendation is to remove all private tags during anonymisation,** which is consistent with DICOM PS3.15 and common practice across major research consortia.

Despite these risks, private tags sometimes store *scientifically important acquisition and reconstruction parameters* that are not available in the public dictionary. These may include advanced sequence settings, gradient tables and diffusion directions, slice-timing information, reconstruction kernels, motion or calibration parameters, PET SUV scaling and correction factors, proprietary sequence descriptors, or software versioning metadata. Such details can be essential for reproducible quantitative imaging workflows, especially in MRI and PET, where analysis pipelines rely on modality-specific metadata that vendors store privately.

**Exception process:**

In rare cases where specific private tags are requested by researchers (e.g. for algorithm development or analysis) or identified as technically necessary to preserve the scientific usability of the dataset, exceptions may be considered. Such requests will require a formal internal review, handled on a case-by-case basis. Any private tags approved for retention will be subject to:

- Reviewing specific manufacturer **conformance statements**, which provide details on private tag usage and content, helping determine whether a given tag can be kept, modified or removed during anonymisation.
- Consultation of **supporting resources,** including the NEMA “Retain Safe Private Option” ((NEMA), PS3.15 - Retain Safe Private Option, 2025), the TCIA Private Tag Dictionary, and vendor-specific dictionaries available through tools such as DCMTK, Pydicom and GDCM, to determine whether certain private attributes are documented, non-identifying, and potentially safe to retain. These resources help clarify private tag purpose, typical content, and associated risk, and can support evidence-based decisions on whether a private element can be kept, modified, or must be removed.
- When **explicit value representation (VR)** is available, it may also be used to evaluate potential risk (see Appendix A for VR and corresponding PHI risk assessment).
- **Manual** decoding and interpretation by the imaging data team.
- A **targeted** personal data review to assess and remove any identifying content before final inclusion.

#### 4.2.3. Other elements

**Sequence elements**: Anonymisation must support full-depth traversal of items within each sequence and apply de-identification rules consistently across all levels. This approach is essential for properly anonymising complex objects such as structured reports, radiation therapy plans, and enhanced MR or CT objects, which heavily rely on nested sequences.

**Encapsulated documents:** Since personal data may be embedded within the document’s content rather than in structured metadata, these files must be parsed and treated with the same level of scrutiny as burned-in annotations (see 4.3.1).

### 4.3 Pixel data anonymisation

Pixel data within DICOM files can contain embedded personal data, in the form of burned-in annotations, visible identifiers on objects within the field of view, or recognisable facial features.

#### 4.3.1. Burned-in annotation

Burned-in annotation refers to text or graphics embedded directly in image pixels, such as patient names, medical record numbers, dates of birth, institutional identifiers, acquisition timestamps, and information displayed on jewellery, metal plates, wristbands, implants or external devices visible in the image. These require dedicated image processing techniques for detection and redaction.

- **Detection**

Burned-in text and visible identifiers may be detected using:

  - OCR-based methods
  - Vision-language models (VLMs), which may offer improved detection performance in complex imaging scenarios.

Both open-source and commercial solutions may be used, provided they are deployed in an HIPAA-compliant environment, including appropriate infrastructure controls, contractual safeguards, and access restrictions.

- **Redaction**

Detected personal data in the text should be redacted or obfuscated before data sharing, ensuring diagnostic value is preserved while eliminating identifiable information.

**Analytically essential burned-in information (exception handling)**
In limited cases, burned-in annotations may contain information critical for scientific interpretation (e.g. timestamps in ophthalmology time-series images generated from non-DICOM source formats such as JPG). In such cases, a **controlled exception process** must be applied, including:

  - Scientific justification for retention
  - Formal privacy risk review
  - Additional safeguarding measures
  - Explicit documentation of the decision.

**Machine registration marks**
Redaction workflows must preserve machine-generated graphical overlays that are essential for image interpretation, such as **laterality markers, scan plane indicators, scale bars and orientation labels,** unless these overlays themselves contain personal identifiers.

**Residual risk after burned-in text redaction**
As part of our evaluation, we reviewed the potential for recovering or reconstructing text information that has been redacted or obscured in DICOM pixel data.

- Our assessment indicates that when opaque masking or pixel replacement methods are applied correctly, the likelihood of reversing or revealing the original burned-in text is extremely low.
- Techniques such as blurring or pixelation alone may leave residual patterns that could, in theory, be partially recovered using advanced image enhancement or machine learning methods; therefore, these approaches are not recommended.
- Overall, proper opaque redaction – validated through visual and OCR-based checks – reduces the risk of re-identification to a negligible level.

(Hill S., 2016) (Ho N.Z-Y., 2008) (Zhai H., 2025)

**Recommendation for text redaction**
Based on current evidence and industry best practices, opaque masking or region replacement should be used for removing burned-in text from DICOM pixel data, as these methods effectively eliminate recoverable signal and minimise re-identification risk, unlike blurring or pixelation techniques.

- **Exclusion**
  If reliable redaction is not feasible or introduces complexity, any image found to contain burned-in text should be excluded from external transfer.

  **Exclusion logs**
  Any image excluded from external sharing due to burned-in annotations or failure of reliable redaction must be formally documented. Exclusions shall be captured in dataset-level exclusion logs and data transfer reports, including the reason for exclusion. This ensures transparency, traceability and auditability of all removed content.

#### 4.3.2. Anatomical anonymisation

In head and brain imaging modalities such as MRI, CT and PET, detailed craniofacial anatomy can be reconstructed from 2D slices into realistic 3D facial renderings and potentially matched to photographs using facial recognition technologies (Schwarz C.G. & Kremers W.K., 2019) (Mazura J.C., 2012) (Schwarz C.G. & Kremers W.K., 2023).

Under HIPAA's Safe Harbor, "full-face photographs and any comparable images" are direct identifiers (PHI), and the GDPR explicitly defines facial images as biometric data and treats their processing as a special-category activity *(U.S. Department of Health and Human Services, 2025) (European Data Protection Board, 2020)*. Therefore, removing or obscuring recognisable facial features is the most standards-aligned way of releasing head images as anonymous data: it directly addresses HIPAA's "comparable images" risk and implements DICOM PS3.15's Clean Recognizable Visual Features option to reduce identifiability under GDPR.

A common technique within anatomical anonymisation is defacing, which involves algorithmically removing facial features from imaging data while preserving the integrity of the brain and other regions of clinical interest. Other methods include face removal, skull stripping, template masking, face replacement and face distortion. Newer methods leverage deep learning for more targeted facial feature removal.

Several tools support automated anatomical anonymisation, varying in robustness and data quality preservation. We systematically reviewed the currently available defacing tools, summarising their methodologies, supported modalities, release information, licensing status, and reported advantages and limitations. A comprehensive overview of this assessment is provided in Appendix B.

General limitations of defacing approaches:

- **Modality-specific:** Most tools only support T1-weighted MRI; limited or poor performance on CT, PET or other MR sequences.
- **Over-defacing risk:** Can remove parts of the brain or skull base, affecting downstream analyses.
- **Under-defacing risk:** May leave parts of the face visible, especially with atypical anatomy or low-quality scans.
- **Lack of standardisation:** Different tools vary in aggressiveness and accuracy.
- **Need for manual QC:** Visual inspection is often required for adequate anonymisation.

**Defacing tool recommendation: mrireface (Mayo Clinic)** is a high-performing facial de-identification tool used by the Alzheimer's Disease Neuroimaging Initiative (ADNI). mrireface replaces the face and ears with an average face via non-linear registration, which tends to preserve skull and extra-cranial information better than pure masking. It is recommended as a strong candidate tool because published evaluations have shown favourable performance in reducing facial recognisability while generally preserving brain measurements across several MRI, PET and CT research use cases (Schwarz C.G. & Kremers W.K., 2021) (Schwarz C.G. & Choe M., 2024). However, its impact is not universally negligible across all modalities, sequences, biomarkers or downstream analysis pipelines. Therefore, mrireface or any alternative anatomical anonymisation method should be validated for the specific imaging modality, cohort and intended analysis, particularly when quantitative biomarkers, radiomics, segmentation or AI model development are planned.

Defacing is evolving rapidly alongside re-identification techniques. Implementers are responsible for reviewing current methods and re-evaluating the chosen approach to ensure the chosen method balances reducing re-identification risk with data utility.

#### 4.3.2.1 Defacing data format (NIfTI)

Most of the defacing tools take as an input and produce outputs in Neuroimaging Informatics Technology Initiative (NIfTI) format.

The NIfTI format is a widely used standard for storing medical imaging data. It supports both single-file (.nii) and two-file (.hdr/.img) storage structures, where voxel data is accompanied by a compact, fixed-length header (see Figure 2) containing essential metadata such as image dimensions, voxel sizes, orientation and data type.

```
<class 'nibabel.nifti1.Nifti1Header'> object, endian='<'
sizeof_hdr      : 348
data_type       : b''
db_name         : b''
extents         : 0
session_error   : 0
regular         : b'r'
dim_info        : 57
dim             : [  4 128  96  24   2   1   1   1]
intent_p1       : 0.0
intent_p2       : 0.0
intent_p3       : 0.0
intent_code     : none
datatype        : int16
bitpix          : 16
slice_start     : 0
pixdim          : [  -1.    2.    2.    2.2  2000.    1.    1.    1. ]
vox_offset      : 0.0
scl_slope       : nan
scl_inter       : nan
slice_end       : 23
slice_code      : unknown
xyzt_units      : 10
cal_max         : 1162.0
cal_min         : 0.0
slice_duration  : 0.0
toffset         : 0.0
glmax           : 0
glmin           : 0
descrip         : b'FSL3.3\x00 v2.25 NIfTI-1 Single file format'
aux_file        : b''
qform_code      : scanner
sform_code      : scanner
quatern_b       : -1.94510681403e-26
quatern_c       : -0.996708512306
quatern_d       : -0.081068739295
qoffset_x       : 117.855102539
qoffset_y       : -35.7229423523
qoffset_z       : -7.24879837036
srow_x          : [  -2.    0.    0.  117.86]
srow_y          : [ -0.    1.97  -0.36 -35.72]
srow_z          : [ 0.    0.32  2.17 -7.25]
intent_name     : b''
magic           : b'n+1'
```

***Figure 2.*** *Example of an NIfTI file header*

Compared to DICOM, NIfTI has a very limited and fixed set of metadata fields that are not dedicated to storing personal data. However, certain free-text fields – notably descrip (80 characters), auxfile (24 characters) and intentname (16 characters) – can inadvertently contain personal data if values are copied directly from DICOM headers during format conversion. Therefore, **NIfTI headers should be reviewed to ensure no inadvertent identifiers are present.**

Where retention of specific DICOM fields is necessary, this can be addressed by:

1) Keeping the required metadata fields in separate JSON/XML files
2) Maintaining a documented mapping between retained metadata and anonymised image files, where required for downstream analysis
3) Exporting the defaced data back to DICOM format.

## 4.4 Folder and file names

In addition to metadata and pixel-level anonymisation, it is critical to inspect directory structures and file names, which may inadvertently include personal data such as patient IDs and patient names.

All directory and file names should be scanned as part of the anonymisation process to identify potential personal data. If any identifiers are present within directory names or file names, they should be removed or hashed using a secure method to preserve linkability without exposing sensitive information.

Our recommendation is to take a cleaner and safer approach by:

- **Standardising** directory structures and file naming conventions (e.g. Site > Patient > Visit > Exams > Files), and then
- Using **anonymised identifiers** for naming directories and files wherever applicable, rather than relying on source-system naming.

This ensures both removal of any residual personal data, and consistent structure for downstream analysis, transfer and automation.

## 4.5 Anonymisation summary table

**Note**: *This table summarises recommended actions for common sources of identifying information in clinical imaging data.* ***It is not an exhaustive list*** *of all possible personal data-containing elements. Even for standard DICOM tags, additional identifiers may exist depending on acquisition protocols, vendor implementations, etc. We strongly recommend applying a comprehensive automated personal data detection approach (e.g. rule-based DICOM tag scanning, NLP for free-text fields, or AI-/ML-based personal data identification) in addition to these actions, followed by manual or semi-automated quality control to validate results.*

| Category | Field/Item | Action to be taken |
|---|---|---|
| Consistency Across Clinical and Imaging Data | N/A | Apply the same anonymisation rules where applicable to preserve analytical linkages while protecting privacy. |
| DICOM – Standard Tags | Patient ID | Replace with a salted, irreversible SHA-256 hash that is stable per participant and not recoverable; discard hashing key to ensure irreversibility. |
| | VR 'PN' Tags | Remove or clear all non-patient Person Name fields. |
| | Patient Name | Replace with the anonymised Patient ID value. |
| | Patient Birth Date | Remove entirely or set to "00000000"; do not shift or surrogate. |
| | Patient Age | Retain only in generalised form (e.g. 090Y, or a value from banded ranges determined by risk assessment). |
| | Demographic Fields | Retain sex/weight/size if needed; remove race, ethnicity, nationality and similar high-risk demographics. |
| | Patient Information (group 0010) | Remove remaining sensitive patient information. |
| | Site ID | Replace with a salted, irreversible SHA-256 hash. |
| | UIDs | Regenerate all UIDs deterministically under a valid UID root. |
| | Dates (VR 'DA' and 'DT') | Apply a subject-specific, deterministic date shift. |
| | Time Fields (VR 'TM') | Remove or zero workflow times; retain only non-identifying technical timing. |
| | Accession Number and MRNs | Remove or replace with non-identifiable placeholders. |
| | Institution & Device Information | Remove or replace identifying sites and hardware information with generic placeholders. |
| | Free-Text Fields (LO, LT, SH, ST, UT) | Remove, replace or retain only after a detailed review. |
| | De-identification Disclosure Tags | Populate required de-identification methods and identity-removed indicators for transparency. |
| | Other attributes | See Appendix C for details. |
| DICOM – Private Tags | Private Tags | Remove all private tags by default. Consider exceptions only via formal review using NEMA "Retain Safe Private Option" guidance and manufacturer's conformance statements; perform targeted personal data review before retention. |
| DICOM – Other Elements | Sequence Elements | Apply full-depth anonymisation rules consistently at all sequence levels. |
| | Encapsulated Documents | Parse and redact personal data within content, similar to burned-in text handling. |
| Pixel Data | Burned-in Annotations | Detect and redact/obfuscate personal data in pixel data; exclude images if redaction is not feasible. |
| | Anatomical Features (Facial Structures) | Apply automated defacing or facial feature removal; perform QC to ensure adequacy. |
| | Defacing Output (NIfTI format) | Minimal metadata risk; still verify that metadata, filenames, directory structures, and image content contain no personal data. |
| File System | Folder & File Names | Scan for personal data; remove or secure hash as needed.<br><br>The recommendation is to standardise directory structures and use anonymised identifiers for naming files and folders. |

## 4.6 Re-identification risk score assessment

Re-identification refers to the ability to associate anonymised data with a specific individual, either through remaining identifiers, combinations of quasi-identifiers, or linkage to external information sources. Imaging data presents distinct re-identification risks due to both metadata identifiers and the recognisability of facial anatomy or other unique anatomical features.

To mitigate these risks, our anonymisation framework removes or neutralises direct identifiers across DICOM standard and private tags, eliminates burnt-in text from pixel data, applies robust anatomical defacing to remove facial structure, and generalises or suppresses quasi-identifiers such as age, clinical attributes, protocol details and acquisition-site information where necessary. These measures significantly reduce the potential for linking an image or metadata record back to an individual and prevent reconstruction of obvious identifying features.

Because some demographic, clinical and anatomical information must remain to preserve scientific validity, re-identification risk cannot be reduced to zero. Residual risk may arise from combinations of quasi-identifiers, rare conditions, uncommon anatomical features, or patterns of longitudinal imaging that cannot be fully masked without degrading data utility. Aligned with GDPR Recital 26 and HIPAA Expert Determination, our objective is therefore to reduce risk to a very small level that is not reasonably likely to occur, particularly given that data is shared only through a secure, access-controlled platform with contractual, technical and organisational safeguards that further limit the possibility of external linkage.

# 5. Supporting files

**Readme file with anonymisation details:**

A short document summarising the anonymisation approach applied to the dataset. It includes a description of key transformations (e.g. hashing rules, date-shifting, removed metadata categories) and any study-specific considerations needed for correct interpretation of the anonymised imaging data.

**Dataset inventory file:**

A structured listing of all imaging files included in the transfer, along with essential metadata such as anonymised subject identifiers, modality, series, and file names/paths. This file enables recipients to understand dataset composition and verify completeness.

**Exclusion logs file:**

A record of all images or series excluded from the dataset prior to transfer. Each entry documents the file path, the reason for exclusion (e.g. burned-in text that could not be safely redacted) and any relevant notes. This provides transparency, traceability and auditability for all omitted content.

# 6. Disclaimer

The opinions expressed in this document are those of the authors and should not be construed to represent the opinions of PHUSE members, respective companies/organisations or regulators' views or policies. The content in this document should not be interpreted as a data standard and/or information required by regulatory authorities.

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## Appendix A. DICOM value representations and personal information/PHI risk overview

| VR Name | VR Full Name | Description | Data Type | PHI Risk |
|---|---|---|---|---|
| AE | Application Entity | Application titles | string | Low |
| AS | Age String | Patient age (e.g. 032Y) | string with formatting | Medium |
| AT | Attribute Tag | Tag references | ordered pair of 16-bit unsigned integers | Low |
| CS | Code String | Enumerated values (e.g. "M", "YES") | string | Low |
| DA | Date | Calendar date (YYYYMMDD) | string with formatting | Medium |
| DS | Decimal String | Floating point numbers in string format | fixed or floating point number | Low |
| DT | Date Time | Combined date/time | string with formatting | Medium |
| FL | Floating Point Single | 32-bit float | floating point number | Low |
| FD | Floating Point Double | 64-bit float | floating point number | Low |
| IS | Integer String | Integers in string format | Integer | Low |
| LO | Long String | Text up to 64 chars | string | High |
| LT | Long Text | Longer blocks of text | string | High |
| OB | Other Byte | Binary data | octet-stream | Medium |
| OD | Other Double | Binary double-precision | A stream of 64-bit floating point words | Low |
| OF | Other Float | Binary float | A stream of 32-bit floating point words | Low |
| OL | Other Long | Binary 32-bit integers | A stream of 32-bit words | Medium |
| OV | Other 64-bit Very Long | Binary 64-bit values | A stream of 64-bit words | Medium |
| OW | Other Word | Binary 16-bit values | A stream of 16-bit words | High |
| PN | Person Name | Structured name fields | string | High |
| SH | Short String | Text up to 16 chars | string | Medium |
| SL | Signed Long | 32-bit signed integer | Integer | Low |
| SQ | Sequence of Items | Nested datasets | dataset | Medium |
| SS | Signed Short | 16-bit signed integer | Signed binary integer 16 bits long | Low |
| ST | Short Text | Limited free text | string | High |
| SV | Signed 64-bit Very Long | 64-bit signed integer | Signed binary integer 64 bits long | Low |
| TM | Time | Time of day | string with formatting | Medium |
| UC | Unlimited Characters | Unicode text | string | High |
| UI | Unique Identifier (UID) | UIDs | string UID | Medium |
| UL | Unsigned Long | 32-bit unsigned integer | Unsigned binary integer 32 bits long | Low |
| UN | Unknown | Unknown encoding | octet-stream with unknown encoding | Medium |
| UR | URI/URL | Web addresses or resource identifiers | string URI/URL | High |
| US | Unsigned Short | 16-bit unsigned integer | Unsigned binary integer 16 bits long | Low |
| UT | Unlimited Text | Very long free text | string | High |
| UV | Unsigned 64-bit Very Long | 64-bit unsigned integer | Unsigned binary integer 64 bits long | Low |

## Appendix B. Defacing tools overview

| Tool | Authors | Year (Latest Update) | Modalities | Method | Used by | Free/Open source | Pros | Cons |
|---|---|---|---|---|---|---|---|---|
| **mri_reface** | Christopher G. Schwarz et al. (Mayo Clinic) | 2024 | MRI (T1/T2/T2*/ FLAIR/ASL), CT, PET (amyloid, tau, FDG) | Face warping | ADNI-4 | Free for non-commercial use, not fully open-source code | Strong validation; multi-modality; minimises impact; active support | Requires MATLAB Runtime and ANTs; closed-source core |
| **MiDeFace** | FreeSurfer/ Martinos Center team | 2023 | MRI (primarily T1w) | Face warping | Recent papers, growing adoption | Free for non-commercial use (FreeSurfer) | Integrated in FreeSurfer; minimal brain impact; QC renders | Newer tool; validation literature still maturing |
| **PyDeface** | Poldrack Lab & contributors | 2022 | MRI (primarily T1w) | Face removal | Common in BIDS and OpenNeuro; ReMIND (TCIA) | Yes (MIT) | Simple CLI; open source; widely used; easy to install | May remove more neck/nose; ears retained; can affect certain measures |
| **FSL Deface** | FMRIB (Oxford) | 2025 | MRI (primarily T1/T2) | Face removal | UK Biobank | Free for non-commercial use (FSL deface) | Well maintained; widely deployed | Can impact on some morphometry metrics |
| **SPM Deface** | SPM team/ community | 2014? | MRI (primarily T1w) | Face removal | OpenNeuro datasets | Yes (GPL) | MATLAB/SPM environments; reproducible; scriptable | MATLAB dependency; may preserve ears; variable impact on measures |
| **AFNI refacer** | AFNI team (NIMH) | 2020 | MRI (primarily T1w) | Face removal or warping | AFNI-centric labs | Yes (GPL) | Header anonymisation option | Reference masks may need tuning |
| **PyFaceWipe** | Patel et al. (2024) | 2024 | MRI (primarily T1w) | Face removal | Early adopters, method paper | Unknown | Promising metrics across contrasts | New; ecosystem/ community still small; no public code repository available yet |
| **mridefacer** | Michael Hanke et al. | 2018 | MRI (primarily T1w) | Face warping | Used via BIDSonym; NeuroDebian packaging | Yes (GPL) | Flexible; can just generate masks for custom workflows | More DIY; fewer turnkey safeguards/ QC |
| **DeepDefacer** | Khazane et al. (with Poldrack Lab) | 2022 | MRI (primarily T1w) | Face removal | Research studies, hackathons | Yes (MIT) | Fast inference; GPU-enabled; potentially adaptable | Reproducibility/ maintenance vary; generalisation risks; fewer production deployments |
| **Face Masking (mask_face)** | XNAT Team (WUSTL) | 2018 | MRI (primarily T1w), CT | Face blurring | XNAT, HCP, GSP | Yes | Integrates with XNAT; minimally invasive | Tied to XNAT; fewer standalone features |
| **mri_deface** | Bischoff-Grethe, Fischl et al. (FreeSurfer/ MBIRN) | 2016 | MRI (primarily T1w) | Face removal | Older pipelines, evaluated widely | Free for non-commercial use (FreeSurfer) | Established; simple CLI; fast | Legacy; can affect downstream metrics more than newer methods |
| **Quickshear** | Schimke et al. | 2017 | MRI (primarily T1w) | Face removal | Older pipelines, educational comparisons | Yes (open source, legacy) | Simple; transparent; fast | Reported higher failure/brain erosion rates; legacy |
| **AnonyMI** | Mikulan et al. | 2025 | MRI (primarily T1w) | Face removal | Replication/ evaluation studies | Yes (3D Slicer) | GUI-friendly; preserves geometry for EEG/MEG co-registration | Workflow inside Slicer |
| **BRAINS Deface** | BRAINS/Slicer community | 2020 | MRI (T1/T2) | Face removal | Institutional pipelines | Yes (Apache-2.0) | Flexible; visible control over region removed | Manual landmarks |
| **Deface** | BioImage Suite Web (Yale) | 2020 | MRI (primarily T1w) | Face removal | Small lab workflows | Yes (Apache-2.0) | Very easy UI; web-based | Fewer publications; limited batch/QA features |
| **HD-BET** | Isensee et al. (DKFZ/Uni Bonn/ Heidelberg) | 2024 | MRI (T1/T2/ FLAIR) | Brain extraction | Used for skull stripping | Yes (Apache-2.0) | Accurate, fast DL stripper; open source | Not a defacer |
| **BrainSuite BSE** | BrainSuite team (USC) | 2024 | MRI (primarily T1w) | Brain extraction | Legacy pipelines, education | Free for non-commercial use | Interactive control; established | Not a defacer |
| **FSL-BET** | Stephen M. Smith/ FMRIB (Oxford) | 2002 | MRI (primarily T1w) | Brain extraction | UK Biobank pipelines | Free for non-commercial use (FSL deface) | Fast; battle-tested; widely available | Not a defacer |

## Appendix C. Recommended anonymisation actions for standard tags

This appendix provides recommended actions **for a selected subset** of standard DICOM attributes. It is not an exhaustive list of all DICOM tags. Instead, it focuses on:

1. Attributes that present a higher risk of re-identification, such as those containing direct or quasi-identifiers
2. Attributes that are commonly required for downstream analysis or scientific use.

For each attribute, the recommended Action (e.g. Keep, Remove, Replace, Hash) reflects both its privacy risk and its analytical relevance.

**Important note on the "Remove" action:**
When the action is listed as Remove, the implementation depends on the DICOM Attribute Type:

- Type 1 or Type 2 attributes:
  These attributes must be present in the dataset according to the DICOM standard. In such cases, the value must be cleared (set to an empty value) rather than removing the attribute entirely.
- Type 3 attributes:
  These attributes are optional and may be safely deleted from the dataset when flagged for removal.

This distinction ensures anonymisation does not violate DICOM conformance.

For more details on certain attributes, groups and actions, see Section 4.2.1.

| Tag | Name | VR | Action |
|---|---|---|---|
| (0000,1000) | Affected SOP Instance UID | UI | Remove |
| (0000,1001) | Requested SOP Instance UID | UI | Replace UID |
| (0002,0001) | File Meta Information Version | OB | Keep |
| (0002,0003) | Media Storage SOP Instance UID | UI | Replace UID |
| (0004,1511) | Referenced SOP Instance UID in File | UI | Replace UID |
| (0008,0012) | Instance Creation Date | DA | Date shift |
| (0008,0013) | Instance Creation Time | TM | Remove |
| (0008,0014) | Instance Creator UID | UI | Replace UID |
| (0008,0015) | Instance Coercion DateTime | DT | Remove |
| (0008,0017) | Acquisition UID | UI | Replace UID |
| (0008,0018) | SOP Instance UID | UI | Replace UID |
| (0008,0019) | Pyramid UID | UI | Replace UID |
| (0008,0020) | Study Date | DA | Date shift |
| (0008,0021) | Series Date | DA | Date shift |
| (0008,0022) | Acquisition Date | DA | Date shift |
| (0008,0023) | Content Date | DA | Date shift |
| (0008,0024) | Overlay Date | DA | Remove |
| (0008,0025) | Curve Date | DA | Remove |
| (0008,002A) | Acquisition DateTime | DT | Remove |
| (0008,0030) | Study Time | TM | Keep |
| (0008,0031) | Series Time | TM | Remove |
| (0008,0032) | Acquisition Time | TM | Remove |
| (0008,0033) | Content Time | TM | Keep |
| (0008,0034) | Overlay Time | TM | Remove |

| | | | |
|---|---|---|---|
| (0008,0035) | Curve Time | TM | Remove |
| (0008,0050) | Accession Number | SH | Remove |
| (0008,0051) | Issuer of Accession Number Sequence | SQ | Remove |
| (0008,0054) | Retrieve AE Title | AE | Remove |
| (0008,0055) | Station AE Title | AE | Remove |
| (0008,0058) | Failed SOP Instance UID List | UI | Replace UID |
| (0008,0070) | Manufacturer | LO | Keep |
| (0008,0080) | Institution Name | LO | Remove |
| (0008,0081) | Institution Address | ST | Remove |
| (0008,0082) | Institution Code Sequence | SQ | Remove |
| (0008,0090) | Referring Physician's Name | PN | Remove |
| (0008,0092) | Referring Physician's Address | ST | Remove |
| (0008,0094) | Referring Physician's Telephone Numbers | SH | Remove |
| (0008,0096) | Referring Physician's Identification Sequence | SQ | Remove |
| (0008,009C) | Consulting Physician's Name | PN | Remove |
| (0008,009D) | Consulting Physician's Identification Sequence | SQ | Remove |
| (0008,0104) | Code Meaning | LO | Check |
| (0008,0106) | Context Group Version | DT | Date shift |
| (0008,0107) | Context Group Local Version | DT | Date shift |
| (0008,010D) | Context Group Extension Creator UID | UI | Replace UID |
| (0008,0110) | Coding Scheme Identification Sequence | SQ | Keep |
| (0008,0112) | Coding Scheme Registry | LO | Keep |
| (0008,0114) | Coding Scheme External ID | ST | Keep |
| (0008,0115) | Coding Scheme Name | ST | Keep |
| (0008,0116) | Coding Scheme Responsible Organization | ST | Keep |
| (0008,0201) | Timezone Offset From UTC | SH | Remove |
| (0008,1000) | Network ID | AE | Remove |
| (0008,1010) | Station Name | SH | Remove |
| (0008,1030) | Study Description | LO | Check or replace with visit label |
| (0008,1032) | Procedure Code Sequence | SQ | Remove |
| (0008,103E) | Series Description | LO | Check |
| (0008,1040) | Institutional Department Name | LO | Remove |
| (0008,1041) | Institutional Department Type Code Sequence | SQ | Remove |
| (0008,1048) | Physician(s) of Record | PN | Remove |
| (0008,1049) | Physician(s) of Record Identification Sequence | SQ | Remove |
| (0008,1050) | Performing Physician's Name | PN | Remove |
| (0008,1052) | Performing Physician's Identification Sequence | SQ | Remove |
| (0008,1060) | Name of Physician's Reading Study | PN | Remove |
| (0008,1062) | Physician's Reading Study Identification Sequence | SQ | Remove |
| (0008,1070) | Operator's Name | PN | Remove |
| (0008,1072) | Operator's Identification Sequence | SQ | Remove |

| | | | |
|---|---|---|---|
| (0008,1080) | Admitting Diagnoses Description | LO | Remove |
| (0008,1084) | Admitting Diagnoses Code Sequence | SQ | Remove |
| (0008,1088) | Pyramid Description | LO | Remove |
| (0008,1090) | Manufacturer's Model Name | LO | Keep |
| (0008,1110) | Referenced Study Sequence | SQ | Remove |
| (0008,1111) | Referenced Performed Procedure Step Sequence | SQ | Remove |
| (0008,1115) | Referenced Series Sequence | SQ | Keep |
| (0008,1120) | Referenced Patient Sequence | SQ | Remove |
| (0008,1125) | Referenced Visit Sequence | SQ | Keep |
| (0008,1130) | Referenced Overlay Sequence | SQ | Keep |
| (0008,113A) | Referenced Waveform Sequence | SQ | Keep |
| (0008,1140) | Referenced Image Sequence | SQ | Remove |
| (0008,114A) | Referenced Instance Sequence | SQ | Keep |
| (0008,114B) | Referenced Real World Value Mapping Instance Sequence | SQ | Keep |
| (0008,1150) | Referenced SOP Class UID | UI | Replace UID |
| (0008,1155) | Referenced SOP Instance UID | UI | Replace UID |
| (0008,1164) | Frame Extraction Sequence | SQ | Keep |
| (0008,1195) | Transaction UID | UI | Replace UID |
| (0008,1198) | Failed SOP Sequence | SQ | Keep |
| (0008,1199) | Referenced SOP Sequence | SQ | Keep |
| (0008,1200) | Studies Containing Other Referenced Instances Sequence | SQ | Keep |
| (0008,1250) | Related Series Sequence | SQ | Keep |
| (0008,1301) | Principal Diagnosis Code Sequence | SQ | Remove |
| (0008,1302) | Primary Diagnosis Code Sequence | SQ | Remove |
| (0008,1303) | Secondary Diagnoses Code Sequence | SQ | Remove |
| (0008,1304) | Histological Diagnoses Code Sequence | SQ | Remove |
| (0008,2111) | Derivation Description | ST | Remove |
| (0008,2112) | Source Image Sequence | SQ | Remove |
| (0008,2135) | Event Code Sequence | SQ | Remove |
| (0008,3010) | Irradiation Event UID | UI | Replace UID |
| (0008,4000) | Identifying Comments | LT | Remove |
| (0008,9123) | Creator Version UID | UI | Replace UID |
| (0010,0010) | Patient's Name | PN | Replace with anonymised Patient ID value |
| (0010,0011) | Person Names to Use Sequence | SQ | Remove |
| (0010,0012) | Name to Use | LT | Remove |
| (0010,0013) | Name to Use Comment | UT | Remove |
| (0010,0014) | Third Person Pronouns Sequence | SQ | Remove |
| (0010,0015) | Pronoun Code Sequence | SQ | Remove |
| (0010,0016) | Pronoun Comment | UT | Remove |
| (0010,0020) | Patient ID | LO | Hash |

| | | | |
|---|---|---|---|
| (0010,0021) | Issuer of Patient ID | LO | Remove |
| (0010,0030) | Patient's Birth Date | DA | Remove |
| (0010,0032) | Patient's Birth Time | TM | Remove |
| (0010,0040) | Patient's Sex | CS | Keep |
| (0010,0041) | Gender Identity Sequence | SQ | Remove |
| (0010,0042) | Sex Parameters for Clinical Use Category Comment | UT | Remove |
| (0010,0043) | Sex Parameters for Clinical Use Category Sequence | SQ | Remove |
| (0010,0044) | Gender Identity Code Sequence | SQ | Remove |
| (0010,0045) | Gender Identity Comment | UT | Remove |
| (0010,0046) | Sex Parameters for Clinical Use Category Code Sequence | SQ | Remove |
| (0010,0047) | Sex Parameters for Clinical Use Category Reference | UR | Remove |
| (0010,0050) | Patient Insurance Plan Code Sequence | SQ | Remove |
| (0010,0101) | Patient's Primary Language Code Sequence | SQ | Remove |
| (0010,0102) | Patient's Primary Language Modifier Code Sequence | SQ | Remove |
| (0010,1000) | Other Patient IDs | LO | Remove |
| (0010,1001) | Other Patient Names | PN | Remove |
| (0010,1002) | Other Patient IDs Sequence | SQ | Remove |
| (0010,1005) | Patient's Birth Name | PN | Remove |
| (0010,1010) | Patient's Age | AS | Replace with generalised value |
| (0010,1020) | Patient's Size | DS | Keep |
| (0010,1030) | Patient's Weight | DS | Keep |
| (0010,1040) | Patient's Address | LO | Remove |
| (0010,1050) | Insurance Plan Identification | LO | Remove |
| (0010,1060) | Patient's Mother's Birth Name | PN | Remove |
| (0010,1080) | Military Rank | LO | Remove |
| (0010,1081) | Branch of Service | LO | Remove |
| (0010,1090) | Medical Record Locator | LO | Remove |
| (0010,1100) | Referenced Patient Photo Sequence | SQ | Remove |
| (0010,2000) | Medical Alerts | LO | Remove |
| (0010,2110) | Allergies | LO | Remove |
| (0010,2150) | Country of Residence | LO | Remove |
| (0010,2152) | Region of Residence | LO | Remove |
| (0010,2154) | Patient's Telephone Numbers | SH | Remove |
| (0010,2155) | Patient's Telecom Information | LT | Remove |
| (0010,2160) | Ethnic Group | SH | Remove |
| (0010,2161) | Ethnic Group Code Sequence | SQ | Remove |
| (0010,2162) | Ethnic Groups | UC | Remove |
| (0010,2180) | Occupation | SH | Remove |
| (0010,21A0) | Smoking Status | CS | Remove |
| (0010,21B0) | Additional Patient History | LT | Remove |
| (0010,21C0) | Pregnancy Status | US | Remove |

| | | | |
|---|---|---|---|
| (0010,21D0) | Last Menstrual Date | DA | Remove |
| (0010,21F0) | Patient's Religious Preference | LO | Remove |
| (0010,2203) | Patient Sex Neutered | CS | Remove |
| (0010,2297) | Responsible Person | PN | Remove |
| (0010,2299) | Responsible Organisation | LO | Remove |
| (0010,4000) | Patient Comments | LT | Remove |
| (0012,0010) | Clinical Trial Sponsor Name | LO | Replace with sponsor name |
| (0012,0020) | Clinical Trial Protocol ID | LO | Replace with study ID |
| (0012,0021) | Clinical Trial Protocol Name | LO | Replace with study name |
| (0012,0022) | Clinical Trial Protocol Ethics Committee Name | LO | Remove |
| (0012,0023) | Other Clinical Trial Protocol IDs Sequence | SQ | Remove |
| (0012,0030) | Clinical Trial Site ID | LO | Replace with anonymised site ID |
| (0012,0031) | Clinical Trial Site Name | LO | Replace with anonymised site ID |
| (0012,0032) | Issuer of Clinical Trial Site ID | LO | Remove |
| (0012,0040) | Clinical Trial Subject ID | LO | Replace with anonymised patient id |
| (0012,0041) | Issuer of Clinical Trial Subject ID | LO | Remove |
| (0012,0042) | Clinical Trial Site Subject Reading ID | LO | Remove |
| (0012,0043) | Issuer of Clinical Trial Subject Reading ID | LO | Remove |
| (0012,0050) | Clinical Trial Time Point ID | LO | Check or replace with visit label |
| (0012,0051) | Clinical Trial Time Point Description | ST | Remove |
| (0012,0055) | Issuer of Clinical Trial Time Point ID | LO | Remove |
| (0012,0060) | Clinical Trial Coordinating Center Name | LO | Remove |
| (0012,0062) | Patient Identity Removed | CS | Redact |
| (0012,0063) | De-identification Method | LO | Redact |
| (0012,0064) | De-identification Code Sequence | SQ | Redact |
| (0012,0071) | Clinical Trial Series ID | LO | Remove |
| (0012,0072) | Clinical Trial Series Description | LO | Check |
| (0012,0073) | Issuer of Clinical Trial Series ID | LO | Remove |
| (0012,0081) | Clinical Trial Protocol Ethics Committee Name | LO | Remove |
| (0012,0082) | Clinical Trial Protocol Ethics Committee Approval Number | LO | Remove |
| (0012,0086) | Ethics Committee Approval Effectiveness Start Date | DA | Remove |
| (0012,0087) | Ethics Committee Approval Effectiveness End Date | DA | Remove |
| (0014,407C) | Calibration Time | TM | Remove |
| (0014,407E) | Calibration Date | DA | Remove |
| (0016,002B) | Maker Note | OB | Remove |
| (0016,004B) | Device Setting Description | OB | Remove |
| (0016,004D) | Camera Owner Name | UT | Remove |
| (0016,004E) | Lens Specification | DS | Remove |
| (0016,004F) | Lens Make | UT | Remove |
| (0016,0050) | Lens Model | UT | Remove |
| (0016,0051) | Lens Serial Number | UT | Remove |

| | | | |
|---|---|---|---|
| (0016,0070) | GPS Version ID | OB | Remove |
| (0016,0071) | GPS Latitude Ref | CS | Remove |
| (0016,0072) | GPS Latitude | DS | Remove |
| (0016,0073) | GPS Longitude Ref | CS | Remove |
| (0016,0074) | GPS Longitude | DS | Remove |
| (0016,0075) | GPS Altitude Ref | US | Remove |
| (0016,0076) | GPS Altitude | DS | Remove |
| (0016,0077) | GPS Time Stamp | DT | Remove |
| (0016,0078) | GPS Satellites | UT | Remove |
| (0016,0079) | GPS Status | CS | Remove |
| (0016,007A) | GPS Measure Mode | CS | Remove |
| (0016,007B) | GPS DOP | DS | Remove |
| (0016,007C) | GPS Speed Ref | CS | Remove |
| (0016,007D) | GPS Speed | DS | Remove |
| (0016,007E) | GPS Track Ref | CS | Remove |
| (0016,007F) | GPS Track | DS | Remove |
| (0016,0080) | GPS Img Direction Ref | CS | Remove |
| (0016,0081) | GPS Img Direction | DS | Remove |
| (0016,0082) | GPS Map Datum | UT | Remove |
| (0016,0083) | GPS Dest Latitude Ref | CS | Remove |
| (0016,0084) | GPS Dest Latitude | DS | Remove |
| (0016,0085) | GPS Dest Longitude Ref | CS | Remove |
| (0016,0086) | GPS Dest Longitude | DS | Remove |
| (0016,0087) | GPS Dest Bearing Ref | CS | Remove |
| (0016,0088) | GPS Dest Bearing | DS | Remove |
| (0016,0089) | GPS Dest Distance Ref | CS | Remove |
| (0016,008A) | GPS Dest Distance | DS | Remove |
| (0016,008B) | GPS Processing Method | OB | Remove |
| (0016,008C) | GPS Area Information | OB | Remove |
| (0016,008D) | GPS Date Stamp | DT | Remove |
| (0016,008E) | GPS Differential | IS | Remove |
| (0018,0010) | Contrast/Bolus Agent | LO | Check |
| (0018,0027) | Intervention Drug Stop Time | TM | Remove |
| (0018,0035) | Intervention Drug Start Time | TM | Remove |
| (0018,1000) | Device Serial Number | LO | Remove |
| (0018,1002) | Device UID | UI | Replace UID |
| (0018,1004) | Plate ID | LO | Remove |
| (0018,1005) | Generator ID | LO | Remove |
| (0018,1007) | Cassette ID | LO | Remove |
| (0018,1008) | Gantry ID | LO | Remove |
| (0018,1009) | Unique Device Identifier | UT | Remove |

| | | | |
|---|---|---|---|
| (0018,100A) | UDI Sequence | SQ | Remove |
| (0018,100B) | Manufacturer's Device Class UID | UI | Replace UID |
| (0018,1012) | Date of Secondary Capture | DA | Remove |
| (0018,1014) | Time of Secondary Capture | TM | Remove |
| (0018,1020) | Software Versions | LO | Keep |
| (0018,1030) | Protocol Name | LO | Remove |
| (0018,1042) | Contrast/Bolus Start Time | TM | Remove |
| (0018,1043) | Contrast/Bolus Stop Time | TM | Remove |
| (0018,1072) | Radiopharmaceutical Start Time | TM | Remove |
| (0018,1073) | Radiopharmaceutical Stop Time | TM | Remove |
| (0018,1078) | Radiopharmaceutical Start DateTime | DT | Remove |
| (0018,1079) | Radiopharmaceutical Stop DateTime | DT | Remove |
| (0018,11BB) | Acquisition Field of View Label | LO | Remove |
| (0018,1200) | Date of Last Calibration | DA | Remove |
| (0018,1201) | Time of Last Calibration | TM | Remove |
| (0018,1202) | DateTime of Last Calibration | DT | Remove |
| (0018,1203) | Calibration DateTime | DT | Date shift |
| (0018,1204) | Date of Manufacture | DA | Remove |
| (0018,1205) | Date of Installation | DA | Remove |
| (0018,1400) | Acquisition Device Processing Description | LO | Remove |
| (0018,2042) | Target UID | UI | Replace UID |
| (0018,4000) | Acquisition Comments | LT | Remove |
| (0018,5011) | Transducer Identification Sequence | SQ | Remove |
| (0018,700A) | Detector ID | SH | Remove |
| (0018,700C) | Date of Last Detector Calibration | DA | Remove |
| (0018,700E) | Time of Last Detector Calibration | TM | Remove |
| (0018,9074) | Frame Acquisition DateTime | DT | Date shift |
| (0018,9151) | Frame Reference DateTime | DT | Date shift |
| (0018,9185) | Respiratory Motion Compensation Technique Description | ST | Remove |
| (0018,9367) | X-Ray Source ID | UC | Remove |
| (0018,9369) | Source Start DateTime | DT | Date shift |
| (0018,936A) | Source End DateTime | DT | Date shift |
| (0018,9371) | X-Ray Detector ID | UC | Remove |
| (0018,9373) | X-Ray Detector Label | ST | Remove |
| (0018,937B) | Multi-energy Acquisition Description | UT | Remove |
| (0018,937F) | Decomposition Description | UT | Remove |
| (0018,9424) | Acquisition Protocol Description | LT | Remove |
| (0018,9516) | Start Acquisition DateTime | DT | Remove |
| (0018,9517) | End Acquisition DateTime | DT | Remove |
| (0018,9623) | Functional Sync Pulse | DT | Date shift |
| (0018,9701) | Decay Correction DateTime | DT | Date shift |

| | | | |
|---|---|---|---|
| (0018,9804) | Exclusion Start DateTime | DT | Date shift |
| (0018,9919) | Instruction Performed DateTime | DT | Date shift |
| (0018,9937) | Requested Series Description | LO | Remove |
| (0018,A002) | Contribution DateTime | DT | Remove |
| (0018,A003) | Contribution Description | ST | Remove |
| (0020,000D) | Study Instance UID | UI | Replace UID |
| (0020,000E) | Series Instance UID | UI | Replace UID |
| (0020,0010) | Study ID | SH | Replace with Study ID |
| (0020,0027) | Pyramid Label | LO | Remove |
| (0020,0052) | Frame of Reference UID | UI | Replace UID |
| (0020,0200) | Synchronization Frame of Reference UID | UI | Replace UID |
| (0020,3401) | Modifying Device ID | CS | Remove |
| (0020,3403) | Modified Image Date | DA | Remove |
| (0020,3404) | Modifying Device Manufacturer | LO | Remove |
| (0020,3405) | Modified Image Time | TM | Remove |
| (0020,3406) | Modified Image Description | LO | Remove |
| (0020,4000) | Image Comments | LT | Remove |
| (0020,9158) | Frame Comments | LT | Remove |
| (0020,9161) | Concatenation UID | UI | Replace UID |
| (0020,9164) | Dimension Organization UID | UI | Replace UID |
| (0028,1199) | Palette Color Lookup Table UID | UI | Replace UID |
| (0028,1214) | Large Palette Color Lookup Table UID | UI | Replace UID |
| (0028,4000) | Image Presentation Comments | LT | Remove |
| (0032,0012) | Study ID Issuer | LO | Remove |
| (0032,0032) | Study Verified Date | DA | Remove |
| (0032,0033) | Study Verified Time | TM | Remove |
| (0032,0034) | Study Read Date | DA | Remove |
| (0032,0035) | Study Read Time | TM | Remove |
| (0032,1000) | Scheduled Study Start Date | DA | Remove |
| (0032,1001) | Scheduled Study Start Time | TM | Remove |
| (0032,1010) | Scheduled Study Stop Date | DA | Remove |
| (0032,1011) | Scheduled Study Stop Time | TM | Remove |
| (0032,1020) | Scheduled Study Location | LO | Remove |
| (0032,1021) | Scheduled Study Location AE Title | AE | Remove |
| (0032,1030) | Reason for Study | LO | Remove |
| (0032,1032) | Requesting Physician | PN | Remove |
| (0032,1033) | Requesting Service | LO | Remove |
| (0032,1040) | Study Arrival Date | DA | Remove |
| (0032,1041) | Study Arrival Time | TM | Remove |
| (0032,1050) | Study Completion Date | DA | Remove |
| (0032,1051) | Study Completion Time | TM | Remove |

| | | | |
|---|---|---|---|
| (0032,1060) | Requested Procedure Description | LO | Remove |
| (0032,1066) | Reason for Visit | UT | Remove |
| (0032,1067) | Reason for Visit Code Sequence | SQ | Remove |
| (0032,1070) | Requested Contrast Agent | LO | Remove |
| (0032,4000) | Study Comments | LT | Remove |
| (0034,0001) | Flow Identifier Sequence | SQ | Remove |
| (0034,0002) | Flow Identifier | OB | Remove |
| (0034,0005) | Source Identifier | OB | Remove |
| (0034,0007) | Frame Origin Timestamp | OB | Replace |
| (0038,0004) | Referenced Patient Alias Sequence | SQ | Remove |
| (0038,0010) | Admission ID | LO | Remove |
| (0038,0011) | Issuer of Admission ID | LO | Remove |
| (0038,0014) | Issuer of Admission ID Sequence | SQ | Remove |
| (0038,001A) | Scheduled Admission Date | DA | Remove |
| (0038,001B) | Scheduled Admission Time | TM | Remove |
| (0038,001C) | Scheduled Discharge Date | DA | Remove |
| (0038,001D) | Scheduled Discharge Time | TM | Remove |
| (0038,001E) | Scheduled Patient Institution Residence | LO | Remove |
| (0038,0020) | Admitting Date | DA | Remove |
| (0038,0021) | Admitting Time | TM | Remove |
| (0038,0030) | Discharge Date | DA | Remove |
| (0038,0032) | Discharge Time | TM | Remove |
| (0038,0040) | Discharge Diagnosis Description | LO | Remove |
| (0038,0050) | Special Needs | LO | Remove |
| (0038,0060) | Service Episode ID | LO | Remove |
| (0038,0061) | Issuer of Service Episode ID | LO | Remove |
| (0038,0062) | Service Episode Description | LO | Remove |
| (0038,0064) | Issuer of Service Episode ID Sequence | SQ | Remove |
| (0038,0300) | Current Patient Location | LO | Remove |
| (0038,0400) | Patient's Institution Residence | LO | Remove |
| (0038,0500) | Patient State | LO | Remove |
| (0038,0502) | Patient Clinical Trial Participation Sequence | SQ | Remove |
| (0038,4000) | Visit Comments | LT | Remove |
| (003A,0310) | Multiplex Group UID | UI | Replace UID |
| (003A,0314) | Impedance Measurement DateTime | DT | Date shift |
| (003A,0329) | Waveform Filter Description | ST | Remove |
| (003A,032B) | Filter Lookup Table Description | ST | Remove |
| (0040,0001) | Scheduled Station AE Title | AE | Remove |
| (0040,0002) | Scheduled Procedure Step Start Date | DA | Remove |
| (0040,0003) | Scheduled Procedure Step Start Time | TM | Remove |
| (0040,0004) | Scheduled Procedure Step End Date | DA | Remove |

| | | | |
|---|---|---|---|
| (0040,0005) | Scheduled Procedure Step End Time | TM | Remove |
| (0040,0006) | Scheduled Performing Physician's Name | PN | Remove |
| (0040,0007) | Scheduled Procedure Step Description | LO | Remove |
| (0040,0009) | Scheduled Procedure Step ID | SH | Remove |
| (0040,000B) | Scheduled Performing Physician Identification Sequence | SQ | Remove |
| (0040,0010) | Scheduled Station Name | SH | Remove |
| (0040,0011) | Scheduled Procedure Step Location | SH | Remove |
| (0040,0012) | Pre-Medication | LO | Remove |
| (0040,0241) | Performed Station AE Title | AE | Remove |
| (0040,0242) | Performed Station Name | SH | Remove |
| (0040,0243) | Performed Location | SH | Remove |
| (0040,0244) | Performed Procedure Step Start Date | DA | Remove |
| (0040,0245) | Performed Procedure Step Start Time | TM | Remove |
| (0040,0250) | Performed Procedure Step End Date | DA | Remove |
| (0040,0251) | Performed Procedure Step End Time | TM | Remove |
| (0040,0253) | Performed Procedure Step ID | SH | Remove |
| (0040,0254) | Performed Procedure Step Description | LO | Remove |
| (0040,0255) | Performed Procedure Type Description | LO | Remove |
| (0040,0275) | Request Attributes Sequence | SQ | Remove |
| (0040,0280) | Comments on the Performed Procedure Step | ST | Remove |
| (0040,0310) | Comments on Radiation Dose | ST | Remove |
| (0040,050A) | Specimen Accession Number | LO | Remove |
| (0040,0512) | Container Identifier | LO | Remove |
| (0040,0513) | Issuer of the Container Identifier Sequence | SQ | Remove |
| (0040,051A) | Container Description | LO | Remove |
| (0040,0551) | Specimen Identifier | LO | Remove |
| (0040,0554) | Specimen UID | UI | Replace UID |
| (0040,0555) | Acquisition Context Sequence | SQ | Remove |
| (0040,0562) | Issuer of the Specimen Identifier Sequence | SQ | Remove |
| (0040,0600) | Specimen Short Description | LO | Remove |
| (0040,0602) | Specimen Detailed Description | UT | Remove |
| (0040,0610) | Specimen Preparation Sequence | SQ | Remove |
| (0040,06FA) | Slide Identifier | LO | Remove |
| (0040,1001) | Requested Procedure ID | SH | Remove |
| (0040,1002) | Reason for the Requested Procedure | LO | Remove |
| (0040,1004) | Patient Transport Arrangements | LO | Remove |
| (0040,1005) | Requested Procedure Location | LO | Remove |
| (0040,100A) | Reason for Requested Procedure Code Sequence | SQ | Remove |
| (0040,1010) | Names of Intended Recipients of Results | PN | Remove |
| (0040,1011) | Intended Recipients of Results Identification Sequence | SQ | Remove |
| (0040,1086) | Default Frame of Reference UID | UI | Replace UID |

| | | | |
|---|---|---|---|
| (0040,1101) | Person's Identification Code Sequence | SQ | Remove |
| (0040,1102) | Person's Address | ST | Remove |
| (0040,1103) | Person's Telephone Numbers | LO | Remove |
| (0040,1104) | Person's Telecom Information | LT | Remove |
| (0040,1400) | Requested Procedure Comments | LT | Remove |
| (0040,2001) | Reason for the Imaging Service Request | LO | Remove |
| (0040,2004) | Issue Date of Imaging Service Request | DA | Remove |
| (0040,2005) | Issue Time of Imaging Service Request | TM | Remove |
| (0040,2008) | Order Entered By | PN | Remove |
| (0040,2009) | Order Enterer's Location | SH | Remove |
| (0040,2010) | Order Callback Phone Number | SH | Remove |
| (0040,2011) | Order Callback Telecom Information | LT | Remove |
| (0040,2016) | Placer Order Number of Imaging Service Request | LO | Remove |
| (0040,2017) | Filler Order Number of Imaging Service Request | LO | Remove |
| (0040,2400) | Imaging Service Request Comments | LT | Remove |
| (0040,3001) | Confidentiality Constraint on Patient Data Description | LO | Remove |
| (0040,4005) | Scheduled Procedure Step Start DateTime | DT | Remove |
| (0040,4008) | Scheduled Procedure Step Expiration DateTime | DT | Remove |
| (0040,4010) | Scheduled Procedure Step Modification DateTime | DT | Remove |
| (0040,4011) | Expected Completion DateTime | DT | Remove |
| (0040,4023) | Referenced General Purpose Scheduled Procedure Step Transaction UID | UI | Replace UID |
| (0040,4025) | Scheduled Station Name Code Sequence | SQ | Remove |
| (0040,4027) | Scheduled Station Geographic Location Code Sequence | SQ | Remove |
| (0040,4028) | Performed Station Name Code Sequence | SQ | Remove |
| (0040,4030) | Performed Station Geographic Location Code Sequence | SQ | Remove |
| (0040,4034) | Scheduled Human Performer's Sequence | SQ | Remove |
| (0040,4035) | Actual Human Performer's Sequence | SQ | Remove |
| (0040,4036) | Human Performer's Organization | LO | Remove |
| (0040,4037) | Human Performer's Name | PN | Remove |
| (0040,4050) | Performed Procedure Step Start DateTime | DT | Remove |
| (0040,4051) | Performed Procedure Step End DateTime | DT | Remove |
| (0040,4052) | Procedure Step Cancellation DateTime | DT | Remove |
| (0040,A023) | Findings Group Recording Date (Trial) | DA | Remove |
| (0040,A024) | Findings Group Recording Time (Trial) | TM | Remove |
| (0040,A027) | Verifying Organization | LO | Remove |
| (0040,A030) | Verification DateTime | DT | Date Shift |
| (0040,A032) | Observation DateTime | DT | Remove |
| (0040,A033) | Observation Start DateTime | DT | Remove |
| (0040,A034) | Effective Start DateTime | DT | Remove |
| (0040,A035) | Effective Stop DateTime | DT | Remove |
| (0040,A073) | Verifying Observer Sequence | SQ | Remove |

| | | | |
|---|---|---|---|
| (0040,A075) | Verifying Observer Name | PN | Remove |
| (0040,A078) | Author Observer Sequence | SQ | Remove |
| (0040,A07A) | Participant Sequence | SQ | Remove |
| (0040,A07C) | Custodial Organization Sequence | SQ | Remove |
| (0040,A082) | Participation DateTime | DT | Date Shift |
| (0040,A088) | Verifying Observer Identification Code Sequence | SQ | Remove |
| (0040,A110) | Date of Document or Verbal Transaction (Trial) | DA | Remove |
| (0040,A112) | Time of Document Creation or Verbal Transaction (Trial) | TM | Remove |
| (0040,A120) | DateTime | DT | Date Shift |
| (0040,A121) | Date | DA | Date Shift |
| (0040,A122) | Time | TM | Keep |
| (0040,A123) | Person Name | PN | Remove |
| (0040,A124) | UID | UI | Replace UID |
| (0040,A13A) | Referenced DateTime | DT | Date Shift |
| (0040,A171) | Observation UID | UI | Replace UID |
| (0040,A172) | Referenced Observation UID (Trial) | UI | Replace UID |
| (0040,A192) | Observation Date (Trial) | DA | Remove |
| (0040,A193) | Observation Time (Trial) | TM | Remove |
| (0040,A307) | Current Observer (Trial) | PN | Remove |
| (0040,A352) | Verbal Source (Trial) | PN | Remove |
| (0040,A353) | Address (Trial) | ST | Remove |
| (0040,A354) | Telephone Number (Trial) | LO | Remove |
| (0040,A358) | Verbal Source Identifier Code Sequence (Trial) | SQ | Remove |
| (0040,A402) | Observation Subject UID (Trial) | UI | Replace UID |
| (0040,A730) | Content Sequence | SQ | Remove |
| (0040,B034) | Annotation DateTime | DT | Remove |
| (0040,B036) | Segment Definition DateTime | DT | Remove |
| (0040,B03B) | Montage Name | LT | Remove |
| (0040,B03F) | Montage Channel Label | LO | Remove |
| (0040,DB06) | Template Version | DT | Remove |
| (0040,DB07) | Template Local Version | DT | Remove |
| (0040,DB0C) | Template Extension Organization UID | UI | Replace UID |
| (0040,DB0D) | Template Extension Creator UID | UI | Replace UID |
| (0040,E004) | HL7 Document Effective Time | DT | Remove |
| (0042,0011) | Encapsulated Document | OB | Check |
| (0044,0004) | Approval Status DateTime | DT | Remove |
| (0044,000B) | Product Expiration DateTime | DT | Remove |
| (0044,0010) | Substance Administration DateTime | DT | Remove |
| (0044,0104) | Assertion DateTime | DT | Date Shift |
| (0044,0105) | Assertion Expiration DateTime | DT | Remove |
| (0050,001B) | Container Component ID | LO | Remove |

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|---|---|---|---|
| (0050,0020) | Device Description | LO | Remove |
| (0050,0021) | Long Device Description | ST | Remove |
| (0054,0410) | Patient Orientation Code Sequence | SQ | Keep |
| (0054,0412) | Patient Orientation Modifier Code Sequence | SQ | Keep |
| (0062,0021) | Tracking UID | UI | Replace UID |
| (0064,0003) | Source Frame of Reference UID | UI | Replace UID |
| (0068,6226) | Effective DateTime | DT | Date Shift |
| (0068,6270) | Information Issue DateTime | DT | Date Shift |
| (006A,0003) | Annotation Group UID | UI | Replace UID |
| (006A,0005) | Annotation Group Label | LO | Check |
| (006A,0006) | Annotation Group Description | UT | Remove |
| (0070,0001) | Graphic Annotation Sequence | SQ | Keep |
| (0070,0082) | Presentation Creation Date | DA | Remove |
| (0070,0083) | Presentation Creation Time | TM | Remove |
| (0070,0084) | Content Creator's Name | PN | Remove |
| (0070,0086) | Content Creator's Identification Code Sequence | SQ | Remove |
| (0070,031A) | Fiducial UID | UI | Replace UID |
| (0070,1101) | Presentation Display Collection UID | UI | Replace UID |
| (0070,1102) | Presentation Sequence Collection UID | UI | Replace UID |
| (0072,000A) | Hanging Protocol Creation DateTime | DT | Date Shift |
| (0072,005E) | Selector AE Value | AE | Check |
| (0072,005F) | Selector AS Value | AS | Replace |
| (0072,0061) | Selector DA Value | DA | Date Shift |
| (0072,0063) | Selector DT Value | DT | Date Shift |
| (0072,0065) | Selector OB Value | OB | Check |
| (0072,0066) | Selector LO Value | LO | Check |
| (0072,0068) | Selector LT Value | LT | Check |
| (0072,006A) | Selector PN Value | PN | Remove |
| (0072,006B) | Selector TM Value | TM | Keep |
| (0072,006C) | Selector SH Value | SH | Check |
| (0072,006D) | Selector UN Value | UN | Check |
| (0072,006E) | Selector ST Value | ST | Check |
| (0072,0070) | Selector UT Value | UT | Check |
| (0072,0071) | Selector UR Value | UR | Check |
| (0074,1234) | Receiving AE | AE | Remove |
| (0074,1236) | Requesting AE | AE | Remove |
| (0088,0140) | Storage Media File-set UID | UI | Replace UID |
| (0088,0200) | Icon Image Sequence | SQ | Remove |
| (0088,0904) | Topic Title | LO | Remove |
| (0088,0906) | Topic Subject | ST | Remove |
| (0088,0910) | Topic Author | LO | Remove |

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|---|---|---|---|
| (0088,0912) | Topic Keywords | LO | Remove |
| (0100,0420) | SOP Authorization DateTime | DT | Remove |
| (0400,0100) | Digital Signature UID | UI | Replace UID |
| (0400,0105) | Digital Signature DateTime | DT | Date Shift |
| (0400,0115) | Certificate of Signer | OB | Remove |
| (0400,0120) | Signature | OB | Remove |
| (0400,0310) | Certified Timestamp | OB | Remove |
| (0400,0402) | Referenced Digital Signature Sequence | SQ | Remove |
| (0400,0403) | Referenced SOP Instance MAC Sequence | SQ | Remove |
| (0400,0404) | MAC | OB | Remove |
| (0400,0550) | Modified Attributes Sequence | SQ | Remove |
| (0400,0551) | Nonconforming Modified Attributes Sequence | SQ | Remove |
| (0400,0552) | Nonconforming Data Element Value | OB | Remove |
| (0400,0561) | Original Attributes Sequence | SQ | Remove |
| (0400,0562) | Attribute Modification DateTime | DT | Date Shift |
| (0400,0563) | Modifying System | LO | Remove |
| (0400,0564) | Source of Previous Values | LO | Remove |
| (0400,0565) | Reason for the Attribute Modification | CS | Check |
| (0400,0600) | Instance Origin Status | CS | Remove |
| (2030,0020) | Text String | LO | Remove |
| (2100,0040) | Creation Date | DA | Remove |
| (2100,0050) | Creation Time | TM | Remove |
| (2100,0070) | Originator | AE | Remove |
| (2100,0140) | Destination AE | AE | Check |
| (2200,0002) | Label Text | UT | Remove |
| (2200,0005) | Barcode Value | LT | Remove |
| (3002,0121) | Position Acquisition Template Name | LO | Remove |
| (3002,0123) | Position Acquisition Template Description | LT | Remove |
| (3006,0002) | Structure Set Label | SH | Check |
| (3006,0004) | Structure Set Name | LO | Remove |
| (3006,0006) | Structure Set Description | ST | Remove |
| (3006,0008) | Structure Set Date | DA | Date Shift |
| (3006,0009) | Structure Set Time | TM | Keep |
| (3006,0024) | Referenced Frame of Reference UID | UI | Replace UID |
| (3006,0026) | ROI Name | LO | Check |
| (3006,0028) | ROI Description | ST | Remove |
| (3006,002D) | ROI DateTime | DT | Remove |
| (3006,002E) | ROI Observation DateTime | DT | Remove |
| (3006,0038) | ROI Generation Description | LO | Remove |
| (3006,004D) | ROI Creator Sequence | SQ | Remove |
| (3006,004E) | ROI Interpreter Sequence | SQ | Remove |

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|---|---|---|---|
| (3006,0085) | ROI Observation Label | SH | Remove |
| (3006,0088) | ROI Observation Description | ST | Remove |
| (3006,00A6) | ROI Interpreter | PN | Remove |
| (3006,00C2) | Related Frame of Reference UID | UI | Replace UID |
| (3008,0024) | Treatment Control Point Date | DA | Date Shift |
| (3008,0025) | Treatment Control Point Time | TM | Keep |
| (3008,0054) | First Treatment Date | DA | Remove |
| (3008,0056) | Most Recent Treatment Date | DA | Remove |
| (3008,0105) | Source Serial Number | LO | Remove |
| (3008,0162) | Safe Position Exit Date | DA | Date Shift |
| (3008,0164) | Safe Position Exit Time | TM | Keep |
| (3008,0166) | Safe Position Return Date | DA | Date Shift |
| (3008,0168) | Safe Position Return Time | TM | Keep |
| (3008,0250) | Treatment Date | DA | Remove |
| (3008,0251) | Treatment Time | TM | Remove |
| (300A,0002) | RT Plan Label | SH | Remove |
| (300A,0003) | RT Plan Name | LO | Remove |
| (300A,0004) | RT Plan Description | ST | Remove |
| (300A,0006) | RT Plan Date | DA | Remove |
| (300A,0007) | RT Plan Time | TM | Remove |
| (300A,000B) | Treatment Sites | LO | Remove |
| (300A,000E) | Prescription Description | ST | Remove |
| (300A,0013) | Dose Reference UID | UI | Replace UID |
| (300A,0016) | Dose Reference Description | LO | Remove |
| (300A,0054) | Table Top Position Alignment UID | UI | Replace UID |
| (300A,0072) | Fraction Group Description | LO | Remove |
| (300A,0083) | Referenced Dose Reference UID | UI | Replace UID |
| (300A,00B2) | Treatment Machine Name | SH | Remove |
| (300A,00C3) | Beam Description | ST | Remove |
| (300A,00DD) | Bolus Description | ST | Remove |
| (300A,0196) | Fixation Device Description | ST | Remove |
| (300A,01A6) | Shielding Device Description | ST | Remove |
| (300A,01B2) | Setup Technique Description | ST | Remove |
| (300A,0216) | Source Manufacturer | LO | Remove |
| (300A,022C) | Source Strength Reference Date | DA | Date Shift |
| (300A,022E) | Source Strength Reference Time | TM | Keep |
| (300A,02EB) | Compensator Description | LT | Remove |
| (300A,0608) | Treatment Position Group Label | LO | Check |
| (300A,0609) | Treatment Position Group UID | UI | Replace UID |
| (300A,0611) | RT Accessory Holder Slot ID | LO | Remove |
| (300A,0615) | RT Accessory Device Slot ID | LO | Remove |

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|---|---|---|---|
| (300A,0619) | Radiation Dose Identification Label | LO | Check |
| (300A,0623) | Radiation Dose In-Vivo Measurement Label | LO | Check |
| (300A,062A) | RT Tolerance Set Label | LO | Remove |
| (300A,0650) | Patient Setup UID | UI | Replace UID |
| (300A,0676) | Equipment Frame of Reference Description | ST | Remove |
| (300A,067C) | Radiation Generation Mode Label | SH | Check |
| (300A,067D) | Radiation Generation Mode Description | ST | Check |
| (300A,0700) | Treatment Session UID | UI | Replace UID |
| (300A,0734) | Treatment Tolerance Violation Description | ST | Check |
| (300A,0736) | Treatment Tolerance Violation DateTime | DT | Date Shift |
| (300A,073A) | Recorded RT Control Point DateTime | DT | Date Shift |
| (300A,0741) | Interlock DateTime | DT | Date Shift |
| (300A,0742) | Interlock Description | ST | Check |
| (300A,0760) | Override DateTime | DT | Date Shift |
| (300A,0783) | Interlock Origin Description | ST | Check |
| (300A,0785) | Referenced Treatment Position Group UID | UI | Replace UID |
| (300A,078E) | Patient Treatment Preparation Procedure Parameter Description | LT | Remove |
| (300A,0792) | Patient Treatment Preparation Method Description | LT | Remove |
| (300A,0794) | Patient Setup Photo Description | LT | Remove |
| (300A,079A) | Displacement Reference Label | LO | Remove |
| (300C,0113) | Reason for Omission Description | LO | Remove |
| (300C,0127) | Beam Hold Transition DateTime | DT | Date Shift |
| (300E,0004) | Review Date | DA | Date Shift |
| (300E,0005) | Review Time | TM | Keep |
| (300E,0008) | Reviewer Name | PN | Remove |
| (3010,0006) | Conceptual Volume UID | UI | Replace UID |
| (3010,000B) | Referenced Conceptual Volume UID | UI | Replace UID |
| (3010,000F) | Conceptual Volume Combination Description | ST | Check |
| (3010,0013) | Constituent Conceptual Volume UID | UI | Replace UID |
| (3010,0015) | Source Conceptual Volume UID | UI | Replace UID |
| (3010,0017) | Conceptual Volume Description | ST | Check |
| (3010,001B) | Device Alternate Identifier | UC | Remove |
| (3010,002D) | Device Label | LO | Remove |
| (3010,0031) | Referenced Fiducials UID | UI | Replace UID |
| (3010,0033) | User Content Label | SH | Check |
| (3010,0034) | User Content Long Label | LO | Check |
| (3010,0035) | Entity Label | SH | Check |
| (3010,0036) | Entity Name | LO | Remove |
| (3010,0037) | Entity Description | ST | Remove |
| (3010,0038) | Entity Long Label | LO | Check |
| (3010,003B) | RT Treatment Phase UID | UI | Replace UID |

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|---|---|---|---|
| (3010,0043) | Manufacturer's Device Identifier | ST | Check |
| (3010,004C) | Intended Phase Start Date | DA | Remove |
| (3010,004D) | Intended Phase End Date | DA | Remove |
| (3010,0054) | RT Prescription Label | LO | Check |
| (3010,0056) | RT Treatment Approach Label | LO | Remove |
| (3010,005A) | RT Physician Intent Narrative | UT | Remove |
| (3010,005C) | Reason for Superseding | ST | Remove |
| (3010,0061) | Prior Treatment Dose Description | UT | Remove |
| (3010,006E) | Dosimetric Objective UID | UI | Replace UID |
| (3010,006F) | Referenced Dosimetric Objective UID | UI | Replace UID |
| (3010,0077) | Treatment Site | LO | Remove |
| (3010,007A) | Treatment Technique Notes | UT | Remove |
| (3010,007B) | Prescription Notes | UT | Remove |
| (3010,007F) | Fractionation Notes | UT | Remove |
| (3010,0081) | Prescription Notes Sequence | SQ | Remove |
| (3010,0085) | Intended Fraction Start Time | TM | Remove |
| (4000,0010) | Arbitrary | LT | Remove |
| (4000,4000) | Text Comments | LT | Remove |
| (4008,0040) | Results ID | SH | Remove |
| (4008,0042) | Results ID Issuer | LO | Remove |
| (4008,0100) | Interpretation Recorded Date | DA | Remove |
| (4008,0101) | Interpretation Recorded Time | TM | Remove |
| (4008,0102) | Interpretation Recorder | PN | Remove |
| (4008,0103) | Reference to Recorded Sound | LO | Remove |
| (4008,0108) | Interpretation Transcription Date | DA | Remove |
| (4008,0109) | Interpretation Transcription Time | TM | Remove |
| (4008,010A) | Interpretation Transcriber | PN | Remove |
| (4008,010B) | Interpretation Text | ST | Remove |
| (4008,010C) | Interpretation Author | PN | Remove |
| (4008,0111) | Interpretation Approver Sequence | SQ | Remove |
| (4008,0112) | Interpretation Approval Date | DA | Remove |
| (4008,0113) | Interpretation Approval Time | TM | Remove |
| (4008,0114) | Physician Approving Interpretation | PN | Remove |
| (4008,0115) | Interpretation Diagnosis Description | LT | Remove |
| (4008,0118) | Results Distribution List Sequence | SQ | Remove |
| (4008,0119) | Distribution Name | PN | Remove |
| (4008,011A) | Distribution Address | LO | Remove |
| (4008,0200) | Interpretation ID | SH | Remove |
| (4008,0202) | Interpretation ID Issuer | LO | Remove |
| (4008,0300) | Impressions | ST | Remove |
| (4008,4000) | Results Comments | ST | Remove |

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|---|---|---|---|
| (50xx,xxxx) | Curve Data | | Remove |
| (60xx,3000) | Overlay Data | OB or OW | Remove |
| (60xx,4000) | Overlay Comments | LT | Remove |
| (FFFA,FFFA) | Digital Signatures Sequence | SQ | Remove |
| (FFFC,FFFC) | Data Set Trailing Padding | OB | Remove |