Status	Final Text
Date of Last Update	2017/09/14
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Correction Number CP-1682
Log Summary: Defined PET Units Defined terms by reference to UCUM used in Context Group
Name of Standard PS3.3, PS3.16 2017c
Rationale for Correction: A context group equivalent to the PET Units (0054,1001) Defined Terms was added in the past, but the two were not specifically mapped. Not all of the Units defined terms are included in CID 84. Those that are intended for SUV have more specific meanings with the SUV type pre-coordinated in CID 85. Standard deviation is challenging, because it could be the square root of any quantity. An inconsistency was observed between the Defined Terms in Table C.8-60 and Section C.8.9.1.1.3, in that CM2ML was present in the former but not the latter; add it to the latter as well as CID 84.
Correction Wording:

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

C.8.9.1 PET Series Module

Table C.8-60. PET Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
...	...	,..	...
Units	(0054,1001)	1	Pixel value units. See Section C.8.9.1.1.3 for **~~explanation~~** **Defined Terms**. **~~Defined Terms:~~** **~~CNTS~~** **~~NONE~~** **~~CM2~~** **~~CM2ML~~** **~~PCNT~~** **~~CPS~~** **~~BQML~~** **~~MGMINML~~** **~~UMOLMINML~~** **~~MLMING~~** **~~MLG~~** **~~1CM~~** **~~UMOLML~~** **~~PROPCNTS~~** **~~PROPCPS~~** **~~MLMINML~~** **~~MLML~~** **~~GML~~** **~~STDDEV~~**
SUV Type	(0054,1006)	3	Type of Standardized Uptake Value (SUV). **Enumerated Values:** **BSA** body surface area **BW** body weight **LBM** lean body mass by James method **LBMJAMES128** lean body mass by James method using a multiplier of 128 for males **LBMJANMA** lean body mass by Janmahasatian method **IBW** ideal body weight If absent, and the Units (0054,1001) are GML, then the type of SUV shall be assumed to be BW. **Note** The type of SUV cannot reliably be deduced from the units alone, i.e., SUVbw, SUVibw and SUVlbm (James or Janmahasatian) all have units of GML.
...	...	...	...

Note

The formulas for the determination of SUVbw, SUVbsa, SUVlbm (James) and SUVibw are defined in Sugawara et al. *Reevaluation of the Standardized Uptake Value for FDG: Variations with Body Weight and Methods for Correction.* Radiology, 1999 at http://radiology.rsna.org/content/213/2/521.

Unfortunately, Sugawara used a parameter of 120 rather than 128 for males, propagating an error in Morgan DJ, Bray KM. Lean Body Mass as a Predictor of Drug Dosage: Implications for Drug Therapy. Clinical Pharmacokinetics. 1994;26(4):292–307, which misquoted the original LBM definition that used 128 in James WPT, Waterlow JC. Research on Obesity: A Report of the DHSS/MRC Group. London: Her Majesty's Stationery Office; 1976. Implementations differ in whether they have used 120 or 128 when the DICOM Defined Term is LBM. See Kelly M. SUV: Advancing Comparability and Accuracy. Siemens; 2009. Available from: http://www.mpcphysics.com/documents/SUV_Whitepaper_Final_11.17.09_59807428_2.pdf.

The Janmahasatian LBM formula is defined in *Janmahasatian et al. Quantification of Lean Bodyweight. Clin Pharmacokinet. 2005 Oct 1;44(10):1051–65.* at http://dx.doi.org/10.2165/00003088-200544100-00004 and its role in SUVlbm(Janma) calculation is discussed in *Tahari et al. Optimum Lean Body Formulation for Correction of Standardized Uptake Value in PET Imaging. Journal of Nuclear Medicine. 2014 Sep 1;55(9):1481–4.* at http://jnm.snmjournals.org/content/55/9/1481. See also CID 85 "SUV Units".

C.8.9.1.1 PET Series Attribute Descriptions

C.8.9.1.1.3 Units

The units of the pixel values obtained after conversion from the stored pixel values (SV) (Pixel Data (7FE0,0010)) to pixel value units (U), as defined by Rescale Intercept (0028,1052) and Rescale Slope (0028,1053).

Defined Terms:

CNTS	counts **({counts}, UCUM, "Counts")**
NONE	unitless **(1, UCUM, "no units")**
CM2	centimeter**2 **(cm2, UCUM, "Centimeter**2")**
CM2ML	**centimeter**2/milliliter (cm2/ml, UCUM, "Centimeter**2/milliliter")**
PCNT	percent **(%, UCUM, "Percent")**
CPS	counts/second **({counts}/s, UCUM, "Counts per second")**
BQML	Becquerels/milliliter **(Bq/ml, UCUM, "Becquerels/milliliter")**
MGMINML	milligram/minute/milliliter **(mg/min/ml, UCUM, "Milligrams/minute/milliliter")**
UMOLMINML	micromole/minute/milliliter **(umol/min/ml, UCUM, "Micromole/minute/milliliter")**
MLMING	milliliter/minute/gram **(ml/min/g, UCUM, "Milliliter/minute/gram")**
MLG	milliliter/gram **(ml/g, UCUM, "Milliliter/gram")**
1CM	1/centimeter **(/cm, UCUM, "/Centimeter")**
UMOLML	micromole/milliliter **(umol/ml, UCUM, "Micromole/milliliter")**
PROPCNTS	proportional to counts **({propcounts}, UCUM, "Proportional to counts")**
PROPCPS	proportional to counts/sec **({propcounts}/s, UCUM, "Proportional to counts per second")**
MLMINML	milliliter/minute/milliliter **(ml/min/ml, UCUM, "Milliliter/minute/milliliter")**
MLML	milliliter/milliliter **(ml/ml, UCUM, "Milliliter/milliliter")**
GML	grams/milliliter **(g/ml, UCUM, "Gram/milliliter")**
STDDEV	standard deviations

Note

The majority of these defined terms are equivalent to PS3.16 CID 84 PET Units. Those that are used for SUV are not qualified by the type of SUV, which is encoded separately as SUV Type (0054,1006).

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

CID 84 PET Units

Type: **Extensible**
Version: **~~20141110~~20170914**

Table CID 84. PET Units

Coding Scheme Designator	Code Value	Code Meaning
Include CID 85 "SUV Units"		
UCUM	{counts}	Counts
UCUM	{counts}/s	Counts per second
UCUM	{propcounts}	Proportional to counts
UCUM	{propcounts}/s	Proportional to counts per second
UCUM	cm2	Centimeter**2
UCUM	**cm2/ml**	**Centimeter**2/milliliter**
UCUM	%	Percent
UCUM	Bq/ml	Becquerels/milliliter
UCUM	mg/min/ml	Milligrams/minute/milliliter
UCUM	umol/min/ml	Micromole/minute/milliliter
UCUM	ml/min/g	Milliliter/minute/gram
UCUM	ml/g	Milliliter/gram
UCUM	/cm	/Centimeter
UCUM	umol/ml	Micromole/milliliter

CID 85 SUV Units

Type: **Extensible**
Version: **20161106**

Table CID 85. SUV Units

Coding Scheme Designator	Code Value	Code Meaning
UCUM	g/ml{SUVbw}	Standardized Uptake Value body weight
UCUM	g/ml{SUVlbm}	Standardized Uptake Value lean body mass (James)
UCUM	g/ml{SUVlbm(James128)}	Standardized Uptake Value lean body mass (James 128 multiplier)
UCUM	g/ml{SUVlbm(Janma)}	Standardized Uptake Value lean body mass (Janma)
UCUM	cm2/ml{SUVbsa}	Standardized Uptake Value body surface area
UCUM	g/ml{SUVibw}	Standardized Uptake Value ideal body weight

Note

The formulas for the determination of SUVbw, SUVbsa, SUVlbm (James) and SUVibw are defined in Sugawara et al. *Reevaluation of the Standardized Uptake Value for FDG: Variations with Body Weight and Methods for Correction.*Radiology, 1999 at http://radiology.rsna.org/content/213/2/521.

Unfortunately, Sugawara used a parameter of 120 rather than 128 for males, propagating an error in Morgan DJ, Bray KM. Lean Body Mass as a Predictor of Drug Dosage: Implications for Drug Therapy. Clinical Pharmacokinetics. 1994;26(4):292–307, which misquoted the original LBM definition that used 128 in James WPT, Waterlow JC. Research on Obesity: A Report of the DHSS/MRC Group. London: Her Majesty's Stationery Office; 1976. Implementations differ in whether they have used 120 or 128 for ({SUVlbm}g/ml{SUVlbm}, UCUM, "Standardized Uptake Value lean body mass (James)"). See Kelly M. SUV: Advancing Comparability and Accuracy. Siemens; 2009. Available from: http://www.mpcphysics.com/documents/SUV_Whitepaper_Final_11.17.09_59807428_2.pdf.

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lation is discussed in *Tahari et al. Optimum Lean Body Formulation for Correction of Standardized Uptake Value in PET Imaging. Journal of Nuclear Medicine. 2014 Sep 1;55(9):1481–4.* at http://jnm.snmjournals.org/content/55/9/1481. The patient size correction factors are summarized here, where weight is in kg and height is in cm:

SUVbw: males & females: weight

SUVlbm (James): males : 1.10 * weight - 120 * (weight/height) ^2

SUVlbm (James): females: 1.07 * weight - 148 * (weight/height) ^2

SUVlbm(Janma): males: 9.27E3 * weight / (6.68E3 + 216 * weight / (height^2))

SUVlbm(Janma): females: 9.27E3 * weight / (8.78E3 + 244 * weight / (height^2))

SUVbsa: males & females: weight^ 0.425 * height^0.725 * 0.007184

SUVibw: males: 48.0 + 1.06 * (height - 152)

females: 45.5 + 0.91 * (height - 152)