Correction Number CP-1457

Log Summary: Identification of groups of pre-clinical research small animal subjects

Name of Standard
PS3.3, PS3.6, PS3.16, PS3.17

Rationale for Correction:

DICOM is used for the output of human and dedicated small animal imaging devices, both for imaging and post-processing results. The existing composite information model is largely sufficient for identification and description of individual small animal imaging subjects ("patients"), particularly since the addition of attributes for veterinary purposes. However, there are some specific gaps, including the presence of multiple animals in the same image, which though treated as a group for acquisition purposes, may later be individually segmented and split out into derived images.

The previous work by WG 26 (Pathology) described the possibility of multiple subjects in tissue microarrays, but is constrained to identifying specimens (spots) on slides. It mentions in informative text the need for a "pseudo-patient identifier", and provides a "content item" template for localization used within a Specimen Localization Content Item Sequence within an item of a Specimen Description Sequence of the Specimen Module. The approach proposed in this CP is to encode only information that is likely to be known at the time that the image of a group of animals is acquired, which includes the relative locations of one animal to another, but not exact image coordinates, nor "forward references" to presentation states, segmentations, etc., which may be derived during (manual or automated) post-processing to separate the animal sub-images.

Add notes that the patient identifiers may describe a group of animals when acquired that way.

Add attributes that reference the original Patient ID value of a group of animals for use when the individual animal information has been extracted and re-encoded and is identified by its own, specific Patient ID value, using a macro that may be included in both the worklist (Patient Identification Module) and composite instances (Patient Module).

Include per-subject Patient Position when multiple subjects.

Add an informative description of how to cross-reference images and segmentations for groups and individual animals, and describe their derivation and history.

Clean up various inappropriate historical descriptions that are no longer appropriate.

Correction Wording:
Amend DICOM PS3.3 as follows (changes to existing text are bold and underlined for additions and struckthrough for removals):

7.3.1.1 Patient

A Patient is a person human or animal receiving, or registered to receive, healthcare services, or is the subject of one or more studies for some other purpose, such as research.

Note

A patient may be a human or an animal. In some circumstances, multiple humans or animals may be studied simultaneously, and for the purpose of the model are identified as a single Patient. E.g., a mother and one or more fetuses during antepartum obstetric ultrasound, multiple specimens in a single tissue microarray, or a group of multiple research small animals imaged simultaneously.

C.2.2 Patient Identification Module

Table C.2-2 defines the Attributes relevant to identifying a patient.

Table C.2-2. Patient Identification Module Attributes

<table>
<thead>
<tr>
<th>Attribute Name</th>
<th>Tag</th>
<th>Attribute Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient's Name</td>
<td>(0010,0010)</td>
<td>Patient's full name</td>
</tr>
<tr>
<td>Patient ID</td>
<td>(0010,0020)</td>
<td>Primary hospital identification number or code for the patient. Note</td>
</tr>
</tbody>
</table>

Note

In the case of imaging a group of small animals simultaneously, the single value of this identifier corresponds to the identification of the entire group. See also Section C.7.1.4.1.1.

Table C.7-1. Patient Module Attributes

<table>
<thead>
<tr>
<th>Attribute Name</th>
<th>Tag</th>
<th>Type</th>
<th>Attribute Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient's Name</td>
<td>(0010,0010)</td>
<td>2</td>
<td>Patient's full name</td>
</tr>
<tr>
<td>Patient ID</td>
<td>(0010,0020)</td>
<td>2</td>
<td>Primary hospital identification number or code for the patient. Note</td>
</tr>
</tbody>
</table>

Note

In the case of imaging a group of small animals simultaneously, the single value of this identifier corresponds to the identification of the entire group. See also Section C.7.1.4.1.1.
C.7.1.4 Patient Group Macro

Table C.7.1.4-1 specifies the Attributes of the Patient Group Macro that describe multiple imaging subjects (such as small animals for pre-clinical research) imaged at the same time as a group. This macro may be included in the Section C.2.2 Patient Identification Module and the Section C.7.1.1 Patient Module.

Table C.7.1.4-1. Patient Group Macro Attributes

<table>
<thead>
<tr>
<th>Attribute Name</th>
<th>Tag</th>
<th>Type</th>
<th>Attribute Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source Patient Group Identification Sequence</td>
<td>(gggg,eee1)</td>
<td>3</td>
<td>A sequence containing the value used for Patient ID (0010.0020) and related Attributes in the source composite instances that contained a group of subjects whose data was acquired at the same time, from which this composite instance was extracted. See Section C.7.1.4.1.1. Only a single Item is permitted in this sequence.</td>
</tr>
<tr>
<td>&gt;Patient ID</td>
<td>(0010.0020)</td>
<td>1</td>
<td>Primary identification number or code for the group of subjects.</td>
</tr>
<tr>
<td>&gt;Group of Patients Identification Sequence</td>
<td>(gggg,eee9)</td>
<td>3</td>
<td>A sequence containing the identifiers and locations of the individual subjects whose data was acquired at the same time (as a group) and encoded in this composite instance. See Section C.7.1.4.1.1. One or more Items are permitted in this sequence.</td>
</tr>
<tr>
<td>&gt;Patient ID</td>
<td>(0010.0020)</td>
<td>1</td>
<td>Primary identification number or code for an individual subject.</td>
</tr>
<tr>
<td>&gt;Subject Relative Position in Image</td>
<td>(gggg,ee10)</td>
<td>3</td>
<td>The position in the image pixel data of the subject identified in this sequence relative to the other subjects. See Section C.7.1.4.1.1.</td>
</tr>
<tr>
<td>&gt;Patient Position</td>
<td>(0018,5100)</td>
<td>3</td>
<td>Patient position descriptor relative to the equipment. See Section C.7.1.4.1.1.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>See Section C.7.3.1.1.2 for Defined Terms and further explanation.</td>
</tr>
</tbody>
</table>

C.7.1.4.1 Patient Group Macro Attributes

C.7.1.4.1.1 Groups of Subjects

It is common to image multiple small animals for pre-clinical research as a group at the same time.

In such cases, the single value of Patient ID (0010.0020) corresponds to the identification of the entire group. The same applies to related attributes, if present, such as Issuer of Patient ID (0010.0021). Other Attributes of the Patient Module that are present shall be those shared by the entire group of animals, otherwise they shall be absent or empty (e.g., Patient’s Sex (0010.0040)). Any acquisition-related Attributes that are patient-specific (e.g., injected contrast or radiopharmaceutical dose) shall also be absent or empty (and the information may be communicated in separate acquisition context instances).

The Group of Patients Identification Sequence (gggg,eee9) provides a means of describing the identifiers and locations of the individual subjects, if known at the time of acquisition, regardless of whether or not the group images are later segmented into individual images.

It is also common to segment the acquired images of the group of animals and extract the image pixel data for each animal into separate images.
**The Source Patient Group Identification Sequence (gggg.eee1) provides a “backward reference” within the segmented (individual subject) images to the Patient ID (0010,0020) of the group.**

**Note**

1. Individual derived SOP Instances may reference the source image explicitly by its SOP Instance UID. Additional objects, such as Segmentations, may be created to encode the regions segmented for individual animals, and referenced from the derived images. See also PS 3.17 Annex XXX “Segmentation of Images of Groups of Animals (Informative)”

2. For example, an image of a group of 6 mice in a 3 column, 2 row single longitudinal plane array might be described as:

   - **Patient ID (0010,0020) = "Inv234_Exp_56_Group78"**
   - **Issuer of Patient ID (0010,0021) = "MyMouseLab"**
   - **Group of Patients Identification Sequence (gggg.eee9)**
   - > **Patient ID (0010,0020) = "Inv234_Exp_56_Group78_Mouse01"**
   - > **Issuer of Patient ID (0010,0021) = "MyMouseLab"**
   - > **Subject Relative Position in Image (gggg.ee10) = 1\11\1**
   - ...
   - > **Patient ID (0010,0020) = "Inv234_Exp_56_Group78_Mouse06"**
   - > **Issuer of Patient ID (0010,0021) = "MyMouseLab"**
   - > **Subject Relative Position in Image (gggg.ee10) = 3\2\1**

   In this example, the optional Issuer of Patient ID (0010,0021) is shown to emphasize that if it is needed, it should be repeated; i.e., there is no “inheritance” of the issuer from the data set enclosing the sequence.

   The naming of the group and the individual animals in the identifier is purely illustrative; it is not meant to imply preference for one local convention or another, or for using a discrete identifier for the group as opposed to, say, a concatenated list of individual animal identifiers used as the group identifier.

   See Figure C.7.1.4-1.

3. For example, segmented images of an individual animal derived from the group image might be described as:

   - **Patient ID (0010,0020) = "Inv234_Exp_56_Group78_Mouse04"**
   - **Issuer of Patient ID (0010,0021) = "MyMouseLab"**
   - **Source Patient Group Identification Sequence (gggg.eee1)**
   - > **Patient ID (0010,0020) = "Inv234_Exp_56_Group78"**
   - > **Issuer of Patient ID (0010,0021) = "MyMouseLab"**

**C.7.1.4.1.1 Subject Relative Position in Image and Patient Position**

**Subject Relative Position in Image (gggg.ee10) shall be encoded as a 3D ordinal position in machine-relative orthogonal dimensions, such that when facing the front of the machine (gantry):**

- the first value starts at one for the left most subject and monotonically increases by one for each successive subject towards the right;

- the second value starts at one for the top most subject and monotonically increases by one for each successively lower subject.
• the third value starts at one for the outer most subject and monotonically increases by one for each successive subject inwards (i.e., increasing values from the front to the back of the gantry along the direction orthogonal to the first two dimensions, usually the long axis of the table).

Note

• The order and sign of the machine-relative directions is consistent with the Axis Definition in ACR-NEMA 300 1985.

• Image-relative positions are not used, since there may be multiple acquisitions in different orientations. The machine-relative positions are applicable regardless of whether acquired images are cross-sections or projections.

• Patient-relative positions are not used, since the animals may not be arranged in the same direction (e.g., a pair of animals may be arranged head-to-head).

• There is no requirement that there be the same number of animals in each dimension. E.g., one in the top “row” and two below, in one longitudinal plane, would be represented as 1\11, 1\21, 2\11.

• The goal is to describe only the relative locations of animals in any form of multiple animal holder (“mouse hotel”), without attempting to specify the exact physical dimensions or absolute locations, regardless of whether the holder is regular or symmetric in any particular dimension or not (e.g., to include "revolver-like" and hexagonal arrangements). Nor is the "distance" between each animal described.

• Due to field of view and anatomical region of interest considerations, adjacent animals may sometimes be partially overlapped (e.g., Cheng TE et al. A rat head holder for simultaneous scanning of two rats in small animal PET scanners: Design, construction, feasibility testing and kinetic validation. Journal of Neuroscience Methods. 2009 Jan 15;176(1):24–33. http://www.researchgate.net/profile/Shannon_Risacher/publication/2328793_A_rat_head_holder_for_simultaneous_scanning_of_two_rats_in_small_animal_PET_scanners_design_construction_feasibility_testing_and_kinetic_validation/links/0deec5318c6f4cbc18000000.pdf and Xu S et al. In vivo multiple-mouse imaging at 1.5 T. Magnetic Resonance in Medicine. 2003;49(3):551-7. http://dx.doi.org/10.1002/mrm.10397 ); such cases may be described as a either a single plane or two planes of animals, as long as there is sufficient information to identify which animal is which.

See Figure C.7.1.4-3.

• The description of the physical relative locations of the animals does not account for any spatial distortion that may occur in the images due to the acquisition technique used (e.g., aliasing in MRI).

Patient Position (0018,5100) may be used to describe the machine-relative position of each animal when the animals are not all arranged in the same direction.

Note

• Patient Position (0018,5100) is used rather than Patient Orientation Code Sequence (0054,0410) because Patient Position (0018,5100) is present in the IODs for those modalities most commonly used for small animal imaging in preclinical research.

• For example, a pair of prone animals arranged head-to-head longitudinally along the bore of the machine would be described as:

  • Subject Relative Position in Image = 1\11 and Patient Position = HFP

  • Subject Relative Position in Image = 1\12 and Patient Position = FFP

See Figure C.7.1.4-2.

The presence of Subject Relative Position in Image (gqgg,ee10) and Patient Position (0018,5100) within Group of Patients Identification Sequence (gqgg,ee9) within the Patient Module implies that the relative locations and orientations of multiple animals within a group cannot change over time. I.e., a "group", identified by a particular Patient ID (0010.0021) (the unique key of the Patient entity in the Information Model), is defined not only by the animals that comprise it but also their relative locations and positioning. If the same animals are imaged together but in a different arrangement, a different Patient ID (0010.0021) for the group shall be used.
Figure C.7.1.4-1. Example of Subject Relative Position in Image for group of 6 mice in a 3 column, 2 row single longitudinal plane array, all feet first prone
Figure C.7.1.4-2. Example of Subject Relative Position in Image and differing Patient Position for group of 2 mice head-to-head
Figure C.7.1.4-3. Example of Subject Relative Position in Image and overlapping narrow field of view group of 2 mice head-to-head

C.7.2.2 Patient Study Module

Table C.7-4a defines Attributes that provide information about the Patient at the time the Study started.

Note

In the case of imaging a group of small animals simultaneously, the Attributes in this Module can only have values that apply to the entire group, otherwise they are absent (e.g., Patient's Weight (0010,1030)) or empty (e.g., Patient's Sex Neutered (0010,2203)).
### Table C.7-4a. Patient Study Module Attributes

<table>
<thead>
<tr>
<th>Attribute Name</th>
<th>Tag</th>
<th>Type</th>
<th>Attribute Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admitting Diagnoses Description</td>
<td>(0008,1080)</td>
<td>3</td>
<td>Description of the admitting diagnosis (diagnoses)</td>
</tr>
<tr>
<td>Admitting Diagnoses Code Sequence</td>
<td>(0008,1084)</td>
<td>3</td>
<td>A sequence that conveys the admitting diagnosis (diagnoses). One or more Items are permitted in this Sequence.</td>
</tr>
</tbody>
</table>

>Include Table 8.8-1 "Basic Code Sequence Macro Attributes"  
No Baseline CID is defined.

<table>
<thead>
<tr>
<th>Attribute Name</th>
<th>Tag</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient's Age</td>
<td>(0010,1010)</td>
<td>3</td>
<td>Age of the Patient.</td>
</tr>
<tr>
<td>Patient's Size</td>
<td>(0010,1020)</td>
<td>3</td>
<td>Length or size of the Patient, in meters.</td>
</tr>
<tr>
<td>Patient's Weight</td>
<td>(0010,1030)</td>
<td>3</td>
<td>Weight of the Patient, in kilograms.</td>
</tr>
</tbody>
</table>

### C.7.3 Common Series IE Modules

### C.7.3.1 General Series Module

### Table C.7-5a. General Series Module Attributes

<table>
<thead>
<tr>
<th>Attribute Name</th>
<th>Tag</th>
<th>Type</th>
<th>Attribute Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Patient Position</td>
<td>(0018,5100)</td>
<td>2C</td>
<td>Patient position descriptor relative to the equipment. Required for images where Patient Orientation Code Sequence (0054,0410) is not present and whose SOP Class is one of the following: CT (&quot;1.2.840.10008.5.1.4.1.1.2&quot;) or MR (&quot;1.2.840.10008.5.1.4.1.1.4&quot;) or Enhanced CT (&quot;1.2.840.10008.5.1.4.1.2.1&quot;) or Enhanced MR Image (&quot;1.2.840.10008.5.1.4.1.1.4&quot;) or Enhanced Color MR Image (&quot;1.2.840.10008.5.1.4.1.4.3&quot;) or MR Spectroscopy (&quot;1.2.840.10008.5.1.4.1.1.4.2&quot;) Storage SOP Classes. May be present for other SOP Classes if Patient Orientation Code Sequence (0054,0410) is not present. See Section C.7.3.1.1.2 for Defined Terms and further explanation.</td>
</tr>
</tbody>
</table>

### C.7.3.1.1 General Series Attribute Descriptions

### C.7.3.1.2 Patient Position

Patient Position (0018,5100) specifies the position of the patient relative to the imaging equipment space. This attribute is intended for annotation purposes only. It does not provide an exact mathematical relationship of the patient to the imaging equipment.

When multiple subjects are present in the same image, and arranged with different positions, then the Patient Position (0018,5100) in the General Series Module is nominal, does not apply to each subject, but does define the relationship of the nominal Patient Coordinate System to the machine.
In conjunction with the Patient Position (0018,5100) in each Item of the Group of Patients Identification Sequence (gggg,eee9), Patient Position (0018,5100) in the General Series Module may be helpful to compute patient-relative spatial information for each subject from the Attributes of the Image Plane Module.

Add new data elements to DICOM PS3.6 as follows:

<table>
<thead>
<tr>
<th>Tag</th>
<th>Name</th>
<th>Keyword</th>
<th>VR</th>
<th>VM</th>
</tr>
</thead>
<tbody>
<tr>
<td>(gggg,ee1)</td>
<td>Source Patient Group Identification Sequence</td>
<td>SQ</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>(gggg,ee9)</td>
<td>Group of Patients Identification Sequence</td>
<td>SQ</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>(gggg,ee10)</td>
<td>Subject Relative Position in Image</td>
<td>US</td>
<td>1-3</td>
<td></td>
</tr>
</tbody>
</table>

Amend DICOM PS3.16 as follows (changes to existing text are bold and underlined for additions and struckthrough for removals):

**CID 7165 Abstract Segmentation Types**

<table>
<thead>
<tr>
<th>Coding Scheme Designator</th>
<th>Code Value</th>
<th>Code Meaning</th>
<th>SNOMED-CT Concept ID</th>
<th>UMLS Concept Unique ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>DCM</td>
<td>125040</td>
<td>Background</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SRT</td>
<td>T-D0050</td>
<td>Tissue</td>
<td>85756007</td>
<td>C0040300</td>
</tr>
<tr>
<td>SRT</td>
<td>F-61779</td>
<td>Waste Material</td>
<td>289925000</td>
<td>C0043045</td>
</tr>
<tr>
<td>DCM</td>
<td>125041</td>
<td>Registration Input</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DCM</td>
<td>ddd003</td>
<td>Single subject extracted from group</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**CID 7202 Source Image Purposes of Reference**

<table>
<thead>
<tr>
<th>Coding Scheme Designator</th>
<th>Code Value</th>
<th>Code Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>DCM</td>
<td>121320</td>
<td>Uncompressed predecessor</td>
</tr>
<tr>
<td>DCM</td>
<td>121321</td>
<td>Mask image for image processing operation</td>
</tr>
<tr>
<td>DCM</td>
<td>121322</td>
<td>Source image for image processing operation</td>
</tr>
<tr>
<td>DCM</td>
<td>121329</td>
<td>Source image for montage</td>
</tr>
<tr>
<td>DCM</td>
<td>121330</td>
<td>Lossy compressed predecessor</td>
</tr>
<tr>
<td>DCM</td>
<td>121358</td>
<td>For Processing predecessor</td>
</tr>
<tr>
<td>DCM</td>
<td>ddd001</td>
<td>Predecessor containing group of imaging subjects</td>
</tr>
</tbody>
</table>
D DICOM Controlled Terminology Definitions (Normative)

This Annex specifies the meanings of codes defined in DICOM, either explicitly or by reference to another part of DICOM or an external reference document or standard.

DICOM Code Definitions (Coding Scheme Designator "DCM" Coding Scheme Version "01")

<table>
<thead>
<tr>
<th>Code Value</th>
<th>Code Meaning</th>
<th>Definition</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>ddd001</td>
<td>Predecessor containing group of imaging subjects</td>
<td>Images used as the source for an image processing operation that extracts data for a single subject from an image containing data for multiple subjects (e.g., a group of animals imaged simultaneously).</td>
<td></td>
</tr>
<tr>
<td>ddd002</td>
<td>Extraction of individual subject from group</td>
<td>An image processing operation that extracts data for a single subject from an image containing data for multiple subjects (e.g., a group of animals imaged simultaneously).</td>
<td></td>
</tr>
<tr>
<td>ddd003</td>
<td>Single subject selected from group</td>
<td>A single subject that has been selected from amongst multiple subjects (e.g., a group of animals imaged simultaneously).</td>
<td></td>
</tr>
</tbody>
</table>

Add new DICOM PS3.17 Annex as follows:

XXX Segmentation of Images of Groups of Animals (Informative)

Imaging of small animals used for preclinical research may involve acquiring images of multiple animals simultaneously (i.e., more than one animal is present in the same image).

This Annex describes methods of cross-referencing image and other composite SOP instances produced in the acquisition and segmentation process and how the provenance of each may be recorded.

Only backward references are described, allowing for a sequential workflow with processing performed by successive devices, without modification of earlier instances.

XXX.1 Use Case

The relevant Attributes are described in PS3.3 and PS3.3 of the General Image Module. The same principles apply if the General Image Module is not used (e.g., for Enhanced Multi-frame images, in which the same Attributes are present, but nested in the appropriate Functional Group Macros).

For the purpose of illustration, three successive steps are assumed:

1. acquisition of an image of several animals
2. processing of that image to detect (manually or automatically) the regions containing each animal, and storing the region as an appropriate composite instance
3. creation of derived images for each animal using as input the acquired image and the stored regions for each animal

Various DICOM composite objects could be used to encode the segmented region. If the form of the segmented region is a

• rasterized (bitmap), then the Segmentation Storage SOP Class is appropriate

Note

A bitmap overlay in a Grayscale or Color Softcopy Presentation State Storage SOP Class could also be used, though there are no defined semantics for this use, which is not intended

• surface (mesh), then the Surface Storage SOP Class is appropriate
• set of isocontours, then:

• for 3D patient-relative coordinates, the RT Structure Set Storage SOP Class is appropriate

• for 2D or 3D coordinates (and geometric shapes), a Structured Report Storage SOP Class may be appropriate, if a template with
  the appropriate semantics (what the contours "mean") is defined

• for 2D coordinates (and geometric shapes), a Grayscale or Color Softcopy Presentation State Storage SOP Class may be appro-
  priate, though there are no defined semantics for recognizing what to do with which graphic objects

For illustrative purposes, the use of the Segmentation Storage SOP Class is assumed, and a consistent Frame of Reference is assumed.

Note

If images from different modalities are acquired, on separate devices, but with the same physical arrangement of animals,
a more complex workflow might involve the use of one segmentation derived from one modality applied to images from a
different modality with a different Frame of Reference, in which case use of the Spatial Registration Storage SOP Class or
Deformable Spatial Registration Storage as persistent object might be appropriate, and appropriate references to it included.
The same might apply if registration were necessary between images acquired on the same device, but given that research
small animals are normally anesthetized. this is usually not required.

XXX.1.1 Reference Attributes

XXX.1.1.1 Acquired Images of Multiple Animals

No references are present, since forward references are not used.

The Frame of Reference UID is present for cross-sectional modalities.

If the animals are not all aligned in the same direction, Patient Position (0018,5100) for each animal is present within Group of Patients
Identification Sequence (gggg,eee9) and a nominal Patient Position (0018,5100) is present in the General Series Module, and the
coordinate system dependent position and orientation Attributes of the Image Plane Module attributes (or corresponding Functional
Groups) are relative to the nominal Patient Position (0018,5100) present in the General Series Module.

XXX.1.1.2 Segmentation Instances

Segmentations are Enhanced Multi-frame Images, so the Derivation Image Functional Group (PS3.3 ???) is used.

As required by the Segmentation IOD (PS3.3 Section A.51.5.1 "Segmentation Functional Groups Description"):

• the value of Purpose of Reference Sequence (0040,A170) within the Source Image Sequence (0008,2112) within Derivation Image
  Sequence (0008,9124) is (121322, DCM,"Source Image for Image Processing Operation")

• the value of Derivation Code Sequence (0008,9215) within Derivation Image Sequence (0008,9124) is (113076, DCM,"Segmentation")

• though not required, the value of Derivation Description (0008, 2111) may contain additional detail describing the image processing
  operation

The Frame of Reference UID is the same as that for the images from which the segmentation was derived.

There is no requirement that application of the Segmentation be restricted to the image referenced in the Derivation Image Functional
Group Macro, which describes the images that the segmentation was derived from, not the images to which it is applicable (potentially
all of the images in the same Frame of Reference).

The Common Instance Reference Module is required to be present, which provides Study and Series Instance UIDs for all referenced
instances.

A segmentation instance may contain multiple segments, thus multiple animals could be described in a single segmentation instance,
or each animal could be described in one of multiple segments within a single segmentation instance. The manner in which each
segment is numbered, labeled and categorized is thus important. Each segment may be described as follows:
• Segment Number (0062,0004) from 1 to the number of animals (since the Attribute definition requires starting at 1, incrementing by 1)

• Segment Label (0062,0005) using a human-readable label that appropriately identifies each animal in the context of the experiment, e.g., it may have the same value as the Patient ID (0010,0020) used for each separate animal.

• Segmented Property Category Code Sequence (0062,0003) value of (R-42018, SRT, "Spatial and Relational Concept")

• Segmented Property Type Code Sequence (0062,000F) value of (ddd003, DCM, "Single subject selected from group")

Note

The properties of (R-42018, SRT,"Spatial and Relational Concept") and (ddd003, DCM, "Single subject selected from group") are suggested instead of a more generic description, such as (T-D000A, SRT, "Anatomical Structure") and (T-D0010, SRT, "Entire Body"), since though the latter would be accurate, it would not convey the additional implication of selection of one from many. Further, in some cases, the entire body may not actually be imaged (e.g., just the head of multiple subjects may be imaged simultaneously for brain studies).

XXX.1.1.3 Derived Images of Single Animals

It is recommended that the source image(s) be referenced using Source Image Sequence (0008,2112), either in the top level data set or within the Derivation Image Functional Group (PS3.3 ???) as appropriate for the IOD, with:

• the value of Purpose of Reference Sequence (0040,A170) within the Source Image Sequence (0008,2112) being (ddd001, DCM, "Predecessor containing group of imaging subjects")

• the value of Derivation Code Sequence (0008,9215) being (ddd002, DCM, "Extraction of individual subject from group")

• the value of Derivation Description (0008, 2111) containing additional detail describing the image processing operation

It is recommended that the segmentation used be referenced using Referenced Image Sequence (0008,1140), either in the top level data set or within the Referenced Image Functional Group (PS3.3 ???) as appropriate for the IOD, with:

• the value of Purpose of Reference Sequence (0040,A170) within Referenced Image Sequence (0008,1140) being (121321, DCM, "Mask image for image processing operation")

Note

If instead of a segmentation (which is a form of image), a non-image object were used to encode the segmented regions, then use of Referenced Instance Sequence (0008,114A) instead of Referenced Image Sequence (0008,1140) would be appropriate.

The Frame of Reference UID is the same as the source images and the segmentation.

If all the animals are not aligned in the same direction (i.e., do not have the same value for Patient Position (0018,5100)), the coordinate system dependent position and orientation Attributes of the Image Plane Module attributes (or corresponding Functional Groups) may have been recomputed. If the animals are aligned in different directions, and Patient Position (0018,5100) from within Group of Patients Identification Sequence (gggg,eee9) in the source images is compared against Patient Position (0018,5100) from the General Series Module in the source images, the difference may be used to recompute (rotate, flip and translate) new patient-relative vectors and offsets within the same Frame of Reference. The value in the Patient Position (0018,5100) from the General Series Module in the derived images are appropriate for the selected animal.

It is recommended that the Common Instance Reference Module be present even if it is not required by the IOD, to provide Study and Series Instance UIDs for all referenced instances.

XXX.1.2 Propagation of Composite Context

Propagation and replacement of the appropriate patient-level and study-level identifying and descriptive attributes is also required.

The issues related to the identification of the "patient" in such cases are addressed in PS3.3 Section C.7.1.4.1.1 "Groups of Subjects". New studies are required, if the patient identifiers have changed.
New series are required for each of the derived (types) of objects, since they are created by different equipment and have different values for Modality.

**XXX.1.3 Propagation of History**

The history of operations applied to a composite instance and its predecessors may be recorded in multiple items of Derivation Code Sequence (0008,9215). It is preferable, when creating a new derived object, to add to the end of the existing sequence of items, rather than to completely replace them. It is also common to add to the plain text that is contained in Derivation Description (0008, 2111), rather than replacing it (maximum length permitting).

The history of which devices (and human operators) have operated on a composite instance and its predecessors may be recorded in Contributing Equipment Sequence (0018,A001). Again, it is preferable that the existing sequence of items be extended rather than replaced, if possible.

For both Derivation Code Sequence (0008,9215) and Contributing Equipment Sequence (0018,A001), if multiple predecessors are applicable (e.g., the source image and a segmentation mask), then the sequence of items of both predecessors may be merged.