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Digital Imaging and Communications in Medicine (DICOM)

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Supplement 184: Brachytherapy Delivery Instruction

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DICOM Standards Committee, Working Group 7, Radiation Therapy

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1300 N. 17th Street, Suite 900

Rosslyn, Virginia 22209 USA

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VERSION: Sup 184 – Final Text
November 10, 2015

Developed pursuant to DICOM Work Item 2000-11-B

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Foreword

4 This supplement specifies an IOD to convey the information necessary to communicate the delivery of a brachytherapy treatment in a treatment session. The object will be exchanged between a workflow management system where the treatment session is scheduled, and the delivery devices.

6 This document is an extension to the following parts of the published DICOM Standard:

	PS 3.2	Conformance
8	PS 3.3	Information Object Definitions
	PS 3.4	Service Class Specifications
10	PS 3.6	Data Dictionary
	PS 3.16	Content Mapping Resource

12

Scope and Field of Application

14 The modifications introduced by this supplement describe worklist support for the brachytherapy treatment management and treatment delivery systems. The intention is to offer similar level of support for brachytherapy treatment workflow as was introduced for the external beam radiotherapy in "Supplement 74: Utilization of Worklist in Radiotherapy Treatment Delivery".

16 This is achieved by the addition of the following:

- 18
- RT Brachy Application Setup Delivery Instruction Storage Composite IOD, which contains the data necessary to instruct a treatment delivery device on what is to be delivered. The key element of the IOD is the RT Brachy Delivery Instruction Module, which contains information on the RT Plan to be used, the channels within the plan that will actually be delivered or omitted.
- 20
- 22

24 This supplement is being driven by the desire to address the lack of support for brachytherapy treatment delivery workflow in the current standard.

Part 2 Addendum

2 **Add new SOP Classes to PS3.2 Table A.1-2 UID Values:**

UID Value	UID Name	Category
1.2.840.10008.5.1.4.34.10	RT Brachy Application Setup Delivery Instruction Storage	Transfer

4

Part 3 Addendum

6 **Add the following columns in PS3.3 Section A.1.4, Table A.1-1 COMPOSITE INFORMATION OBJECT MODULES OVERVIEW – RADIOTHERAPY**

8

IODs Modules	RT Brachy Application Setup Delivery Instruction
Patient	<u>M</u>
Clinical Trial Subject	<u>U</u>
General Study	<u>M</u>
Patient Study	<u>U</u>
Clinical Trial Study	<u>U</u>
General Series	<u>M</u>
Clinical Trial Series	<u>U</u>
General Equipment	<u>M</u>
Enhanced General Equipment	<u>M</u>
RT Brachy Application Setup Delivery Instruction	<u>M</u>
Common Instance Reference	<u>M</u>
SOP Common	<u>M</u>

10

2 **Add the following to PS3.3 Annex A:**

A.1.2 IOD Entity-Relationship Model

4 ...

A.1.2.X Plan IE

6 The Plan IE defines the parameters and instructions to deliver treatment, particularly Radiotherapy, to
8 the Patient. The entity includes the set of machine and positioning parameters to be applied during
treatment delivery and instructions guiding the treatment workflow.

10 **A.TT RT BRACHY APPLICATION SETUP DELIVERY INSTRUCTION INFORMATION OBJECT
DEFINITION**

12 **A.TT.1 RT Brachy Application Setup Delivery Instruction IOD Description**

14 In order to deliver a Brachytherapy treatment fraction described in an RT Plan IOD, the RT Brachy
Application Setup Delivery Instruction IOD describes which part of the RT Plan is to be delivered and
contains additional parameters. This information is supplied by a Treatment Management System
16 (TMS) when it creates an RT Brachy Application Setup Delivery Instruction SOP instance which is
referenced by a Unified Procedure Step (UPS) in the Unified Worklist and Procedure Step model.

18 **A.TT.2 RT Brachy Application Setup Delivery Instruction IOD Entity-Relationship Model**

20 The E-R Model in Section A.1.2 depicts those components of the DICOM Information Model that
directly reference the RT Brachy Application Setup Delivery Instruction IOD.

A.TT.3 RT Brachy Application Setup Delivery Instruction IOD Module Table**2 Table A.TT.3-1 – RT BRACHY APPLICATION SETUP DELIVERY INSTRUCTION IOD MODULES**

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Plan	RT Brachy Application Setup Delivery Instruction	C.8.8.aa	M
	Common Instance Reference Module	C.12.2	M
	SOP Common	C.12.1	M

4 A.TT.4 RT Brachy Application Setup Delivery Instruction IOD Content Constraints**A.TT.4.1 Modality**

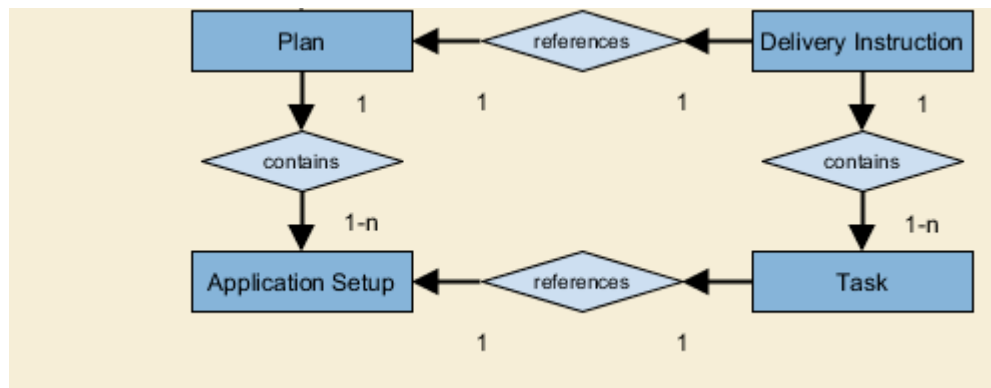
6 The value of modality (0008,0060) shall be PLAN.

2 **Add the following to PS3.3 Annex C:**

4 **C.8.8.aa RT Brachy Application Setup Delivery Instruction Module**

6 The RT Brachy Application Setup Delivery Instruction Module contains additional information required by a Treatment Delivery System (TDS) when specifying delivery of a brachytherapy treatment.

8 This module references the RT Plan to be delivered and specifies the treatment tasks to be performed for the Application Setups of the RT Plan.



10

Figure C.8.8.aa-1 Relationship of brachytherapy treatment plan and delivery instruction

12 The RT Brachy Application Setup Delivery Instruction Module consists of a Sequence of one or more tasks.

14

Table C.8.8.aa-1 RT BRACHY APPLICATION SETUP DELIVERY INSTRUCTION MODULE ATTRIBUTES

16

Attribute Name	Tag	Type	Description
Referenced RT Plan Sequence	(300C,0002)	1	Reference to a single RT Plan SOP Instance containing all the brachy application setups and the fraction group referenced in this SOP Instance. Only a single item shall be included in this sequence.
<i>>Include 'Hierarchical SOP Instance Reference Macro' Table C.17-3</i>			
Referenced Fraction Group Number	(300C,0022)	1	Indicates which fraction group of the referenced RT Plan in the Referenced RT Plan Sequence (300C,0002) is to be treated in the treatment session.

Attribute Name	Tag	Type	Description
Current Fraction Number	(3008,0022)	1	The index of the fraction that is to be delivered or completed in this treatment session. See C.8.8.aa.3.
Continuation Pulse Number	(0074,1404)	1C	The index of the pulse that is to be delivered or completed in this treatment session. Required if Brachy Treatment Type (300A,0202) of the referenced RT Plan in the Referenced RT Plan Sequence (300C,0002) is PDR and if Treatment Delivery Type (300A,00CE) is CONTINUATION in any of the items in the Brachy Task Sequence (0074,1401). See C.8.8.aa.4.
Brachy Task Sequence	(0074,1401)	1	Specification of Brachy Application Setups to be delivered. One or more Items shall be included in this Sequence. See C.8.8.aa.1.
>Treatment Delivery Type	(300A,00CE)	1	Delivery Type of treatment. Enumerated Values: TREATMENT = normal patient treatment CONTINUATION = continuation of interrupted treatment See C.8.8.aa.2.
>Continuation Start Total Reference Air Kerma	(0074,1402)	1C	Total Reference Air Kerma within the Application Setup referenced by Referenced Brachy Application Setup Number (300C,000C) at which treatment delivery starts. Required if Delivery Type (300A,00CE) is CONTINUATION.
>Continuation End Total Reference Air Kerma	(0074,1403)	1C	Total Reference Air Kerma within the Application Setup referenced by Referenced Brachy Application Setup Number (300C,000C) at which treatment delivery ends. Required if Delivery Type (300A,00CE) is CONTINUATION.

Attribute Name	Tag	Type	Description
>Referenced Brachy Application Setup Number	(300C,000C)	1	Brachy Application Setup Number (300A,0234) within Brachy Application Setup Sequence (300A,0230) in the referenced RT Plan. One or more Items shall be included in this sequence.
>Channel Delivery Order Sequence	(0074,1405)	3	The order in which the channels are to be delivered. One or more Items are permitted in this sequence.
>>Referenced Channel Number	(0074,1406)	1	The channel to be delivered, specified by the value of Channel Number (300A,0282) in referenced RT Plan.
>>Channel Delivery Order Index	(0074,140C)	1	The order of delivery of this channel, monotonically increasing by 1, starting from 1, where number 1 is the first channel to be delivered.
>Channel Delivery Continuation Sequence	(0074,140D)	1C	The treatment time weights for channels to be delivered to complete a previously interrupted fraction. Required if Delivery Type (300A,00CE) is CONTINUATION. One or more items shall be included in this sequence.
>>Referenced Channel Number	(0074,1406)	1	The channel to be delivered, specified by the value of Channel Number (300A,0282) in referenced RT Plan.
>>Start Cumulative Time Weight	(0074,1407)	1	Cumulative Time Weight where to start/continue the delivery of the referenced channel. See C.8.8.15.6.
>>End Cumulative Time Weight	(0074,1408)	1	Cumulative Time Weight where to stop the delivery of the referenced channel. See C.8.8.15.6.
Omitted Application Setup Sequence	(0074,140E)	1C	Application Setups of the current RT Plan containing channels not to be delivered. Required if Delivery Type (300A,00CE) is CONTINUATION and one or more channels of any Application Setup are omitted. One or more items shall be included in this sequence.

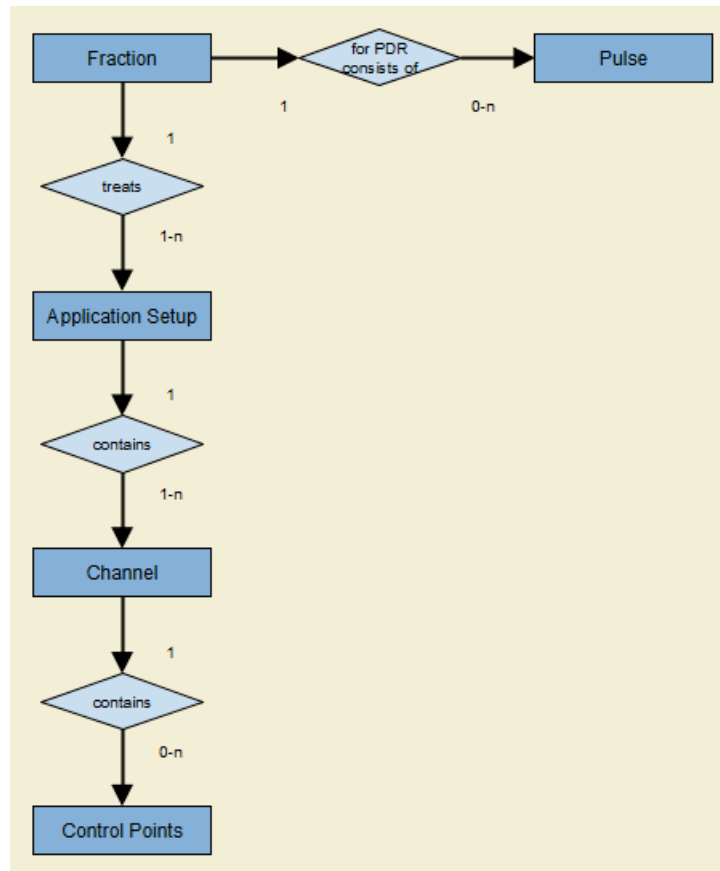
Attribute Name	Tag	Type	Description
>Referenced Brachy Application Setup Number	(300C,000C)	1	Brachy Application Setup Number (300A,0234) within Brachy Application Setup Sequence (300A,0230) in referenced RT Plan.
>Omitted Channel Sequence	(0074,1409)	1	Channels defined for this Application Setup not to be delivered. One or more items shall be included in this sequence.
>>Referenced Channel Number	(0074,1406)	1	Channel to be omitted, specified by the value of Channel Number (300A,0282) in the referenced RT Plan.
>>Reason for Channel Omission	(0074,140A)	1	Reason why the referenced channel is not to be delivered: Defined Terms: ALREADY_TREATED The channel has been already delivered. OTHER This channel is not to be delivered for other reasons.
>>Reason for Channel Omission Description	(0074,140B)	3	Description of reason for omission.

2 **C.8.8.aa.1 Brachy Task Sequence**

4 The Brachy Task Sequence (0074,1401) contains instructions for the delivery of a single treatment
 6 session. A treatment session is the time that the patient is connected to the treatment delivery
 8 system. During a treatment session, one fraction of the referenced plan is delivered. If the value of
 Brachy Treatment Type (300A,0202) in the reference RT Plan is HDR, the entire fraction is delivered
 at one time. If the value is PDR, the fraction is divided into a number of pulses which are delivered
 periodically during the treatment session.

10 The Application Setup groups together the channels to be delivered. The task sequence can also
 contain the delivery order of the channels. The Omitted Application Setup Sequence (0074,140E)
 contains the channels to skip in the case of continuation of an interrupted treatment.

12



2 **Figure C.8.8.aa-2 — Relation of the Fraction, Pulse and Channels within the RT Brachy Task Sequence**

4 The following scenarios demonstrate the usage of the RT Brachy Application Setup Delivery
 6 Instruction Module for the Treatment Management System (TMS) to instruct the Treatment Delivery
 System (TDS) to initiate brachytherapy treatment and continue an interrupted delivery.

8 **C.8.8.aa.1.1 Usage Scenario 1: HDR treatment, interruption skipping remainder of the interrupted delivery**

Brachytherapy plan overview:

- 10 • Plan1, HDR, 2 fractions;
- Channel1, two dwell positions, 10 sec + 10 sec
- 12 • Channel2, two dwell positions, 10 sec + 10 sec

Treatment session 1:

14 Treatment Management System (TMS):

Requests the delivery of the first fraction of the plan:

16 **RT Brachy Application Setup Delivery Instruction:**

Referenced RT Plan Sequence (300C,0002) = UID of "Plan1"

Referenced Fraction Group Number (300C,0022) = 1

2 Current Fraction Number (3008,0022) = 1

Brachy Task Sequence (0074,1401):

4 Treatment Delivery Type (300A,00CE) = TREATMENT

Referenced Brachy Application Setup Number (300C,000C) = 1

6 Treatment Delivery System (TDS):

8 Delivers the first fraction and returns a RT Brachy Treatment Record that describes interruption at channel 2 after 9 seconds of the second dwell position is being delivered.

Treatment session 2:

10 It has been decided to proceed to fraction 2 without delivering the remainder of fraction 1. This is not a continuation case.

12 Treatment Management System (TMS):

Requests the delivery of the second fraction of the plan:

14 **RT Brachy Application Setup Delivery Instruction:**

Referenced RT Plan Sequence (300C,0002) = UID of "Plan1"

16 Referenced Fraction Group Number (300C,0022) = 1

Current Fraction Number (3008,0022) = 2

18 Brachy Task Sequence (0074,1401):

Treatment Delivery Type (300A,00CE) = TREATMENT

20 Referenced Brachy Application Setup Number (300C,000C) = 1

Treatment Delivery System (TDS):

22 Delivers the second fraction and returns a RT Brachy Treatment Record that describes a complete delivery of that fraction.

24 C.8.8.aa.1.2 Usage Scenario 2: PDR treatment, interruption and continuation

Brachytherapy plan overview:

- 26
- Plan2, PDR, 10 pulses;
 - Channel1, two dwell positions, 50 sec + 50 sec
- 28
- Channel2, two dwell positions, 50 sec + 50 sec

Treatment Session 1

30 Treatment Management System (TMS):

Requests the delivery of the first fraction of the plan:

RT Brachy Application Setup Delivery Instructions:

2 Referenced RT Plan Sequence (300C,0002) = UID of "Plan2"

Referenced Fraction Group Number (300C,0022) = 1

4 Current Fraction Number (3008,0022) = 1

Brachy Task Sequence (0074,1401):

6 Treatment Delivery Type (300A,00CE) = TREATMENT

Referenced Brachy Application Setup Number (300C,000C) = 1

8 Treatment Delivery System (TDS):

10 Delivers the first fraction and returns a RT Brachy Treatment Record that that describes interruption at pulse 5 of the first fraction at channel 2, after 25 seconds of the first dwell position was delivered. Total Reference Air Kerma Delivered was 100.

12 **Treatment Session 2**

14 It has been decided to proceed to fraction 2 to deliver the remainder of the interrupted plan as instructed by the following task transmitted inside the delivery instruction:

16 The remainder is defined as to skip 25 sec of the first dwell position of channel 2 and continue with the second dwell position.

Treatment Management System (TMS):

18 Requests the continuation of the delivery of the first fraction of the plan:

Referenced RT Plan (300C,0002) = UID of "Plan2"

20 Referenced Fraction Group Number (300C,0022) = 1

Current Fraction Number (3008,0022) = 1

22 Continuation Pulse Number (0074,1404) = 5

Brachy Task Sequence (0074,1401):

24 Treatment Delivery Type (300A,00CE) = CONTINUATION

Continuation Start Total Reference Air Kerma (0074,1402) = 100

26 Continuation End Total Reference Air Kerma (0074,1403) = 1000

Referenced Brachy Application Setup Number (300C,000C) = 1

28 Channel Delivery Order Sequence (0074,1405):

Referenced Channel Number (0074,1406) = 2

30 Channel Delivery Order Index (0074,140C) = 1

Channel Delivery Continuation Sequence (0074,140D):

Referenced Channel Number (0074,1406)=2

2 Start Cumulative Time Weight (0074,1407) = 50

End Cumulative Time Weight (0074,1408) = 100

4 Omitted Application Setup Sequence (0074,140E):

Referenced Brachy Application Setup Number (300C,000C) = 1

6 Omitted Channel Sequence (0074,1409):

Referenced Channel Number (0074,1406) = 1

8 Reason for Channel Omission (0074,140A) = ALREADY_TREATED

Treatment Delivery System (TDS):

10 Delivers the first fraction and returns RT Brachy Treatment Record that describes that the treatment
12 first fraction was continued and the remainder was delivered fully (including the rest of the pulses from
6-10).

C.8.8.aa.2 Treatment Delivery Type

14 For RT Brachy Application Setup Delivery Instructions with a Treatment Delivery Type (300A,00CE)
of CONTINUATION in an RT Plan with a Treatment Type (300A,0202) of PDR, instructions in the
16 Task Sequence apply only to the continuation pulse. The pulses following the continuation pulse will
be fully delivered.

18 **C.8.8.aa.3 Current Fraction Number**

For RT Brachy Application Setup Delivery Instruction of Treatment Delivery Type (300A,00CE) of
20 CONTINUATION, the Current Fraction Number (3008,0022) is that of the fraction to be completed.

C.8.8.aa.4 Current Pulse Number

22 For RT Brachy Application Setup Delivery Instruction with a Treatment Delivery Type (300A,00CE) of
CONTINUATION and the Treatment Type (300A,0202) of PDR of the Referenced RT Plan, the
24 Continuation Pulse Number (0074,1404) is that of the original pulse to be completed by the current
application setup.

26 **Part 4 Addendum**

Add the following to PS3.4, Appendix B.5, Table B.5-1

28

SOP Class Name	SOP Class UID	IOD Spec (defined in PS 3.3)
RT Brachy Application Setup Delivery Instruction Storage	1.2.840.10008.5.1.4.34.10	RT Brachy Application Setup Delivery Instruction IOD (see Section A.TT)

2 **Add the following to PS3.4, Appendix I.4, Table I.4-1**

Table I.4-1 Media Storage Standard SOP Classes

SOP Class Name	SOP Class UID	IOD Specification
RT Brachy Application Setup Delivery Instruction Storage	1.2.840.10008.5.1.4.34.10	RT Brachy Application Setup Delivery Instruction IOD

4 **Part 6 Addendum**

Add the following data elements to PS3.6:

6 **6 Registry of DICOM data elements**

Tag	Name	Keyword	VR	VM
(0074,1401)	Brachy Task Sequence	BrachyTaskSequence	SQ	1
(0074,1402)	Continuation Start Total Reference Air Kerma	ContinuationStartTotalReferenceAirKerma	DS	1
(0074,1403)	Continuation End Total Reference Air Kerma	ContinuationEndTotalReferenceAirKerma	DS	1
(0074,1404)	Continuation Pulse Number	ContinuationPulseNumber	IS	1
(0074,1405)	Channel Delivery Order Sequence	ChannelDeliveryOrderSequence	SQ	1
(0074,1406)	Referenced Channel Number	ReferencedChannelNumber	IS	1
(0074,1407)	Start Cumulative Time Weight	StartCumulativeTimeWeight	DS	1
(0074,1408)	End Cumulative Time Weight	EndCumulativeTimeWeight	DS	1
(0074,1409)	Omitted Channel Sequence	OmittedChannelSequence	SQ	1
(0074,140A)	Reason for Channel Omission	ReasonForChannelOmission	CS	1
(0074,140B)	Reason for Channel Omission Description	ReasonForChannelOmissionDescription	LO	1
(0074,140C)	Channel Delivery Order Index	ChannelDeliveryOrderIndex	IS	1
(0074,140D)	Channel Delivery Continuation Sequence	ChannelDeliveryContinuationSequence	SQ	1
(0074,140E)	Omitted Application Setup Sequence	OmittedApplicationSetupSequence	SQ	1

2 **Add the following to PS3.6 Annex A:**

4 **Annex A Registry of DICOM unique identifiers (UID) (Normative)**

UID Value	UID Name	UID Type	Part
1.2.840.10008.5.1.4.34.10	RT Brachy Application Setup Delivery Instruction Storage	SOP Class	PS 3.4

6 **Part 16 Addendum**

Add the following new Code to CID 9241 in PS3.16, Annex B:

8 **CID 9241 RADIOTHERAPY WORKITEM DEFINITION**

10 Context ID 9241
Radiotherapy Workitem Definition

12 Type: Extensible Version: ~~20130408~~ 20151110

Coding Scheme Designator (0008,0102)	Code Value (0008,0100)	Code Meaning (0008,0104)
...		
<u>DCM</u>	<u>1217350</u>	<u>RT Brachy Treatment</u>

14 **Add the following to the table in PS3.16, Annex D:**

16 **DICOM CONTROLLED TERMINOLOGY DEFINITIONS (NORMATIVE)**

Code Value	Code Meaning	Definition	Notes
...			
121735	RT Brachy Treatment	Brachytherapy Treatment Delivery	

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End of Document