### DICOM Correction item

<table>
<thead>
<tr>
<th>Correction Number</th>
<th>CP 919</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log Summary: Add orientation for quadrupeds</td>
<td></td>
</tr>
<tr>
<td>Type of Modification</td>
<td>Name of Standard</td>
</tr>
<tr>
<td>Addition</td>
<td>PS 3.3 2008</td>
</tr>
</tbody>
</table>

#### Rationale for Correction

Many animals are not built the same way as humans, so the human orientation information, encoded in Patient Orientation as row and column directions for projection radiography, and defined for the three orthogonal axes of the Patient Coordinate System for cross-sectional imaging, may not work. For veterinary purposes, and in particular for quadrupeds, there is a standard for describing orientation, defined in "Smallwood JE et al. A Nomenclature For Radiographic Projections Used In Veterinary Medicine".

This is not simply a matter of "preferred" terminology representation, but a fundamental difference in concepts, the standard “anatomical position” for quadrupeds is different from that of humans, since the limbs project ventrally at right angles to the trunk rather than being coplanar with the trunk, and the head is flexed ninety degrees ventrally with respect to the neck when compared to humans. This means that the directions H and F for “towards the head” and “towards the feet”, which correspond to craniad and caudad, are not appropriate for quadrupeds. For example, simply defining the DICOM “F” value to mean “caudad” fails in the limbs and in the head. Whilst a set of mapping rules from quadruped to human and back depending on the exact body region examined could perhaps be constructed, this would likely be difficult to implement reliably, as well as inadequate to cover images that spanned body regions.

Accordingly, it is proposed to allow a different set of values for Patient Orientation for projection radiography. For cross-sectional radiography, when the subject is an animal, the definitions of the orthogonal axes are adjusted.

In order to allow for those animals that are more appropriately described in the same manner as humans (such as apes), as well as legacy equipment, the choice of which anatomical orientation terminology to use is explicitly flagged as bipedal or quadrupedal, independently of any species information that may be present. This flag is available in the worklist and encoded in instances at the series level (since its use is a characteristic of the generated instances, not the patient).

Though the Code String (CS) Value Representation of Patient Orientation does not permit lowercase characters, the use of the existing Patient Orientation attribute is retained, to take advantage of the installed base of viewers that annotate images based on this attribute, by capitalizing the Smallwood abbreviations without introducing ambiguity.

#### Sections of documents affected

PS 3.3 2, C.4.10, C.7.3.1, C.7.6.1, C.7.6.2

#### Correction Wording:

Add to PS 3.3. Section 2 Normative references:
OTHER REFERENCES


Amend PS 3.3 C.4.10 Scheduled Procedure Step Module:

C.4.10 Scheduled Procedure Step Module

Table C.4-10
SCHEDULED PROCEDURE STEP MODULE ATTRIBUTES

<table>
<thead>
<tr>
<th>Attribute Name</th>
<th>Tag</th>
<th>Attribute Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scheduled Procedure Step Sequence</td>
<td>(0040,0100)</td>
<td>One or more Scheduled Procedure Steps for one Requested Procedure.</td>
</tr>
<tr>
<td>&gt;Modality</td>
<td>(0008,0060)</td>
<td>Source equipment for the image. See Section C.7.3.1.1.1 for Defined Terms.</td>
</tr>
<tr>
<td>&gt;Requested Contrast Agent</td>
<td>(0032,1070)</td>
<td>Contrast agent requested for use in the Scheduled Procedure Step.</td>
</tr>
<tr>
<td>&gt;Pre-Medication</td>
<td>(0040,0012)</td>
<td>Medication to be administered at the beginning of the Scheduled Procedure Step, e.g. Nuclear Medicine radiopharmaceutical.</td>
</tr>
<tr>
<td>&gt;Anatomical Orientation Type</td>
<td>(0010,2210)</td>
<td>The anatomical orientation type appropriate for this patient. Enumerated Values: BIPED QUADRUPED</td>
</tr>
</tbody>
</table>

Amend PS 3.3 C.7.3.1 General Series Module:

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>Include Performed Procedure Step Summary Macro Table 10-16</td>
<td></td>
<td></td>
<td>No Baseline Context IDs defined</td>
</tr>
<tr>
<td>Anatomical Orientation Type</td>
<td>(0010,2210)</td>
<td>1C</td>
<td>The anatomical orientation type used in instances generated by this equipment. Enumerated Values: BIPED QUADRUPED</td>
</tr>
</tbody>
</table>
Required if the patient is an animal and the anatomical frame of reference is not bipedal. May be present otherwise. See C.7.6.1.1 and C.7.6.2.1.1.

Note: If this Attribute is not present, the default human standard anatomical position is used to define the patient orientation of projection images and the patient coordinate system of cross-sectional images.

Add orientation for quadrupeds

Amend PS 3.3 C.7.6.1 Patient Orientation:

C.7.6.1 General Image Module

Table C.7-9
GENERAL IMAGE 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 Orientation</td>
<td>(0020,0020)</td>
<td>2C</td>
<td>Patient direction of the rows and columns of the image. Required if image does not require Image Orientation (Patient) (0020,0037) and Image Position (Patient) (0020,0032). See C.7.6.1.1.1 for further explanation. Note: IOD’s may have attributes other than Patient Orientation, Image Orientation, or Image Position (Patient) to describe orientation in which case this attribute will be zero length.</td>
</tr>
</tbody>
</table>

C.7.6.1.1 General Image Attribute Descriptions

C.7.6.1.1.1 Patient Orientation

The Patient Orientation (0020,0020) relative to the image plane shall be specified by two values that designate the anatomical direction of the positive row axis (left to right) and the positive column axis (top to bottom). The first entry is the direction of the rows, given by the direction of the last pixel in the first row from the first pixel in that row. The second entry is the direction of the columns, given by the direction of the last pixel in the first column from the first pixel in that column.

If Anatomical Orientation Type (0010,2210) is absent or has a value of BIPED, a anatomical direction shall be designated by abbreviations using the capital letters:
- A (anterior)
- P (posterior)
- R (right)
- L (left)
- H (head)
- F (foot)

If Anatomical Orientation Type (0010,2210) has a value of QUADRUPED, anatomical direction shall be designated by the abbreviations using capital letters:

- LE (Le or Left)
- RT (Rt or Right)
- D (Dorsal)
- V (Ventral)
- CR (Cr or Cranial)
- CD (Cd or Caudal)
- R (Rostral)
- M (Medial)
- L (Lateral)
- PR (Pr or Proximal)
- DI (Di or Distal)
- PA (Pa or Palmar)
- PL (Pl or Plantar)

Notes:

1. These abbreviations are capitalized versions of those defined in Smallwood et al for describing radiographic projections. Because of the Code String (CS) Value Representation of the Patient Orientation (0020,0020), lowercase letters cannot be used.

2. It is unfortunate that the conventional veterinary abbreviations (e.g., R for rostral and Rt for right) differ from those chosen for humans for DICOM usage (e.g., R for right), but confusion with in the respective human and animal domains will be reduced. Hanging protocols may need to account for the difference by checking for the correct species.

3. Smallwood et al define an O (Oblique) abbreviation, which is useful for describing radiographic projections, but do not specify its use for directional terms, and hence it is not included here for describing the row and column directions.

4. The terms “anterior” and “posterior” are commonly used in vertebrate zoology to describe the cranial and caudal directions respectively. The veterinary terms are used in preference here, also in order to avoid confusion with the contradictory human use of anterior and posterior to mean ventral and dorsal.
5. For animals other than quadrupeds, for example, birds and fish, it is anticipated that the same nomenclature can be logically extended to describe, for example, wings and fins.

Each value of the orientation attribute shall contain at least one of these characters abbreviations. If refinements in the orientation descriptions are to be specified, then they shall be designated by one or two additional letters abbreviations in each value. Within each value, the letters abbreviations shall be ordered with the principal orientation designated in the first character.

Notes:
1. For bipeds, since each abbreviation is a single character, no delimiter is required within a single value and none is used. For quadrupeds, though lowercase letters cannot be used, delimiters are not necessary within a single value to eliminate ambiguity, since the abbreviations used are sufficiently distinct, and can be parsed from left to right with a single character of lookahead.

2. E.g., a medio-lateral oblique projection of the left breast of a human might be encoded with Patient Orientation values of “A\FR” rather than “A\F”, since the plane is obliquely inclined such that the columns are directed both downwards and medially, which for a left breast is towards the right, though the downwards direction is the principal column orientation.

3. E.g., a right dorsal-left ventral oblique view of a quadruped’s abdomen might be encoded with Patient Orientation values of “LTV\CD”, rather than “LT\CD”, since the plane is obliquely inclined such that the rows are directed both to the left and ventrally, though the left direction is the principal row orientation. The abbreviations “LTV”, “LT” and “CD”, correspond to the designations in Smallwood et al of “LtV”, “Lt” and “Cd”, respectively.

Amend PS 3.3 C.7.6.2 Image Plane Module:

C.7.6.2 Image Plane Module

Table C.7-10
IMAGE PLANE MODULE ATTRIBUTES

<table>
<thead>
<tr>
<th>Attribute Name</th>
<th>Tag</th>
<th>Type</th>
<th>Attribute Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image Orientation (Patient)</td>
<td>(0020,0037)</td>
<td>1</td>
<td>The direction cosines of the first row and the first column with respect to the patient. See C.7.6.2.1.1 for further explanation.</td>
</tr>
<tr>
<td>Image Position (Patient)</td>
<td>(0020,0032)</td>
<td>1</td>
<td>The x, y, and z coordinates of the upper left hand corner (center of the first voxel transmitted) of the image, in mm. See C.7.6.2.1.1 for further explanation.</td>
</tr>
</tbody>
</table>

C.7.6.2.1 Image Plane Attribute Descriptions

C.7.6.2.1.1 Image Position And Image Orientation

The Image Position (0020,0032) specifies the x, y, and z coordinates of the upper left hand corner of the image; it is the center of the first voxel transmitted. Image Orientation (0020,0037) specifies the direction cosines of the first row and the first column with respect to the patient. These Attributes shall be provide as a pair. Row value for the x, y, and z axes respectively followed by the Column value for the x, y, and z axes respectively.
The direction of the axes is defined fully by the patient’s orientation.

If Anatomical Orientation Type (0010,2210) is absent or has a value of BIPED, the x-axis is increasing to the left hand side of the patient. The y-axis is increasing to the posterior side of the patient. The z-axis is increasing toward the head of the patient.

If Anatomical Orientation Type (0010,2210) has a value of QUADRUPED, the

- x-axis is increasing to the left (as opposed to right) side of the patient
- the y-axis is increasing towards
  - the dorsal (as opposed to ventral) side of the patient for the neck, trunk and tail,
  - the dorsal (as opposed to ventral) side of the patient for the head,
  - the dorsal (as opposed to plantar or palmar) side of the distal limbs,
  - the cranial (as opposed to caudal) side of the proximal limbs, and
- the z-axis is increasing towards
  - the cranial (as opposed to caudal) end of the patient for the neck, trunk and tail,
  - the rostral (as opposed to caudal) end of the patient for the head, and
  - the proximal (as opposed to distal) end of the limbs

Notes: 1. The axes for quadrupeds are those defined and illustrated in Smallwood et al for proper anatomic directional terms as they apply to various parts of the body.
2. It should be anticipated that when quadrupeds are imaged on human equipment, and particularly when they are position in a manner different from the traditional human prone and supine head or feet first longitudinal position, then the equipment may well not indicate the correct orientation, though it will remain an orthogonal Cartesian right-handed system that could be corrected subsequently.

The patient based coordinate system is a right handed system, i.e. the vector cross product of a unit vector along the positive x-axis and a unit vector along the positive y-axis is equal to a unit vector along the positive z-axis.

Note: If a patient lies positioned parallel to the ground, in dorsal recumbency (i.e., for humans, face-up) on the table, with his-the caudo-cranial (i.e., for humans, feet-to-head) direction the same as the front-to-back direction of the imaging equipment, the direction of the axes of this patient based coordinate system and the equipment based coordinate system in previous versions of this Standard will coincide.

Add the following attribute to PS 3.6 Section 6

<table>
<thead>
<tr>
<th>Tag</th>
<th>Name</th>
<th>VR</th>
<th>VM</th>
</tr>
</thead>
<tbody>
<tr>
<td>(0010,2210)</td>
<td>Anatomical Orientation Type</td>
<td>CS</td>
<td>1</td>
</tr>
</tbody>
</table>