Unofficial translation from Finnish.
Legally binding only in Finnish and Swedish.

REGULATION STUK S/4/2019

Radiation and Nuclear Safety Authority Regulation on Justification Assessment and Optimisation of Radiation Protection in Medical Exposure

Adopted in Helsinki on 4 April 2019

In accordance with a decision of the Radiation and Nuclear Safety Authority, the following provisions are issued by virtue of section 10, subsection 3, section 109, subsection 2, and section 112, subsection 4 of the Radiation Act (859/2018):

Section 1

Definitions

The *reference level for a patient's exposure* means, in this regulation, a predetermined value describing the radiation exposure of a patient arising from an examination or procedure and the value of the activity administered to a patient in a nuclear medicine examination, which is not expected to be exceeded in an examination or procedure performed according to good practice upon a patient of normal size.

Section 2

Ensuring justification assessment

To ensure the justification assessment, the undertaking must ascertain:

1) the identity of the person subject to medical exposure;
2) the adequacy of the information referred to in section 113, subsection 1, paragraph 1 of the Radiation Act in terms of ensuring the justification assessment of the examination, procedure, or treatment;
3) the accuracy and subject of the examination, procedure, or treatment specified in the referral.

However, what is specified above in subsection 1, paragraph 1 does not apply to carers and comforters.

Section 3

Justification assessment in the absence of referral guidelines

In the absence of referral guidelines, the referring physician or dentist must carry out the justification assessment referred to in section 110 of the Radiation Act.

Council Directive 2013/59/Euratom (32013L0059); OJEU L 13, 17.1.2014, p. 1
Reported to the Commission in accordance with Article 33 of the Treaty establishing the European Atomic Energy Community.

STUK
SÄTEILYTURVAKESKUS
STRÅLSÄKERHETSCENTRALEN
RADIATION AND NUCLEAR SAFETY AUTHORITY

Osoite / Address | Laippatie 4, 00880 Helsinki
Postiosoite / Postal address | PL / P.O. Box 14, FI-00811 Helsinki, FINLAND
Puh. / Tel. (09) 759 881, +358 9 759 881 | Fax (09) 759 88 500, +358 9 759 88 500 | www.stuk.fi

Section 4

Justification assessment concerning the medical exposure of a foetus or child

Before referring a person of childbearing age to an examination, procedure, or treatment resulting in medical exposure, the referring physician or dentist must investigate whether the person is pregnant. However, the investigation is not required prior to an X-ray examination or procedure resulting in medical exposure of the teeth, head and neck area, or the extremities, provided that the radiation is not directed near the abdomen or pelvis, and when medical exposure is justified as an urgent procedure necessary for saving the patient's life.

In addition to what is provided in subsection 1, the possibility of pregnancy must be checked with an adequately sensitive and specific method in the case of:

1) radiotherapy;
2) a nuclear medicine examination resulting in a high level of medical exposure for a foetus;
3) an X-ray examination or procedure of the abdomen or pelvis area carried out with computed tomography or some other method which results in a high level of medical exposure.

The justification assessment concerning the examination, procedure, or treatment of a pregnant or breastfeeding person resulting in medical exposure to a foetus or breastfed child must particularly consider medical methods alternative to medical exposure or the possibility of postponing the examination, procedure, or treatment to a later date.

The justification assessment concerning an examination, procedure, or treatment causing medical exposure to a child must particularly consider alternative medical methods or the possibility of postponing the examination, procedure, or treatment to a later date.

Section 5

Practical measures in the optimization of radiation protection in medical exposure

Written instructions must be provided for the performance of the most common examinations, procedures, and treatments, including the phases of the examination, procedure, or treatment process to optimize radiation protection in medical exposure.

The examination instructions concerning X-ray examinations and procedures must include the examination-specific typical projections and the patient shielding to be used in each examination. The patient shielding must be used if it can materially reduce the radiation exposure of the person or foetus subject to the examination, procedure, or treatment and provided that the shielding does not compromise the performance of the examination, procedure, or treatment.

The indication of the examination or procedure must be accounted for when optimizing radiation protection in the examination or procedure.

The radiation beam in an X-ray examination or procedure must be limited so that it is as small as possible, but nevertheless in such a way that nothing which is material in terms of the examination or procedure is left outside the imaging area.

The undertaking must ensure that the optimization has been carried out in terms of the most common imaging programs of each appliance used for patient imaging.

Section 6

Optimizing the radiation protection of a foetus or a child

The effective dose of a foetus may not exceed 1 mSv, unless this is particularly justified in terms of the overall care of the person examined. The radiation protection of a foetus must be optimized particularly in medical exposure as referred to in section 4, subsection 2.

The optimization of a child's radiation protection must account for the child's size and any other special characteristics of the examination. An examination, procedure, or treatment exposing a child to radiation must be planned individually and performed with an appliance that allows for achieving the lowest radiation exposure reasonably possible.

Patients must be urged to stop breastfeeding or to take a break from breastfeeding due to a nuclear medicine examination or nuclear medicine treatment so that the radiation exposure of the breastfed child is as low as possible and at the very least not higher than the dose limit for members of the public.

Section 7

Optimization in nuclear medicine

The activity of a radiopharmaceutical or a tracer must be measured with an activity meter prior to administering the pharmaceutical or tracer to the patient.

If the use of alternative radiopharmaceuticals in the examination is possible, a radiopharmaceutical which results, within reason, in the smallest radiation dose for the patient must be selected.

Section 8

The optimization of radiation protection due to a nuclear medicine examination or nuclear medicine treatment

Following a nuclear medicine examination or nuclear medicine treatment, patients must be urged to avoid pregnancy for a sufficient period of time which ensures that the radiation exposure of an unborn child does not exceed the dose limit for members of the public.

Section 9

Optimizing radiotherapy

In radiotherapy, the radiation must be directed at the target area with the precision required by the objective of the therapy.

In external radiotherapy, the uncertainty of the dose may not be greater than, on average,

1) 5%, when using photon radiation greater than 1 MV;
2) 10%, when using electron or X-radiation.

Medical exposure in radiotherapy must be planned patient-specifically and the magnitude and focus of the exposure must be verified. The dose received by tissues and organs other than those targeted must be as low as reasonably possible.

Section 10

Reference level for a patient's exposure

The reference levels for a patient's exposure are specified in Annex 1–7. The value of a reference level determined by the undertaking itself may not exceed that which is specified in the Annex.

The undertaking must compare the value describing the average radiation exposure of a patient and the activity administered to a patient to the reference level at least once every three years and whenever examination practices or imaging values are changed in such a way that the radiation dose or activity undergoes a material change. This is not applicable to the use of a dental X-ray equipment that images to an intraoral image detector.

The average value and activity describing the radiation exposure must be determined as the median of a sample of at least ten patients of a normal size, either by measurement or by calculated estimation, unless otherwise provided in the Annex.

During the years when the determination is not carried out, it must be ensured that the value describing the radiation exposure or activity has not changed.

If the determined average value describing the patient's radiation exposure or activity exceeds the reference level, the reason for the high radiation exposure or activity must be investigated and, if necessary, measures must be taken to reduce patients' radiation exposure.

Section 11

Entry into force

This regulation enters into force on 5 April 2019 and is valid until further notice.

This regulation applies to any matters pending on the date of its entry into force.

In Helsinki on 4 April 2019

Director General Petteri Tiippana

Director Tommi Toivonen

Availability of the regulation, guidance and advice

This regulation has been published as part of the regulations issued by the Radiation and Nuclear Safety Authority (STUK) and it is available from the Radiation and Nuclear Safety Authority.

Visiting address: Laippatie 4, FI-00880 Helsinki
Mailing address: P.O. Box 14, FI-00811 Helsinki
Telephone: +358 9 759 881
Collection of regulations: http://www.finlex.fi/en/viranomaiset/normi/555001/

ANNEX 1

Reference levels for patients' exposure in the computed tomography examinations of adults

Table 1 shows the reference levels for a particular imaging area and Table 2 shows the reference levels based on the imaging indication or concerning certain other types of examinations. The reference levels are shown as the volume CT air kerma index ($CTKI_{vol}$) and as the air kerma-length product (KLP). The volume CT air kerma index is also referred to as the CT dose volume index ($CTDI_{vol}$). The air kerma-length product is also referred to as the dose-length product (DLP). The reference levels shown in the tables are based on data collected from patient examinations. If an examination includes several image series, the reference levels presented in the tables mean the radiation exposure resulting from a single series of images. Reference levels have also been determined for examinations using a single scan only (e.g. one scan used for entire body, no separate scans for the lungs and abdomen).

Table 1. Reference levels for certain imaging areas in the computed tomography examinations of adults. The examinations refer to conventional CT examinations in the body part in question, and examination indications have not been taken into account for any part of the body.

Part of the body	**$CTKI_{vol}$ mGy**	**KLP mGy·cm**
Head	55	800
Paranasal sinuses	13	190
Lungs	9	290
Abdomen	12	560
Body	12	770
Aorta (imaging area: neck – groin)	10	630

Table 2. Reference levels in the computed tomography examinations of adults based on certain types of examinations or imaging indications. Examinations refer to conventional CT examinations performed with the imaging indication mentioned, or certain types of named examination types.

Imaging indication/type of examination	**$CTKI_{vol}$ mGy**	**KLP mGy·cm**
Suspicion of lung tumour	11	430
HRCT examination of the lungs	5	140
Suspicion of urolithiasis (so-called side pain-CT)	7	330
Suspicion of lymphoma	11	970
Trauma CT (trunk)	17	1,300
CT colonography (prone)	6.5	prone + on back total 930
CT colonography (on back)	12	

The weight of the patients must be between 60–90 kg, with the exception of examinations in the head and face area, where no weight restrictions exist.

$CTKI_{vol}$ refers to the quantity defined on the basis of the average of the variable current used in the imaging. If the appliance defines the quantity in some other way, the indication of the equipment's dose display and the $CTKI_{vol}$ presented in the decision are not mutually comparable.

ANNEX 2

Reference levels for patients' exposure in nuclear medicine examinations

Table 1 shows the reference levels for the nuclear medicine examinations of adult patients. The minimum activity of radiopharmaceuticals administered to children is provided in Table 2

Table 1. Reference levels for the nuclear medicine examinations of adults.

Nuclear medicine examination	Radio-nuclide	Compound or chemical form	Reference level MBq
Bone and soft tissue			
Gamma imaging of the skeletal system	^{99m}Tc	Phosphates and phosphonates	670
Infection/inflammation imaging	^{99m}Tc	Leukocytes (HMPAO)	300
Respiratory system			
Gamma imaging of pulmonary perfusion	^{99m}Tc	MAA	150
Urinary tract and genitals			
Gamma imaging of renal function	^{99m}Tc	MAG3	100
Circulatory system			
Myocardial perfusion SPECT	^{201}Tl	Ion	100
Myocardial perfusion SPECT	^{99m}Tc	MIBI	1,000[1)] 1,200[2)]
Myocardial perfusion SPECT	^{99m}Tc	Tetrofosmin	1,000[1)] 1,200[2)]
Cardiac blood pool imaging (MUGA)	^{99m}Tc	Erythrocytes	750
Nervous system			
Brain dopamine transporters imaging, SPECT	^{123}I	β-CIT	180
Brain dopamine transporters imaging, SPECT	^{123}I	FP-CIT	180
Endocrine system			
Gamma imaging of thyroid metastases (after ablation)	^{131}I	Iodide	185
Parathyroid imaging	^{99m}Tc	MIBI	740
Somatostatin receptors imaging	^{111}In	Octreotide	170
PET (positron emission tomography) scans			
Brain tumour imaging	^{18}F	FDG	240
Whole body tumour imaging	^{18}F	FDG	280[3)] 370[4)]

[1)] Total activity administered to the patient when the stress and rest phases are performed on the same day.
[2)] Total activity administered to the patient when the stress and rest phases are performed on different days.
[3)] Using 3D imaging and time-of-flight technique.
[4)] Using 2D imaging.

Table 2. Minimum activity administered to children (MBq).[1)]

Radiopharmaceutical	Minimum activity MBq
^{67}Ga-citrate	10
^{123}I-amphetamine (brain)	18
^{123}I-hippurate	10
^{123}I-iodide (thyroid)	3
^{123}I-MIBG	37[2)]
^{99}mTc-albumin (heart)	80
^{99}mTc-colloid (liver and spleen)	15
^{99}mTc-colloid (bone marrow)	20
^{99}mTc-colloid (gastric juice reflux)	10
^{99}mTc-DTPA (kidneys)	20
^{99}mTc-DMSA	15
^{99}mTc-MDP (bone)	40
^{99}mTc-denatured erythrocytes (spleen)	20
^{99}mTc-IDA (gall bladder)	20
^{99}mTc-HMPAO (brain)	100
^{99}mTc-HMPAO (leucocytes)	40
^{99}mTc-MAA or microspheres	10
^{99}mTc-MAG3	15
^{99}mTc-pertechnetate (micturating cystogram)	20
^{99}mTc-pertechnetate (heart, primary circulation)	80
^{99}mTc-pertechnetate (Meckel's diverticulum)	20
^{99}mTc-pertechnetate (thyroid)	10
^{99}mTc/red cells (blood volume)	80
^{18}F-FDG (body)	26[2)]
^{18}F-FDG (head)	14[2)]

[1)] European Commission publication Radiation protection 109, Guidance on diagnostic reference levels (DRLs) for medical exposures, European Communities, 1999.

[2)] Minimum activity recommended in the EANM's Dosage Card (www.eanm.org).

ANNEX 3

Reference levels for patients' exposure in paediatric CT scans

Tables 1 and 2 present the reference levels concerning the CT scans of a child's head for different age groups as a volume CT air kerma index ($CTKI_{vol}$) and as the air kerma-length product (KLP). The volume CT air kerma index is also referred to as the CT dose volume index ($CTDI_{vol}$). The air kerma-length product is also referred to as the dose-length product (DLP). The reference levels have been provided separately for two imaging indications: a routine head CT scan and a cerebral ventricle size examination. Figures 1–6 present the reference levels for CT scans of a child's lungs, abdomen and body (lungs + abdomen) as a volume CT air kerma index ($CTKI_{vol}$) and as the air kerma-length product (KLP), both as a function of the patient's weight. Figures 1–6 also present the achievable dose levels; these describe the dose levels that can be achieved by means of modern CT equipment, such as those using iterative reconstruction. The equations for the curves presented in Figures 1–6 are provided in Table 3.

If an examination includes several image series, the reference levels presented mean the radiation exposure resulting from a single series of images. Reference levels have also been determined for examinations using a single scan only.

Table 1. Reference levels for the patient's radiation exposure in paediatric CT scans when the imaging indication is a standard CT scan of the head.

Age group years	**$CTKI_{vol}$ mGy**	**KLP mGy·cm**
< 1	23	330
1-5	25	370
5-10	29	460
10-15	35	560

Table 2. Reference levels for the patient's radiation exposure in paediatric CT-scans when the imaging indication is an examination of the cerebral ventricle size.

Age group years	**$CTKI_{vol}$ mGy**	**KLP mGy·cm**
< 1 – 15	4	35

Osoite / Address | Laippatie 4, 00880 Helsinki
Postiosoite / Postal address | PL / P.O. Box 14, FI-00811 Helsinki, FINLAND
Puh. / Tel. (09) 759 881, +358 9 759 881 | Fax (09) 759 88 500, +358 9 759 88 500 | www.stuk.fi

Table 3. Reference levels for the patient's radiation exposure and achievable levels in the CT scans of a child's body; equations for the reference level curves presented in Figures 1–6.

CT scan	Quantity and unit	Equation for the reference level curve	Equation for the achievable level curve
Lung	$CTKI_{vol}$, mGy	$y=0.726\ e^{0.026x}$	$y=0.5773\ e^{0.0273x}$
	KLP, mGy·cm	$y=10.871\ e^{0.0409x}$	$y=9.005\ e^{0.04x}$
Abdomen	$CTKI_{vol}$, mGy	$y=1.314\ e^{0.0282x}$	$y=0.9648\ e^{0.0283x}$
	KLP, mGy·cm	$y=38.75\ e^{0.0358x}$	$y=27.015\ e^{0.0378x}$
Body (lung + abdomen)	$CTKI_{vol}$, mGy	$y=1.8486\ e^{0.0234x}$	$y=1.3108\ e^{0.0267x}$
	KLP, mGy·cm	$y=62.129\ e^{0.0373x}$	$y=49.072\ e^{0.0377x}$

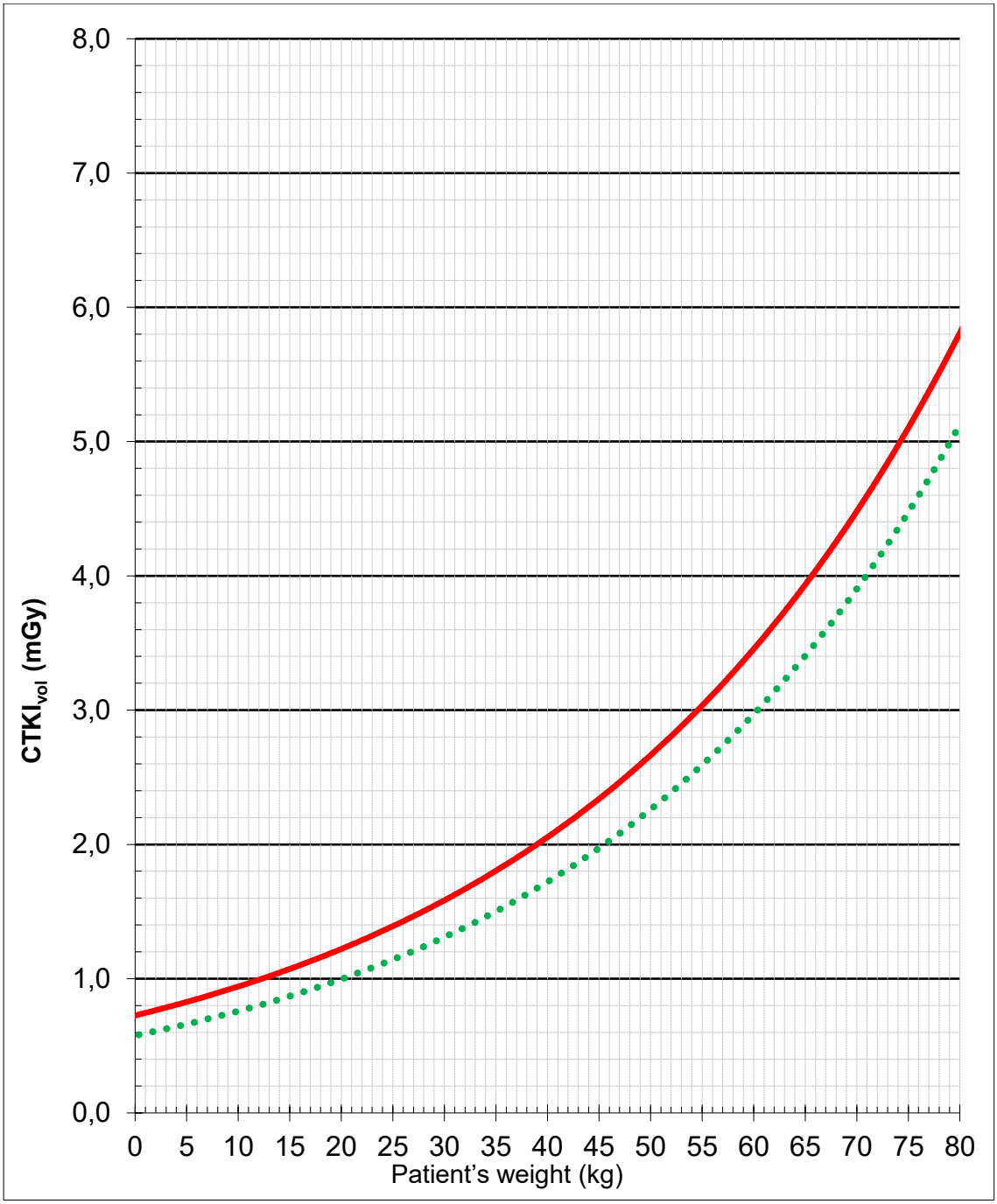

Figure 1. Lung CT-scans for children: $CTKI_{vol}$ as a function of the patient's weight. Solid red curve: reference level, dotted green curve: achievable level.

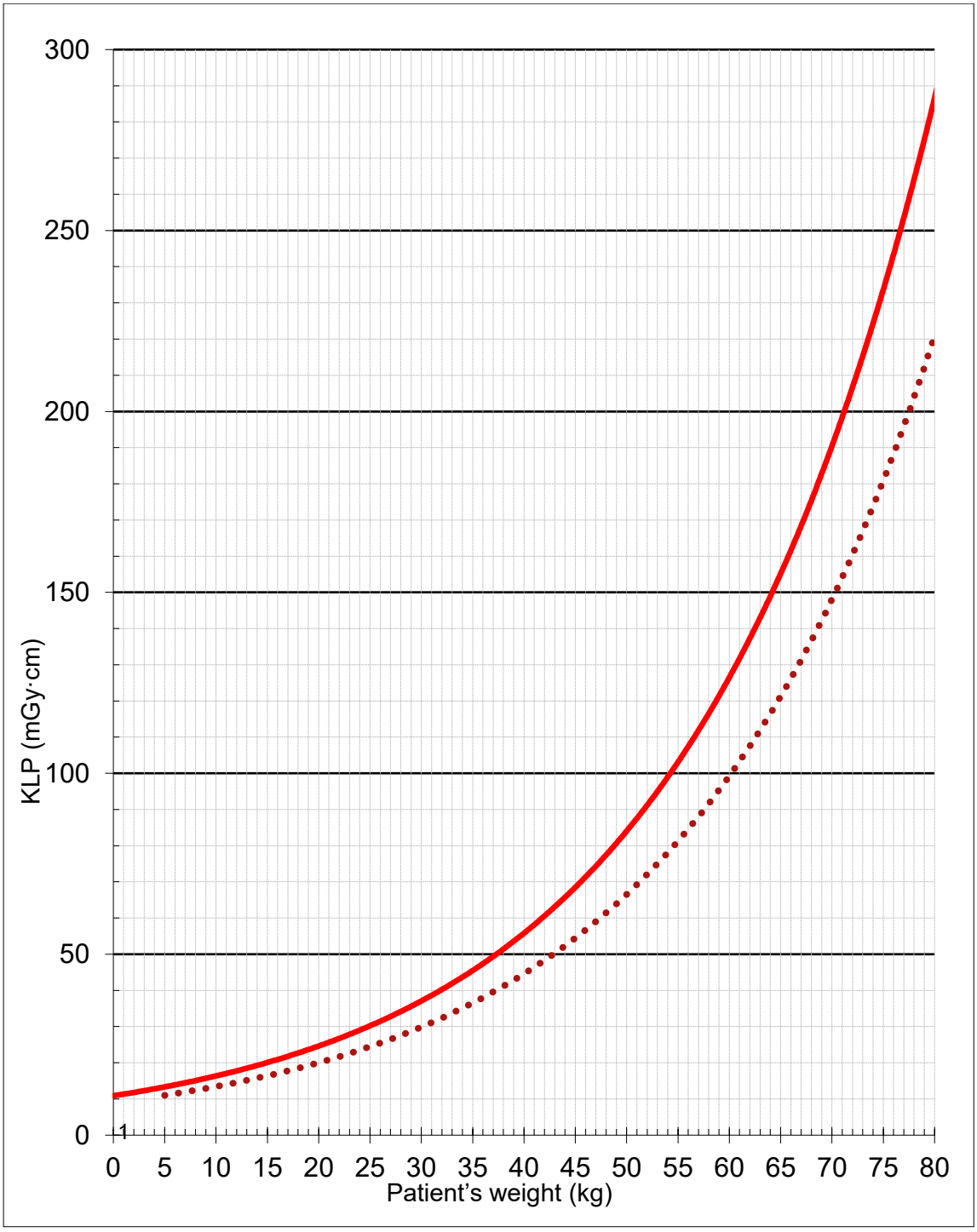

Figure 2. Lung CT-scans for children: KLP as a function of the patient's weight. Solid red curve: reference level, dotted red curve: achievable level.

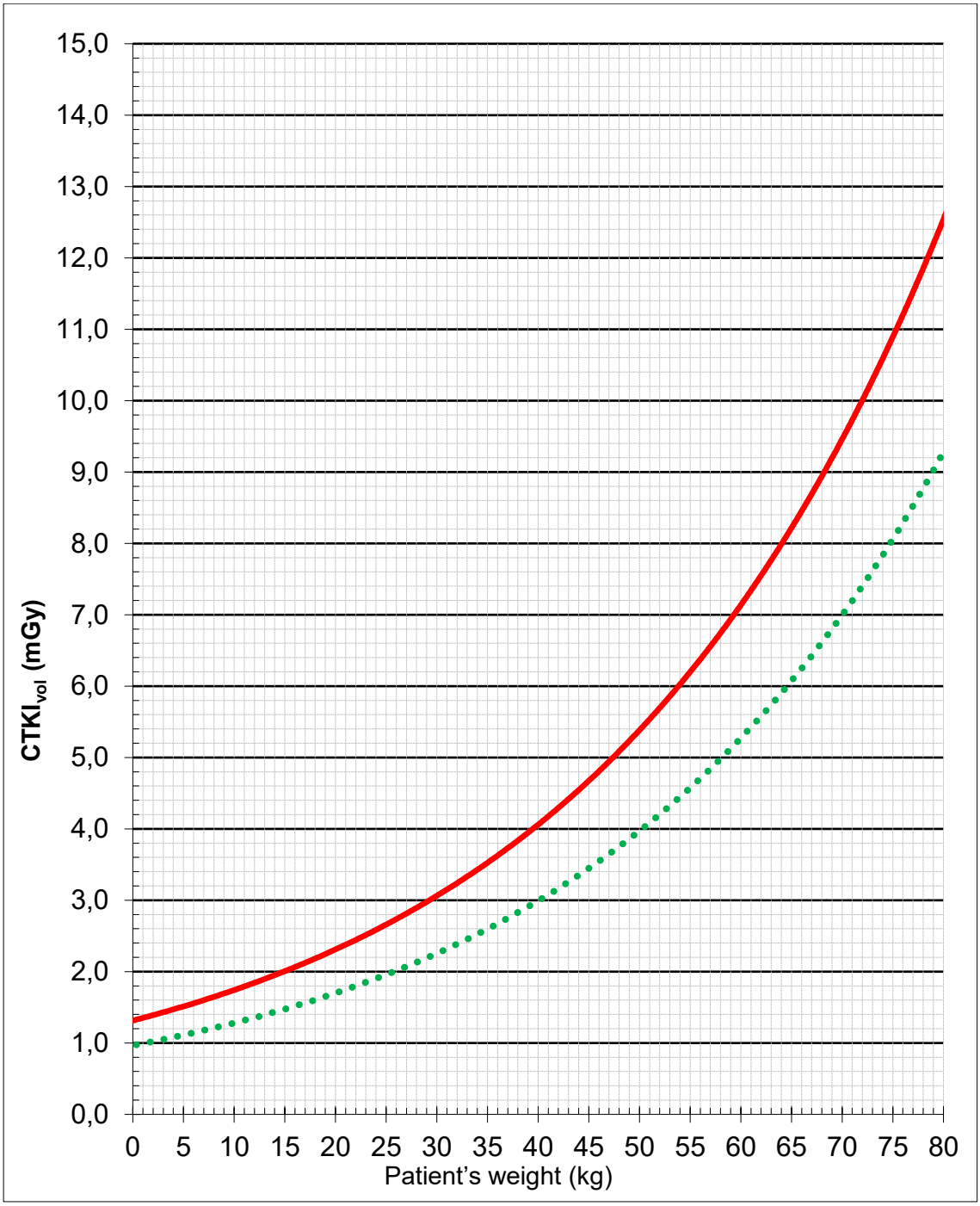

Figure 3. Abdomen CT scans for children: $CTKI_{vol}$ as a function of the patient's weight. Solid red curve: reference level, dotted green curve: achievable level.

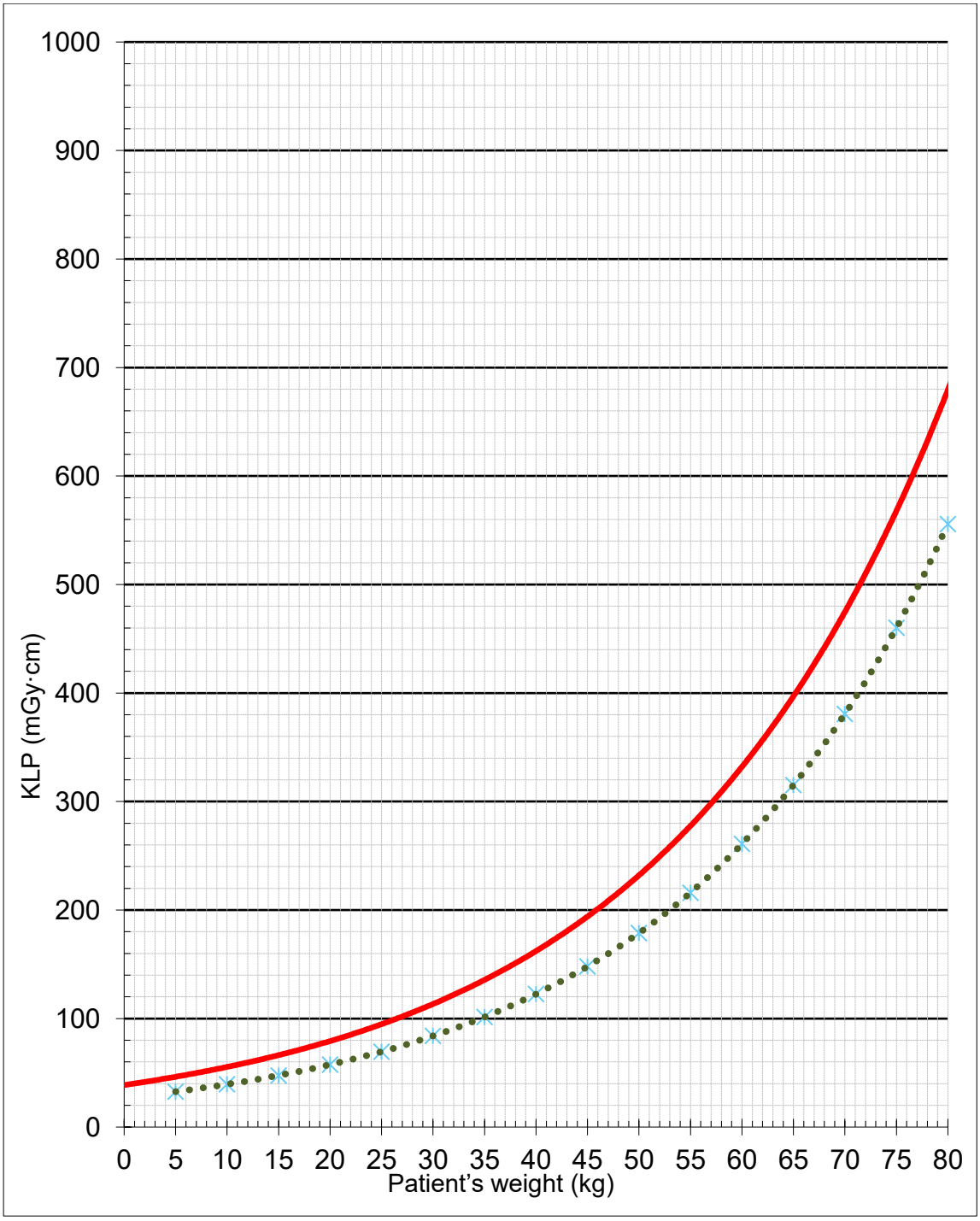

Figure 4. Abdomen CT scans for children: KLP as a function of the patient's weight. Solid red curve: reference level, dotted green curve: achievable level.

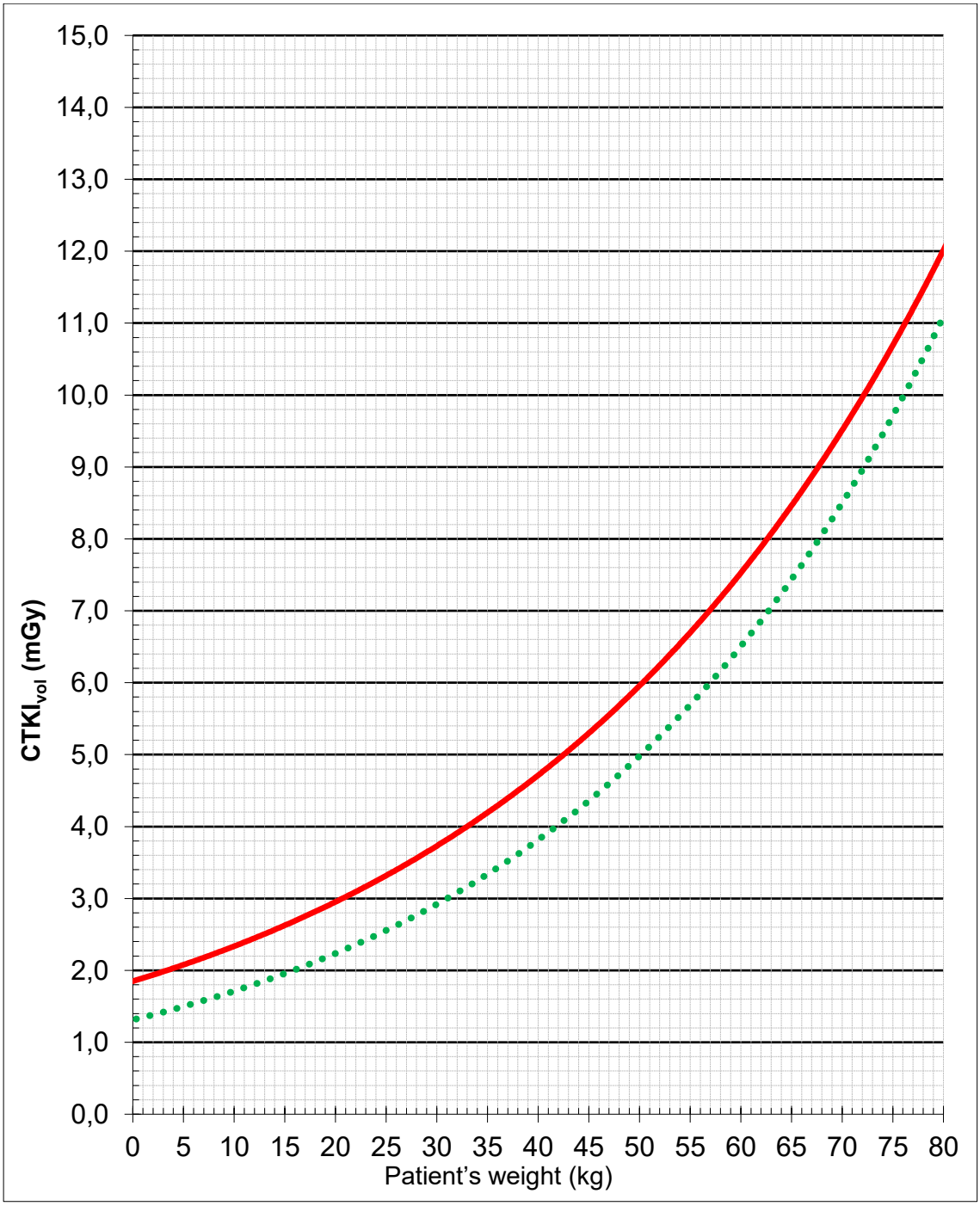

Figure 5. Body (lung + abdomen) CT-scans for children: $CTKI_{vol}$ as a function of the patient's weight. Solid red curve: reference level, dotted green curve: achievable level.

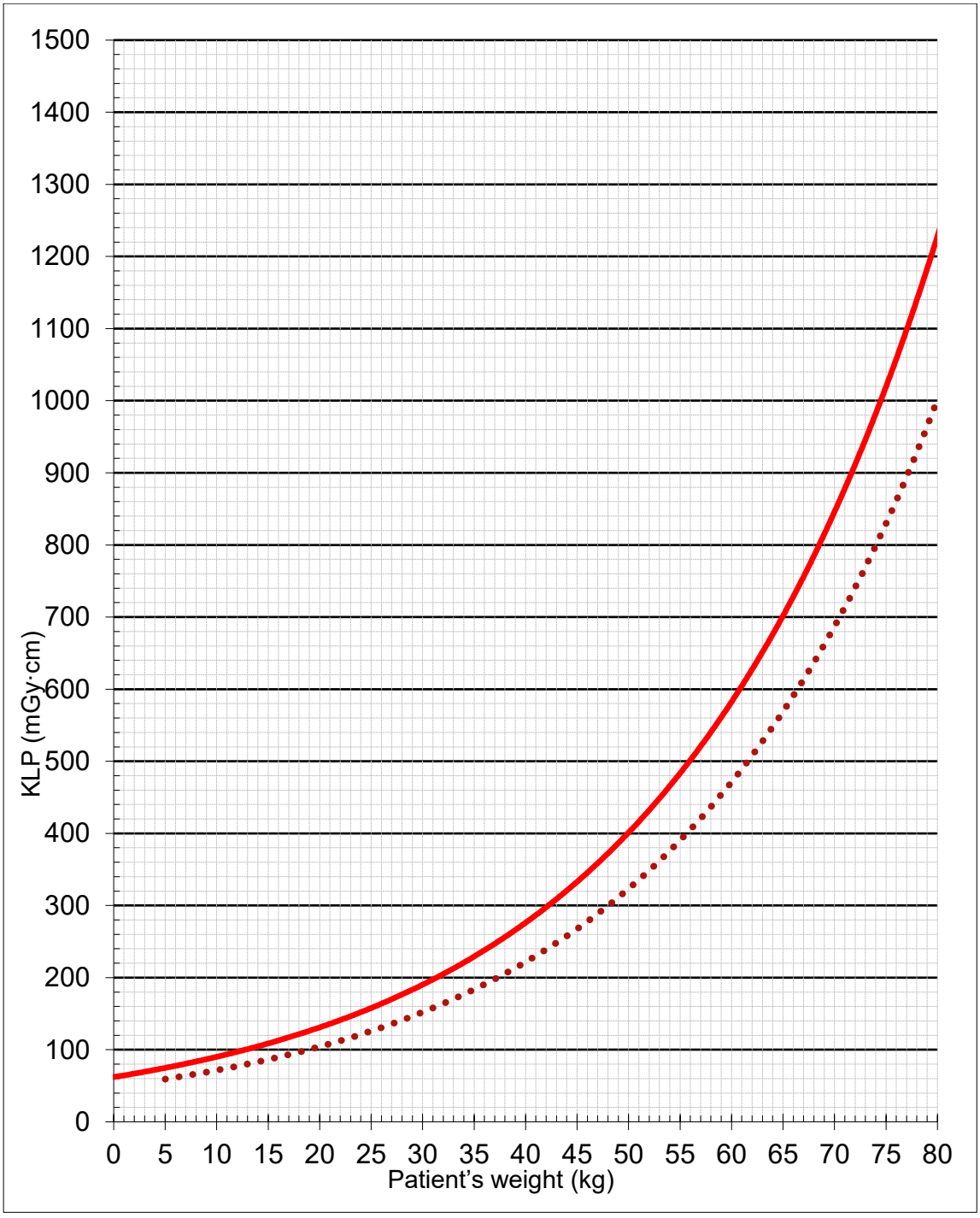

Figure 6. Body (lung + abdomen) CT-scans for children: KLP as a function of the patient's weight. Solid red curve: reference level, dotted red curve: achievable level.

For paediatric head CT-scans, the reading of the dose display must correspond to the dose received in a standard phantom with a diameter of 16 cm; for other paediatric CT scans, the dose must correspond to the dose received in a standard phantom with a diameter of 32 cm. The radiation exposure is determined, in each age group (head CT scans) and in each reference curve (CT scans of the lungs, abdomen and body), for a group of at least ten patients. In the case of the reference level curve, the patient doses should be determined as comprehensively as possible along the weight range depicted by the reference level curve (0–80 kg).

In paediatric head CT scans, the reference level is provided for different age groups.

The reference levels for paediatric CT scans of the lung, abdomen, and body (lung + abdomen) are provided as a reference level curve where the reference level is shown as a function of the patient's weight. Therefore, the weight of the patient must be known in addition to their radiation exposure. For example, the reference level curve can be used as a printed image; the radiation doses are marked in the image according to the patient's weight and compared to the reference level curve. If there are more dots above the reference level curve than below it, this indicates that the reference level has been exceeded.

The comparison to the reference level curve can also be performed computationally by comparing the curve fitted to the patient doses determined by the undertaking to the reference level curve. If the fitted curve is above the reference level curve, this indicates that the reference level has been exceeded.

$CTKI_{vol}$ refers to the quantity defined on the basis of the average of the variable current used in the imaging. If the appliance defines the quantity in some other way, the indication of the equipment's dose display and the $CTKI_{vol}$ presented in the decision are not mutually comparable.

ANNEX 4

Reference levels for patients' exposure in cone-beam computed tomography examinations of adults' head region

Table 1. Reference levels for cone-beam computed tomography examinations (CBCT) of adults' head region. Examinations refer to conventional CBCT examinations conducted with the imaging indication in question.

Imaging indication	**KAP[1)] mGy·cm²**
Preoperative imaging of implant therapy (one tooth)	360
Assessment of relationship between wisdom tooth and mandibular canal	380
Assessment of tooth's periapical area and root canal morphology	550
Imaging of paranasal sinuses (excluding trauma imaging)	1,150
[1)] The air kerma-area product is also referred to as the dose-area product (DAP).	

ANNEX 5

Reference levels for patients' exposure in cardiology

Table 1. Reference levels for cardiological examinations and procedures conducted under fluoroscopic guidance.

Examination or procedure	KAP[1)] Gy·cm²
Coronary artery examination using a contrast medium (CA)	30
Percutaneous coronary intervention (PCI)[2]	75
Pacemaker installation (excluding CRT pacemaker installation)	3.5
Transcatheter aortic valve implantation (TAVI)	90
Electrophysiological treatment of atrial fibrillation	25

[1)] The air kerma-area product is also referred to as the dose-area product (DAP).
[2)] Including potential angiography (ad hoc PCI).

The median of several patient's KAP values must be used in the comparison to the reference level and, when necessary, the difficulty of the procedure must be taken into account.

The radiation exposure is determined as the air kerma-area product (KAP) of the entire examination (fluoroscopy and x-ray imaging) for a group of several dozens of consecutive patients. A median radiation exposure (a median of KAP values) is calculated for this group and compared to the appropriate reference level.

Fluoroscopy time

Separate reference levels are not given for fluoroscopy times. Typical fluoroscopy times are presented in Table 2. An undertaking may compare their own median fluoroscopy times to these figures. The fluoroscopy times in Table 2 have been determined using the same calculation method as for the reference levels in Table 1.

Table 2. Typical fluoroscopy times for cardiological examinations and fluoroscopy guided procedures.

Examination or procedure	Fluoroscopy time min
Coronary artery examination using a contrast medium (CA)	4
Percutaneous coronary intervention (PCI)	15
Pacemaker installation (excluding CRT pacemaker installation)	5
Transcatheter aortic valve implantation (TAVI)	19
Electrophysiological treatment of atrial fibrillation	12

Cardiological examinations and procedures which have not been given reference levels

Table 3 provides indicative dose information for examinations which have not been given reference levels. An undertaking may compare their own median radiation exposure values to the KAP values presented. The KAP values in Table 3 have been determined using the same calculation method as for the reference levels in Table 1.

Table 3. KAP values for cardiological examinations and fluoroscopy guided procedures.

Examination or procedure	**KAP[1)] Gy·cm²**
CRT pacemaker installation	22
Electrophysiological treatment of atrial flutter	16
Electrophysiological treatment of atrioventricular nodal reentrant tachycardia (AVNRT)	6

[1)] The air kerma-area product is also referred to as the dose-area product (DAP).

ANNEX 6

Reference levels for patients' exposure in the conventional X-ray examinations of adults

Table 1 provides reference levels as entrance surface air kerma (ESAK) and as air kerma-area products (KAP). The entrance surface air kerma is also referred to as the entrance surface dose (ESD). The air kerma-area product is also referred to as the dose-area product (DAP). Table 2 provides the reference level for mammography examinations as mean glandular dose (MGD). In addition, table 3 provides achievable dose levels for X-ray equipment with flat panel detectors. The achievable dose levels describe dose levels enabled by the performance of the flat panel technology.

Table 1. Reference levels for conventional X-ray examinations as entrance surface doses and dose-area products for adults.

Imaging projection	**Entrance surface air kerma/projection (ESAK)[1] mGy**	**Air kerma-area product (KAP)[2] Gy · cm²**
Thorax PA	0.12	0.1
Thorax LAT	0.5	0.2
Lumbar spine AP or PA	3.5	1
Lumbar spine LAT	10	2.1
Abdomen AP or PA	3.5	1.6
Dental imaging, upper molar	2.5	
Panoramic tomography of the teeth and jaw		0.12
Paranasal sinuses in one projection		0.09

[1] Entrance surface air kerma refers to air kerma on skin (ESAK).
[2] Product of the cross-section air kerma and area of the radiation beam (KAP).

Table 2. Reference level for mammography examinations

Imaging projection	**Mean glandular dose (MGD)[1]/projection mGy**
Breast CC, MLO LAT	1.5

[1] The Mean Glandular Dose, MGD, refers to the average dose to the glandular tissue of the breast.

The individuals for mammography examinations should be selected so that the compressed tissue thickness of the breast is 4–6 cm. The average compressed breast tissue thickness of the examined individuals should be approximately 5 cm. For other examinations, the patients should be selected so that their weights are between 55–85 kg, averaging approximately 70 kg.

Table 3. Achievable dose levels for conventional X-ray examinations of adults with X-ray equipment with flat panel detectors.

Imaging projection	**Entrance surface air kerma/projection (ESAK)[1] mGy**	**Air kerma-area product (KAP)[2] Gy · cm²**
Thorax PA	0.05	0.07
Thorax LAT		0.14
Lumbar spine AP or PA	1.8	0.7
Lumbar spine LAT		1.5
Dental imaging, upper molar	1.7	
Abdomen AP or PA		0.8

[1] Entrance surface air kerma refers to air kerma on skin (ESAK).
[2] Product of the cross-section air kerma and area of the radiation beam (KAP).

ANNEX 7

Reference levels for patients' exposure in conventional paediatric X-ray examinations

Table 1 shows the reference levels for panoramic tomography examinations of children's teeth and jaws, and Table 2 shows the equations for the reference level curves for paediatric chest X-ray examinations. The reference levels given in Table 2 apply only to examinations carried out in a standing or sitting position.

In addition, Tables 3 and 4 show the dose levels achievable with X-ray equipment with flat panel detectors, illustrating the dose levels that can be achieved using X-ray devices equipped with flat panel detector technology.

Figures 1 and 2 are graphs showing the reference levels of chest X-ray examinations in AP (or PA) and LAT projections as air kerma-area products (KAP) as a function of the patient's weight. The air kerma-area product is also referred to as the dose-area product (DAP).

Table 1. Reference level as an air kerma-area product for panoramic tomography of children's teeth and jaws for different age groups.

Examination	**Age group years**	**Air kerma-area product (KAP)[1)] mGy · cm²**
Panoramic tomography of the teeth and jaws	5–9	55
	10–16	75
[1)] Product of the cross-section air kerma and area of the radiation beam (KAP).		

Table 2. Reference level curve equations as a function of the patient's weight for paediatric chest X-ray examinations.

Examination	**Reference level curve equation[1)]**
Thorax AP/PA	$y = 4.0196 \cdot e^{0.0382 \cdot x}$
Thorax LAT	$y = 5.002 \cdot e^{0.0430 \cdot x}$
[1)] where y is the radiation beam cross-sectional air kerma-area product KAP [mGy·cm²] and x is the patient's weight [kg].	

Table 3. Achievable dose levels for panoramic tomography of the teeth and jaws as an air kerma-area product for different age groups of children.

Examination	**Age group years**	**Air kerma-area product (KAP)[1)] mGy · cm²**
Panoramic tomography of the teeth and jaws	5-9	45
	10-16	55
[1)] Product of the cross-section air kerma and area of the radiation beam (KAP).		

Table 4. Equations for the achievable dose level curves as a function of the patient's weight for paediatric chest X-ray examinations.

Examination	**Equation for the achievable level curve[1)]**
Thorax AP/PA	$y = 2.3702 \cdot e^{0.0413 \cdot x}$
Thorax LAT	$y = 2.7869 \cdot e^{0.0467 \cdot x}$
[1)] where y is the radiation beam cross-sectional air kerma-area product KAP [mGy·cm^2] and x is the patient's weight [kg].	

Osoite / Address | Laippatie 4, 00880 Helsinki
Postiosoite / Postal address | PL / P.O. Box 14, FI-00811 Helsinki, FINLAND
Puh. / Tel. (09) 759 881, +358 9 759 881 | Fax (09) 759 88 500, +358 9 759 88 500 | www.stuk.fi

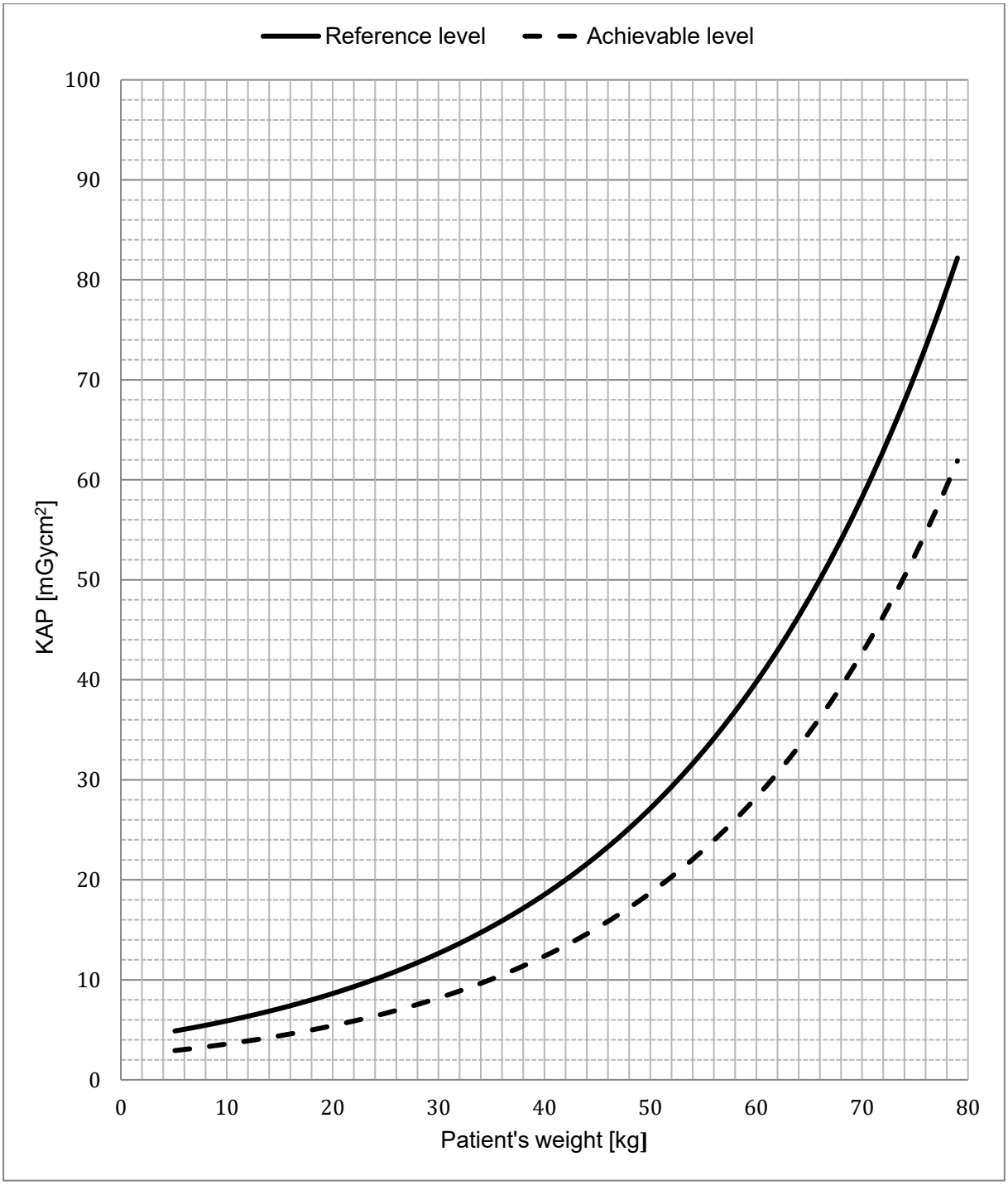

Figure 1. Reference level curve for chest X-ray examination and achievable dose level curve in the AP/PA projection as an air kerma-area product (KAP) as a function of the patient's weight. The equation for the reference level curve is $y = 4.0196 \cdot e^{0.0382 \cdot x}$ and for the achievable dose level curve $y = 2.3702 \cdot e^{0.0413 \cdot x}$.

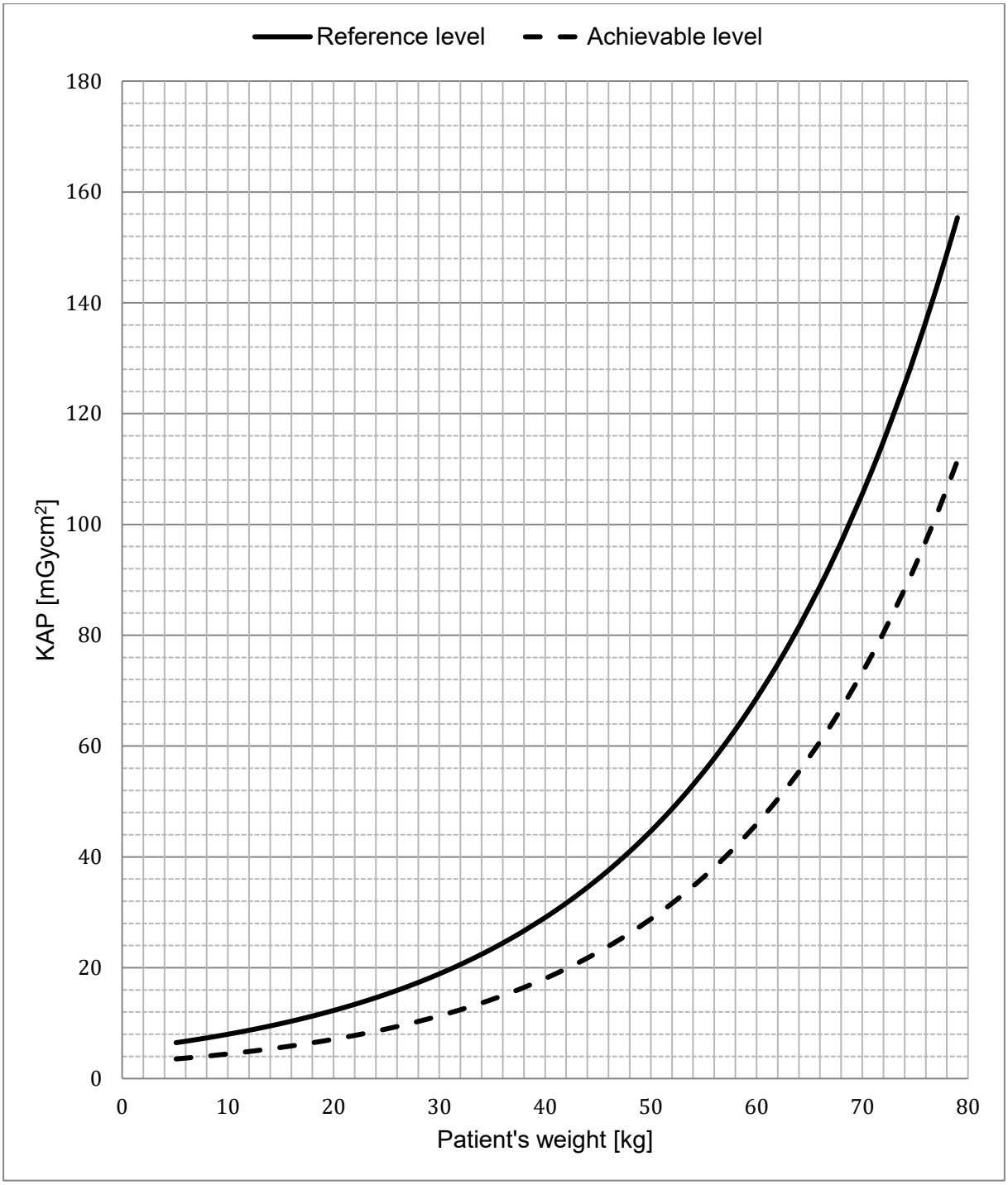

Figure 2. Reference level curve for chest X-ray examination and achievable dose level curve in the LAT projection as an air kerma-area product (KAP) as a function of the patient's weight. The equation for the reference level curve is $y = 5.002 \cdot e^{0.0430 \cdot x}$ and for the achievable dose level curve $y = 2.7869 \cdot e^{0.0467 \cdot x}$.

Chest X-ray examinations

The reference levels for paediatric chest X-ray examinations are provided as reference level curves in Figures 1 and 2 where the reference levels are shown as a function of the patient's weight. When collecting patient data, the patient's weight is determined in addition to the radiation exposure in the chest X-ray examination.

Panoramic tomography of the teeth and jaw

The reference level of panoramic tomography of the teeth and jaws has been determined in Figure 3 for the age groups 5–9-year-olds and 10–16-year-olds.