DICOM Correction Proposal

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Correction Number

CP-2127

Log Summary: Clarify Origin of Device-Based FoR

Name of Standard:

PS3.3, PS3.6 2022d

Rationale for Correction:

The PS3.3 10.39 Patient to Equipment Relationship Macro declares a transformation matrix, which maps the patient coordinate space in the Frame of Reference used for the patient model to the coordinate system defined by the equipment.

This mapping is used in PS3.3 C.36.2.2.4 RT Treatment Position Macro to describe the position of a patient positioning device in respect to the therapeutic equipment.

The patient coordinate space is identified by the Frame of Reference UID (0020,0052) of the SOP Instance.

The orientation of the patient coordinate system is aligned along the main axis of patient support device under consideration of Patient Orientation Code Sequence (0054,0410), Patient Orientation Modifier Code Sequence (0054,0412) and Patient Equipment Relationship Code Sequence (3010,0030).

The origin of the patient coordinate system is defined by SOP Instances which refer to the Frame of Reference UID (0020,0052) and represent the patient, like Image SOP Instances of SOP Instances containing segments or surfaces.

However, the C.36.2.2.4 RT Treatment Position Macro may be used also in SOP Instances where the Frame of Reference UID and its origin is not defined by any Instances as described above. Rather than the Frame of Reference UID is defined in a set of Instances which do not contain a geometric representation of the patient. An example are Instances dealing with Patient Setup or imaging instructions, where a location of a patient positioning device is defined by the Image to Equipment Mapping Matrix (0028,9520), but no images exist yet which represent the patient in the treatment room.

In these cases, the orientation in respect to the patient support device is well-defined as described above. Yet the origin of the Frame of Reference is not defined since there are no image objects present.

Therefore, the origin must be defined in some way in respect to the device, since there are no SOP Instances which define the origin. The solution is to use a device-bound well-known Frame of Reference, which defines both the origin and the orientation in respect to a device.

For that purpose, a normative paragraph is added to PS3.3, section 10.39 "Patient To Equipment Relationship Macro".

PS 3.2 has been reviewed regarding the requirements for conformance documentation and the information would go in Annex A.9.1 IOD Contents.

Correction Wording:

In PS3.3, extend 10.39.1 Patient to Equipment Relationship Macro Attributes Description as follows:

10.39 Patient to Equipment Relationship Macro

The Patient to Equipment Relationship Macro describes a position of the patient with respect to a device. The position is defined by means of a transformation matrix between a Patient Frame of Reference and an Equipment Frame of Reference.

Attribute Name	Tag	Туре	Attribute Description	
Image to Equipment Mapping Matrix	(0028,9520)	1	A rigid, homogeneous 4x4 transformation matrix that maps the patient coordinate space in the Frame of Reference used for the patient model to the coordinate system defined by the equipment. Matrix elements shall be listed in row-major order. See Section 10.39.1.1, Section 10.39.1.2 and Section C.7.6.21.1.	
Frame of Reference Transformation Comment	(3006,00C8)	3	Comments entered by a human operator about the relationship between the patient frame of reference and the equipment. For display purposes only, shall not be used for other purposes.	
Patient Location Coordinates Sequence	(3006,00C9)	2	Specific points in the patient coordinate system which further characterize the position of the patient with respect to the equipment. Zero or more Items shall be included in this Sequence.	
>3D Point Coordinate	(0068,6590)	1	Coordinate (x,y,z) in mm describing the location in the patient Frame of Reference that will be transformed to the Equipment Frame of Reference by using the Image to Equipment Mapping Matrix (0028,9520).	
>Patient Location Coordinates Code Sequence	(3006,00CA)	1	Identifies the type of Patient Location Coordinate. One or more Items shall be included in this Sequence.	
>>Include Table 8.8-1 "Code Sequence Macro Attributes".			CID is specified at invocation.	
Patient Support Position Sequence	(3006,00CB)	2	Actual Patient Support Position parameters. Shall be consistent with the Image to Equipment Mapping Matrix (0028,9520). See Section 10.39.1.2. Zero or one Item shall be included in this Sequence.	

Table 10.39-1. Patient to Equipment Relationship Macro Attributes

>Include Table 10.40-1 "Patient Support Position Macro Attributes".

10.39.1 Patient to Equipment Relationship Macro Attributes Description

10.39.1.1 Equipment Coordinate System

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10.39.1.2 Image to Equipment Mapping Matrix and Patient Support Position Macro

The Image to Equipment Mapping Matrix (0028,9520) describes the relationship between the Patientoriented coordinate system and an Equipment Coordinate System. This matrix AM Bdescribes a rigid transformation of a point (^Bx, ^By, ^Bz) with respect to the Patient coordinate system into (^Ax, ^Ay, ^Az) with respect to the Equipment Coordinate System as defined in Section C.7.6.21.1.

The Equipment Coordinate System is identified by the Equipment Frame of Reference UID (300A,0675). For further information on the definition of the Equipment Frame of Reference, see Section 10.39.1.1. The patient-oriented coordinate system is identified by the Frame of Reference UID (0020,0052) of the SOP Instance it is used within. Both coordinate systems are expressed in millimeters.

The Patient Support Position Macro invoked by Patient Support Position Sequence (3006,00CB) allows the exchange of device-specific parameters for the patient support device. Applications designed to guide a specific patient support device will be able to de-compose the transformation into device-specific parameters or derive a transformation matrix out of these parameters. Applications that are unable to know the decomposition of the transformation to those parameters and vice versa will still be able to display the native labels and numerical values of those parameters to human readers.

The Patient Support Position Sequence (3006,00CB) may be present to annotate the matrix and display the decomposed matrix contents. The content of the Patient Support Position Macro shall be used for display purposes only. It shall not be used for other purposes. The content of this Macro shall not be used as a substitute for the Image to Equipment Mapping Matrix (0028,9520). In general, there is more than one way to reach the point in space that is described by the Image to Equipment Mapping Matrix (0028,9520). Hence it is explicitly not implied how this position is reached.

In some cases (e.g., emergency treatments in Radiotherapy), the Patient Frame of Reference is not defined by an image series. In this case an arbitrary Frame of Reference is used for the patient coordinate system in the Frame of Reference Module of the SOP Instance. The Image to Equipment Mapping Matrix (0028,9520) has the same meaning as in the case of image-based Patient Frame of Reference.

When a Frame of Reference of a patient model is not available, the well-known Frame of Reference of a patient support device may be used.

The well-known Frame of Reference and its origin and orientation with respect to the device shall be documented in the Conformance Statement. Note that the orientation of the axes of the well-known Frame of Reference are tied to the device and not to the patient.

As an example, the initial position needs to be specified for the patient setup, prior to any imaging. For a treatment table whose origin and orientation are defined by [IEC61217-2], the well-known Frame of Reference UID "1.2.840.10008.1.4.3.3" may be used.

If the Image to Equipment Mapping Matrix (0028,9520) and the Patient Support Position Sequence (3006,00CB) are both present, the information in both locations shall be consistent.

In PS3.6, add the following entry to Table A-2. Well-known Frames of Reference:

Table A-2. Well-known Frames of Reference

UID Value	UID Name	UID Keyword	Normative Reference
1.2.840.10008.1.4.3.3	IEC 61217 Table Top Coordinate System Frame of Reference	IEC61217TableTop CoordinateSystem	<u>Table top system ("t") of</u> [IEC 61217].