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Radiation Dose to Patients in Diagnostic Nuclear Medicine

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ICRP Publication XXX

RADIATION DOSE TO PATIENTS IN DIAGNOSTIC NUCLEAR MEDICINE

ICRP PUBLICATION XXX

Approved by the Commission in MMMMM 20XX

Abstract– In its 2007 Recommendations, ICRP introduced changes in the system of radiation protection that affect the calculation of effective dose and implied a revision of dose coefficients for internal exposure by administration of radiopharmaceuticals in medical diagnostics published in earlier publications, lastly in *Publication 128*. This report replaces the previous series of Publications on Radiation Dose to Patients from Radiopharmaceuticals (*Publications 53, 80, 106 and 128*) and the related Addenda published in *Publications 62* (Erratum in *Publication 75*) as well as online. It provides data on individual radiopharmaceuticals and their labelled radioisotopes including their use in nuclear medicine; their physical half-lives; the biokinetic information available; the structure and parameter values of the proposed biokinetic model. Internal distribution and excretion of radiopharmaceuticals have been calculated using improved compartmental biokinetic models. These models are based on available experimental data and knowledge of human physiology also allowing more complex physiologically based model structures than in earlier reports, in an attempt to make them more realistic representations of uptake and retention in organs and tissues and of excretion. The *Publication 100* Human Alimentary Tract Model (HATM) was also used when appropriate. For the calculation of the dose to the urinary bladder wall a dynamic bladder model has been used as well as a specific bladder voiding regime which is typical for the situation in the application of the radiopharmaceutical considered. The dose coefficients have been calculated implementing the changes that were introduced in *Publication 103* to: the radiation weighting factors used in the calculation of equivalent doses to tissues; the tissue weighting factors used in the calculation of effective dose; and the calculation of effective dose based on averaging sex-specific tissue or organ equivalent doses. Dose calculations were also improved by using the updated radionuclide decay data of *Publication 107* and specific absorbed fractions computed using the reference anatomical voxel phantoms of *Publications 110* and *143* and published in *Publications 133* and *155*. This report gives sex-specific coefficients of absorbed dose to 27 target tissues or organs for patients in diagnostic nuclear medicine for the ages 3 months, 1 year, 5 years, 10 years, 15 years, and for adults. It also gives the corresponding effective dose coefficients for each age group considered. In cases when the group of patients considered deviates noticeably from the ICRP reference person, specific dose calculations were performed accordingly. Data are also given in an electronic Annex. The data presented here are intended for diagnostic applications of radiopharmaceuticals only. For therapeutic applications of radionuclides individual planning must be based on detailed patient-specific dosimetry.

Keywords: Diagnostic nuclear medicine; Radiopharmaceuticals; Internal dose assessment; Biokinetic and dosimetric models

MAIN POINTS

- **This report gives age-dependent dose coefficients for patients undergoing diagnostic investigations in nuclear medicine. This document updates the Compendium presented in *Publication* 128 and all related documents.**
- **As in the previous Publications, dose coefficients are presented in this report for 3-month-old infants, 1-, 5-, 10-, and 15-year-old children, and adults. Specific dose calculations were performed in cases when the group of patients deviates noticeably from the ICRP reference person.**
- **For each radiopharmaceutical considered in this report, following data are provided: structure of the biokinetic model and values of the transfer coefficients; tables with the time-integrated activity coefficients (h) in the source regions identified in the biokinetic model; tables of organ absorbed doses per activity administered (mGy MBq^{-1}), given separately for male and female, and effective dose per activity administered (mSv MBq^{-1}) for each age group.**
- **The data are available in printed form for a subset of radiopharmaceuticals. The complete set of data is available in electronic form.**
- **This document gives additional guidance for pregnant and breast-feeding patients as well as in the cases of extravasation after a nuclear medicine examination.**

1. INTRODUCTION

(1) The administration of radioactive substances to humans for diagnosis and therapy is a well-established and continuously developing branch of medical practice and research, and is, in most countries, recognised under the name of 'nuclear medicine and molecular imaging'.

(2) New methods and new radiopharmaceuticals are being introduced continually for diagnostic purposes. Hybrid technologies – combining positron emission tomography (PET) or single-photon emission computed tomography (SPECT) with X-ray computed tomography (CT) or magnetic resonance imaging (MRI) – have opened possibilities for imaging with increased specificity and localization, thus providing the possibility of more accurate diagnosis.

(3) Reasonably accurate dosimetry for representative groups of patients for each specific procedure is needed to compare and optimise the use of the various alternative radiodiagnostic techniques, and to estimate the dose and possible related risk from nuclear medicine diagnostic procedures. The data presented here apply only to radiopharmaceuticals used in diagnostic nuclear medicine, and they are based on generic models defined for reference individuals.

(4) Radiopharmaceuticals are also administered for the treatment of various tumours and non-cancer diseases. The use of radiopharmaceuticals for therapy using novel radionuclides, compounds, tracer molecules and administration techniques has been rapidly increasing in recent years. In the case of therapeutic applications of radionuclides, detailed patient-specific dosimetry based on individual biokinetics and dose planning is required.

(5) *Publication 140* (ICRP, 2019b) provides information on practical approaches for the management of patient dose in therapy with radiopharmaceuticals as well as for protection of staff, carers, comforters and members of the public. A growing number of scientific publications and guidelines from relevant national and international professional associations provide guidance in this matter.

(6) ICRP first addressed the issue of radiation protection in nuclear medicine in its *Publication 17*, entitled 'Protection of the patient in radionuclide investigations' (ICRP, 1971), which contained mainly information on ionic form of radionuclides administered for diagnostic purposes. It was superseded by *Publication 53*, entitled 'Radiation dose to patients from radiopharmaceuticals' (ICRP, 1988), which presented organ absorbed doses and effective dose equivalents per administered activity[2] for some 120 radiopharmaceuticals in regular use at the time. A little less than half of entries still referred to radionuclides in ionic form, with the rest referencing more complicated labelled organic molecules or complexes or radionuclide-labelled cells, most of which have since been replaced by other substances.

(7) A first Addendum to *Publication 53* was released in *Publication 62* (ICRP, 1992) with models for six additional substances. Moreover, the coefficients of the effective dose equivalent used in *Publication 53* were replaced for all substances by the effective dose coefficients calculated with the new tissue weighting factors recommended in *Publication 60* (ICRP, 1991).

(8) *Publication 80* (ICRP, 1998), the second Addendum to *Publication 53*, presented biokinetic and dosimetric data on ten new radiopharmaceuticals, and recalculations of dose data for 19 of the most frequently used radiopharmaceuticals from *Publication 53*.

(9) Models and dose coefficients for 17 new substances and errata for previously published data were issued in interim reports which were approved for web site publication between 1999 and 2002, and finally published in *Publication 106* (ICRP, 2008b) as Addendum 3 to *Publication 53*. *Publication 106* utilized revised S-values for the brain, skeleton, and salivary glands and also included recommendations relating to breastfeeding for lactating patients who have undergone nuclear medicine procedures.

[2] The original formulation used in *Publication 53* was 'per unit activity administered'

(10) A fourth addendum, including models and coefficients for six additional substances was made available on the ICRP's website in 2013[3].

(11) A compendium of the available information for selected, widely used radiopharmaceuticals was published as *Publication 128* (ICRP, 2015b). It also contained updated information for ^{82}Rb-labelled rubidium chloride and ^{123}I-, ^{124}I-, ^{125}I-, and ^{131}I-labelled iodide. Finally, an addendum to *Publication 128* was published online in 2020 (ICRP, 2020a). It contained biokinetic data and dose coefficients for two substances: ^{11}C-labelled Pittsburgh Compound B (PiB) and ^{68}Ga-labelled High-Affinity DOTATATE. All substances covered in at least one of the previous reports are summarized in Table 1.1.

(12) In the documents from *Publication 62* onwards organ and effective doses were estimated according to the methodology and definitions of *Publication 60* (ICRP, 1991). The specific absorbed fractions of photons used in *Publication 60* calculations were estimated by Monte Carlo methods with the composite age-dependent mathematical models (stylized phantoms) described by Cristy and Eckerman (1987).

(13) The present report contains results from calculations of organ absorbed dose and effective dose per administered activity (in mGy MBq^{-1} and mSv MBq^{-1}, respectively) for 28 radiopharmaceuticals, including some of the substances considered in the previous documents and new radiopharmaceuticals that have since been introduced into clinical use.

(14) These data have been calculated in accordance with the methodology and definitions of *Publication 103* (ICRP, 2007). The concept and use of equivalent and effective dose remain unchanged with respect to the previous recommendations (ICRP, 1991), but a number of revisions were made to the methods used in their calculation, including changes to radiation and tissue weighting factors, adoption of reference male and female computational phantoms, and how to calculate the effective dose.

(15) Absorbed dose coefficients are calculated for the relevant 'target organs and tissues', as given in Tables A.1 and A.2 of *Publication 133* (ICRP, 2016a). These absorbed doses are typically the sum of contributions from various regions ('source regions') and may arise as a result of radioactive decays occurring in the target organ or tissue itself (self-irradiation) or in other regions (crossfire irradiation). In general, mean absorbed doses are calculated assuming uniform distribution of the radionuclide in the source regions.

(16) An exception to the assumption of a uniform dose distribution can be made for selected substances and tissues, such as the kidneys or the brain, provided that a non-uniform distribution of the radionuclide in those tissues is documented. Such cases are discussed in detail in the specific sections of the Annex where those substances are presented. However, even in these cases, absorbed doses to other organs and tissues are calculated under the assumption that the radionuclide is distributed uniformly in the source region. This is assumed to be justified since dose due to crossfire irradiation is not highly dependent on how the activity is distributed within a source region some distance away from the target tissue. Moreover, if there is also significant activity present within the target tissue, this self-irradiation is likely to be the more important contributor to the target's dose than emissions from distant source regions.

(17) The dose contribution of the Computed Tomography (CT) examination in hybrid imaging is not considered in this document. A separate publication on reference organ and effective dose coefficients for common CT examinations will be issued by ICRP.

[3] Available at: http://www.icrp.org/docs/Radiation%20Dose%20to%20Patients%20from%20Radiopharmaceuticals%20-%20A%20fourth%20addendum%20to%20ICRP%20Publication%2053.pdf

Table 1.1. List of substances present in previous ICRP Publications on dose coefficients for patients in diagnostic nuclear medicine.

Substance	ICRP Publication						
	17 (1971)	53 (1988)	62 (1992)	80 (1998)	106 (2008)	128 (2015)	Addendum (2020)
^{3}H-inulin	-	X	X	X	-	X	-
^{3}H-neutral fat and free fatty acids	-	-	X	X	-	X	-
^{3}H-tritiated water (HTO)	X	X	X	-	-	-	-
[1-^{11}C]-acetate	-	-	-	-	X	X	-
^{11}C-carbon monoxide	X	X	X	-	-	-	-
^{11}C-carbon dioxide	X	X	X	-	-	-	-
^{11}C-CO-Hb labelled erythrocytes	-	X	X	-	-	-	-
^{11}C-labelled amino acids (generic model)	-	-	-	-	X	X	-
^{11}C-labelled brain receptor substances (generic model)	-	-	-	-	X	X	-
L-[methyl-^{11}C]-methionine	-	-	-	-	X	X	-
^{11}C-labelled thymidine	-	-	-	X	-	X	-
^{11}C-labelled substances (realistic maximum model)	-	-	-	-	X	X	-
^{11}C-Pittsburgh Compound B (PiB)	-	-	-	-	-	-	X
^{11}C-raclopride	-	-	-	-	-	X	-
^{11}C-spiperone	-	X	X	-	-	-	-
^{14}C-carbon dioxide	X	-	-	-	-	-	-
^{14}C-inulin	-	X	X	-	-	-	-
^{14}C-neutral fat and free fatty acids	-	-	X	X	-	X	-
^{14}C-labelled urea	-	-	-	X	-	X	-
^{14}C-serotonin	X	-	-	-	-	-	-
^{13}N-ammonia	-	X	X	-	-	-	-
^{13}N-L-glutamate	-	X	X	-	-	-	-
^{13}N-nitrogen gas	X	X	X	-	-	-	-
^{15}O-carbon monoxide	-	X	X	-	-	-	-
^{15}O-carbon dioxide	X	X	X	-	-	-	-
^{15}O-oxygen gas	X	X	X	-	-	-	-
^{15}O-water	-	-	-	X	X	X	-
2-[^{18}F]-fluoro-2-deoxy-D-glucose (FDG)	-	X	X	X	X	X	-
O-(2-[^{18}F]-fluorethyl)-L-tyrosine (FET)	-	-	-	-	-	X	-
3'-deoxy-[^{18}F]-3'-fluorothymidine (FLT)	-	-	-	-	-	X	-
^{18}F-boron-fluoropotassium (BFK)	X	-	-	-	-	-	-

Substance	ICRP Publication						
	17 (1971)	53 (1988)	62 (1992)	80 (1998)	106 (2008)	128 (2015)	Addendum (2020)
^{18}F-choline	-	-	-	-	-	X	-
^{18}F-fluoro-L-DOPA	-	-	-	-	X	X	-
^{18}F-fluoride	-	X	X	-	-	X	-
^{18}F-labelled amino acids (generic model)	-	-	-	-	X	X	-
^{18}F-labelled brain receptor substances (generic model)	-	-	-	-	X	X	-
^{22}Na and ^{24}Na ion	X	X	X	-	-	-	-
^{28}Mg ion	X	X	X	-	-	-	-
^{32}P-phosphate	X	X	X	-	-	-	-
^{32}P-defluorinated phosphate (DFP)	X	-	-	-	-	-	-
^{33}P-phosphate	-	X	X	-	-	-	-
^{35}S-sulphate	X	X	X	-	-	-	-
^{34m}Cl-, ^{36}Cl- and ^{38}Cl-chloride	-	X	X	-	-	-	-
^{36}Cl- and ^{38}Cl-perchlorate ion	X	-	-	-	-	-	-
^{38}K ion (ultrashort-lived)	-	X	X	-	-	-	-
^{42}K ion	-	X	X	-	-	-	-
^{43}K ion	X	X	X	-	-	-	-
^{45}Ca ion	X	X	X	-	-	-	-
^{47}Ca ion	-	X	X	-	-	-	-
^{47}Ca+^{47}Sc ion	X	-	-	-	-	-	-
^{46}Sc- and ^{47}Sc-labelled non absorbable markers	-	X	X	-	-	-	-
^{51}Cr ion	X	-	-	-	-	-	-
^{51}Cr-chloride	-	X	X	-	-	-	-
^{51}Cr-labelled erythrocytes (RBC)	X	X	X	-	-	-	-
^{51}Cr-labelled denatured erythrocytes (RBC)	X	X	X	-	-	-	-
^{51}Cr-labelled ethylenediaminetetraacetic acid (EDTA)	X	X	X	X	-	X	-
^{51}Cr-labelled human serum albumin (HSA)	X	-	-	-	-	-	-
^{51}Cr-labelled leukocytes (WBC)	-	X	X	-	-	-	-
^{51}Cr-labelled non absorbable markers	-	X	X	-	-	-	-
^{51}Cr-labelled platelets (thrombocytes)	-	X	X	-	-	-	-
^{51}Cr-labelled polystyrene	X	-	-	-	-	-	-
^{52}Fe ion	-	X	X	-	-	-	-
^{55}Fe and ^{59}Fe ion	X	X	X	-	-	-	-

Substance	ICRP Publication						
	17 (1971)	53 (1988)	62 (1992)	80 (1998)	106 (2008)	128 (2015)	Addendum (2020)
^{59}Fe-labelled ethylenediaminetetraacetic acid (EDTA)	X	-	-	-	-	-	-
^{56}Co and ^{60}Co-labelled Vitamin B_{12}	X	-	-	-	-	-	-
^{57}Co and ^{58}Co-labelled Vitamin B_{12}	X	X	X	-	-	-	-
^{57}Co-labelled bleomycin	-	X	X	-	-	-	-
^{64}Cu and ^{67}Cu ion	X	X	X	-	-	-	-
^{64}Cu-diethylenetriaminepentaacetic acid (DTPA)	X	-	-	-	-	-	-
^{64}Cu-labelled ethylenediaminetetraacetic acid (EDTA)	X	-	-	-	-	-	-
^{62}Zn and ^{69m}Zn ion	-	X	X	-	-	-	-
^{65}Zn ion	X	X	X	-	-	-	-
^{66}Ga-, ^{68}Ga- and ^{72}Ga-citrate	-	X	X	-	-	-	-
^{67}Ga-citrate	-	X	X	X	-	X	-
^{68}Ga-labelled ethylenediaminetetraacetic acid (EDTA)	-	-	X	X	-	X	-
^{68}Ga-High-Affinity DOTATATE	-	-	-	-	-	-	X
^{72}As-, ^{74}As- and ^{76}As-arsenate, arsenite	-	X	X	-	-	-	-
^{74}As, ^{79}As ion	X	-	-	-	-	-	-
^{75}Se-cysteine	X	-	-	-	-	-	-
^{75}Se-labelled amino acids (generic model)	-	-	-	-	X	X	-
^{75}Se-labelled bile acid (SeHCAT)	-	X	X	X	-	X	-
^{75}Se-selenite	-	X	X	-	-	-	-
^{75}Se-selenomethionine	X	X	-	-	-	-	-
^{75}Se-selenomethylcholesterol	-	X	X	-	-	-	-
^{76}Br- and ^{77}Br-bromide	-	X	X	-	-	-	-
^{77}Br-bromospiperone	-	X	X	-	-	-	-
^{82}Br-bromide	X	X	X	-	-	-	-
^{79}Kr and ^{85}Kr gas	X	-	-	-	-	-	-
^{81m}Kr gas	X	X	X	-	-	-	-
^{81}Rb and ^{86}Rb ion	X	X	X	-	-	-	-
^{81}Rb labelled denatured erythrocytes (RBC)	-	X	X	-	-	-	-
^{82}Rb ion (ultrashort-lived)	-	X	X	-	-	-	-
^{82}Rb-chloride	-	-	-	-	-	X	-
^{84}Rb ion	-	X	X	-	-	-	-
^{85}Sr and ^{87m}Sr ion	X	X	X	-	-	-	-

Substance	ICRP Publication						
	17 (1971)	53 (1988)	62 (1992)	80 (1998)	106 (2008)	128 (2015)	Addendum (2020)
^{89}Sr ion	-	X	X	-	-	-	-
^{90}Y ion	X	-	-	-	-	-	-
^{90}Nb ion	X	-	-	-	-	-	-
^{99}Mo ion	X	-	-	-	-	-	-
^{99m}Tc-antimony sulphide colloid	X	-	-	-	-	-	-
^{99m}Tc-apcitide	-	-	-	-	X	X	-
^{99m}Tc-diethylenetriaminepentaacetic acid (DTPA)	-	X	X	X	-	X	-
^{99m}Tc-dimercaptosuccinic acid (DMSA)	-	X	X	X	-	X	-
^{99m}Tc-ethylenedicysteine (EC)	-	-	-	-	X	X	-
^{99m}Tc-ethylenedicysteine diester (ECD, Neurolite)	-	-	-	-	X	X	-
^{99m}Tc-furifosmin (Q12)	-	-	-	-	X	X	-
^{99m}Tc-gluconate, glucoheptonate	-	X	X	-	-	-	-
^{99m}Tc-iron complex salt	X	-	-	-	-	-	-
^{99m}Tc-labelled 2-methoxy-isobutyl-isonitrile (MIBI, Sestamibi, Hexamibi)	-	-	X	X	-	X	-
^{99m}Tc-labelled aerosols	-	X	X	-	-	-	-
^{99m}Tc-labelled albumin (HSA)	X	X	X	-	-	-	-
^{99m}Tc-labelled heat denaturated albumin (HSA)	X	-	-	-	-	-	-
^{99m}Tc-labelled albumin microspheres	-	X	X	-	-	-	-
^{99m}Tc-labelled citrate complex	-	X	X	-	-	-	-
^{99m}Tc-labelled colloids (large)	-	X	X	X	-	X	-
^{99m}Tc-labelled colloids (small, intratumoural injection)	-	X	X	-	-	X	-
^{99m}Tc-labelled erythrocytes (RBC)	X	X	X	X	-	X	-
^{99m}Tc-labelled denaturated erythrocytes (RBC)	-	X	X	-	-	-	-
^{99m}Tc-labelled fibrinogen	-	X	X	-	-	-	-
^{99m}Tc-labelled heparin	-	X	X	-	-	-	-
^{99m}Tc-labelled hexamethylpropyleneamineoxine (HM-PAO)	-	-	X	X	-	X	-
^{99m}Tc-labelled human immunoglobulin (HIG)	-	-	-	X	-	X	-
^{99m}Tc-labelled iminodiacetic acid derivatives (HIDA, etc.)	-	X	X	X	-	X	-
^{99m}Tc-labelled leukocytes (WBC)	-	X	X	X	-	X	-
^{99m}Tc-labelled macro-aggregated albumin (MAA)	-	X	X	X	-	X	-
^{99m}Tc-labelled mercaptoacetyl triglycine (MAG3)	-	-	X	X	-	X	-

Substance	ICRP Publication						
	17 (1971)	53 (1988)	62 (1992)	80 (1998)	106 (2008)	128 (2015)	Addendum (2020)
^{99m}Tc-labelled monoclonal tumour-associated antibodies	-	-	-	-	X	X	-
^{99m}Tc-labelled non-absorbable markers	-	X	X	X	-	X	-
^{99m}Tc-labelled plasmin	-	X	X	-	-	-	-
^{99m}Tc-labelled platelets (thrombocytes)	-	X	X	-	-	-	-
^{99m}Tc-labelled phosphates and phosphonates	-	X	X	X	-	X	-
^{99m}Tc-labelled tetrofosmin	-	-	-	X	X	X	-
^{99m}Tc-penicillamine	-	X	X	-	-	-	-
^{99m}Tc-Pertechnegas	-	-	-	X	-	X	-
^{99m}Tc-pertechnetate	X	X	X	X	-	X	-
^{99m}Tc-Technegas	-	-	-	X	-	X	-
^{111}In and ^{113m}In ion	-	X	X	-	-	-	-
^{111}In-diethylenetriaminepentaacetic acid (DTPA)	-	X	X	-	-	-	-
^{111}In- and ^{113m}In aerosols	-	X	X	-	-	-	-
^{111}In-labelled bleomycin	-	X	X	-	-	-	-
^{111}In-labelled human immunoglobulin (HIG)	-	-	-	X	-	X	-
^{111}In-labelled leukocytes (WBC)	-	X	X	-	-	-	-
^{111}In-labelled monoclonal tumour-associated antibodies	-	-	-	-	X	X	-
^{111}In- and ^{113m}In-labelled non absorbable markers	-	X	X	-	-	-	-
^{111}In-labelled octreotide	-	-	-	X	X	X	-
^{111}In-labelled platelets (thrombocytes)	-	X	X	-	-	-	-
^{113m}In-citrate	X	-	-	-	-	-	-
^{113m}In-diethylenetriaminepentaacetic acid (DTPA)	X	X	X	-	-	-	-
^{113m}In-hydroxide (colloidal)	X	X	X	-	-	-	-
^{113m}In-hydroxide (macro-particles)	X	-	-	-	-	-	-
^{121}Sn ion	X	-	-	-	-	-	-
^{125}Sb ion	X	-	-	-	-	-	-
^{123}I, ^{124}I, ^{125}I, and ^{131}I-iodide	X	X	X	-	-	X	-
^{123}I-Hippuran	-	X	X	X	-	-	-
^{123}I-iodoamphetamine (IMP)	-	X	X	-	-	-	-
^{123}I-labelled albumin (HSA)	-	X	X	-	-	-	-
^{123}I-labelled fatty acids	-	-	-	-	X	X	-
^{123}I-, ^{125}I- and ^{131}I-labelled fibrinogen	-	X	X	-	-	-	-

Substance	ICRP Publication						
	17 (1971)	53 (1988)	62 (1992)	80 (1998)	106 (2008)	128 (2015)	Addendum (2020)
^{123}I-labelled brain receptor substances (generic model)	-	-	-	-	X	X	-
^{123}I-Metaiodobenzylguanidine (MIBG).	-	X	X	-	X	-	-
^{123}I- and ^{131}I-labelled microaggregated albumin	-	X	X	-	-	-	-
^{123}I-labelled 2ß-carbomethoxy 3ß-(4-iodophenyl)-N-(3-fluoropropyl) nortropane (FP-CIT, b-CIT-FP, ioflupane)	-	-	-	-	-	X	-
^{123}I-, ^{131}I-labelled monoclonal tumour-associated antibodies	-	-	-	-	X	X	-
^{123}I-sodium Rose Bengal	-	X	X	-	-	-	-
^{125}I- and ^{131}I-diiodothyronine (T2)	-	X	X	-	-	-	-
^{125}I-Hippuran	X	X	X	-	-	-	-
^{125}I- and ^{131}I-iodinated polyvinylpyrrolidone (PVP)	X	X	X	-	-	-	-
^{125}I- and ^{131}I-iodoantypirine	-	X	X	-	-	-	-
^{125}I-iothalamate	-	X	X	-	-	-	-
^{125}I- and ^{131}I-labelled albumin (HSA)	X	X	X	-	-	-	-
^{125}I- and ^{131}I-labelled non-absorbable markers	-	X	X	-	-	-	-
^{125}I- and ^{131}I-thyroxine (T4)	-	X	X	-	-	-	-
^{125}I- and ^{131}I-triiodothyronine (T3)	-	X	X	-	-	-	-
^{125}I- and ^{131}I-reverse triiodothyronine (rT3)	-	X	X	-	-	-	-
^{125}I-sodium Rose Bengal	X	-	-	-	-	-	-
^{126}I-iodide	X	-	-	-	-	-	-
^{130}I-iodide	X	-	-	-	-	-	-
^{131}I-colographin	X	-	-	-	-	-	-
^{131}I-diodrast	X	-	-	-	-	-	-
^{131}I-heat denaturated human serum albumin (HSA)	X	-	-	-	-	-	-
^{131}I-Hippuran	X	X	X	X	-	-	-
^{131}I-Iodomethyl-19-norcholesterol (NP 59)	-	X	X	X	-	X	-
^{131}I-labelled macroaggregated albumin (MAA)	-	X	X	-	-	-	-
^{131}I-Metaiodobenzylguanidine (MIBG).	-	X	X	-	-	-	-
^{131}I-sodium Rose Bengal	X	X	X	-	-	-	-
^{131}I-triolein	X	-	-	-	-	-	-
^{132}I-iodide	X	-	-	-	-	-	-
^{133}I-iodide	X	-	-	-	-	-	-
^{127}Xe and ^{133}Xe gas	-	X	X	-	-	X	-

Substance	ICRP Publication						
	17 (1971)	53 (1988)	62 (1992)	80 (1998)	106 (2008)	128 (2015)	Addendum (2020)
^{131}Xe gas	X	-	-	-	-	-	-
^{129}Cs, ^{130}Cs, ^{131}Cs and ^{134m}Cs ion	X	X	X	-	-	-	-
^{131}Ba, ^{133m}Ba and ^{135m}Ba ion	-	X	X	-	-	-	-
^{131}Ba-labelled non-absorbable markers	-	X	X	-	-	-	-
^{140}La-diethylenetriaminepentaacetic acid (DTPA)	-	X	X	-	-	-	-
^{169}Y-diethylenetriaminepentaacetic acid (DTPA)	-	X	X	-	-	-	-
^{198}Au ion	X	-	-	-	-	-	-
^{198}Au-colloid	X	X	X	-	-	-	-
^{197}Hg-mercury (II) chloride	-	X	X	-	-	-	-
^{197}Hg-bromo-1-mercuri-2-hydroxypropane (BMHP)	X	X	X	-	-	-	-
^{197}Hg- and ^{203}Hg-chlormerodrin	X	X	X	-	-	-	-
^{203}Hg-bromo-1-mercuri-2-hydroxypropane (BMHP)	X	-	-	-	-	-	-
^{201}Tl ion	-	X	X	X	X	X	-
^{206}Bi ion	X	-	-	-	-	-	-

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(18) The lens of the eye is considered as a tissue at risk for tissue reactions (ICRP, 1991; 2012; Hamada et al., 2020) and the induction of opacities that may interfere with vision. Most radionuclides in radiopharmaceuticals currently used in nuclear medicine are considered not to concentrate in the tissues of the healthy human eye.

(19) Radionuclides used in diagnostic nuclear medicine emit nearly exclusively photons and electrons, for which the radiation weighting factors w_R is set equal to 1 (ICRP, 2007). Therefore, the absorbed doses to organs and tissues given in this publication are numerically the same as the equivalent doses used in the calculation of effective dose. It is important to notice the recent interest for radionuclides, like ^{149}Tb (Müller et al., 2017), that emit both alpha particles and positrons ($ß^+$). This would allow their simultaneous use in PET imaging and therapy. In that case the higher value of w_R for alpha-particles needs to be taken into account.

(20) The values of tissue weighting factors (w_T) recommended in *Publication 103* (ICRP, 2007) are shown in Table 1.2. They represent averages across the sexes and across all ages. The main changes from values given in *Publication 60* (ICRP, 1991) are a decrease (from 0.2 to 0.08) for gonads and an increase (from 0.05 to 0.12) for breast and the remainder tissues. Changes in the 2007 recommendations reflect improved knowledge of radiation risks. The main sources of data on cancer risks are the follow-up studies of the Japanese atomic bomb survivors, used to derive risk coefficients averaged over seven Western and Asian populations with different background cancer rates (ICRP, 2007). The revised w_T values are based on cancer incidence rather than mortality data, adjusted for lethality, loss of quality of life and years of life lost. Weighting for hereditary effects is now based on estimates of disease in the first two generations rather than at theoretical equilibrium.

Table 1.2. ICRP tissue weighting factors (ICRP, 2007)

Tissue	w_T	$\sum w_T$
Bone-marrow, breast, colon, lung, stomach, remainder tissues (13 for each sex*)	0.12	0.72
Gonads	0.08	0.08
Urinary bladder, oesophagus, liver, thyroid	0.04	0.16
Bone surface, brain, salivary glands, skin	0.01	0.04

*Remainder tissues: adrenals, ET regions of the respiratory tract, gall bladder, heart, kidneys, lymphatic nodes, muscle, oral mucosa, pancreas, prostate (male), small intestine, spleen, thymus, uterus/cervix (female).

(21) The contribution to effective dose from the Remainder tissues is now calculated as the arithmetic mean of the doses to the thirteen organs and tissues of which it is constituted. The list of thirteen tissues, given in the footnote to Table 1.2, are different from those given in the previous recommendations, and are sex-specific. The so-called splitting rule in the treatment of the remainder in *Publication 60* (ICRP, 1991) is no longer used. This guarantees that the effective dose is thus a fully additive quantity.

(22) Beyond internal dosimetry in nuclear medicine, the Commission has published reference biokinetic and dosimetric models and reference data for workers and members of the public, giving dose coefficients for intake of radionuclides by inhalation and ingestion. The most recent series of publications, complying with the specifications of the 2007 Recommendations, are the reports on Occupational Intakes of Radionuclides (ICRP, 2015a, 2016b, 2017b, 2019a) and the reports on intakes of radionuclides by members of the public (ICRP, 2024, 202x). This publication has made extensive use of the information and material available from these sources.

(23) The ICRP reference Human Alimentary Tract Model (HATM) (ICRP, 2006) is adopted in this report to describe the fate of orally administered radiopharmaceuticals and the elimination pathway into faeces. An overview of this model is given in Section 4.

Radiopharmaceuticals administered via inhalation are assumed to be instantly and homogeneously distributed in the lung tissues.

(24) The systemic biokinetic models for most of the substances treated in this publication were revised based on a thorough review of the most recent literature. Previous publications on radiation dose to patients from radiopharmaceuticals made extensive use of descriptive models, but compartmental structures are used to describe biokinetics in the present publication in similar fashion to contemporary ICRP models for intake by workers and members of the public (ICRP, 2015a, 2016b, 2017b, 2019a, 2022, 2024, 202x). More details on the biokinetic structures and assumptions used in this publication are given in Section 4 and in the individual radiopharmaceutical sections in the annex.

(25) Specific absorbed fractions (SAFs) are used to compute the S-values needed to calculate the absorbed dose to a target per nuclear transformation taking place in a source region. Specific absorbed fractions have been computed by the ICRP Task Group 96 using radiation transport codes in a variety of computational phantoms representing reference male and female at birth, 1 year, 5 years, 10 years, 15 years and adults, as defined in ICRP *Publication 89* (ICRP, 2002). For adults the SAFs are found in *Publication 133* (ICRP, 2016a) which are based largely on the voxel phantoms in *Publication 110* (ICRP, 2009). For children the SAFs are found in *Publication 155* (ICRP, 2023) which are based largely on the voxel phantoms in *Publication 143* (ICRP, 2020b). More details on the dosimetric models and assumptions used in this publication are given in Section 6.

(26) Unless otherwise specified, the dose coefficients presented in this report refer to administration of radiopharmaceuticals to 3-month-old infants, 1-, 5-, 10-, and 15-year-old children, and adults. These reference dose coefficients can also be used for intakes occurring at other ages. Table 1.3 shows the correspondence between the reference age and the age ranges for which the respective dose coefficient is valid.

Table 1.3. Reference age ranges(ICRP, 2002)

Reference age	Age range
3 months	from 0 to 12 months
1 year	from 1 year to 2 years
5 years	more than 2 years to 7 years
10 years	more than 7 years to 12 years
15 years	more than 12 years to 17 years
Adult	more than 17 years

(27) Organ doses are provided for reference persons of both sexes. If substances are intended to be administered only to specific age groups or to patients of a specific sex, then dose coefficients are given only for those age groups and/or for patients of that sex.

(28) Complete radionuclide and radiochemical purity is assumed in all absorbed dose calculations, unless otherwise stated. Due to the short physical half-lives of the radionuclides used in nuclear medicine, no interpolation according to age is required for the transfer rates of the biokinetic models or the SAF values.

(29) A software code named ‘IDAC-Dose2.2’ (Andersson et al., 202X) was developed specifically for this publication and was used as the reference code for calculating the values published here. For further information regarding IDAC-Dose2.2, see Section 6.

(30) Information regarding dose calculations for radiopharmaceuticals has also been published in reports of the International Commission on Radiation Units and Measurements (ICRU), notably ICRU Reports 32 and 67 (ICRU, 1979, 2002). Of particular importance is the work of the Medical Internal Radiation Dose (MIRD), Committee of the Society of Nuclear Medicine and Molecular Imaging (SNMMI) and the dosimetry work performed at Oak Ridge

National Laboratory (http://crpk.ornl.gov/), and the Radiation Dose Assessment Resource (RADAR) (http://www.doseinfo-radar.com).

2. SELECTION OF RADIOPHARMACEUTICALS

(31) Certain general principles were followed in establishing the list of radiopharmaceuticals for inclusion in this report. A survey was performed to identify which diagnostic radiopharmaceuticals are commonly in use. Internationally, there are regional differences in the use of radiopharmaceuticals due to varied economic status and level of healthcare as well as distance from the sites where radiopharmaceuticals are produced. Therefore, the selection of radiopharmaceuticals in this publication should be broad.

(32) Further, radiopharmaceuticals that have been described in the literature and proposed for use in humans were included if there is evidence that they have been in, or are coming into, common use, provided that acceptable and sufficient whole body biokinetic data for making absorbed dose calculations are available.

(33) The list of radiopharmaceuticals covers thus not only those used in the practice of nuclear medicine, but also some of those used in clinical research. Data relating to the substances included were obtained from an extensive search of the literature.

(34) It is important to note that the inclusion of a radiopharmaceutical in this report does not imply any recommendation regarding its use. For this reason, the amount of administered activity required for a particular investigation is not given here.

(35) Recommended values of the administered activity for specific substances can be found in guidelines published by national and international scientific societies. An indication of typical activities administered at regional or national level can be given by the diagnostic reference levels (DRLs) for medical investigations (*Publication 135*, (ICRP, 2017a)). In nuclear medicine, they are expressed in terms of activity (MBq) or activity per unit of body weight (MBq kg^{-1}). It must be emphasized that DRLs are tools for the optimization of medical exposures which are regularly updated. They are values that, if 'consistently exceeded' at a given facility, will trigger an investigation to determine possible reasons and implement corrective actions, whenever necessary. Therefore they do not necessarily represent recommended activities to be administered

3. METHODS FOR CALCULATING DOSE COEFFICIENTS

3.1. Absorbed doses

(36) The dose received after administration of radioactive substances cannot be directly measured and needs to be calculated. The calculation of the absorbed doses to organ and tissues is done in two steps.

(37) First, the distribution and retention of the radioactive substance within the body is estimated by biokinetic models, which describe where in the body it is transferred and for how long it is retained there. In this way, activity as a function of time $A(r_S, t)$ is calculated for each region where the substance has accumulated (source region, r_S).

(38) In its decay, the radioactive substance emits a number N of radiations of different type and energy. Each of these emissions i (i=1, N) may deposit its energy in the source region itself and in the other organs and tissues of the body (target regions, r_T).

(39) The dose rate to the target r_T resulting from emissions in the source region r_S is given by:

$$\dot{D}(r_T \leftarrow r_S, t) = A(r_S, t)\, S(r_T \leftarrow r_S, t) \tag{3.1}$$

where $S(r_T \leftarrow r_S, t)$ is the radionuclide-specific S-value.

(40) The S-values are based on the Specific Absorbed Fractions (SAF), defined as the fraction of energy $E_{R,i}$ of radiation type R emitted within the source region r_S that is absorbed per mass in the target region r_T (kg^{-1}). For this work, the SAFs were taken from ICRP *Publication 133* (ICRP, 2016a) for adults and *Publication 155* for paediatric patients. These SAFs were calculated for sex- and age-dependent reference individuals defined largely by information provided in *Publication 89* (ICRP, 2002). Radiation transport simulations were performed in a variety of computational models of anatomical geometry, most notably the ICRP reference voxel phantoms (ICRP, 2009; 2020b). Among the improvements in the values in *Publications 133* and *155* are the inclusion of energy dependent SAF values for internally emitted electrons.

(41) The value of $S(r_T \leftarrow r_S, t)$ depends on the radiation type, the energy emitted per nuclear transformation, the mass of the target organ, and the fraction of energy emitted from a source region which is absorbed in a target tissue. These in turn depend on the size and relative position of the source and target regions. It can be assumed that these factors do not to vary over the generally short physical half-lives of the radiopharmaceuticals, so that the S-value $S(r_T \leftarrow r_S, t)$ can be considered time-independent.

(42) Integrating (3.1) over a defined dose-integration period T_D one obtains the corresponding absorbed dose to the target. Since $S(r_T \leftarrow r_S, t)$ is considered to be time-independent, the integration is performed only on $A(r_S, t)$. The absorbed dose in r_T from a radionuclide in a source r_S is thus calculated as:

$$D(r_T \leftarrow r_S) = \int_0^{T_D} \dot{D}(r_T \leftarrow r_S, t)\, dt = \int_0^{T_D} A(r_S, t)\, S(r_T \leftarrow r_S) \mathrm{d}t =$$

$$S(r_T \leftarrow r_S) \int_0^{T_D} A(r_S, t) \mathrm{d}t = \tilde{A}(r_S, T_D) S(r_T \leftarrow r_S) \tag{3.2}$$

$\tilde{A}(r_S, T_D)$ is the integral of the activity function over the integration period T_D. For computation T_D is set to infinity in this report. Due to the short physical half-lives of the radionuclides used in diagnostic nuclear medicine, the dose is in fact delivered in the very first hours or few days after administration.

(43) $\tilde{A}(r_S, T_D)$ is also referred to as time-integrated activity. The time-integrated activity per unit administered activity (MBq) is also referred to as time-integrated activity coefficient, abbreviated as TIAC.

(44) Summing the contributions $D(r_T \leftarrow r_S)$ from all source regions r_S gives the total dose $D(r_T)$ to the target region r_T:

$$D(r_T) = \sum_S D(r_T \leftarrow r_S) \tag{3.3}$$

(45) By employing sex-specific computational phantoms, and, where appropriate, sex-specific biokinetic parameters, separate organ absorbed doses for the female and the male are calculated, indicated by $D^F(r_T)$ and $D^M(r_T)$, respectively.

(46) For a large number of source-target geometries, the reference voxel phantoms provided in *Publications 110* (ICRP, 2009) and *143* (ICRP, 2020b) were used to compute the SAFs in *Publications 133* (ICRP, 2016a) and *155* (ICRP, 2023). But there are many smaller regions where a finer, detailed geometrical model of anatomy is required. Absorbed fraction values for electron and alpha particles were taken from *Publication 66* (ICRP, 1994) for respiratory tract geometries and modified to be consistent with age and sex dependent tissue masses in *Publication 155*. Moreover, new SAF values for electron and alpha particles are provided for alimentary tract geometries that supersede those given in *Publication 100* (ICRP, 2006). For the skeleton, image-based models of the skeletal microstructure were used to simulate charged particle transport (ICRP, 2016a, 2023). For photons traversing the skeleton, dose response functions were used to assign dose to the red marrow and bone surface target regions (ICRP, 2010, 2016a).

(47) The biokinetic models employed to calculate the activity as a function of time in each source region $A(r_S, t)$ are described in more detail in Section 4. The dosimetric models and the reference computational phantoms of the human body used to calculate the energy deposition for each pair of source/target regions based on Monte Carlo methods are described in Section 5.

3.2. Effective dose

(48) Effective dose was developed primarily for radiation protection of occupationally exposed persons (ICRP, 1977, 1991) and may be considered an approximate indicator of possible risk (ICRP, 2021). It takes into account the different relative biological effectiveness of the different radiation types, and the different radiation sensitivities of the target organs and tissues.

(49) To consider the dependence on the radiation type, the quantity equivalent dose H_T to a target organ or tissue T is defined, based on the absorbed dose:

$$H_{\mathrm{T}}^{\mathrm{F}} = \sum_{R} w_{\mathrm{R}} D_{\mathrm{R}}^{\mathrm{F}}(r_{\mathrm{T}}) \quad \text{(female)}$$

$$H_{\mathrm{T}}^{\mathrm{M}} = \sum_{R} w_{\mathrm{R}} D_{\mathrm{R}}^{\mathrm{M}}(r_{\mathrm{T}}) \quad \text{(male)} \tag{3.4}$$

where $D_{\mathrm{R}}^{\mathrm{F}}(r_{\mathrm{T}})$ ($D_{\mathrm{R}}^{\mathrm{M}}(r_{\mathrm{T}})$) is the mean absorbed dose from radiation type R (photons, electrons, alpha particles, etc.) in tissue or organ r_{T} of the female (male) reference person, and w_{R} is the corresponding radiation weighting factor. The special name for the SI unit for equivalent dose is the sievert (Sv). For all types of radiation used in diagnostic nuclear medicine, w_{R} equals 1 (even if this value may not be appropriate for Auger emitters incorporated into DNA), so the numerical value of the equivalent dose coincides with that of the absorbed dose.

(50) To reflect the combined detriment from stochastic effects in all the organs and tissues of the body, the sex-average of the equivalent doses $H_{\mathrm{T}}^{\mathrm{M}}$ and $H_{\mathrm{T}}^{\mathrm{F}}$ is multiplied by the corresponding tissue weighting factor w_{T} (Table 1.3), and the results are summed over all the target organs and tissues to give the effective dose E:

$$E = \sum_{T} w_{\mathrm{T}} \left[\frac{H_{\mathrm{T}}^{\mathrm{F}} + H_{\mathrm{T}}^{\mathrm{M}}}{2} \right] \tag{3.5}$$

The special name for the SI unit for effective dose is the sievert (Sv).

3.2.1. Use of effective dose in nuclear medicine

(51) *Publication 103* (ICRP, 2007) clearly states that effective dose is intended for use as a protection quantity on the basis of reference values and relates to reference persons and not to specific individuals. The main uses of effective dose are in prospective dose assessment for planning and optimisation in radiological protection, and retrospective demonstration of compliance for regulatory purposes.

(52) *Publication 147* (ICRP, 2021) addressed the use of effective dose in medical applications. When using effective dose for comparing medical administrations it '…is used to provide a generic indicator for classifying different types of medical procedure into broad risk categories for the purpose of communicating risks to clinicians and patients.'[4] Use of effective dose provides an approximate measure of possible detriment and therefore can be used prospectively to assist in justification decisions and when planning medical research studies.

(53) It can also be of practical value for comparing doses related to stochastic effects from: different diagnostic examinations and interventional procedures; the use of similar technologies, substances and procedures in different hospitals and countries; and the use of different alternative methodologies for the same medical examination, provided that the representative patients or patient populations for which the effective doses are derived are similar with regard to age and sex. However, comparisons of effective doses may be inappropriate when there are significant dissimilarities between the age and sex distributions of the representative patients or patient populations being compared (e.g. children, all patients of one specific sex, elderly populations) and the Commission's reference sex and age distribution.

[4] item (f) in the executive summary.

(54) There are situations where the reference persons for which the effective dose is calculated are not representative for the specific patient collective which undergoes a given nuclear medicine diagnostic procedure. Some examinations, like for instance, examination to prostate cancer patients after administration of ^{18}F- or ^{68}Ga-labelled-PSMA, are performed only for patients of one specific sex. In these cases, effective dose as per *Publication 103* (ICRP, 2007) and equation (3.5), cannot be evaluated. Instead, a value of the coefficient for either $\sum_T w_T \; H_T^F$ or $\sum_T w_T \; H_T^M$, is provided, depending on whether the examination is performed on female or male patients, respectively. In the case where anatomical or physiological properties differ from those of the reference individual (e.g. abnormal liver masses in case of diffuse parenchymal liver disease, or ablated thyroid in thyroid cancer patients), the dose calculations are performed considering also these diverging characteristics. For these cases, equation (3.5) is adjusted accordingly, i.e. the missing tissue is not included or the abnormal mass is considered instead of the reference mass, and appropriately marked as $\sum_T w_T \left[\frac{H_T^F + H_T^M}{2}\right]^{\#}$ to indicate that it does not correspond to the formal definition of effective dose. These values are given in the individual radiopharmaceutical sections, in addition to the standard values.

4. BIOKINETIC MODELS

(55) For absorbed dose calculations, knowledge of the activity as a function of time in different regions of the body after administration of a radiopharmaceutical is needed.

(56) Radiopharmaceuticals are radionuclides bound or incorporated into molecules which the human body will preferentially transport to specific organs, tissues or cells. Thus, while the dose delivery depends on the physical properties of the radionuclide, the biodistribution of the substance depends on the properties of the compound to which it is bound. In a few selected cases (e.g. ^{99m}Tc-labelled pertechnetate, radioiodine) the biodistribution of the radiopharmaceutical is determined by the chemical properties of the radionuclide itself.

4.1. Biokinetic data

(57) The best way to get biokinetic information is by measurements of organ uptake at various time points combined with pharmacokinetic analysis, which includes knowledge about mechanisms affecting radionuclide localisation and physiological assumptions regarding its behaviour in body tissues. Based on this knowledge, a biokinetic model is defined, delineating the detailed distribution and flow, or transfer, of the radionuclide or radiopharmaceutical amongst various tissue compartments.

(58) Published quantitative data on reliable biokinetic information from measurements on humans are scarce. Clinicians are often primarily interested in the initial distribution and metabolism of the administered substance and in its diagnostic performance. For dose calculations, however, more detailed information on the fractional long-term retention of the radionuclides and the labelled compounds, the turnover of the radiopharmaceutical and its metabolites, the fractional absorption from the alimentary tract, the distribution of radionuclides within different organs, and their excretion pathways are of prime importance.

(59) The Task Group wishes to repeat the requests most recently made in *Publication 106* (ICRP, 2008b) and *Publication 128* (ICRP, 2015b) for securing the maximum information possible from any investigation involving radiopharmaceuticals. Collection of relevant data should be encouraged by professional and scientific societies and by regulatory authorities, and data should be made available by publication and storage in accessible databases. The editors and referees of scientific journals are encouraged to request such information from authors of papers on new, as well as commonly administered, radiopharmaceuticals.

4.2. Biokinetic models

(60) Biokinetic models can be mathematically expressed as a system of differential equations describing the temporal variation of the amounts of radionuclide in different parts of the body. Knowledge of the values for the model characteristic parameters allows numerical solution of the system of differential equations, giving activity–time relationships for all parts of the system which are then integrated to obtain the cumulated activities needed for calculations of absorbed dose.

(61) For each radiopharmaceutical, the Task Group has agreed upon a biokinetic model giving quantitative estimates for the distribution and metabolism of the radiopharmaceutical in the body. In this publication biokinetic models are expressed as compartmental structures, following a physiologically descriptive modelling scheme, similarly to what is done in the ICRP Publications on intake of radionuclides by workers or members of the public (ICRP, 2015a, 2016b, 2017b, 2019a, 2022, 2024, 202x). This is a shift from the previous publications

on radiopharmaceuticals, where mostly simple descriptive models (defined by the fraction f_S distributed to a source region r_S and the corresponding uptake and elimination biological half-times T) were used.

(62) In general, model frameworks used in internal dosimetry are a compromise between biological realism and practical considerations regarding the amount and quality of information that is available to determine parameter values for specific compounds. For simplicity, first-order kinetics is generally assumed in the compartmental structures used, i.e. the amount flowing from one compartment to the next is proportional to the amount present in the compartment of origin. The compartmental structures used in this report allows for flows of material in both directions (recycling models).

(63) Due to the scarcity of available information, some biokinetic models have been developed not for specific radiopharmaceuticals but for application to a class of them (e.g. monoclonal antibodies and brain receptor substances).

(64) The method outlined above could, in principle, be applied to derive absorbed doses in those disease states leading to quantitative changes in normal physiological processes. However, this is not generally possible because, with some exceptions, there is insufficient information to define a complete model including all pools or compartments, as well as flow rates in or out of the system and between the parts of the system for abnormal physiological cases.

(65) Variations of absorbed dose in disease states can generally be calculated using the same model as for the healthy state, but with appropriate data for organ or tissue mass, uptake, and retention. Separate absorbed dose estimates are presented in cases where sufficient information is available and such variations lead to significant changes in these absorbed doses.

(66) Due to a lack of reliable quantitative biokinetic information, the biokinetic models presented here are assumed to be independent of age, sex and health status except where otherwise specified.

(67) For some radiopharmaceuticals administered to breast-feeding patients, activity may be excreted in the breast milk and thus ingested by the breast-fed child. This exposure pathway is covered in Section 9 of this report. Excretion in breast milk in connection with occupational exposure is covered in *Publication 95* (ICRP, 2004).

4.3. Model for very short-lived radionuclides

(68) For radionuclides with a half-life less than three minutes, the early uptake from blood, mainly during the first circulation, is the relevant process defining the distribution in the body. Therefore, it is assumed that radiopharmaceutical labelled with such short-lived radionuclides are taken up in organs and tissues in accordance with the fraction of cardiac output after intravenous administration. These substances may often be given via a continuous intravenous infusion during the imaging and is therefore the assumed administration in this publication for such very short-lived radionuclides.

(69) Table 4.1 presents the fractional cardiac output to different organs and tissues (in percent). These data are taken from *Publication 89* (ICRP, 2002). The fractional cardiac output data have been applied as a model for the activity distribution of the positron emitters ^{15}O (T½ 2.04 minutes) water and gas and ^{82}Rb (T½ 1.27 min) ion.

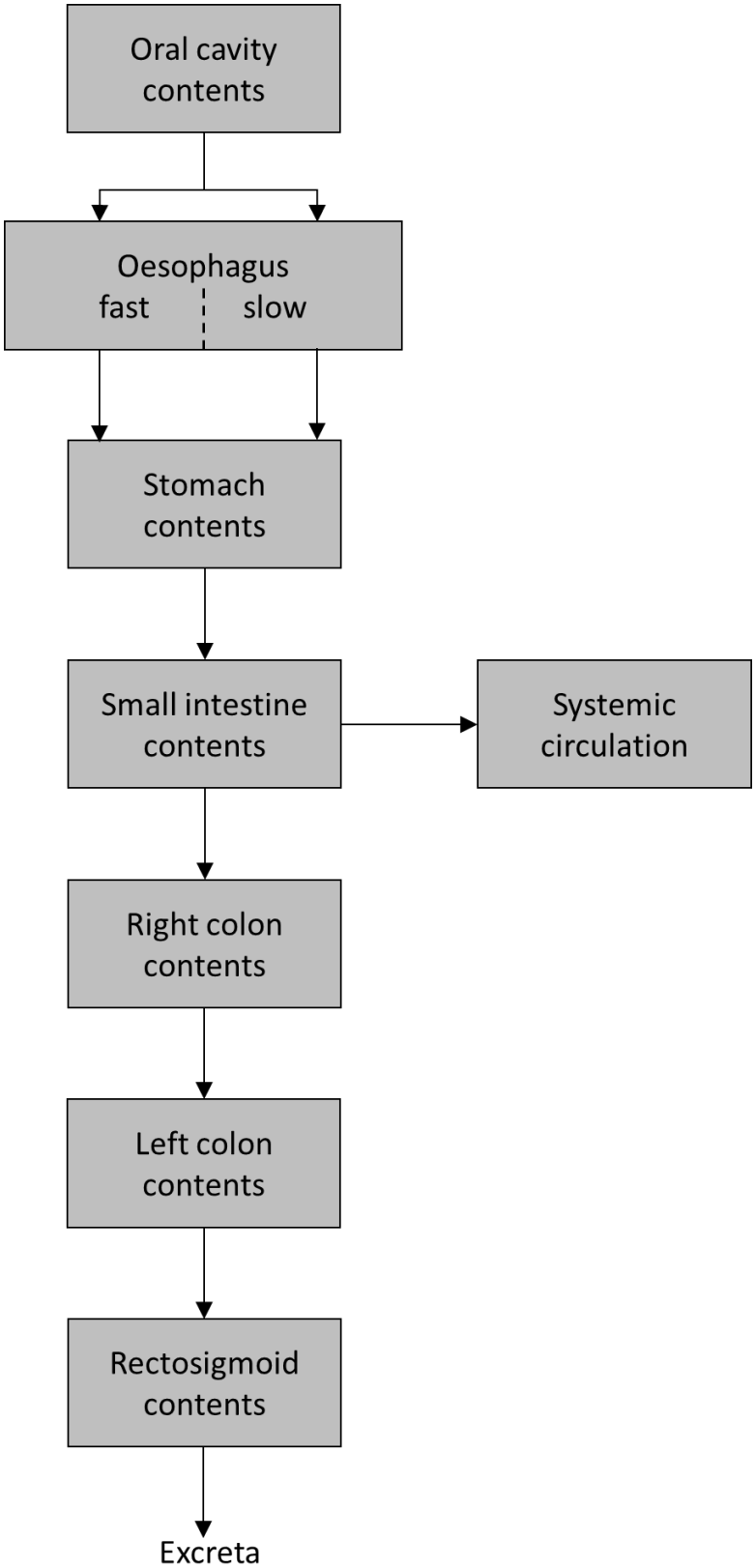
588 Table 4.1 Reference values for regional blood flow rates in different organs (adapted from
589 *Publication 89* (ICRP, 2002)).

	Blood flow rate (% cardiac output)	
Organ	Male	Female
Adrenals	0.3	0.3
Brain	12	12
Stomach and oesophagus wall	1.0	1.0
Small intestine wall	10	11
Colon wall	4.0	5.0
Fat	5.0	8.5
Heart wall	4.0	5.0
Kidneys	19	17
Liver	25.5	27.0
Lungs	2.5	2.5
Lymph nodes	1.7	1.7
Ovaries	-	0.02
Pancreas	1.0	1.0
Red marrow	3.0	3.0
Cortical bone	0.6	0.6
Trabecular bone	0.9	0.9
Other skeleton	0.5	0.5
Skeletal muscle	17	12
Skin	5.0	5.0
Spleen	3.0	3.0
Testes	0.05	-
Thyroid	1.5	1.5
Urinary bladder	0.06	0.06
All other tissues	1.39	1.92

590 ## 4.4. Models for radiopharmaceuticals administered orally or by inhalation.

591 (70) For radiopharmaceuticals administered orally, the model presented in *Publication 100*
592 (ICRP, 2006) for the human alimentary tract (HAT-model) has been used. This model is quite
593 comprehensive, and therefore a simplified reduced version is applied in most cases. The
594 activity is assumed to enter the oesophagus through the oral cavity and then proceed to stomach
595 (ST), small intestine (SI), right colon (RC) left colon (LC) and rectosigmoid (RS). In this
596 simplified model it is assumed, unless otherwise stated, that the uptake from the gut takes place
597 from the small intestine only, and that, during this process, there is no retention in the walls of
598 the tract. This simplified model is shown in Fig. 4.1.
599 (71) Radiopharmaceuticals administered orally are generally given in liquid form, or as a
600 capsule swallowed with water. In both cases the transfer coefficients for non-caloric liquids are
601 used (see Table 4.2).
602 (72) In gastric emptying studies the patient is orally given a meal with ^{99m}Tc-labelled
603 sulphur colloid or MAA mixed with scramble eggs, toast and water (indicated as non-
604 absorbable markers). In this case the transfer coefficients for solid meal are used (see the
605 specific section in the Annex).
606 (73) For substances for which the dose is calculated for infants, further details about data
607 for the transit time through the intestine are given in the biokinetic model, where applicable.

608



609

610 Fig. 4.1. A reduced and simplified model used to describe the kinetics of radionuclides in the
611 alimentary tract.

612

Table 4.2. Transfer coefficients (per day) for non-caloric liquids (from *Publication 100* (ICRP, 2006)) used for the simplified alimentary tract biokinetic model.

Section of gastrointestinal tract		Adult female	Adult male	Age 5-15 years	Age 1 year	Age 3 months
Oral cavity to Oesophagus		43,200	43,200	43,200	43,200	43,200
Oesophagus to stomach						
	fast	17,280	17,280	17,280	17,280	21,600
	slow	2,880	2,880	2,880	2,880	2,880
Stomach to small intestine		48	48	48	48	144
Small intestine to right colon		6	6	6	6	6
Right colon to left colon		1.5	2	2.182	2.4	3
Left colon to rectosigmoid		1.5	2	2.182	2.4	3
Rectosigmoid to excretion		1.5	2	2	2	2

(74) In the case of radiopharmaceuticals administered by inhalation, it is assumed that they are immediately homogeneously distributed in the lung tissues and from there rapidly absorbed into the systemic circulation, unless otherwise stated in the specific section for that substance. The absorption kinetics are substance-dependent.

4.5. The dynamic bladder model

(75) Most radiopharmaceuticals are primarily eliminated via urinary excretion. As short-lived radionuclides are generally used in nuclear medicine, the urinary bladder wall is a critical organ for what concerns the dose. Therefore, the assumptions on filling and voiding intervals and volume of urine in the bladder are crucial for dosimetry.

(76) Patients are generally advised to frequently empty their urinary bladder to reduce the residence time of activity in the bladder. Additionally, the clinical protocol may require emptying of the bladder before scanning so that the activity in the bladder does not interfere with the imaging process.

(77) In the calculations for occupational and public exposures, the geometry of the bladder is considered constant, independently on how full it is. However, a proper calculation of the dose to the bladder wall should consider the volume of the liquid contained in it, and how this volume changes the bladder shape.

(78) Dynamic urinary models were developed by Snyder and Ford (1976) to investigate the effects of the above physiological variables on absorbed dose to the bladder wall, and were extended by Smith et al. (1982) to examine these effects for any radiopharmaceutical. The MIRD Committee has published a dynamic bladder model (Thomas et al., 1999) incorporating more physiologically realistic features providing for a varying bladder volume, varying initial content and voiding interval, and including a night gap in the voiding pattern.

(79) In this publication the calculations for the urinary bladder have been further developed and coupling the dynamic excretion kinetics directly to the systemic biokinetic models and including dynamic S-values (Andersson et al., 2014). Age specific urine production rates and mass of the bladder wall are taken from *Publication 89* (ICRP, 2002) and presented in Table 4.3.

(80) For the calculations with the dynamic urinary bladder model, the activity is assumed to be uniformly distributed within the bladder. It is assumed that an initial urine content is present in the bladder, corresponding to a fraction of 0.5 the total voiding volume, and that a residual volume, corresponding to a fraction of 0.05 of the total voiding volume, remains in the bladder after voiding.

650 Table 4.3. Parameters used for the dynamic urinary bladder.

	Mass of the bladder wall (g)	Urinary production rate (ml/day)	Voiding volume (ml)
Adult male	50	1600	250
Adult female and 15 years male	40	1200	200
15 years female	35	1200	175
10 years old	25	700	125
5 years old	16	500	100
1 year old	9	400	75
Newborn	4	300	50

651

652 (81) The use of a dynamic model with realistic voiding times, varying bladder volume and
653 geometry depending on the degree of bladder filling and consequently time-dependent SAF
654 values has been investigated (Andersson et al., 2014; Andersson and Mattsson, 2016;
655 Andersson, 2017). For instance, increasing voiding time from 1 to 4 hours leads to an increase
656 of factor up to 3 for the absorbed dose to the urinary bladder wall. The use of dynamic SAF-
657 values results in a slight increase of the bladder dose for adult patients (ca. 10% for both 2-
658 [^{18}F]FDG and ^{99m}Tc-labelled pertechnetate) but a substantial reduction for pediatric patients (-
659 40% for 2-[^{18}F]FDG, -25% for ^{99m}Tc-labelled pertechnetate at the age of 5 years).

660 ## 4.6. Other specific models

661 (82) Specific biokinetic models are used for some substances, e.g. for liver and biliary
662 excretion, and for cerebrospinal fluid space. These models are described in the individual
663 sections of the radiopharmaceutical for which they are employed.
664

665 Table 4.4. Summary of assumptions used in the calculations of the dose coefficients presented
666 in this report.

Process	Default assumption	Comments
Default administration route	Bolus i.v. administration	
For inhaled radionuclides	Activity homogeneously distributed in the lung tissues and rapidly absorbed into blood	For ^{99m}Tc-labelled Technegas see specific details in individual section.
For oral administration	Parameters for non-caloric liquids used No uptake in the gut walls Absorption to blood from small intestine only	Specific model assumptions for ^{14}C-labelled urea and ^{99m}Tc-labelled non-absorbable markers
Uptake to bone	Radionuclides are distributed on the bone surface	
Urinary bladder emptying	According to the dynamic model No emptying overnight (from 0 to 8 am, assuming administration at 10 am)	

667
668

5. DOSIMETRIC MODELS

(83) As indicated in Equation (3.1), the absorbed dose rate in a target tissue r_T due to the activity in the source region r_S is given by the product of the activity in r_S and of a S-value.

(84) The time-dependent S-value (Sv (Bq-s)$^{-1}$) for a radionuclide is calculated as:

$$S(r_T \leftarrow r_S, t) = \sum_R \sum_i E_{R,i}\ Y_{R,i}\ \Phi\left(r_T \leftarrow r_S,\ E_{R,i}, t\right) \tag{5.1}$$

where:

- $E_{R,i}$ is the energy of the i^{th} radiation of type R emitted in nuclear transformations of the radionuclide;
- $Y_{R,i}$ is the yield of the i^{th} radiation of type R per nuclear transformation;
- $\Phi\left(r_T \leftarrow r_S,\ E_{R,i}, t\right)$ is the specific absorbed fraction, defined as the fraction of energy $E_{R,i}$ of radiation type R emitted within the source tissue r_S that is absorbed per mass in the target tissue r_T at time t after intake.

(85) The energies and yields of the emitted radiations, $E_{R,i}$ and $Y_{R,i}$, are taken from *Publication 107* (ICRP, 2008a). For beta emissions, the S-values are assessed considering the spectral distribution of energies rather than mean values.

(86) For both sexes and all age-groups, the values of the specific absorbed fractions $\Phi\left(r_T \leftarrow r_S,\ E_{R,i}, t\right)$ for photons, electrons, and alpha particles have been tabulated over a grid of discrete energies and provided in *Publications 133* (ICRP, 2016a) and *155* (ICRP, 2023). Specific absorbed fractions at the radionuclide-specific energies are then obtained using piecewise cubic Hermite spline (PCHIP) interpolation (Fritsch and Carlson, 1980).

(87) *Publication 89* (ICRP, 2002) describes the complexities associated with growth rates in different tissues in the first year of life. Accordingly, during the first year of life a weighted linear interpolation is used and described fully in *Publication 155* (ICRP, 2023). As described earlier, for nuclear medicine applications the short half-lives of the radionuclides allow the S-value to be treated as invariant with time. But since radiopharmaceutical administrations to an infant are modelled at age 3-months (100-days) and reference S-values are defined in a newborn (0-day) and at age 1 year, Eq. (5.2) is used to find the S-value at age 3-months given the S-values at 1y and 0y. Eq. (5.2) is the t = 100 day solution to the equations provided in *Publication 155*.

$$S(t) = 0.653[S(1\text{y}) - \text{S}(0\text{y})] + \text{S}(0\text{y}) \tag{5.2}$$

(88) As described in *Publications 133* and *155*, the specific absorbed fractions for photons, electrons and neutrons for many source and target geometries are based on Monte Carlo radiation transport calculations (Zankl et al., 2012; Schwarz et al., 2021) performed using the reference phantoms for the ICRP reference adult male and female described in *Publication 110* (ICRP, 2009) and the paediatric reference phantoms described in *Publication 143* (ICRP, 2020b). These phantoms are constructed from tomographic images of real individuals.

(89) The absorbed fraction data for electrons in the alimentary tract of *Publication 100* (ICRP, 2006) have been updated with supplementary calculations included in *Publication 133* (ICRP, 2016a) and *Publication 155* (ICRP, 2023). The same reports give the absorbed fractions for electrons in the respiratory tract.

(90) *Publication 155* contains a detailed review of past and present skeletal dosimetry approaches including past ICRP publications on radiopharmaceutical dosimetry. *Publication 106* (ICRP, 2008b) represented the first departure from the electron absorbed fraction values of *Publication 30*. *Publication 106* used values for the adult from Stabin and Siegel (2003)

which were based on work by Eckerman and Stabin (2000) and Bouchet et al. (2000) and was described in Stabin et al. (2002).

(91) The skeletal target regions are the 50-µm endosteal region (referred to as bone surface); and the active (red) marrow. The endosteal region is thought to be the region where osteoprogenitor cells sensitive to radiogenic bone cancer reside. This target tissue is independent of the marrow cellularity (the fraction of bone marrow volume that is haematopoietically active). The change in the definition of the bone surface is a significant dosimetric change represented in this work for the first time in ICRP radiopharmaceutical dosimetry. Prior publications on radiopharmaceutical dosimetry modelled this target as a 10-µm thick region.

(92) The microstructure of the skeleton is not modelled in the reference voxel phantoms due to the size of the voxels in these phantoms. Instead, separate, image-based voxel models of the human skeletal microstructure were used to compute specific absorbed fractions for intraskeletal electrons in the adult (Hough et al., 2011; O'Reilly et al., 2016) and paediatric individuals (Pafundi et al., 2009, 2010). In addition to their application to beta-emitters in the skeleton, these values inform photon fluence-to-dose response functions described below.

(93) Specific absorbed fractions to the skeletal targets for both intra-skeletal and extra-skeletal photon sources were computed by coupling Monte Carlo-derived, energy- and site-dependent photon fluences with fluence-to-dose response functions (ICRP, 2010, 2016a, 2023).

(94) The S-values for the dynamic bladder model were Monte Carlo simulated for 27 mono-energetic energies between 0.001 MeV and 10 MeV for photons, electrons and alphas particles for 26 different spherical urinary bladder volumes between 10 mL up to 500 mL. For each simulation the mass of the bladder wall was kept constant (Andersson et al., 2014).

6. DATA PROVIDED IN THIS REPORT

(95) The annex to this document contains individual sections with data on each radiopharmaceutical considered.

(96) In the first subsection, the available biokinetic information used for the definition of the model is described. If calculations have been performed under specific assumptions which deviate from the standard ones used in this document, these are given in subsequent subsections. Deviations from the standard assumptions can be justified in presence of a specific patient collective (e.g. the radiopharmaceutical is used only for patients of one sex), or modified morphology (e.g. enlarged organs) or physiology (e.g. abnormal organ functions).

(97) In the next subsection, the structure of the systemic model is graphically presented, and its characteristic transfer coefficients are listed in a table. The transfer coefficients are expressed in the unit (h^{-1}), and are generally considered to be age- or sex-dependent, unless there is enough information available to differentiate. If this is the case, the table contains as many columns as required.

(98) The next table contains the time-integrated activity coefficients (TIACs), e.g. the number of decays occurring in each source region per intake of activity. They are expressed in the unit (h).

(99) For the sake of practicability, the organ dose coefficients (mGy MBq^{-1}) (calculated for both sexes and for all ages, if the radiopharmaceutical is also administered to paediatric patients) are given in the printed version of the report for a few selected substances only. For all other substances, the printed report simply gives the effective dose coefficients (mSv MBq^{-1}) and, where appropriate, the coefficient(s) $\sum_T w_T H_T^F$, $\sum_T w_T H_T^M$ and/or $\sum_T w_T \left[\frac{H_T^F + H_T^M}{2}\right]^*$ calculated for specific patient groups or for specific pathologies.

(100) The transfer coefficients of the biokinetic models, the time-integrated activity coefficients, the organ dose coefficients and the effective dose coefficients are given separately for all substances as an electronic annex (plain text file). From this annex the data can be easily copied and extracted in digital form for further use. Details on the data structure and their use are given in the accompanying *readme.txt* file.

(101) Dose coefficients are also available electronically through the ICRP Dose Viewer, an app which can be downloaded from GooglePlay (https://play.google.com/store/) or AppStore (https://www.apple.com/app-store/).

(102) As described in the previous sections, the dose coefficients have been calculated using the IDAC-Dose Software (version 2.2) (Andersson et al., 202X). It was developed specifically for this publication and was used as the reference code for calculating the values published here.

(103) The IDAC-Dose software is written in MATLAB (MathWorks, Natick, MA, USA) and compiled as a standalone program, including a graphical user interface. IDAC-Dose software 2.2 is a free software for research and available at http://www.idac-dose.org. The online version can be operated directly through a web browser and the standalone version is an executable file, which is downloaded and installed directly on the local computer.

(104) IDAC-Dose numerically solves the biokinetic model, the dynamic emptying of the urinary bladder and the liver and biliary excretion model. The SAF values are generated for each radiopharmaceutical, separately. For 1-yr to adult the SAF values are generated using a monotone interpolation using a piecewise cubic Hermite spline, while for the infant a weighted linear interpolation is used. The absorbed dose and effective dose are calculated assuming fixed age and sex transfer rates and SAF values. Effective dose is calculated as defined in *Publication 103*.

(105) The code was benchmarked against the software 'DCAL ver.2022', an updated version of the DCAL software developed at Oak Ridge National Laboratories (Eckerman et al., 2006). Both DCAL ver. 2022 and IDAC-Dose2.2 are codes which use the radionuclide data of *Publication 107* (ICRP, 2008a) and the specific absorbed fraction data of *Publication 133* (ICRP, 2016a) and *155* (ICRP, 2023) and follow the ICRP computational framework for internal dose assessment of the reference person to estimate the effective dose (ICRP, 2007). Quality assurance of the calculations was conducted by different Task Group members using software codes developed independently at BfS (code *'Dosage'*), Helmholtz Munich (code *'Nuclear dosimetry tool'* (Ocampo Ramos, 2016; Petoussi-Henss et al., 2017)), ORNL (code *'QCAL',* (Martinez et al., 2020; DOE, 2022)) and in collaboration with the European Radiation Dosimetry group EURADOS (https://eurados.org).

(106) The dose coefficients have been quality assured by different Task Group members using software codes developed independently at BfS (code *'Dosage'*), Helmholtz Munich (code *'Nuclear dosimetry tool'*), ORNL (code *'QCALrogue'*) and in collaboration with EURADOS.

(107) Among the various other codes available to calculate organ absorbed doses and effective doses to patients in diagnostic nuclear medicine, the more recent one is the software MIRDcalc v1.1 (Kesner et al., 2023); (https://mirdsoft.org/mirdcalc) which enables biodistribution-to-dosimetry calculations using the MIRD schema and incorporates calculation-specific details for the 12 ICRP reference phantoms. MIRDCalc uses SAF values and decay data from ICRP, but is not following completely the ICRP computational framework, therefore MIRDcalc and IDAC-Dose2.2 may yield differences in dose coefficients for some substances (Carter et al., 2023).

(108) The Radiation Dose Assessment Resource (RADAR) has developed the software code called OLINDA/EXM version 2.0 (Stabin and Farmer, 2012; Stabin, 2023). This software calculates organ absorbed doses and effective dose using absorbed fractions estimated on the basis of voxel-based realistic human non-reference phantoms. The organ masses of the target regions in the RADAR phantoms deviate from the ICRP reference individuals, as they do not include the mass of blood in tissues as given in *Publication 89*. Another difference is the treatment of circulating blood. With the adoption of systemic compartment models, the ICRP framework has currently a separate source region called 'Blood' representing the circulating blood.

(109) The RADAR-method deviates in other respects from the ICRP framework. For instance, the ICRP framework uses an additive method (ICRP, 2015a) to calculate the same source region 'Other' while the RADAR-method uses a subtractive method (Roedler, 1984) for 'Other'. Due to differences in the basic data and methods of assessments, absorbed dose calculations with OLINDA/EXM and IDAC-Dose2.2 are likely to have significant differences for organs and tissues.

(110) A thorough comparison of the available calculation tools and the respective results is given in (Lee, 2024).

7. INFORMATION ON THE DEVELOPMENT OF MODELS FOR INTERNAL DOSE ASSESSMENT AND THEIR RELIABILITY

7.1. Introduction

(111) Effective dose calculated for protection purposes is determined from the equivalent doses to organs and tissues of the human body, which are in turn calculated from the mean absorbed doses to those organs and tissues (Section 4). Effective dose provides a value which takes account of the given exposure conditions, but not of the characteristics of a specific individual. In particular, the tissue weighting factors that are used to determine effective dose are selected, rounded values representing averages over many individuals of different ages and both sexes. The equivalent doses to each organ or tissue of the Reference Male and the Reference Female are averaged, and these averaged doses are each multiplied with the corresponding tissue weighting factor to determine the sex-averaged effective dose for the Reference Person (ICRP, 2007). It follows that effective dose does not provide an individual-specific dose, but rather that for a Reference Person under given exposure conditions (ICRP, 2007) .

(112) As mentioned in paragraph (59) there may be some circumstances in which parameter values may be changed from the reference values. It is therefore important to distinguish between those reference parameter values that might be changed in the calculation of effective dose under particular circumstances of exposure, and those values that cannot be changed under the definition of effective dose. As effective dose applies to a Reference Person, when individual-specific parameter values are changed the derived quantity is no longer effective dose as defined by ICRP.

7.2. Uncertainties in internal dose assessment

(113) *Publication 103* (ICRP, 2007) makes the following statement with respect to the assessment of uncertainties:

In order to assess radiation doses, models are necessary to simulate the geometry of the external exposure, the biokinetics of incorporated radionuclides, and the human body. The reference models and necessary reference parameter values are established and selected from a range of experimental investigations and human studies through judgements. For regulatory purposes, these models and parameter values are fixed by convention and are not subject to uncertainty.

(114) Although no uncertainty is assigned to ICRP reference values, the following paragraphs are here to describe on which datasets and approaches reference values are based. Corresponding sources of uncertainties are detailed and their impact on the models are discussed to provide some degree of reliability and limitations associated with model development for radiation protection purposes in internal dose assessment. Further considerations on uncertainties on organ and effective doses in nuclear medicine can be found in (Martin, 2011).

7.2.1. Uncertainties in biokinetic models

(115) Biokinetic models are used in radiation protection to predict the time-dependent distribution and retention of a radionuclide in the body and the rate of excretion of the radionuclide in urine and faeces. Investigations of the reliability of many of the biokinetic models that have been used in ICRP reports can be found in the following papers and reports

published by Apostoaei et al. (1998); Leggett et al. (1998; 2007; 2008); Bolch et al. (2001; 2003); Harrison et al. (2001; 2002); Leggett (2001); Skrable et al. (2002); Likhtarev et al. (2003); Apostoaei and Miller (2004); Pawel et al. (2007); Sanchez (2007); NCRP (2009); Li et al. (2015).

7.2.1.1. Uncertainties associated with the formulation of a biokinetic structure

(116) The confidence that can be placed in predictions of a biokinetic model for an element or compound depends not only on uncertainties associated with parameter values of the model but also on uncertainties associated with the model structure. Such uncertainties may arise because the structure provides an oversimplified representation of the known processes, because unknown processes have been omitted from the model, or because part, or all of the model formulation is based on mathematical convenience rather than consideration of processes. Some combination of these limitations in model structure is associated with virtually all biokinetic models for radionuclides. These limitations hamper the assignment of meaningful uncertainty statements to the parameter values of a model because they cast doubt on the interpretation of the parameter values.

7.2.1.2. Types of information used to construct biokinetic models for elements

(117) Regardless of the model formulation or modelling approach, a biokinetic model for an element or compound, particularly a systemic model, is usually based largely on some combination of the following sources of information (Leggett, 2001):

H1: direct information on humans, i.e. quantitative measurements of the element in human subjects;
H2: observations of the behaviour of chemically similar elements in human subjects;
A1: observations of the behaviour of the element in non-human species; and
A2: observations of the behaviour of one or more chemically similar elements in non-human species.

H2, A1 and A2 data serve as surrogates for H1, (direct information on humans) which is the preferred type of information on which to base a biokinetic model.

(118) H1, H2, A1 and A2 data are sometimes supplemented with various other types of information or constraints, such as quantitative physiological information (e.g. rates of bone restructuring); considerations of mass balance; predictions of theoretical models based on fundamental physical, chemical, and mathematical principles (e.g. a theoretical model of deposition of inhaled particles in the different segments of the lung); experimental data derived with anatomically realistic physical models (e.g. hollow casts of portions of the respiratory tract used to measure deposition of inhaled particles); and *in vitro* data (e.g. dissolution of compounds in simulated lung fluid). Among these supplemental sources of information, mass balance and quantitative physiological data (data type P) have particularly wide use.

7.2.1.3. Sources of uncertainty in applications of human data

(119) It is desirable to base a biokinetic model on observations of the time-dependent distribution and excretion in human subjects (H1 data). Some degree of this type of direct information is available for most radiopharmaceuticals. Depending on the degree of biological realism in the model formulation, it may be possible to use supplementary physiological information on generic processes in humans, for example regarding passage in the alimentary tract or excretion pathways.

(120) Although it is the preferred type of information for purposes of model construction, H1 data often have one or more of the following limitations: small study groups; short

observation periods (both aspects coupled with potentially large intra-subject variability); paucity of observations for women and children; inaccuracies in measurement techniques; uncertainty in the pattern or level of intake of the element.

(121) A confidence statement based on H1 data would reflect a variety of factors, such as the reliability of the measurement technique(s), the number and state of health of the subjects, representativeness of the subjects and biological samples, consistency in data from different studies, knowledge concerning the level and pattern of intake, and the relevance of the information to the situation being modelled.

7.2.1.4. Uncertainty in interspecies extrapolation of biokinetic data

(122) Interspecies extrapolation of biokinetic data is based on the concept of a general biological regularity across the different species with regard to cellular structure, organ structure, and biochemistry. Mammalian species, with cellular structure, organ structure, biochemistry, and body temperature regulation particularly close to those of humans are expected to provide better analogies to humans than do non-mammalian species with regard to biokinetics of contaminants.

(123) Despite the broad structural, functional, and biochemical similarities among mammalian species, interspecies extrapolation of biokinetic data has proven to be an uncertain process. Similarities across species are often more of a qualitative than quantitative nature, in that two species that handle an internally deposited radionuclide in the same qualitative manner may exhibit dissimilar kinetics with regard to that substance. Moreover, there are important structural, functional and biochemical differences among the mammalian species, including differences in specialised organs, hepatic bile formation and composition, level of biliary secretion, urine volume and acidity, the amount of fat in the body, the magnitude of absorption or secretion in various regions of the digestive tract, types of bacteria in the digestive tract, and microstructure and patterns of remodelling of bones.

(124) In general, the choice of an animal model will depend strongly on the processes and subsystems of the body thought to be most important in the biokinetics of the radionuclide in humans, because a given species may resemble humans with regard to certain processes and subsystems, but not others. For example, data on monkeys or baboons may be given relatively high weight for purposes of modelling the distribution of a radionuclide in the skeleton due to the close similarities in the skeletons of non-human primates and humans. Data on dogs may be given relatively high weight for purposes of modelling the rate of loss of a radionuclide from the liver due to broad quantitative similarities between dogs and humans with regard to hepatic handling of many radionuclides.

(125) In the case of radiopharmaceuticals used in diagnostic nuclear medicine, it is usually possible to rely on the availability of human data, although scarce, so that resorting to animal data is in general not necessary.

7.2.1.5. Uncertainty in inter-element extrapolation of biokinetic data

(126) Biokinetic models are often constructed partly or wholly from data for chemically similar substances, on the basis of empirical evidence that chemical analogues often exhibit close physiological similarities.

(127) The level of confidence that can be placed in a model value based on human data for a chemically similar substance depends on the quality and completeness of the data for the analogue, as well as the expected strength of the analogy for the given situation. Whatever the quality of the data for the chemical analogue, the confidence interval should reflect the fact that some confidence in the predictive strength of the data is lost when the data are extrapolated across elements.

7.2.1.6. Uncertainty in central estimates stemming from variability in the population

(128) 'Uncertainty' refers here to lack of knowledge of a central value for a population, and 'variability' refers to quantitative differences between different members of a population. Although uncertainty and variability are distinct concepts, the variability in biokinetic characteristics within a population is often an important factor contributing to the uncertainty in a central estimate of a biokinetic quantity. This is because such variability complicates the problem of identifying the central tendency of these characteristics in the population due to the small number of observations generally available and the fact that usually, subjects of biokinetic studies are not randomly selected.

(129) Variability in the biokinetics of radionuclides, pharmaceuticals, or chemicals in human populations appears to result from many different physiological factors or modulating host factors of an environmental nature, including age, sex, pregnancy, lactation, exercise, disease, stress, smoking and diet. Large inter-individual biokinetic variations sometimes persist in the absence of appreciable environmental differences and suggest that these variations may be genetically controlled. In real-world situations, genetic and environmental factors may interact dynamically, producing sizable variations in the behaviour of substances taken into the human body.

7.2.2. Uncertainties in dosimetric models

(130) Dosimetric models are used to estimate the mean absorbed dose resulting from radiations emitted by nuclear transformations of radionuclides present in the body. The absorbed dose is computed for target regions (organs, tissues, or regions of tissues) considered to be radiosensitive. Radiation weighting factors and tissue weighting factors are applied to the mean absorbed dose to determine the equivalent and effective dose. The weighting factors are assigned reference values, and as such, are not regarded as uncertain quantities. Thus, the uncertainties associated with an estimated equivalent dose to an organ, for example, are considered to be those associated with the underlying mean absorbed dose.

(131) The physical and anatomical parameters contributing to uncertainties in the mean absorbed dose for internal emitters are:

- Energy and intensity of the nuclear and atomic radiations emitted by the radionuclide and by any radioactive progeny;
- Interaction coefficients of the emitted radiations in tissues;
- Elemental composition of the tissues of the body;
- Volume, shape, and density of the organs of the body; and
- Parameters describing the spatial relationship of the source regions (regions containing the radionuclide) and the target regions (radiosensitive organs and tissues for which dose values are desired).

(132) Limitations are present in the computational model representing the anatomy and in the numerical procedures used to calculate the energy absorbed in the target regions. The magnitudes of these uncertainties vary with radiation type, the energy of the radiation, and the specific source-target pair. The adoption of computational phantoms based upon medical imaging data (often referred to as voxel phantoms) has reduced the uncertainties associated with cross-irradiation of tissues by photon and neutron radiations to some extent by providing more realistic spatial relationships of some source and target regions (ICRP, 2009, 2020b). However, the absorbed dose is frequently dominated by the contributions from non-penetrating radiations. For source and target regions that cannot be resolved in the medical image data, e.g. source and target regions in the respiratory and alimentary tracts and in the skeleton,

uncertainties are associated with the special computational models used to represent these regions.

(133) The anatomical models are static and thus do not address uncertainties in the spatial position of the organs due to breathing and posture other than reclining.

(134) The parameters of the dosimetric model contributing to uncertainties in the absorbed dose are those physical parameters associated with the nuclear transformation processes that determine the energy and intensity of the emitted radiation, and parameters which govern the transport radiations in the body. Attenuation and absorption coefficients for photons involve relatively small uncertainties, typically less than 10%, but somewhat higher uncertainties are ascribed to soft tissue stopping power values for alpha particles and electrons. Improvements in the basic nuclear data have reduced the uncertainties in the physical half-lives of radionuclides and the branching fractions of decay modes. The simplified procedures used in the dosimetric calculations to address the delayed beta and gamma radiations of spontaneous fission can contribute to substantial uncertainties in the mean absorbed dose in some tissues.

(135) The dosimetric calculations must associate an anatomical region (source region) with each biokinetic compartment. Many biokinetic models partition the systemic activity among a few identified organs/tissues and include a compartment referred to as ‘Other tissue’ which represents the residual activity. The dosimetric procedure distributes the activity in the ‘Other tissue’ compartment uniformly among all tissues not explicitly identified in the model. Substantial uncertainty may be associated with the mean absorbed dose for tissues that are members of ‘Other tissue’. ‘Other tissue’ frequently includes tissues assigned an explicit tissue weighting factor. For example, breast tissue is rarely explicitly identified as a source region in biokinetic models, and thus, its mean absorbed dose is often based on its inclusion in ‘Other tissue’.

(136) A number of numerical methods are capable of solving the set of potentially large numbers (hundreds) of coupled differential ‘stiff’ equations that describe the kinetics, although frequently the demands of numerical accuracy have to be balanced with computational time. Compartment-model issues contributing to uncertainties in the mean absorbed dose include the assumed biokinetics of members of a decay chain (independent or shared kinetics), and the representation of ‘Other’ tissues when their anatomical identity varies among the decay chain members (Annex C of *Publication 71* (ICRP, 1995)).

8. DOSE TO EMBRYO AND FETUS

(137) The absorbed dose coefficient for the uterus, which is included in the dose tabulations, may be used as a substitute for the dose coefficients for an embryo if the patient is in the first 1-2 months of pregnancy. For radioactive substances with placental transfer, the absorbed dose to organs and tissues of the pregnant patient may, as a first approximation, be taken as representative of the absorbed dose to the corresponding organs and tissues of the fetus.

(138) For substances in their ionic form, a comprehensive compilation of doses to the embryo and fetus is found in *Publication 88* (ICRP, 2001) and may also be used for the same substances in this report.

(139) Recently a compilation of doses to the embryo and fetus calculated for a large number of radioactive compounds using the most recent biokinetic models available and the formalism of *Publication 103* was published (Bundesanzeiger, in German)[5].

(140) More detailed radiation dose estimates for the fetus from administration of a number of radiopharmaceuticals to women at various stages of pregnancy are given by Russell et al. (1997) and Stabin (2017). Their data illustrate that the majority of procedures will probably involve fetal doses <10 mGy. Only procedures using ^{131}I-labelled iodide,^{111}In-labelled pentetreotide, and ^{67}Ga-labelled citrate appear to result in fetal doses >10 mGy.

(141) Other studies confirm that for planar imaging using ^{99m}Tc-labelled substances, doses are mostly low and well below 10 mGy. Somewhat higher fetal doses come from procedures that require higher amount of activity for acceptable image quality, often obtained using SPECT (e.g. myocardial stress/rest procedures) and some PET/CT examinations (e.g. tumour imaging with ^{18}F-labelled fluorodeoxyglucose 2-[^{18}F]FDG) (Mattsson et al., 2021).

(142) Nowadays a low dose CT is often performed with PET and increasingly with SPECT. The CT scans in SPECT/CT and PET/CT procedures on pregnant patients are most often performed with the purpose of attenuation correction and localisation (sometimes called low dose CT). Thus the CT dose component can be reduced with a factor of 2–4 (Mattsson et al., 2016; Bebbington et al., 2019) in comparison to a standard diagnostic CT investigation.

(143) Higher fetal doses may also be received from procedures using ^{111}In, such as ^{111}In-labelled pentetreotide (octreotide), due to relatively long physical half-life and the physical properties of the decay.

(144) For procedures using radioactive iodide, the situation is more problematic. Eight to 10 weeks after conception (10–12 weeks' gestational age), the fetal thyroid starts to accumulate iodide that has crossed the placenta barrier (ICRP, 2000; Leung, 2012). The fetal thyroid dose, 2.7–6.4 mGy MBq^{-1} for ^{123}I and 230–580 mGy MBq^{-1} for ^{131}I, will be much higher than the fetal whole-body dose. The consequences are that in spite of a low whole body fetal dose, the dose to the fetal thyroid is so high that the function of the thyroid gland may be affected. High fetal thyroid doses can result in hypothyroidism with consequences for the thyroid hormone production and the development of the fetus, and also an increased risk for thyroid cancer (Kurtoglu et al., 2012). If pregnancy is discovered within 12 h of radioiodide administration, rapid and repeated oral administration of stable potassium iodide to the pregnant patient (60–130 daily, up to 5 days after administration of ^{131}I, 3 days after administration of ^{124}I and just once for ^{123}I) reduces the fetal thyroid dose significantly (ICRP, 2000; ARSAC, 2025).

(145) Radiopharmaceuticals labelled with ^{123}I are frequently used in diagnostic nuclear medicine, e.g. ^{123}I-labelled mIBG and ^{123}I-labelled ioflupane. Iodine-123 is nowadays, typically produced through irradiation of highly enriched ^{124}Xe-gas which makes the ^{123}I end product ultra-pure (Ziessman et al., 2014). Nevertheless, there is a slight probability of

[5] https://www.bundesanzeiger.de/pub/publication/RlLUqHDc6h4bufgquFL/content/220611001661M001/BAnzAT04072022B1300.pdf

impurities, such as ^{124}I and ^{125}I, ~0.3% of the total activity (CIS Bio International, 2018). The radiochemical purity of ^{123}I-labelled mIBG and ^{123}I-labelled ioflupane preparations is high, although a fraction of free ^{123}I of ~2–3 and 6% for ^{123}I-labelled mIBG and ^{123}I-labelled ioflupane, respectively, can be expected according to the Summary of product characteristics for each product. Routinely, thyroid blocking treatment as described above is therefore carried out when performing these procedures, in order to minimize the uptake of free iodide in the thyroid.

(146) Most other diagnostic nuclear medicine procedures, except some SPECT and PET investigations, do not cause large fetal doses. For those giving higher doses, fetal doses can be reduced using less activity and longer measurement time. For radiopharmaceuticals that are excreted through the kidneys, which applies to the majority of radiopharmaceuticals, the fetal dose can be reduced by encouraging the pregnant patient to drink more than usual (1–2 L of extra fluid) so that she can empty the bladder frequently for 1–2 days after the administration of the radiopharmaceutical.

(147) Therapeutic administrations are contra-indicated in the case of pregnancy or breastfeeding as this may result in very high fetal doses and dose to the nursing infant (ICRP, 2019b). Fetal thyroid doses of several 100 Gy can be reached after radionuclide therapy with ^{131}I-labelled iodide (Berg et al., 1998; Berg et al., 2008), resulting in total elimination of thyroid function and thus increasing the risk for detrimental effects on the fetus.

9. RECOMMENDATIONS ON BREASTFEEDING INTERRUPTIONS

(148) As many radiopharmaceuticals are secreted in breast milk, it is safest to assume that, unless there are data to the contrary, some radioactive substances will be found in the breast milk when a radiopharmaceutical is administered to a lactating female. Therefore, patients should inform their healthcare provider of their breastfeeding status so that decisions can be made to optimise the procedure while minimising the radiation risk for patient and infant.

(149) Consideration should be given to postponing the procedure. If the procedure is performed, the child should not be breast fed until the radiopharmaceutical is no longer secreted in an amount estimated to give an effective dose greater than 1 mSv to the child. It is therefore recommended that the actions shown in Table 9.1 should be taken for various radiopharmaceuticals (Tobin and Schneider, 1976; Ahlgren et al., 1985; Mountford and Coakley, 1989; Rose et al., 1990; Evans et al., 1993; Rubow et al., 1994; Johnston et al., 1996; Castronovo et al., 2000; Stabin and Breitz, 2000; McCauley and Mackie, 2002; Leide-Svegborn et al., 2016; IAEA, 2018; Mattsson et al., 2021).

(150) Complete suspension of breastfeeding is needed after ^{131}I therapy and all other therapies with radiopharmaceuticals, since the dose to the child may be of a magnitude resulting in detrimental health effects.

(151) To keep the effective dose to the child from ingestion of the breast milk below 1 mSv, breastfeeding should be suspended as indicated in Table 9.1 which can be summarized as follows:

- 3 weeks after ^{131,125,123}I-labelled substances for diagnostic use (except hippurate), ^{75}Se-, ^{67}Ga- and ^{22}Na-labelled compounds
- 48 h after ^{111}In-labelled octreotide, ^{111}In-labelled leukocytes and ^{201}Tl-labelled tallium chloride.
- 12 h after ^{131,125,123}I-labelled hippurate and ^{99m}Tc-labelled pertechnetate, -macro-aggregated albumin (MAA), -microspheres, -red blood cells (RBC) (in vivo) and -leukocytes.
- 4 h after administration with ^{18}F-labelled fluorodeoxyglucose due to external irradiation, and other ^{99m}Tc-labelled compounds than above, due to the risk of free pertechnetate and due to external irradiation.
- Not necessary after administration of ^{11}C-, ^{13}N-, ^{15}O-labelled substances, ^{51}Cr-labelled EDTA, ^{81m}Kr-labelled krypton gas and ^{133}Xe-labelled xenon gas.

(152) The infant is also exposed to external irradiation due to the activity in the body of the breastfeeding patient. This is significant in the case of e.g. ^{18}F-FDG, where interruption in breastfeeding is not necessary according to the activity in the breast milk, but where an interruption period of 4 h is recommended so the breastfeeding patient and the infant are not unnecessarily in close proximity for long times. A similar interruption period is motivated for ^{99m}Tc-labelled substances (IAEA, 2018). This is due to the risk of free ^{99m}Tc-labelled pertechnetate in the preparation which justifies a 4 h interruption during which one feed is discarded.

(153) The activity in the breastmilk will also result in in an increased dose to the mother´s breasts. Absorbed doses of the order of 10 to 15 mGy can be reached at investigations with ^{67}Ga-labelled gallium citrate and ^{99m}Tc-labelled leucocytes (ACMUI, 2019). Due to the relatively high sensitivity of the breasts for radiation carcinogenesis, extracting breast milk using a pump or by hand may be a matter for consideration. However, for the majority of radiopharmaceuticals the breast dose is quite low, and breast milk extraction is probably not worth the effort, as it may be cumbersome and difficult for many women.

(154) For newer radiopharmaceuticals where no information on radionuclide excretion in breast milk have been published, several consecutive samples of breast milk should be collected. The activity concentration in these samples should be measured and the cumulated activity determined. Based upon this information and biokinetic data on the radiopharmaceutical within the body, the absorbed dose to various organs and tissues and the effective dose can be calculated.

Table 9.1. Recommendations concerning interruption of breastfeeding. The table contains substances, which in some countries are no longer in use. They are included as a service to those who still use them and as a base for retrospective dose estimates and comparisons.

Radiopharmaceutical	Recommended breastfeeding interruption	Comment	Recommendation valid for indicated administered activity
^{11}C-labelled substance	No		Any activity
^{13}N-labelled substance	No		Any activity
^{14}C-triolein	No		
^{14}C-GCA	No		
^{14}C-urea	No		
^{15}O-labelled substance	No		Any activity
^{18}F-FDG	4 h		400 MBq
^{22}Na	≥ 3 weeks		
^{51}Cr-EDTA	No		4 MBq
^{67}Ga-citrate	≥ 3 weeks		200 MBq
^{68}Ga-DOTA conj. peptides	4 h		100-250 MBq
^{75}Se-labelled substance	≥ 3 weeks		
^{81m}Kr gas	No		
^{99m}Tc-IDA and mebrofenin	4 h *	One meal discarded	150-300 MBq
^{99m}Tc-DMSA	4 h *	One meal discarded	80-200 MBq
^{99m}Tc-DTPA	4 h *	One meal discarded	40-400 MBq
^{99m}Tc-DTPA aerosols	4 h *	One meal discarded	50 MBq
^{99m}Tc-ECD	4 h *	One meal discarded	800 MBq
^{99m}Tc-gluconate	4 h *	One meal discarded	
^{99m}Tc-glucoheptonate	4 h *	One meal discarded	
^{99m}Tc-HMPAO	4 h *	One meal discarded	500 MBq
^{99m}Tc-sulfur colloids	4 h *	One meal discarded	200-400 MBq
^{99m}Tc-MAA	12 h †	Three meals discarded	40-200 MBq
^{99m}Tc-MAG3	4 h *	One meal discarded	40-400 MBq
^{99m}Tc-MIBI	4 h *	One meal discarded	250-900 MBq
^{99m}Tc-microspheres	12 h †	Three meals discarded	
^{99m}Tc-human nanocolloids	4 h *	One meal discarded	5-120 MBq (Sentinel node)
	4 h *	One meal discarded	120-200 MBq (Liver)
^{99m}Tc-pertechnetate	12 h †	Three meals discarded	100-400 MBq
^{99m}Tc-phosphonates	4 h *	One meal discarded	800 MBq
^{99m}Tc-PYP	4 h *	One meal discarded	
^{99m}Tc-RBC (*in vivo*)	12 h †	Three meals discarded	800 MBq
^{99m}Tc-RBC (*in vitro*)	4 h *	One meal discarded	
^{99m}Tc-Technegas	4 h *	One meal discarded	40 MBq
^{99m}Tc-tetrofosmin	4 h *	One meal discarded	250-700 MBq
^{99m}Tc-HMPAO leukocytes	4 h *	One meal discarded	180-400 MBq
^{111}In-octreotide	48 h		100-200 MBq
^{111}In-leukocytes	48 h		
^{123}I-BMIPP	≥ 3 weeks		
^{123}I-HSA	≥ 3weeks		
^{123}I-iodo hippurate	12 h †	Three meals discarded	20-40 MBq
^{123}I-IPPA	≥ 3weeks		
^{123}I-MIBG	≥ 3weeks		400 MBq
^{123}I-NaI	≥ 3weeks		20 MBq
^{123}I-ioflupane (FP-CIT)	≥ 3weeks		150-250 MBq
^{125}I-HSA	≥ 3weeks		
^{125}I-iodo hippurate	12 h †	Three meals discarded	
^{131}I-iodo hippurate	12 h †	Three meals discarded	
^{131}I-MIBG	≥ 3weeks		Any activity
^{131}I-NaI	≥ 3weeks		Any activity
^{133}Xe gas	No		
^{201}Tl-chloride	48 h		100 MBq

Footnote: The recommended interruption period is a combination of minimizing the external dose due to close contact between patient and child and internal dose including contribution from possible free pertechnetate in the case of ^{99m}Tc-labelled substances.

* For these ^{99m}Tc-labelled substances breast milk should be expressed once, 4 hours after the administration and discharged.

† For these ^{99m}Tc-labelled substances and for iodine-labelled hippurate, breast milk should be expressed three times, approximately 4, 8 and 12 hours after the administration and discharged.

10.RECOMMENDATIONS IN CASE OF EXTRAVASATION

(155) A diagnostic nuclear medicine procedure begins with an administration of the radiopharmaceutical, most often via an intravenous injection. The injection site is almost always a blood vessel in the bend of the arm, but in rare occasions it may be in a blood vessel on the hand or the foot.

(156) Depending on the condition of the blood vessel and on the injection technique there is a slight possibility that the injection becomes inadvertently extravascular. This so-called extravasation event is leakage of injected radiopharmaceutical from the injection site of the blood vessel to surrounding tissue.

(157) In the case of an extravascular injection of a radiopharmaceutical, a locally high radiation dose can arise at the injection site. The magnitude of the radiation dose depends on the substance and the spread of it at the injection site, the physical properties of the radionuclide, activity and volume administered and on the elimination rate from the injection site. If the local absorbed dose is high, on the order of 2-3 Gy, there is a plausible risk of skin erythema. In this case patients need to be followed-up and it is essential to determine the absorbed dose to the site of the extravasation event. Due to their emission properties, extravasation of radiopharmaceuticals labelled with ^{18}F, ^{68}Ga ^{99m}Tc and ^{123}I, do not cause very large radiation doses to the injection site and most often do not require specific intervention (van der Pol et al., 2017). Extravasation of therapeutic radiopharmaceuticals can result in severe soft tissue lesions, and surgical intervention may be recommended. In *Publication 140* 'Radiological protection in therapy with radiopharmaceuticals', the matter is carefully discussed in more detail (ICRP, 2019b).

(158) An extravascular injection also affects the quality of the diagnostic procedure. If a major part of the injected activity is found in the extravascular volume, the activity in the organs and tissues of clinical interest may be insufficient to be able to interpret the examination. A dynamic examination such as renography is not possible to complete if the activity is not properly administered. Another example is that the SUV (standardized uptake value) in a PET-examination (positron emission tomography) may be inaccurate if the injection site containing a large part of the activity is outside the field-of-view of the PET camera.

(159) It is important to immediately estimate the amount of activity that is present in the extravascular volume, to assess whether it is possible to proceed with the examination and complete it or if the patient has to come back another day for a new examination.

(160) The amount of activity can be quantified through imaging of the extravasation site using the gamma camera or the PET/CT-camera. The activity in the volume is determined via the count rate (cps) in a region-of-interest (ROI) knowing the efficiency (Bq cps^{-1}) of the gamma camera. In a PET/CT-camera the activity concentration (kBq mL^{-1}) in a ROI or a Volume of interest (VOI) is obtained directly from the images. The volume of the extravascular site is also obtained from the images.

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ANNEX A. RADIOPHARMACEUTICALS SECTION

A.1. ^{3}H-labelled neutral fat and free fatty acids

A.1.1. Biokinetic information

(A 1) Orally administered fat is absorbed rapidly and completely from the gastrointestinal tract. Within 3–4 h, all activity has reached the blood via the lymphatic system. After transient uptake and chemical modification in the liver, the fat is transported to the adipose tissue, which occurs principally in subcutaneous tissue, yellow marrow, and the abdominal cavity, and to the muscles. Other organs and tissues receive small amounts. It is then metabolised by beta-oxidation, with water and carbon dioxide (CO_2) as end products. The turnover rate is highly dependent on the nutritional state, especially the supply of carbohydrates.

(A 2) Pedersen and Marqversen (1981) measured $^{14}CO_2$ in expired air in five healthy subjects who were given labelled neutral fat in a test meal after an 8-h fast. Unrestricted food was allowed from 6 h later. After 1 day, 15–33% of ingested fat had been metabolised, and this increased to 25–40% by 10 days. The residue was retained for a much longer time with a calculated half-time of 304–493 days. Malmendier et al. (1974) injected ^{14}C-labelled palmitic acid into four fasting normal subjects and measured expired air for 24 h. They found that 45% of the fatty acid was oxidised directly to CO_2. No carbohydrate was given simultaneously, which may explain the larger fraction that was metabolised more rapidly than in the study of Pedersen and Marqversen (1981). Hirsch et al. (1960) studied the turnover of neutral fat incorporated into adipose tissue, and found half-times up to 750 days.

A.1.2. Biokinetic model

(A 3) The model adopted here is based on the one presented in *Publication 128* and is intended for fat containing unbranched longchain (13–18 carbon atoms) fat molecules and labelled with ^{14}C or ^{3}H, administered orally or intravenously. The simplified model of the Human Alimentary Tract presented in Figure 4.1 is used here with the transfer coefficients for total diet. Rapid and complete resorption is assumed. After transient uptake in the liver, the activity is deposited in the adipose tissue (85%), in muscles (10%), and in all other organs and tissues (5%).

(A 4) Assuming adequate supply of carbohydrates, 30% of the amount deposited in the adipose tissue is metabolised rapidly ($T_{1/2}$=2 days) and 70% is retained for a longer time ($T_{1/2}$=400 days). For muscles a retention half-time of 2 days is assumed, and for other a retention half-time of 400 days. The long-lived component refers in this case to the fraction of body fat which becomes labelled with the administered radiopharmaceutical (Gunnarsson et al., 2000). This probably only represents a small fraction of the total carbon pool in the body. The half-time of 400 days assumed for the longer-term component of retention of ^{3}H in the body fat is comparable to the value indicated in *Publication 131* (ICRP, 2016) for the longer-term retention of organically bound tritium (1 year).

(A 5) This model is intended for adults only. It is possible that the metabolism is significantly different in children, with longer half-times in some tissues.

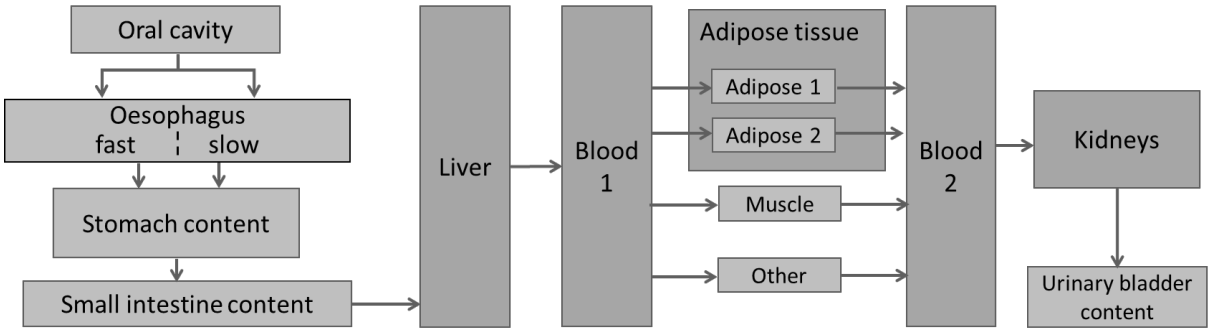

Fig. A.1.1. Biokinetic model for ^{3}H-labelled neutral fat and free fatty acids.

Table A.1.1. Values of the transfer coefficients (h^{-1}).

From	To	Adults only
Oral cavity	Oesophagus slow	3.00E+01
Oral cavity	Oesophagus fast	2.70E+02
Oesophagus slow	Stomach content	9.00E+01
Oesophagus fast	Stomach content	5.14E+02
Stomach content	Small intestine content	8.57E-01
Small intestinal content	Liver	2.50E-01
Liver	Blood 1	1.20E+01
Blood 1	Adipose 1	1.24E+01
Blood 1	Adipose 2	5.30E+00
Blood 1	Muscle	2.08E+00
Blood 1	Other	1.04E+00
Adipose 1	Blood 2	7.22E-05
Adipose 2	Blood 2	1.44E-02
Muscle	Blood 2	1.44E-02
Other	Blood 2	7.22E-05
Blood 2	Kidneys	1.20E+02
Kidneys	UB Contents	1.20E+01

Radioactive half-life of ^{3}H: 12.32 year

A.1.3. Specific assumptions for the calculations

(A 6) For oral administration, the parameters for 'Total diet' are used.

A.1.4. References for ^{3}H-labelled neutral fat and free fatty acids

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A.2. 1-[^{11}C]-labelled acetate

A.2.1. Biokinetic information

(A 7) Acetate labelled with ^{11}C in the carboxyl position, [1-^{11}C]-acetate, is used for dynamic positron emission tomography (PET) studies of myocardial metabolism (Armbrecht et al., 1990; van den Hoff et al., 1996; Sun et al., 1997; Porenta et al., 1999), and in renal (Shreve et al., 1995), pancreatic (Shreve and Gross, 1997), and nasopharyngeal disease (Yeh et al., 1999).

(A 8) More recently it has also been used in oncology for detecting malignancies such as prostate cancer, renal cell carcinoma, bladder cancer, brain tumors, lung carcinoma (Schiepers et al., 2008; Grassi et al., 2012). Its use for diagnosis of well differentiated hepatocellular carcinoma represents was also proposed.

(A 9) In most tissues, after extraction from the blood, [1-^{11}C]-acetate is activated to acetyl co-enzyme A (CoA) and enters the tricarboxylic acid (TCA) cycle. From the TCA cycle, the label is lost mainly in the form of $^{11}CO_2$ (Armbrecht et al., 1990). In resting myocardium, the behaviour of [1-^{11}C]-acetate can be summarised as follows (Armbrecht et al., 1990):

- extraction of approximately two-thirds of the activity in a single capillary transit;
- a very rapid initial washout phase ($T_{1/2}$<5 s);
- activation of [1-^{11}C]-acetate to [1-^{11}C]-acetyl-CoA within a few seconds;
- labelling of TCA cycle intermediates takes several minutes;
- onset of rapid $^{11}CO_2$ release after 2–3 min;
- $^{11}CO_2$ release is bi-exponential.

(A 10) In all the tissues studied, peak uptake appears to be reached within less than 3 min. After 3–5 min, 50% of the tissue activity is present as $^{11}CO_2$, 24% as nonionised species, and 13% each as acetate and TCA-amino acid intermediates (Sun et al., 1997). The rate of metabolism of the radiopharmaceutical reflects the rate of oxidative metabolism in the tissue, and thus the oxygen supply.

(A 11) Clinical studies indicate that in both myocardium and kidney parenchyma, the initial uptake is complete by 2.5–3 min post injection, and that between 3 and 30 min, the ^{11}C is lost from the tissues with a half-time of approximately 10 min. In normal pancreas, the uptake is also complete in 3 min, and by 30 min, the activity is lost from the tissue with a half-time of 38 min. In the liver, uptake is again rapid, peaking at approximately 3 min; thereafter, loss of ^{11}C from the tissue follows a triexponential clearance, with 35% being cleared with a half-time of 10 min and the remainder with half-times of 1 (30%) and 2 h (35%).

(A 12) Biokinetic data and radiation dose estimates for [1-^{11}C]-acetate have been presented by Seltzer et al. (2004).

A.2.2. Biokinetic model

(A 13) The biokinetic model illustrated below, which is based on the descriptive model of ICRP *Publication 128*, was constructed using the blood flow data for most human tissues tabulated by Leggett and Williams (1995). In this model, uptake in all tissues is assumed to be rapid, with a half-time of 1 min.

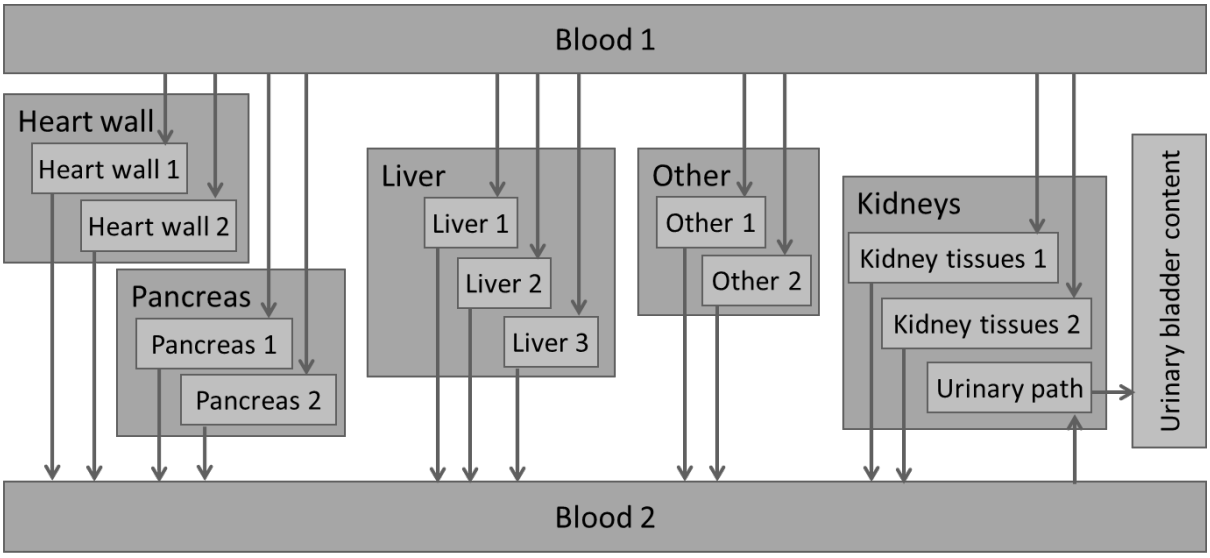

Fig. A.2.1. Biokinetic model for [^{11}C]-labelled acetate.

Table A.2.1. Values of the transfer coefficients (h^{-1}).

From	To	All age groups
Blood 1	Heart wall 1	9.36E-01
Blood 1	Heart wall 2	9.36E-01
Blood 1	Pancreas 1	2.08E-01
Blood 1	Pancreas 2	2.08E-01
Blood 1	Liver 1	3.64E+00
Blood 1	Liver 2	3.12E+00
Blood 1	Liver 3	3.64E+00
Blood 1	Kidney tissues 1	3.95E+00
Blood 1	Kidney tissues 2	3.95E+00
Blood 1	Other tissues1	1.05E+01
Blood 1	Other tissues 2	1.05E+01
Heart wall 1	Blood 2	4.08E+00
Heart wall 2	Blood 2	8.66E-02
Pancreas 1	Blood 2	1.03E+00
Pancreas 2	Blood 2	3.47E-01
Liver 1	Blood 2	4.08E+00
Liver 2	Blood 2	6.93E-01
Liver 3	Blood 2	3.47E-01
Kidney tissues 1	Blood 2	4.08E+00
Kidney tissues 2	Blood 2	2.89E-02
Other tissues 1	Blood 2	4.08E+00
Other tissues 2	Blood 2	8.66E-02
Blood 2	Urinary path	1.20E+02
Urinary path	UB Contents	1.20E+01

Radioactive half-life of ^{11}C: 20.39 min

A.2.3. Specific assumptions for the calculations

(A 14) None.

A.2.4. References for [^{11}C]-labelled acetate

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A.3. ^{11}C-labelled amino acids (generic model)

A.3.1. Biokinetic information

(A 15) The methionine analogue [^{75}Se]-selenomethionine has been used in nuclear medicine for many years (ICRP, 1987), and more recently, a number of other amino acids labelled with ^{11}C or ^{18}F have been used, or proposed, for clinical applications such as l-[methyl-^{11}C]-methionine (Deloar et al., 1998), L-[2-^{18}F]-fluorotyrosine (Cottrall et al., 1973; Taylor and Cottrall, 1973; Coenen et al., 1989), [^{18}F]-p-fluorophenylalanine (Cottrall et al., 1973), 6-[^{18}F]-fluorotryptophan (Atkins et al., 1972; Taylor and Cottrall, 1973), cis-4-[^{18}F]-fluoroproline and trans-4-[^{18}F]-fluoroproline (Wester et al., 1999a,b), and L-3-[^{18}F]-fluoro-a-methyl tyrosine (Inoue et al., 1998). Labelled amino acids are potentially important for studies of protein synthesis in the brain (Bergmann et al., 1995; Schmidt et al., 1997; Shoup et al., 1999).

(A 16) The Commission had previously published biokinetic models for [^{75}Se]-selenomethionine (ICRP, 1988) and L-[methyl-^{11}C]-methionine (ICRP, 2008). Taylor (2000) developed a generic biokinetic model for use in assessment of the internal dose received by human subjects injected intravenously with amino acids labelled with ^{11}C, ^{18}F, or ^{75}Se. Comparison of the radiation doses to adults calculated using this generic model with those calculated using compound-specific models for [^{11}C]-labelled and [^{18}F]-labelled amino acids and [^{75}Se]-selenomethionine indicated that, in general, the effective doses, as well as the organ and tissue doses, calculated using Taylor's generic model (2000) agreed within a factor of two or less with those calculated using compound-specific models.

(A 17) It was further noted that the generic model tended to overestimate, rather than underestimate, the organ and tissue doses. It was concluded that for [^{11}C]-, [^{18}F]-, and [^{75}Se]-labelled amino acids or their analogues, the generic biokinetic model could be applied for general radiation protection purposes.

A.3.2. Biokinetic model

(A 18) The generic model proposed by Taylor and adopted in *Publication 128* assumes that, following entry of a labelled amino acid into the blood stream, the radiopharmaceutical is taken up instantaneously by the organs and tissues. This is followed by a phase of rapid elimination of that fraction of the injected material which goes directly into the excretory pathways or is excreted following early metabolism, a second phase that represents loss due to metabolic breakdown of labelled proteins and other compounds with relatively rapid turnover times, and a final phase representing elimination of the small fraction of the radionuclide that had been incorporated into structural proteins or other body components with very slow turnover.

(A 19) Elimination of the radionuclide from the various organs and tissues is assumed to approximate a three-component exponential relationship with biological half-times of 0.5, 50, and 5000 days. The long biological half-time assigned to the small final component of the model reflects the evidence that ^{14}C incorporated into structural tissues such as bone is retained with a very long half-time (Stenhouse and Baxter, 1977; Stenström et al., 1996). Since the slowest component is much larger than the physical half-life of ^{11}C, it is approximated as infinite.

(A 20) The descriptive model of *Publication 128* is adopted here with slight modifications. The amount eliminated from the blood is assumed to be excreted in the urine according to the dynamic bladder model presented in 4.5.

Table A.3.1. Biokinetic data for ^{11}C-labelled amino acids (descriptive model).

Organ (S)	F_s	T (h)	a
Blood	0.20	0.2	0.25
		6.0	0.75
Brain	0.015	1200	0.70
		∞	0.30
Thyroid	0.0007	1200	0.70
		∞	0.30
Lungs	0.02	12	0.10
		1200	0.85
		∞	0.05
Kidneys	0.02	12	0.15
		1200	0.80
		∞	0.05
Liver	0.08	12	0.40
		1200	0.55
		∞	0.05
Spleen	0.004	12	0.33
		1200	0.67
Pancreas	0.03	12	0.85
		1200	0.15
Small intestine wall	0.03	6	0.50
		12	0.50
Ovaries	0.0003	1200	0.70
		∞	0.30
Testes	0.001	1200	0.70
		∞	0.30
Muscles	0.24	12	0.15
		1200	0.45
		∞	0.40
Other organs and tissues	0.359	12	0.15
		1200	0.45
		∞	0.40

F_s, fractional distribution to organ or tissue S.
T, biological half-life for an uptake or elimination component;
a, fraction of F_s taken up or eliminated with the corresponding half-life

Radioactive half-life of ^{11}C: 20.39 min

A.3.3. Specific assumptions for the calculations

(A 21) None.

A.3.4. References for ^{11}C-labelled amino acids (generic model)

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Deloar, H.M., Fujiwara, T., Nakamura, T., et al., 1998. Estimation of internal absorbed dose of L-[methyl-11C] methionine using whole body positron emission tomography. Eur. J. Nucl. Med. 25, 629–633.

Inoue, T., Tomiyoshi, K., Higuichi, T., et al., 1998. Biodistribution studies on L-3-[fluorine-18]fluoro-a-methyl tyrosine: a potential tumor-detecting agent. J. Nucl. Med. 39, 663–667.

ICRP, 1988. Radiation dose to patients from radiopharmaceuticals. ICRP Publication 53. Ann. ICRP 18(1–4).

ICRP, 2008. Radiation Dose to Patients from Radiopharmaceuticals - Addendum 3 to ICRP Publication 53. ICRP Publication 106. Ann. ICRP 38(1-2).

Schmidt, D., Langen, K-J., Herzog, H., et al., 1997. Whole-body kinetics and dosimetry of L-3-[^{123}I]iodo-a-methyltyrosine. Eur. J. Nucl. Med. 24, 1162–1166.

Shoup, T.M., Olson, J., Hoffman, J.M., et al., 1999. Synthesis and evaluation of [^{18}F]1-amino-3-fluorocyclobutane-1-carboxylic acid to image brain tumours. J. Nucl. Med. 40, 331–338.

Stenhouse, M.J., Baxter, M.S., 1977. Bomb ^{14}C as a biological tracer. Nature (Lond.) 267, 828–832.

Stenström, K., Leide-Svegborn, S., Erlandsson, B., et al., 1996. Application of accelerator mass spectrometry (AMS) for high-sensitivity measurements of $^{14}CO_2$ in long-term studies of fat metabolism. Appl. Radiat. Isot. 47, 417–422.

Taylor, D.M., Cottrall, M.F., 1973. Evaluation of amino acids labelled with ^{18}F for pancreas scanning. In: Radiopharmaceuticals and Labelled Compounds. Vol. I. International Atomic Energy Agency, Vienna, pp. 443–441.

Taylor, D.M., 2000. Generic models for radionuclide dosimetry: ^{11}C, ^{18}F or ^{75}Se-labelled amino acids. Appl. Radiat. Isot. 52, 911–922.

Wester, H.J., Herz, M., Senkowitsch-Schmidtke, R., Schwaiger, M., Stöcklin, G., Hamacher, K., 1999a. Preclinical evaluation of 4-[^{18}F]fluoroprolines: diasteromeric effect on metabolism and uptake in mice. Nucl. Med. Biol. 26, 259–265.

Wester, H.J., Herz, M., Weber, W., et al., 1999b. Synthesis and radiopharmacology of O-(2-[^{18}F]fluoroethyl)-L-tyrosine for tumor imaging. J. Nucl. Med. 40, 205–212.

A.4. ^{11}C-labelled brain receptor substances (generic model)

A.4.1. Biokinetic information

(A 22) A large number of radiopharmaceuticals labelled with ^{11}C are employed for PET studies of different types of receptor in the human brain. In the absence of sufficient biokinetic data to construct realistic compound-specific biokinetic models, a generic model was introduced in *Publication 128* (ICRP, 2015) based on the one developed by Nosslin et al. (2002).

(A 23) Based on biokinetic data for a number of ^{11}C-labelled radiopharmaceuticals used clinically for imaging different brain receptors, it was considered that, despite differences in chemical structure, their uptake and retention in the human brain and other tissues are broadly similar.

A.4.2. Biokinetic model

(A 24) The model proposed here is a compartmental version of the descriptive one presented in (ICRP, 2015). Five percent of the injected activity is assumed to be transferred to the brain, with the remaining activity being distributed rapidly and uniformly throughout all other tissues. Elimination from all tissues is assumed to occur with a half-time of 2 h. It is further assumed that 75%of the injected ^{11}C is excreted in the urine and 25% via the gallbladder.

(A 25) Further details on the model and the underlying data are given in (ICRP, 2015).

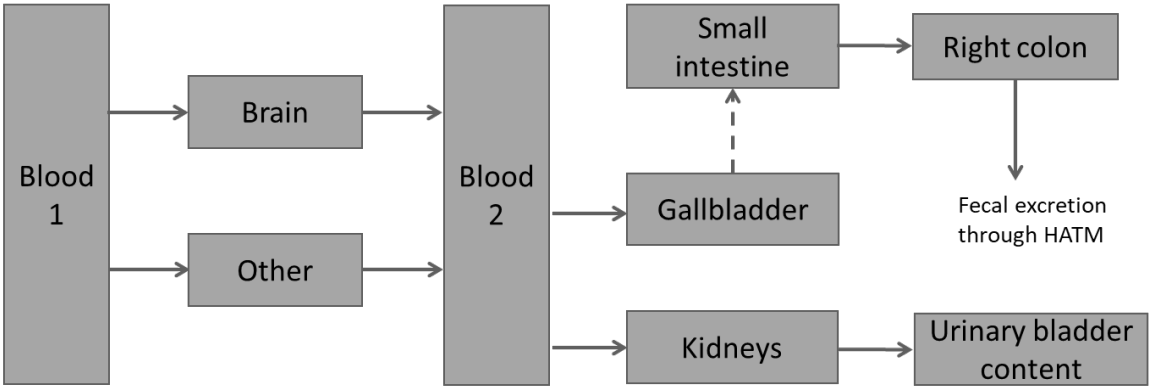

Fig. A.4.1. Biokinetic model for ^{11}C-labelled brain receptor substances (generic model).

Table A.4.1. Values of the transfer coefficients (h^{-1}).

From	To	All age groups
Blood 1	Brain	1.04E+00
Blood 1	Other	1.98E+00
Brain	Blood 2	3.47E-01
Other	Blood 2	3.47E-01
Blood 2	Gallbladder	3.00E+01
Blood 2	Kidneys	9.00E+01
Kidneys	Urinary bladder content	1.20E+01

Radioactive half-life of ^{11}C: 20.39 min

A.4.3. Specific assumptions for the calculations

(A 26) According to the model for liver and biliary excretion (ICRP, 2015), the gallbladder empties at intervals on stimulation by food. Three hours after administration, 75% of the material that has accumulated in the gallbladder is eliminated and moved into the small intestine. After a further 6 hours (i.e. 9 hours after administration), another 75% of what is then in the gallbladder is again moved into the small intestine. Finally, after another 15 hours (i.e. 24 hours after the first administration), everything that is still in the gallbladder is completely moved to the small intestine. Earlier emptying can be induced by a meal of high fat content or by cholecystokinin.

A.4.4. References for ^{11}C-labelled brain receptor substances (generic model)

ICRP, 2015. Radiation dose to patients from radiopharmaceuticals: a compendium of current information related to frequently used substances. ICRP Publication 128. Ann. ICRP 44(2S).

Nosslin, B., Johansson, L., Leide-Svegborn, S., Liniecki, J., Mattsson, S., Taylor, D., 2003. A generic model for ^{11}C-labelled radiopharmaceuticals for imaging receptors in the human brain. Presented at Workshop of Internal Dosimetry of Radionuclides in Oxford, 9–12 September 2002. Rad. Prot. Dosim. 105, 587–591.

A.5. Methyl-^{11}C-choline

A.5.1. Biokinetic information

(A 27) Methyl-^{11}C-choline ([^{11}C]-choline) is a radiopharmaceutical used for oncological PET studies.

(A 28) The model presented here is based on biokinetics and dosimetric data presented in the literature (Roivainen et al., 2000, 2003; Sutinen et al., 2004; Tolvanen et al., 2010). There is experimental evidence that the choline molecule oxidizes to betaine (Kwee et al., 2006), so that the observed kinetics is actually a combination of the kinetics of the two substances.

A.5.2. Biokinetic model

(A 29) The proposed model assumes that ^{11}C-choline is transferred to muscles (30%), liver (24%), cortical bone (8,5%), kidneys (4%), lung (2,6%), pancreas (2%), stomach (1,5%), spleen (1%) and heart (0,4%). The remaining 26% is associated with a compartment other.

(A 30) The material distributed to the organs is retained with a biological half-life of 12 h (due to the short physical half-life of ^{11}C, the choice of the biological half-life does not affect the effective retention). Thirty % of the material present in all organs but stomach and liver are excreted in the urine, the rest goes to the right colon and from there excreted in the feces according to the simplified alimentary tract model presented in Chapter 4 (see Fig. 4.1). Material in the stomach is transferred to the small intestine with a biological half-life of 6 h.

(A 31) This model reproduces well the time-integrated activity coefficients published by Tolvanen et al. (2010), which are partly extrapolated from animal data. It differs from the one presented in Section A.15 for ^{18}F-labelled choline. There is actually experimental evidence of potential differences between the pharmacokinetics of these two substances, especially with regard to the excretion (DeGrado et al., 2002).

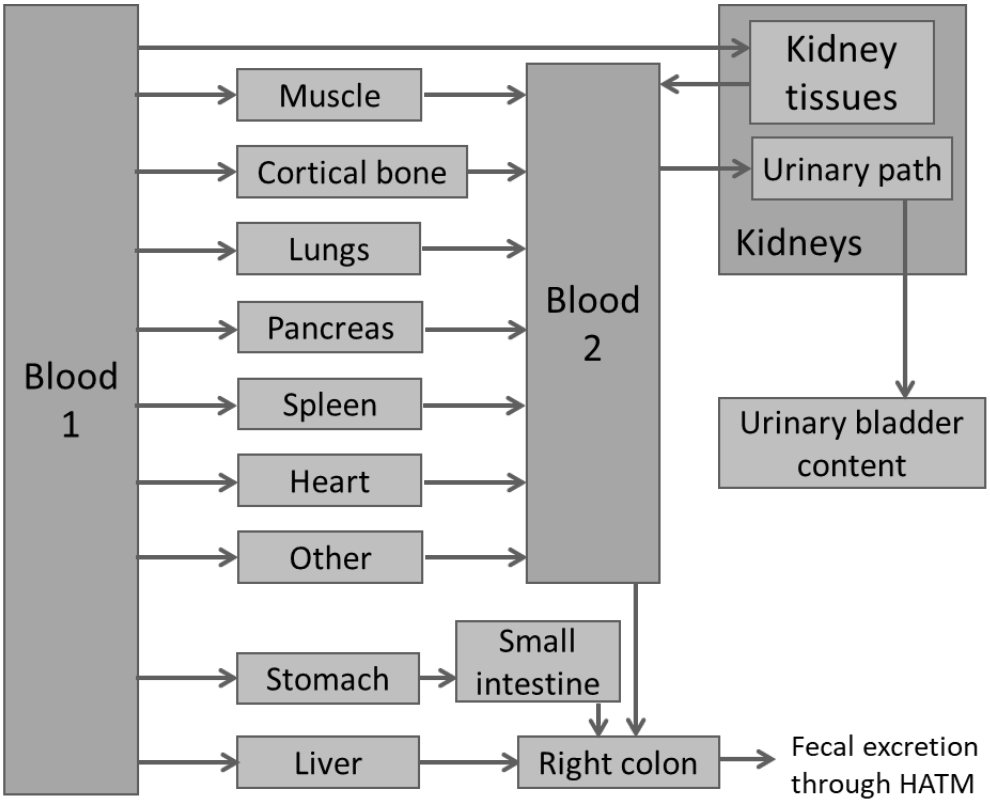

Fig. A.5.1. Biokinetic model for Methyl-^{11}C-choline.

Table A.5.1 Values of the transfer coefficients (h^{-1}).

From	To	All age groups
Blood 1	Muscle	6.24E+00
Blood 1	Cortical bone	1.77E+00
Blood 1	Lungs	5.41E-01
Blood 1	Pancreas	4.16E-01
Blood 1	Spleen	2.08E-01
Blood 1	Heart	8.32E-02
Blood 1	Stomach	3.12E-01
Blood 1	Kidney tissues	8.32E-01
Blood 1	Liver	4.99E+00
Blood 1	Other	5.41E+00
Muscle	Blood 2	5.78E-02
Cortical bone	Blood 2	5.78E-02
Lungs	Blood 2	5.78E-02
Pancreas	Blood 2	5.78E-02
Spleen	Blood 2	5.78E-02
Heart	Blood 2	5.78E-02
Kidney tissues	Blood 2	5.78E-02
Other	Blood 2	5.78E-02
Stomach	Small intestine	1.16E-01
Liver	Right colon	5.78E-02
Small intestine	Right colon	2.50E-01
Blood 2	Urinary path	3.60E+01
Blood 2	Right colon	8.40E+01
Urinary path	UB Contents	1.20E+01

Radioactive half-life of ^{11}C: 20.39 min

A.5.3. Specific assumptions for the calculations

(A 32) None.

A.5.4. References for Methyl-^{11}C-choline

DeGrado, T.R., Reiman, R.E., Price, D.T., Shuyan, W., Coleman, R.E., 2002. Pharmacokinetics and radiation dosimetry of ^{18}F-fluorocholine. J. Nucl. Med. 43, 92–96.

Kwee, S.A., Wei, H., Sesterhenn, I., Yun, D., Coel, M.N., 2006. Localization of primary prostate cancer with dual-phase ^{18}F-fluorocholine PET. J. Nucl. Med. 47, 262–269.

Roivainen, A., Forsback, S., Grönroos, T., et al., 2000. Blood metabolism of [methyl-^{11}C]choline; implication for in vivo imaging with positron emission tomography, Eur. J. Nucl. Med. 27, 25-32.

Roivainen, A., Parkkola, R., Yli-Kerttula, T., et al., 2003. Use of Positron Emission Tomography With Methyl-^{11}C-Choline and 2-^{18}F-Fluoro-2-Deoxy-D-Glucose in Comparison With Magnetic Resonance Imaging for the Assessment of Inflammatory Proliferation of Synovium, Arth. Rheum 48, 3077-3084.

Sutinen, E., Nurmi, M., Roivainen, A., et al., 2004. Kinetics of [^{11}C]choline uptake in prostate cancer: a PET study, Eur. J. Nucl. Med. Mol. Imaging 31, 317-324.

Tolvanen, T., Yli-Kerttula, T., Ujula, T., Autio, A., Lehikoinen, P., Minn, H., Roivainen, A. 2010. Biodistribution and radiation dosimetry of [^{11}C]choline: a comparison between rat and human data. Eur. J. Nucl. Med. Mol. Imaging 37, 874-83.

A.6. L-[methyl-^{11}C]-methionine

A.6.1. Biokinetic information

(A 33) The amino acid L-[methyl-^{11}C]-methionine can be applied in tumour diagnosis and in the study of protein synthesis using PET. Deloar et al. (1998) reported quantitative PET studies on the distribution of L-[methyl-^{11}C]-methionine in five healthy, male volunteers aged 22–40 years. The data suggested that approximately 90% of the activity was lost from all tissues during the first 90 min after injection, with biological half-times of approximately 20–30 min. Thereafter, the loss of activity appeared to be slower, with a half-time that could be considered to be long in relation to the physical half-life of ^{11}C.

A.6.2. Biokinetic model

(A 34) The biokinetic model presented below was developed on the basis of the human data of Deloar et al. (1998), who estimated the uptake of L-[methyl-^{11}C]-methionine into the brains of the five volunteers to be 2.8±0.7% of the injected activity; that is seven times higher than the value of 0.4% previously estimated by Comar et al. (1976).

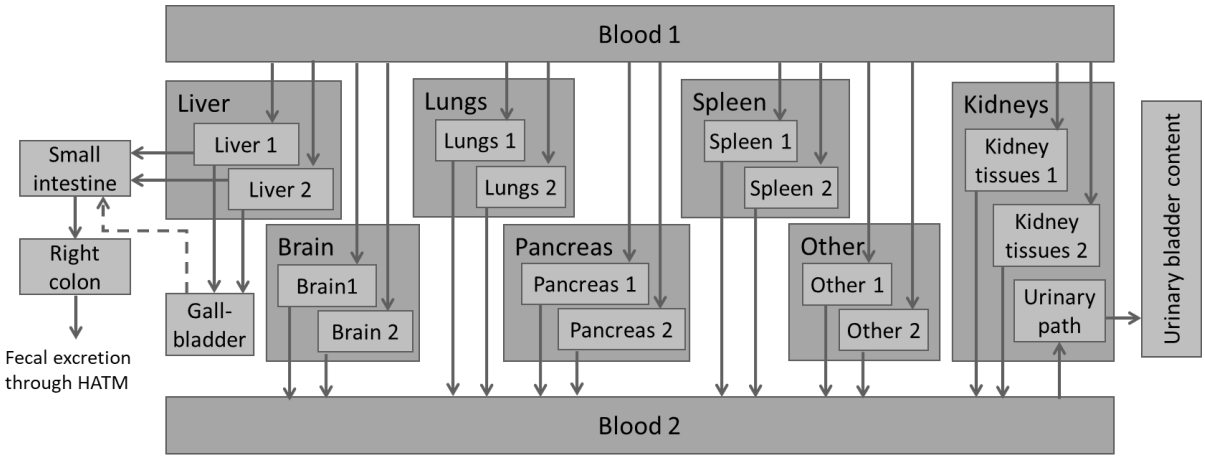

Fig. A.6.1. Biokinetic model for L-[methyl-^{11}C]-methionine.

Table A.6.1. Values of the transfer coefficients (h^{-1}).

From	To	All age groups
Blood 1	Brain 1	5.61E-01
Blood 1	Brain 2	6.24E-02
Blood 1	Lungs 1	9.36E-01
Blood 1	Lungs 2	1.04E-01
Blood 1	Pancreas 1	2.99E-01
Blood 1	Pancreas 2	3.33E-02
Blood 1	Spleen 1	1.87E-01
Blood 1	Spleen 2	2.08E-02
Blood 1	Kidney tissues 1	4.12E-01
Blood 1	Kidney tissues 2	4.57E-02
Blood 1	Liver 1	4.12E+00
Blood 1	Liver 2	4.57E-01
Blood 1	Other 1	1.22E+01
Blood 1	Other 2	1.36E+00
Brain 1	Blood 2	1.73E+00
Brain 2	Blood 2	5.78E-02
Lungs 1	Blood 2	1.73E+00
Lungs 2	Blood 2	5.78E-02
Pancreas 1	Blood 2	1.73E+00
Pancreas 2	Blood 2	5.78E-02
Spleen 1	Blood 2	1.73E+00
Spleen 2	Blood 2	5.78E-02
Kidney tissues 1	Blood 2	1.73E+00
Kidney tissues 2	Blood 2	5.78E-02
Other 1	Blood 2	1.73E+00
Other 2	Blood 2	5.78E-02
Blood 2	Urinary Path	1.20E+02
Urinary Path	Urinary bladder contents	1.20E+01
Liver 1	Small intestine	1.13E+00
Liver 1	Gallbladder	6.07E-01
Liver 2	Small intestine	3.75E-02
Liver 2	Gallbladder	2.02E-02
Small intestine	Right colon	2.50E-01

Radioactive half-life of ^{11}C: 20.39 min

A.6.3. Specific assumptions for the calculations

(A 35) The excretion to the intestine is described using the model for liver and biliary excretion (ICRP, 2015). This model assumes that 65% of the activity entering the liver is transferred from the liver to the small intestine, and 35% goes to the gallbladder (Wu et al., 1984).

(A 36) The gallbladder empties at intervals on stimulation by food. Three hours after administration, 75% of the material that has accumulated in the gallbladder is eliminated and moved into the small intestine. After a further 6 hours (i.e. 9 hours after administration), another 75% of what is then in the gallbladder is again moved into the small intestine. Finally, after another 15 hours (i.e. 24 hours after the first administration), everything that is still in the gallbladder is completely moved to the small intestine. Earlier emptying can be induced by a meal of high fat content or by cholecystokinin.

A.6.4. References for L-[methyl-^{11}C]-methionine

Comar, D., Catron, J.C., Maziere, M., Marazanop, C., 1976. Labelling and metabolism of methionine-methyl-^{11}C. Eur. J. Nucl. Med. 1, 11–14.

Deloar, H.M., Fujiwara, T., Nakamura, T., et al., 1998. Estimation of internal absorbed dose of L-[methyl-^{11}C]-methionine using whole body positron emission tomography. Eur. J. Nucl. Med. 25, 629–633.

ICRP, 2015. Radiation dose to patients from radiopharmaceuticals: a compendium of current information related to frequently used substances. ICRP Publication 128. Ann. ICRP 44(2S).

Wu, R.K., Siegel, J.A., Rattner, Z., Malmud, L.S., 1984. Tc-99m HIDA dosimetry in patients with various hepatic disorders. J. Nucl. Med. 25, 905–912.

A.7. ^{11}C-labelled Pittsburgh Compound B ([^{11}C]-PiB)

A.7.1. Biokinetic information

(A 37) The compound {N-methyl-[^{11}C]}2-(4'-methylaminophenyl)-6-hydroxybenzothiazole [Pittsburgh compound B (PiB)] is a beta-amyloid tracer for assessing brain amyloidosis, used primarily for diagnosis of Alzheimer's disease. The biokinetics of this substance have been studied in humans by Scheinin et al. (2007) and O'Keefe et al. (2009). In addition, animal studies of the biodistribution have been performed (e.g. on baboons by Parsey et al. (2005)].

(A 38) Substantial uptake in the colon has been noted by Scheinin et al. (2007), whereas O'Keefe et al. (2009) reported lower uptake, as seen in the diagnostic images. Blomquist et al. (2008) reported increased uptake in the cortical brain area in patients with Alzheimer's disease. This increased uptake will slightly affect the absorbed dose to the brain. The effective dose, however, will only be affected to a negligible degree, and this pathological variation is therefore not further considered for dose estimation.

A.7.2. Biokinetic model

(A 39) The model adopted here is based on the one presented in the Addendum 1 to ICRP 128, and is built solely on human data.

(A 40) PiB injected intravenously is assumed to be distributed rapidly in the body, with a considerable fraction of the activity located initially in the liver. Elevated concentrations are also found in the kidneys, brain, colon, and bone. Uptake in vertebral bone is reported by Scheinin et al. (2007), interpreted by the authors as localisation in cortical bone. Uptake in the skeleton of 7% is adopted here, with distribution in cortical and trabecular bone surfaces. It is assumed that 2% of the injected activity is transferred to the right colon contents.

(A 41) Half of the activity in the liver is assumed to stay with a biological half-time which is much longer in comparison with the physical half-time (20.39 min) and is therefore set to ∞. The other half is assumed to be transferred to the gallbladder with a half-time of 1 h, and then remains there. This deviates from the normal model for excretion of activity in the bile (ICRP, 2015), in which activity is also transferred directly from the liver to the small intestine.

(A 42) Thirty percent of the activity transferred to the kidneys, brain, and remaining tissues is assumed to be excreted via the urinary bladder with a biological half-time of 1 h, the rest is assumed to be retained with a biological half-time which is much longer in comparison with the physical half-time (20.4 min) and therefore assumed to be retained there indefinitely.

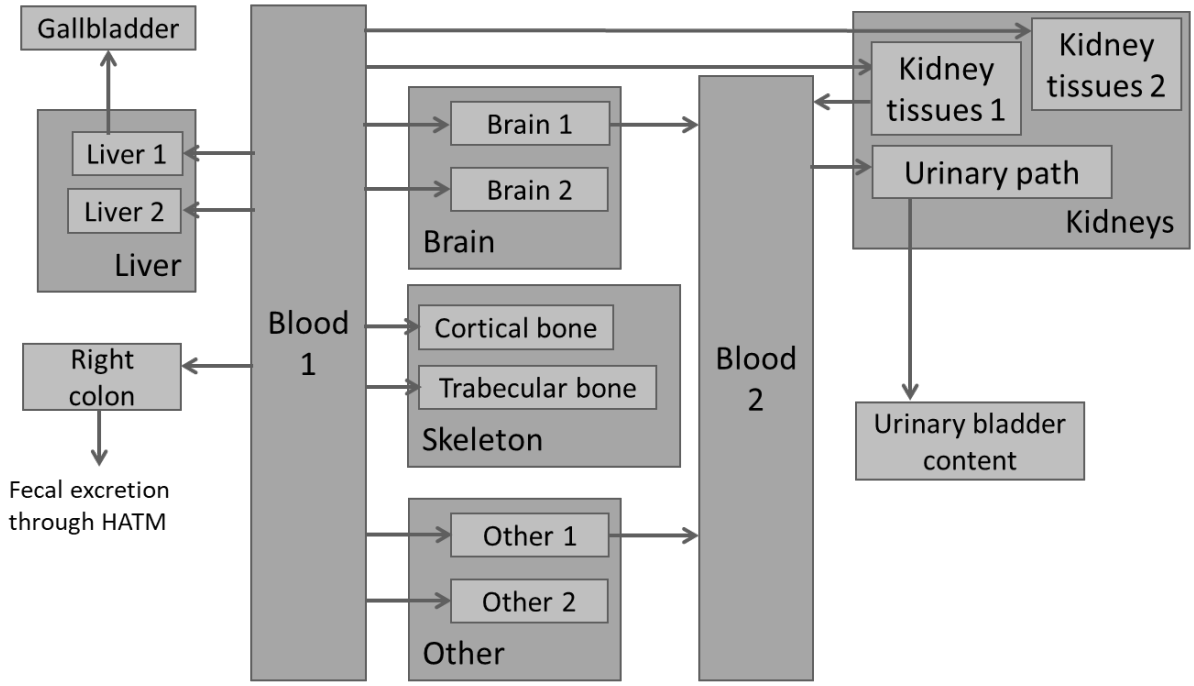

Fig. A.7.1. Biokinetic model for ^{11}C-labelled Pittsburgh Compound B.

Table A.7.1. Values of the transfer coefficients (h^{-1}).

From	To	All age groups
Blood 1	Brain 1	1.87E-01
Blood 1	Brain 2	4.37E-01
Blood 1	Liver 1	2.60E+00
Blood 1	Liver 2	2.60E+00
Blood 1	Cortical bone	7.28E-01
Blood 1	Trabecular bone	7.28E-01
Blood 1	Kidney tissues 1	1.25E-01
Blood 1	Kidney tissues 2	2.91E-01
Blood 1	Right colon	4.16E-01
Blood 1	Other 1	3.81E+00
Blood 1	Other 2	8.88E+00
Brain 1	Blood 2	6.93E-01
Liver 1	Gallbladder	6.93E-01
Kidney tissues 1	Blood 2	6.93E-01
Other 1	Blood 2	6.93E-01
Blood 2	Urinary Path	1.20E+02
Urinary Path	Urinary bladder contents	1.20E+01

Radioactive half-life of ^{11}C: 20.39 min

A.7.3. Specific assumptions for the calculations

(A 43) None

A.7.4. References for ^{11}C-labelled Pittsburgh Compound B

Blomquist, G., Engler, H., Nordberg, A., et al., 2008. Unidirectional influx and net accumulation of PIB. Open Neuroimag. J. 2, 114–125.

ICRP, 2015. Radiation dose to patients from radiopharmaceuticals: a compendium of current information related to frequently used substances. ICRP Publication 128. Ann. ICRP 44(2S).

1852 O'Keefe, G.J., Saunder, T.H., Ng, S., et al., 2009. Radiation dosimetry of b-amyloid tracers ^{11}C-PiB
1853 and ^{18}F-BAY94-9172. J. Nucl. Med. 50, 309–315.
1854 Parsey, R.V., Sokol, L.O., Bélanger, M-J., et al., 2005. Amyloid plaque imaging agent [C-11]-6-OH-
1855 BTA-1: biodistribution and radiation dosimetry in baboon. Nucl. Med. Commun. 26, 875–880.
1856 Scheinin, N.M., Tolvanen, T.K., Wilson, I.A., et al., 2007. Biodistribution and radiation dosimetry of
1857 the amyloid imaging agent ^{11}C-PIB in humans. J. Nucl. Med. 48, 128–133.
1858

A.8. ^{11}C-labelled thymidine

A.8.1. Biokinetic information

(A 44) ^{11}C-labelled thymidine is a DNA precursor that can be used as an in-vivo marker for cell proliferation in malignant tumours. It also has applications in tumour staging and for monitoring the effectiveness of treatment. It has been used in two forms: labelled with ^{11}C in the methyl group, [methyl-^{11}C]-thymidine, or labelled with ^{11}C on C2 of the pyrimidine ring, [2-^{11}C]-thymidine. The two forms differ in respect of the metabolic fate of the ^{11}C label. [Methyl-^{11}C]-thymidine is metabolised to [^{11}C]-beta-amino-iso-butyric acid, while the C2-labelled molecule is metabolised to [^{11}C]CO_2.

A.8.2. Biokinetic model

(A 45) The descriptive model presented in *Publication 128* consider five source regions: Blood, Liver, Kidneys, Muscle and Other (all other organs and tissues). Two different sets of parameters for the fractional distribution and for retention times were given for the two different forms.

(A 46) The parameters for [methyl-^{11}C]-thymidine were set based on the data from the PET studies of Martiat et al. (1988) and Thierens et al. (1994), in which the distribution of [methyl-^{11}C]-thymidine was followed over a period of 40 min following intravenous injection. Thierens et al. (1994) observed that 95% of the activity was cleared rapidly from the blood ($T_{1/2}$=1 min) and deposited in the liver (40–45%), skeletal muscle (30–34%), and kidneys (5–6%), with much smaller quantities going to other tissues. At 10 min after injection, less than 15% of the activity remaining in the blood was present as [methyl-^{11}C]thymidine; this amounts to less than 0.75% of the injected activity.

(A 47) Martiat et al. (1988) reported ‘substantial’ uptake in lungs, spleen, and intestine, but Thierens et al. (1994) stated that the concentration in spleen and lungs does not exceed that observed in muscle. Using the data of Martiat et al. (1988) to calculate organ contents at 30-min post injection suggests uptake of 40% in liver, 10% in kidneys, 2% in lungs and spleen, and 13% in muscle. Analysis of the tissue retention data reported by Martiat et al. (1988) and Thierens et al. (1994) suggests biological half-times of retention ranging from 60 min in the lungs to 460 min in muscle.

(A 48) The parameters for [2-^{11}C]-thymidine have been assessed based on the assumption that 70% of the injected compound is converted rapidly to [^{11}C]CO_2, which then follows the biokinetic model for continuous inhalation of [^{11}C]CO_2 proposed in *Publication 53* (ICRP, 1987); the remaining activity is assumed to follow a model derived from that for [methyl-^{11}C]-thymidine, but with uptake values for liver and kidneys based on the observations of Van der Borght et al. (1992).

(A 49) The model structure proposed here is a compartmental version of the descriptive models presented in *Publication 128*.

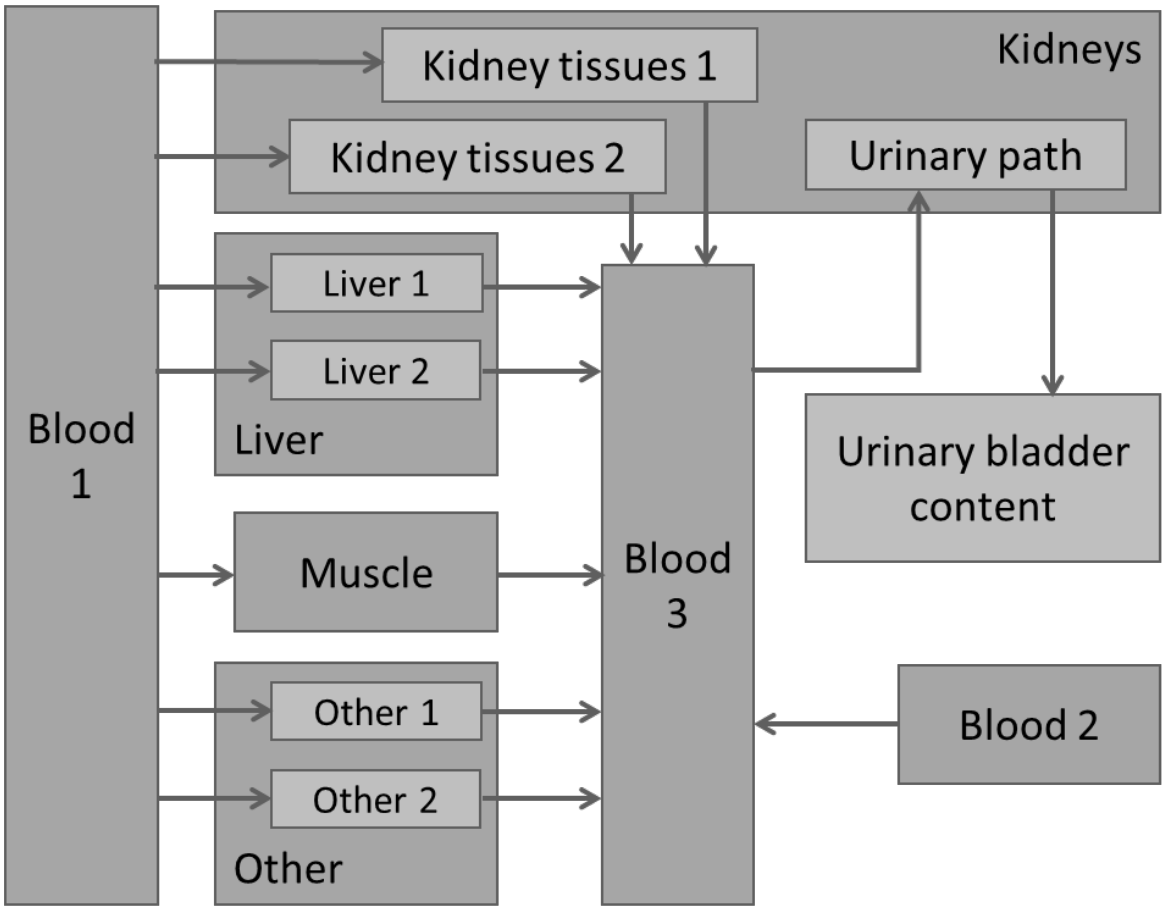

Fig. A.8.1. Biokinetic model for ^{11}C-labelled thymidine.

Table A.8.1. Values of the transfer coefficients (h^{-1}).

From	To	[methyl-^{11}C]-thymidine	[2-^{11}C]-thymidine
Blood 1	Liver 1	1.87E+01	2.04E+00
Blood 1	Liver 2	-	8.73E-01
Blood 1	Muscle	1.25E+01	-
Blood 1	Kidney tissues 1	2.91E+00	8.73E-01
Blood 1	Kidney tissues 2	-	3.74E-01
Blood 1	Other 1	5.41E+00	2.59E+01
Blood 1	Other 2	-	1.11E+01
Liver 1	Blood 3	3.47E-01	1.03E+00
Liver 2	Blood 3	-	3.47E-01
Muscle	Blood 3	8.66E-02	-
Kidney tissues 1	Blood 3	2.89E-02	1.03E+00
Kidney tissues 2	Blood 3	-	2.89E-02
Other 1	Blood 3	1.73E-01	1.03E+00
Other 2	Blood 3	-	8.66E-02
Blood 2	Blood 3	2.89E-02	2.89E-02
Blood 3	Urinary Path	1.20E+02	1.20E+02
Urinary Path	Urinary bladder contents	1.20E+01	1.20E+01

Radioactive half-life of ^{11}C: 20.39 min

A.8.3. Specific assumptions for the calculations

(A 50) The initial activity is split between Blood 1 and Blood 2 in a ratio 95:5 for [methyl-^{11}C]-thymidine and 99:1 for [2-^{11}C]-thymidine.

(A 51) For both forms of ^{11}C-labelled thymidine it is assumed that the material leaving the organ is excreted in the urine, following the dynamic bladder model.

A.8.4. References for ^{11}C-labelled thymidine

ICRP, 1988. Radiation doses to patients from radiopharmaceuticals. ICRP Publication 53. Ann. ICRP 18(1–4).

ICRP, 2015. Radiation dose to patients from radiopharmaceuticals: a compendium of current information related to frequently used substances. ICRP Publication 128. Ann. ICRP 44(2S).

Martiat, P., Ferrant, A., Labar, D., et al., 1988. In vivo measurement of carbon-11 thymidine uptake in non-Hodgkin's lymphoma using positron emission tomography. J. Nucl. Med. 29, 1633–1637.

Thierens, H., van Eijkeren, M., Goethals, P., 1994. Biokinetics and dosimetry for [methyl-^{11}C]thymidine. Br. J. Radiol. 67, 292–295.

Van der Borght, T., de Maeght, S., Labar, D., et al., 1992. Comparison of thymidine labelled in methyl group and in 2C-ring position in human PET studies. Eur. J. Nucl. Med. 19, 578.

A.9. ^{11}C-labelled raclopride

A.9.1. Biokinetic information

(A 52) Raclopride is a synthetic compound of the salicylamide series with high selectivity and affinity for central D2-dopamine receptors. It can be labelled with ^{11}C and used in PET. The neurotransmitter dopamine may be involved in various neuropsychiatric diseases. ^{11}C-raclopride is cleared rapidly from both plasma and whole blood, and crosses the blood–brain barrier. After intravenous administration, ^{11}C-raclopride localises in the basal ganglia, a region with a high density of dopamine receptors. PET images show the concentration of ^{11}C-raclopride in the region of the putamen relative to the rest of the brain. Images can be taken immediately after injection and continued for approximately 60 min (Glatting et al., 2004; Slifstein et al., 2007).

(A 53) In another study (Slifstein et al., 2011) the lower large intestine and the cortical bone were indicated as source regions collecting activity, but not muscle. The authors also reported a lower kidney uptake.

A.9.2. Biokinetic model

(A 54) The model structure proposed here is a compartmental version of the descriptive model presented in *Publication 128* (ICRP, 2015). This model was presented, mainly based on experimental data from Ribeiro et al. (2005) (11 measurements from 2 to 112 min after application). The transfer coefficients describing the outflow from the compartment 'Blood 2' have been chosen to reproduce same the ratio between excretion in the alimentary tract and via the urinary bladder.

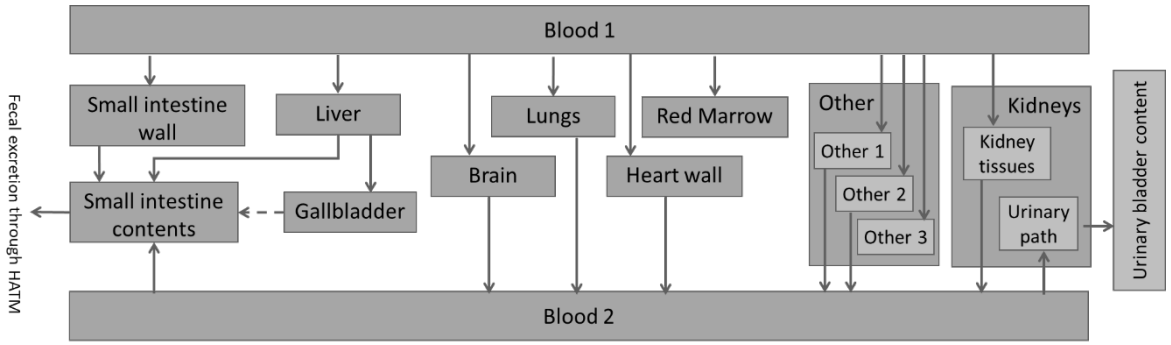

Fig. A.9.1. Biokinetic model for ^{11}C-labelled raclopride.

Table A.9.1. Values of the transfer coefficients (h^{-1}).

From	To	All age groups
Blood 1	Liver	3.74E+00
Blood1	Brain	6.24E-01
Blood 1	Red Marrow	4.16E-01
Blood 1	Lungs	4.16E-01
Blood 1	Heart wall	2.08E-01
Blood 1	Small intestine wall	1.66E+00
Blood 1	Kidney tissues	1.25E+00
Blood 1	Other 1	1.25E+00
Blood 1	Other 2	5.61E+00
Liver	Gallbladder content	1.56E-01
Liver	Small intestine contents	1.73E-02
Small intestine wall	Small intestine contents	2.10E+00
Brain	Blood 2	6.93E-01
Lungs	Blood 2	6.93E-01
Heart wall	Blood 2	6.93E-01
Kidney tissues	Blood 2	6.93E-01
Other 1	Blood 2	2.10E+00
Other 2	Blood 2	1.73E-01
Blood 2	Small intestine contents	3.73E+01
Blood 2	Urinary Pathway	8.27E+01
Urinary Path	Urinary bladder contents	1.20E+01

Radioactive half-life of ^{11}C: 20.39 min

A.9.3. Specific assumptions for the calculations

(A 55) Activity in liver is excreted according to the liver-biliary model (see A.6.3), with 90% of the activity being transferred to the gallbladder.

(A 56) Activity in the small intestine wall is assumed to be excreted into the contents.

A.9.4. References for ^{11}C-labelled raclopride

Glatting, G., Mottaghy, F.M., Karitzky, J., et al., 2004. Improving binding potential analysis in [^{11}C]raclopride PET studies using cluster analysis. Med. Phys. 31, 902–906.

ICRP, 2015. Radiation dose to patients from radiopharmaceuticals: a compendium of current information related to frequently used substances. ICRP Publication 128. Ann. ICRP 44(2S).

Ribeiro, M-J., Ricard, M., Bourgeois, S., et al., 2005. Biodistribution and radiation dosimetry of [^{11}C]raclopride in healthy volunteers. Eur. J. Nucl. Mol. Imag. 32, 952–958.

Slifstein, M., Lawrence, S., Kegeles, L.S., et al., 2007. [^{11}C]NNC 112 selectivity for dopamine D_1 and serotonin 5-HT_{2A} receptors: a PET study in healthy human subjects. J. Cerebr. Blood Flow Metab. 27, 1733–1741.

Slifstein, M., Suckow, R.F., Javitch, J.A., Cooper, T., 2011. Characterization of in vivo pharmacokinetic properties of the dopamine D_1 receptor agonist DAR-0100A in nonhuman primates using PET with [^{11}C] NNC112 and [^{11}C] raclopride. J. Cerebr. Blood Flow Metab. 31, 293–304.

A.10. ^{11}C-labelled substances (realistic maximum)

A.10.1. Biokinetic information

(A 57) The 'realistic maximum' model presented in *Publication 128* (ICRP, 2015) is intended to provide a conservative estimate of the dose received after administration of any substance labelled with ^{11}C. It assumes that 50% of the decay occurs while the substance passes the urinary bladder, and the remaining 50% of the total disintegration occurs when it is distributed homogeneously throughout the whole body.

A.10.2. Biokinetic model

(A 58) The compartmental model adopted here assumes that 50% of the activity is homogeneously distributed in all organ and tissues of the body, where it is retained indefinitely, and that 50% is eliminated in the urine, according to the dynamic bladder model.

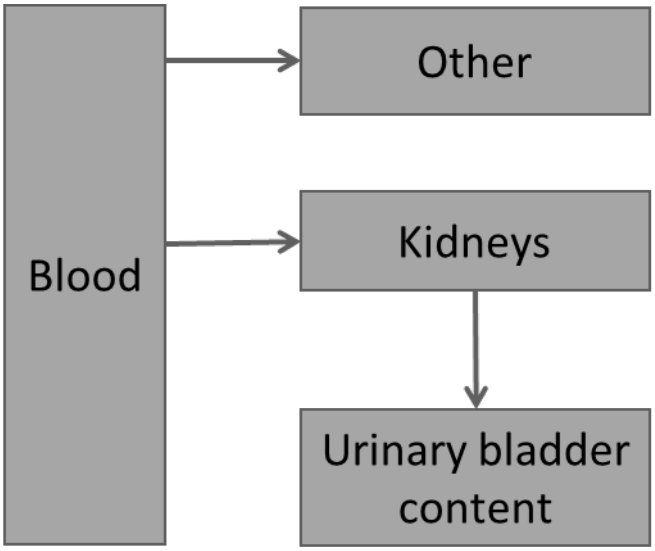

Fig. A.10.1. Biokinetic model for ^{11}C-labelled substances (realistic maximum).

Table A.10.1. Values of the transfer coefficients (h^{-1}).

From	To	All age groups
Blood	Other	1.80E+01
Blood	Kidneys	1.80E+01
Kidneys	Urinary bladder contents	1.20E+01

Radioactive half-life of ^{11}C: 20.39 min

A.10.3. Specific assumptions for the calculations

(A 59) None

A.10.4. References for ^{11}C-labelled substances (realistic maximum)

ICRP, 2015. Radiation dose to patients from radiopharmaceuticals: a compendium of current information related to frequently used substances. ICRP Publication 128. Ann. ICRP 44(2S).

A.11. ^{14}C-labelled neutral fat and free fatty acids

A.11.1. Biokinetic information

(A 60) The model for ^{14}C-labelled neutral fat and free fatty acids is the same as the one for ^{3}He-labelled neutral fat and free fatty acids. Refer to Section A.1 for more details.

(A 61) The half-life of ^{14}C is 5.70E+03 years.

A.12. ^{14}C-labelled urea

A.12.1. Biokinetic information

(A 62) Urea (carbamide, H_2NCONH_2) is the main end product in the human catabolism of proteins, polypeptides, amino acids, and other nitrogen-containing substances. It is freely water soluble and distributes rapidly into the total body water. The main part is excreted unchanged by the kidneys, while a small part diffuses into the intestinal content where it is broken down by urease-producing bacteria to ammonia and CO_2. The CO_2 is reabsorbed and equilibrates with bicarbonate, thus entering the CO_2/bicarbonate pools in the body and finally being exhaled by the lungs (Walser and Bodenlos, 1959).

(A 63) CO_2 is formed continuously in the metabolism of all organic substances in the body. Together with water, it forms carbonic acid (H_2CO_3), which dissociates and equilibrates with bicarbonate ions (HCO_3^-). The substances are present in all body fluids.

(A 64) A breath test employing oral administration of ^{14}C-urea is used to detect the presence of *Helicobacter pylori* in the stomach of patients with peptic ulcer and other gastric diseases. Normally, the stomach does not contain urease-producing bacteria, so the urea is rapidly absorbed unchanged into body water. *H. pylori*, on the other hand, produces urease and therefore brings about extensive early expiration of labelled CO_2, resulting in a positive breath test (Walser and Bodenlos, 1959; Marshall and Surveyor, 1988; Combs et al., 1999).

(A 65) The biokinetics of ^{14}C was studied by Leide-Svegborn et al. (1999) in subjects undergoing ^{14}C urea breath test for *H. pylori* infection (four adults and eight children aged 7-14 years), and in four adult volunteers. After oral administration of ^{14}C-urea, samples of exhaled air were taken up to 180 days after administration and samples of urine were collected up to 40 days. In 16 subjects including 11 patients who were not positive to *H. pylori*, ~88% of the administered activity was excreted in urine over the first 3 days in both adults and children. Adults exhaled slightly more activity on average than did children over the first 20 days.

(A 66) Gunnarson et al. (2002) performed a study in 7 children aged 3-6 years making use of accelerator mass spectrometry. Activity concentration in urine and exhaled air compared well with those for older children from the study mentioned above.

A.12.2. Biokinetic model

14C-labelled urea

(A 67) In the model originally presented in *Publication 80* (ICRP, 1998) and reproduced in the following reports (ICRP, 2008, 2015), orally administered ^{14}C-labelled urea is assumed to be completely and rapidly absorbed from the stomach ($T_{1/2}$=5 min) and then distributed in the total body water. Eighty percent is excreted by the kidneys with a half-time of 6 h, and 20% is broken down rapidly in the same way as intravenously administered urea to ammonia and CO_2, and then follow the model for CO_2/bicarbonate. In the case of *H. pylori* infection in the stomach, it is assumed that 65% is immediately converted to CO_2. The remaining 35% is resorbed from the stomach in the same way as in the normal case.

(A 68) In *Publication 158* (ICRP, 2024) a generic model for radiocarbon labelled substances with age-dependent transfer coefficients is introduced. According to this model, after ingestion the substances can be absorbed from the small intestine into the systemic circulation, and from there excreted in the urine or transferred to two compartments representing short and long-term retention in the systemic tissue, respectively. From the short-term tissue compartment, the substances can be recycled back to blood, eliminated through the alimentary tract or converted to CO_2. The substances present in the long-term tissue compartment are converted to CO_2.

According to this model, 59.5% of the activity in blood is eliminated in the urine, 14.3% in the alimentary tract and 26.2% is transformed into CO_2 and follows the model for CO_2/bicarbonate.

(A 69) The age-dependent model for ^{14}C-labelled urea presented here is an adaptation of the model of *Publication 158*, assuming complete and rapid absorption from the stomach into blood. The transfer coefficients have been adjusted in order to reproduce the ratios between transfer to the urinary path (80%) and to the CO_2/bicarbonate systemic model (20%) as assumed in the model for ^{14}C-labelled urea from *Publication 80*. In Figure A.12.1 the model for urea is shown coupled to the systemic model for CO_2/bicarbonate (see below).

(A 70) The transfer coefficients from the systemic tissues to blood and to the CO_2/bicarbonate model in adults have been scaled to corresponding transfer coefficients for ages 100 days, 1 year, 5 years, 10 years, and 15 years using following multiplicative factors: 4.0, 2.5, 2.5, 2.0, and 1.2, respectively. For more details on the age-dependency of the transfer coefficients please refer to *Publication 158*.

^{14}C-labelled carbon dioxide/bicarbonate

(A 71) The model originally presented in *Publication 80* (ICRP, 1998) and reproduced in the following reports (ICRP, 2008, 2015) was a modified version of the one presented by Winchell et al. (1970) and further refined by Stubbs and Marshall (1993).

(A 72) The biokinetic model adopted here is the one presented in *Publication 158* for members of the public with age-dependent parameters and is shown in Figure A.12.1 coupled to the urea model.

(A 73) The transfer coefficients from the systemic tissues and from bone surfaces to blood in adults have been scaled to corresponding transfer coefficients for the other ages using the same multiplicative factors as indicated above for the biokinetic model of ^{14}C-labelled urea. The rate of removal of carbon from trabecular or cortical bone volume at a given age is assumed to be the same as the corresponding rate of bone turnover as given in *Publication 89* (ICRP, 2002). For more details on the age-dependency of the transfer coefficients please refer to *Publication 158*.

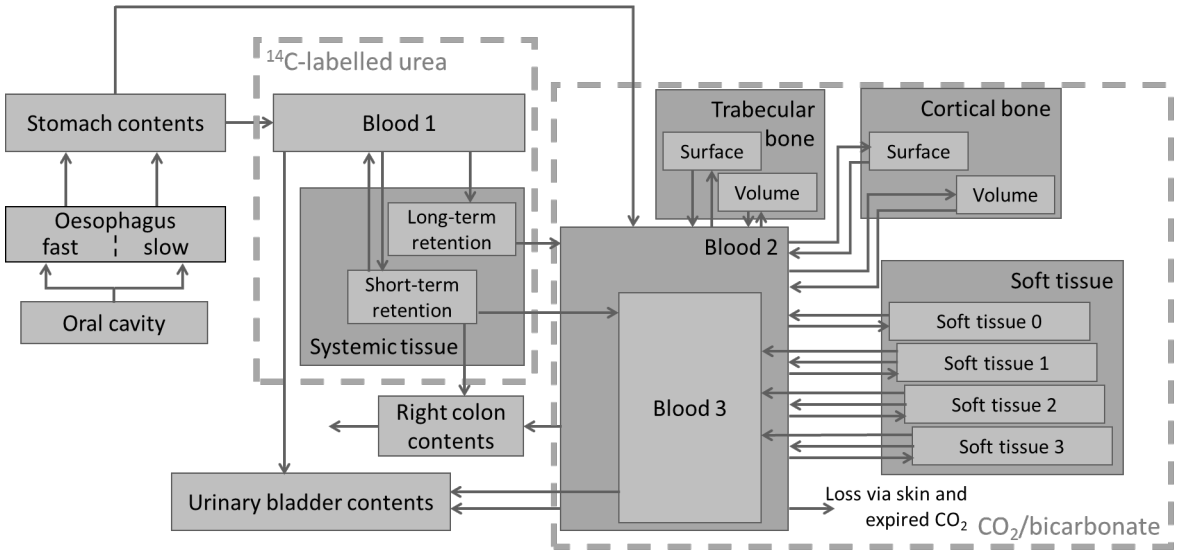

Fig. A.12.1. Biokinetic model for ^{14}C-labelled urea, including the transformation to CO_2. The outflow from the compartment 'Right colon contents' represents the elimination into the feces according to the HATM model.

2071 Table A.12.1. Values of the transfer coefficients (h^{-1}).

From	To	Adults	15 years	10 years	5 years	1 year	infant
Stomach contents	Blood_1*	8.32E+00	8.32E+00	8.32E+00	8.32E+00	8.32E+00	8.32E+00
Blood 1	Syst. tissue / short	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02
Blood 1	Syst. tissue / long	1.25E-02	1.25E-02	1.25E-02	1.25E-02	1.25E-02	1.25E-02
Blood 1	UB-contents	6.25E-02	6.25E-02	6.25E-02	6.25E-02	6.25E-02	6.25E-02
Syst. tissue / short	Blood 1	3.85E-03	4.63E-03	7.71E-03	9.63E-03	9.63E-03	1.54E-02
Syst. tissue / short	Blood 2	2.89E-03	3.47E-03	5.79E-03	7.21E-03	7.21E-03	1.15E-02
Syst. tissue / short	RC-contents	2.89E-03	2.89E-03	2.89E-03	2.89E-03	2.89E-03	2.89E-03
Syst. tissue / long	Blood 2	4.13E-04	4.96E-04	8.25E-04	1.03E-03	1.03E-03	1.65E-03
Blood 2	Out†	1.52E+00	1.52E+00	1.52E+00	1.52E+00	1.52E+00	1.52E+00
Blood 2	Soft tissue 0	2.50E+00	2.50E+00	2.50E+00	2.50E+00	2.50E+00	2.50E+00
Blood 2	Soft tissue 1	7.50E-02	7.50E-02	7.50E-02	7.50E-02	7.50E-02	7.50E-02
Blood 2	Soft tissue 2	1.25E-02	1.25E-02	1.25E-02	1.25E-02	1.25E-02	1.25E-02
Blood 2	Soft tissue 3	1.83E-02	1.83E-02	1.83E-02	1.83E-02	1.83E-02	1.83E-02
Blood 2	Trab. bone surface	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03
Blood 2	Cort. bone surface	2.50E-03	2.50E-03	2.50E-03	2.50E-03	2.50E-03	2.50E-03
Blood 2	Trab. bone volume	2.50E-04	2.50E-04	2.50E-04	2.50E-04	2.50E-04	2.50E-04
Blood 2	Cort. bone volume	1.67E-04	1.67E-04	1.67E-04	1.67E-04	1.67E-04	1.67E-04
Blood 2	UB-contents	2.71E-02	2.71E-02	2.71E-02	2.71E-02	2.71E-02	2.71E-02
Blood 2	RC-contents	6.25E-03	6.25E-03	6.25E-03	6.25E-03	6.25E-03	6.25E-03
Soft tissue 0	Blood 2	2.08E+00	2.50E+00	4.16E+00	5.21E+00	5.21E+00	8.33E+00
Soft tissue 1	Blood 2	5.54E-02	6.67E-02	1.11E-01	1.39E-01	1.39E-01	2.22E-01
Soft tissue 2	Blood 2	9.25E-03	1.11E-02	1.85E-02	2.31E-02	2.31E-02	3.70E-02
Soft tissue 3	Blood 2	6.92E-04	8.33E-04	1.39E-03	1.73E-03	1.73E-03	2.78E-03
Soft tissue 1	Blood 3	2.31E-03	2.77E-03	4.63E-03	5.79E-03	5.79E-03	9.25E-03
Soft tissue 2	Blood 3	3.85E-04	4.63E-04	7.71E-04	9.63E-04	9.63E-04	1.54E-03
Soft tissue 3	Blood 3	2.89E-05	3.47E-05	5.79E-05	7.21E-05	7.21E-05	1.15E-04
Trab. bone surface	Blood 2	7.21E-04	8.67E-04	1.45E-03	1.80E-03	1.80E-03	2.89E-03
Cort. bone surface	Blood 2	7.21E-04	8.67E-04	1.45E-03	1.80E-03	1.80E-03	2.89E-03
Trab. bone volume	Blood 2	2.05E-05	4.00E-05	5.50E-05	7.54E-05	1.20E-04	3.43E-04
Cort. bone volume	Blood 2	3.42E-06	2.17E-05	3.77E-05	6.38E-05	1.20E-04	3.43E-04
Blood 3	UB-contents	4.17E+01	4.17E+01	4.17E+01	4.17E+01	4.17E+01	4.17E+01

2072 * In the case of *H. pylori* infection in the stomach, this value is reduced to 2.91E+00 h^{-1}, and the transfer coefficient
2073 from 'Stomach contents' to 'Blood 2' (=0 in the healthy subjects) is equal to 5.41E+00 h^{-1}.
2074 † of which 1.508E+00 h^{-1} in expired air and 1.25E-02 h^{-1} via skin.
2075 Radioactive half-life of ^{14}C. 5.70E+03 years

2076 **A.12.3. Specific assumptions for the calculations**

(A 74) It is assumed that CO_2 produced in the systemic tissues after oral administration of ^{14}C-labelled urea enters the compartment Blood 2 in the CO_2/bicarbonate model. Similarly, the fraction which is immediately converted to CO_2 in the stomach of patients with *H. pylori* is assumed to be transferred directly to compartment Blood 2 in the CO_2/bicarbonate model.

A.12.4. References for ^{14}C-labelled urea

Combs, M.J., Stubbs, J.B., Agarwal, A.K., et al., 1999. Dose estimates for a capsule-based ^{14}C-urea breath test. In: S-Stelson, A.T., Stabin, M.G., Sparks, R.B. (Eds.), Proceedings of the Sixth International Radiopharmaceutical Dosimetry Symposium, Gatlinburg, TN, USA, May 7–10, 1996. Oak Ridge Associated Universities, Oak Ridge, TN. pp. 620–630.

Gunnarsson, M., Leide-Svegborn, S., Stenström, K., Skog, G., Nilsson, L.E., Hellborg,R., Mattsson, S., 2002. No radiation protection reasons for restrictions on ^{14}C urea breath tests in children. Br. J. Radiol. 75(900), 982-986.

ICRP, 1998. Radiation dose to patients from radiopharmaceuticals. Addendum 2 to ICRP Publication 53. ICRP Publication 80. Ann. ICRP 28(3).

ICRP, 2002. Basic anatomical and physiological data for use in radiological protection reference values. ICRP Publication 89. Ann. ICRP 32(3-4).

ICRP, 2008. Radiation dose to patients from radiopharmaceuticals. Addendum 3 to ICRP Publication 53. ICRP Publication 106. Ann. ICRP 38(1/2).

ICRP, 2015. Radiation dose to patients from radiopharmaceuticals: a compendium of current information related to frequently used substances. ICRP Publication 128. Ann. ICRP 44(2S).

ICRP, 2024. Dose coefficients for intakes of radionuclides by members of the public: Part 1. ICRP Publication 158. Ann. ICRP 53(4-5).

Leide-Svegborn, S., Stenström, K., Olofsson, M., et al., 1999. Biokinetics and radiation doses for carbon-14 urea in adults and children undergoing the Helicobacter pylori breath test. Eur. J. Nucl. Med. 26, 573–580.

Marshall, B.J., Surveyor, I., 1988. Carbon-14 urea breath test for the diagnosis of Campylobacter pylori associated gastritis. J. Nucl. Med. 29, 11–16.

Stubbs, J.B., Marshall, B.J., 1993. Radiation dose estimates for the carbon-14-labeled urea breath test. J. Nucl. Med. 34, 821–825.

Walser, M., Bodenlos, L.J., 1959. Urea metabolism in man. J. Clin. Invest. 38, 1617–1626.

Winchell, H.S., Stahelin, H., Kusubov, N., et al., 1970. Kinetics of CO_2-HCO_3^- in normal adult males. J. Nucl. Med. 12, 711–715.

A.13. ^{18}F-labelled amino acids (generic model)

A.13.1. Biokinetic information

(A 75) The model for ^{18}F-amino acids (generic model) is the same as the one for ^{11}C-amino acids. Refer to Section A.3 for more details.

(A 76) The radioactive half-life of ^{18}F is 109.77 min.

A.14. ^{18}F-labelled brain receptor substances (generic model)

A.14.1. Biokinetic information

(A 77) A large number of radiopharmaceuticals labelled with ^{18}F and ^{123}I have been developed for PET and single photon emission computer tomographic (SPECT) studies of different types of receptor in the human brain. For many of these substances, the available biokinetic data are insufficient to construct realistic compound-specific biokinetic models for the calculation of absorbed dose to persons undergoing an investigation. Therefore, a generic model for radionuclide-labelled brain receptor substances that would predict the internal radiation dose with sufficient accuracy for general radiation protection purposes has been developed.

(A 78) A review of the literature conducted for *Publication 106* (ICRP, 2008) had identified biokinetic and dosimetric data for five ^{18}F-labelled and 15 ^{123}I-labelled compounds considered to be potential substances for the clinical imaging of brain receptors. These data indicate that despite fairly large differences in chemical structure, the patterns of uptake in the human brain, and other tissues for which information is available, appear to be sufficiently similar to justify a generic model for each radionuclide. For details, the reader is referred to Booij et al. (1998a,b), Boundy et al. (1995), Deterding et al. (2001), Gründer et al. (2001, 2003), Kauppinen et al. (2003), Kuikka et al. (1994), Mitterhauser et al. (2004), Mozley et al. (1995, 1996), van de Wiele et al. (1999), Verhoeff et al. (1993a,b), Versijpt et al. (2000), Votaw et al. (1995), Volkow et al. (1995), and Waterhouse et al. (2003).

A.14.2. Biokinetic model

(A 79) The model proposed here is a compartmental version of the descriptive one presented in (ICRP, 2015). It assumes that fractions of 0.07, 0.08, 0.05, 0.02, 0.02, and 0.002 of the administered activity are distributed to the brain, liver, lungs, kidneys, stomach wall, and thyroid, respectively. The remaining activity is assumed to be distributed uniformly throughout the rest of the body. The biological half-time in all the tissues amount to 10 h.

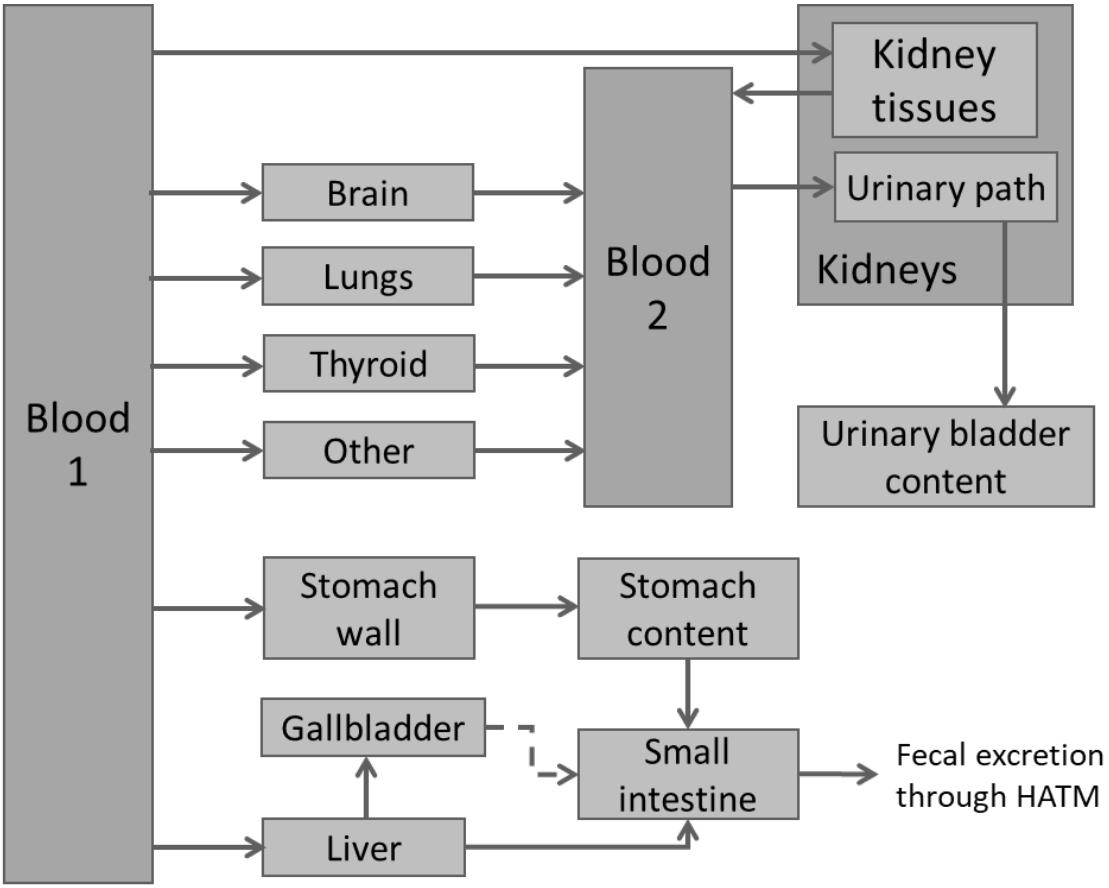

Fig. A.14.1. Biokinetic model for ^{18}F-labelled brain receptor substances (generic model).

Table A.14.1. Values of the transfer coefficients (h^{-1}).

From	To	All age groups
Blood 1	Brain	1.46E+00
Blood 1	Lungs	1.04E+00
Blood 1	Thyroid	4.16E-02
Blood 1	Liver	1.66E+00
Blood 1	Stomach wall	4.16E-01
Blood 1	Kidney Tissues	4.16E-01
Blood 1	Other	1.58E+01
Brain	Blood 2	6.93E-02
Lungs	Blood 2	6.93E-02
Thyroid	Blood 2	6.93E-02
Kidney Tissues	Blood 2	6.93E-02
Other	Blood 2	6.93E-02
Stomach wall	Stomach contents	6.93E-02
Liver	Small intestine	4.85E-02
Liver	Gallbladder	2.08E-02
Blood 2	Urinary Path	1.20E+02
Urinary Path	Urinary bladder content	1.20E+01

Radioactive half-life of ^{18}F: 109.77 min

A.14.3. Specific assumptions for the calculations

(A 80) Activity in liver is excreted according to the liver-biliary model (see A.6.3), with 30% of the activity being transferred to the gallbladder.

A.14.4. References for ^{11}C-labelled brain receptor substances (generic model)

Booij, J., Sokole, E.B., Stabin, M.G., Janssen, A.G.M., de Bruin, K., van Royen, E.A., 1998a. Human biodistribution and dosimetry of [^{123}I]FP-CIT: a potent radioligand for imaging of dopamine transporters. Eur. J. Nucl. Med. 25, 24–30.

Booij, J., Sokole, E.B., Stabin, M.G., Janssen, A.G.M., de Bruin, K., van Royen, E.A., 1998b. Human biodistribution and dosimetry of [^{123}I]FP-CIT: a potent radioligand for imaging of dopamine transporters: erratum. Eur. J. Nucl. Med. 25, 458.

Boundy, K.L., Barnden, L.R., Rowe, C.C., et al., 1995. Human dosimetry and biodistribution of iodine-123-iododexetimide: a SPECT imaging agent for cholinergic muscarinic neuroreceptors. J. Nucl. Med. 36, 1332–1338.

Deterding, T.A., Votaw, J.R., Wang, C.K., et al., 2001. Biodistribution and radiation dosimetry of the dopamine transporter ligand [^{18}F]FECNT. J. Nucl. Med. 42, 376–381.

Gründer, G., Siessmeier, T., Lange-Asschenfeldt, C., et al., 2001. [^{18}F]Fluoroethylflumaazenil: a novel tracer for PET imaging of human benzodiazepine receptors. Eur. J. Nucl. Med. 28, 1463–1470.

Gründer, G., Siessmeier, T., Piel, M., et al., 2003. Quantification of D2-like dopamine receptors in the human brain with [^{18}F]-desmethoxyfallypride. J. Nucl. Med. 44, 109–116.

ICRP, 2008. Radiation dose to patients from radiopharmaceuticals. Addendum 3 to ICRP Publication 53. ICRP Publication 106. Ann. ICRP 38(1/2).

ICRP, 2015. Radiation dose to patients from radiopharmaceuticals: a compendium of current information related to frequently used substances. ICRP Publication 128. Ann. ICRP 44(2S).

Kauppinen, T.A., Bergström, K.A., Heikman, P., Hiltunen, J., Ahonen, A.K., 2003. Biodistribution and radiation dosimetry of [^{123}I]ADAM in healthy human subjects: preliminary results. Eur. J. Nucl. Med. 30, 132–136.

Kuikka, J.T., Bergström, K.A., Ahonen, A., Länsimies, E., 1994. The dosimetry of iodine-123 labelled 2b-carbomethoxy-3b-(4-iodophenyl)tropane. Eur. J. Nucl. Med. 21, 53–56.

Mitterhauser, M., Wadsak, W., Wabnegger, L., et al., 2004. Biological evaluation of 2'-[^{18}F]fluoroflumazenil ([^{18}F]FFMZ): a potential GABA receptor ligand for PET. Nucl. Med. Biol. 31, 291–295.

Mozley, P.D., Stubbs, J.T., Kim, H-J., et al., 1995. Dosimetry of a D2/D3 dopamine receptor antagonist that can be used with PET or SPECT. J. Nucl. Med. 36, 1322–1331.

Mozley, P.D., Stubbs, J.T., Kim, H-J., et al., 1996. Dosimetry of an iodine-123-labeled tropane to image dopamine transporters. J. Nucl. Med. 37, 151–159.

van de Wiele, C., De Vos, F., De Sutter, J., et al., 1999. Biokinetics and dosimetry of (iodine-123)-iodomethyl-N,N-dimethyltamoxifen, an (anti)oestrogen receptor radioligand. Eur. J. Nucl. Med. 26, 1259–1264.

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A.15. ^{18}F-labelled choline

A.15.1. Biokinetic information

(A 81) Choline uptake is increased in cancerous tissues because the high metabolic rates of tumour cells require choline for the synthesis of phospholipids. For example, choline kinase is overexpressed in prostate cancer cells (Ramirez de Molina et al., 2002; Ackerstaff et al., 2003), thus making choline a suitable indicator for early and differential diagnosis of prostate cancer. PET with radiolabelled choline is therefore used for diagnosis of malignant and recurrent tumours, and metastases in prostate cancer patients (DeGrado et al., 2002; Schmid et al., 2005; Kwee et al., 2006; Steiner et al., 2009).

A.15.2. Biokinetic model

(A 82) The biokinetic model presented here is based on the results of a study conducted in the frame of the European Collaborative project MADEIRA (Hoeschen et al., 2010; Uusijärvi et al., 2010). In these investigations, biodistribution and excretion data were collected for up to 4 h after injection of the radiopharmaceutical (Janzen et al., 2010; Giussani et al., 2012; Tavola et al., 2012). Previous human studies with ^{11}C- or ^{18}F-choline were limited up to 1 h after administration (Roivainen et al., 2000; DeGrado et al., 2002; Sutinen et al., 2004; Schmid et al., 2005; Kwee et al., 2006; Steiner et al., 2009).

(A 83) The model consists of a central blood compartment which exchanges with liver, separated into two compartments, spleen, kidneys and other tissues (rest of the body). The passage from blood to the urinary bladder contents describes the fast urinary excretion, whereas the later excretion goes through the urinary path.

(A 84) This model differs from the one presented for ^{11}C-labelled choline. There is actually experimental evidence of potential differences between the pharmacokinetics of these two substances, especially with regard to the excretion. As discussed by DeGrado et al. (2002), these differences may be attributed to the presence of the fluorine atom, which renders the choline molecule less susceptible for oxidation to betaine, as usually observed with ^{11}C-labelled choline (Kwee et al., 2006).

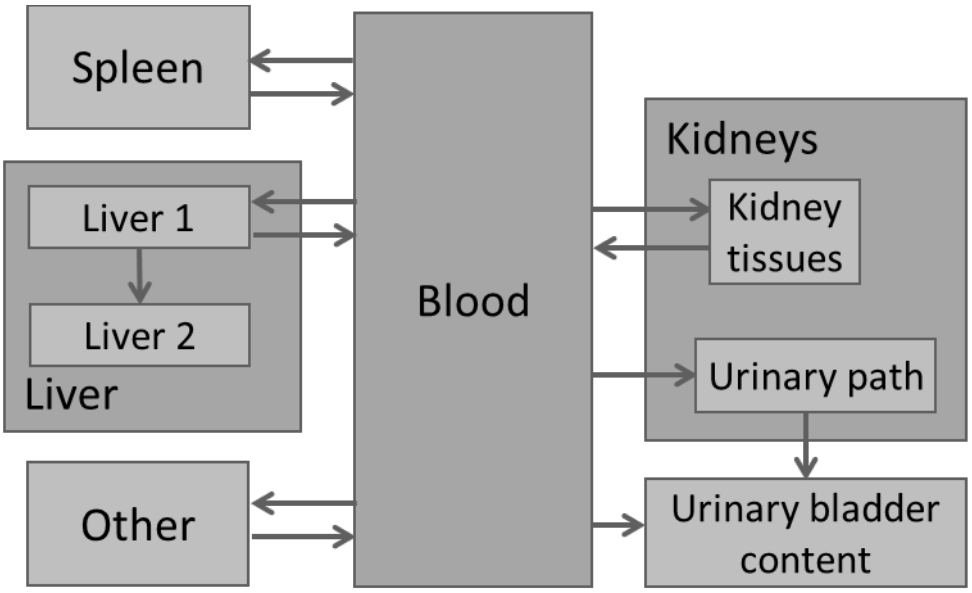

Fig. A.15.1. Biokinetic model for ^{18}F-labelled choline.

Table A.15.1. Values of the transfer coefficients (h^{-1}).

From	To	All age groups
Blood	Liver 1	9.66E-01
Blood	Spleen	6.78E-02
Blood	Kidney tissues	2.88E-01
Blood	Urinary path	2.52E-01
Blood	Urinary bladder contents	3.06E-02
Blood	Other	3.94E+00
Liver 1	Blood	1.10E+00
Liver 1	Liver 2	1.38E+00
Spleen	Blood	4.62E-01
Kidney tissues	Blood	3.72E-01
Other	Blood	2.76E-01
Urinary path	Urinary bladder contents	5.82E+00

Radioactive half-life of ^{18}F: 109.77 min

A.15.3. Specific assumptions for the calculations

(A 85) None.

A.15.4. References for ^{18}F-labelled choline

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2268 Table A.15.2. Time-integrated activity coefficients for ^{18}F-labelled choline (h).

Organs		
Blood		2.70E-01
Liver		4.22E-01
Kidneys		1.14E-01
Spleen		2.17E-02
Urinary bladder contents	Adult male	1.00E-01
	Adult female	1.04E-01
	15-year-old male	1.04E-01
	15-year-old female	1.02E-01
	10-year-old male/female	1.03E-01
	5-year-old male/female	1.04E-01
	1-year-old male/female	9.56E-02
	Infant male/female	7.46E-02
Other		1.62E+00

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2270 Table A.15.3. Dose coefficients for ^{18}F-labelled choline.

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	2.7E-02	3.3E-02	2.1E-02	2.3E-02	3.4E-02	3.4E-02	5.3E-02	5.3E-02	9.0E-02	9.0E-02	1.2E-01	1.2E-01
Brain	8.1E-03	9.5E-03	1.5E-02	1.6E-02	2.3E-02	2.3E-02	3.4E-02	3.4E-02	5.6E-02	5.6E-02	8.2E-02	8.2E-02
Breast	9.8E-03	1.1E-02	1.2E-02	1.3E-02	1.7E-02	1.6E-02	2.9E-02	8.8E-03	4.9E-02	4.9E-02	8.3E-02	8.3E-02
Colon wall	1.4E-02	1.5E-02	1.5E-02	1.5E-02	2.3E-02	2.3E-02	3.7E-02	3.7E-02	7.0E-02	6.9E-02	1.0E-01	1.0E-01
Endosteum (bone surface)	1.1E-02	1.3E-02	1.7E-02	1.7E-02	2.7E-02	2.7E-02	4.8E-02	4.9E-02	9.5E-02	9.5E-02	1.2E-01	1.2E-01
ET region	5.9E-03	7.3E-03	2.1E-02	2.0E-02	2.6E-02	2.6E-02	3.1E-02	3.1E-02	4.3E-02	4.3E-02	6.2E-02	6.2E-02
Gall bladder wall	3.0E-02	3.5E-02	2.7E-02	3.1E-02	4.0E-02	4.0E-02	5.8E-02	5.8E-02	9.2E-02	9.3E-02	1.2E-01	1.2E-01
Heart wall	1.7E-02	2.0E-02	1.4E-02	1.7E-02	2.5E-02	2.5E-02	3.9E-02	3.9E-02	6.8E-02	6.8E-02	1.0E-01	1.0E-01
Kidneys	6.2E-02	7.3E-02	7.0E-02	7.9E-02	1.0E-01	1.0E-01	1.6E-01	1.6E-01	2.8E-01	2.8E-01	4.4E-01	4.4E-01
Liver	5.0E-02	6.2E-02	6.2E-02	6.7E-02	9.6E-02	9.6E-02	1.4E-01	1.4E-01	2.5E-01	2.5E-01	3.4E-01	3.4E-01
Lung	1.4E-02	1.6E-02	1.3E-02	1.5E-02	2.2E-02	2.2E-02	3.4E-02	3.5E-02	6.6E-02	6.6E-02	9.6E-02	9.6E-02
Lymphatic nodes	1.3E-02	1.5E-02	1.5E-02	1.4E-02	2.0E-02	2.0E-02	3.4E-02	3.4E-02	5.8E-02	5.8E-02	8.5E-02	8.5E-02
Muscle	9.6E-03	1.2E-02	1.1E-02	1.1E-02	1.8E-02	1.8E-02	2.8E-02	2.9E-02	5.2E-02	5.2E-02	8.7E-02	7.9E-02
Oesophagus	1.4E-02	1.7E-02	1.6E-02	1.8E-02	2.6E-02	6.4E-02	4.3E-02	4.3E-02	6.8E-02	6.9E-02	1.0E-02	1.0E-02
Oral mucosa	8.7E-03	1.0E-02	2.3E-02	2.2E-02	3.0E-02	3.0E-02	3.6E-02	3.6E-02	5.3E-02	5.4E-02	9.0E-02	9.1E-02
Ovaries	-	1.8E-02	-	2.1E-02	-	2.8E-02	-	4.5E-02	-	7.7E-02	-	1.0E-01
Pancreas	2.2E-02	2.5E-02	1.8E-02	2.2E-02	3.0E-02	3.0E-02	4.6E-02	4.6E-02	7.5E-02	7.5E-02	1.1E-01	1.1E-01
Prostate	1.6E-02	-	1.7E-02	-	2.8E-02	-	4.3E-02	-	8.2E-02	-	9.8E-02	-
Red marrow	1.6E-02	2.0E-02	1.8E-02	2.0E-02	2.7E-02	2.7E-02	4.1E-02	4.1E-02	7.2E-02	7.2E-02	1.1E-01	1.1E-01
Salivary glands	7.7E-03	9.4E-03	2.3E-02	2.0E-02	2.7E-02	2.7E-02	3.6E-02	3.6E-02	5.7E-02	5.7E-02	9.6E-02	9.6E-02
Skin	7.4E-03	8.8E-03	9.2E-03	1.0E-02	1.5E-02	1.5E-02	2.5E-02	2.5E-02	4.6E-02	4.6E-02	6.9E-02	6.9E-02
Small intestine wall	1.4E-02	1.8E-02	1.4E-02	1.6E-02	2.1E-02	2.1E-02	3.5E-02	3.6E-02	6.5E-02	6.5E-02	9.3E-02	9.3E-02
Spleen	2.8E-02	3.5E-02	2.9E-02	3.4E-02	4.9E-02	4.9E-02	7.8E-02	7.8E-02	1.4E-01	1.4E-01	2.1E-01	2.1E-01
Stomach wall	1.6E-02	2.1E-02	1.6E-02	1.8E-02	2.7E-02	2.7E-02	4.0E-02	4.0E-02	7.7E-02	7.7E-02	1.1E-01	1.1E-01
Testes	9.2E-03	-	1.3E-02	-	2.0E-02	-	3.0E-02	-	4.9E-02	-	6.5E-02	-
Thymus	9.5E-03	1.1E-02	1.3E-02	1.4E-02	2.1E-02	2.1E-02	3.4E-02	3.4E-02	6.3E-02	6.3E-02	9.2E-02	9.2E-02
Thyroid	9.9E-03	1.2E-02	1.4E-02	1.4E-02	2.0E-02	2.0E-02	3.5E-02	3.5E-02	5.7E-02	5.7E-02	8.2E-02	8.2E-02
Urinary bladder wall	2.9E-02	3.5E-02	3.4E-02	3.5E-02	5.3E-02	5.3E-02	7.4E-02	7.4E-02	1.2E-01	1.2E-01	1.6E-01	1.5E-01
Uterus/ cervix	-	1.9E-02	-	6.9E-02	-	9.4E-02	-	4.9E-02	-	2.0E-01	-	2.2E-01
Effective dose (mSv/MBq)	1.8E-02		2.0E-02		2.9E-02		4.4E-02		7.8E-02		1.1E-01	

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A.16. ^{18}F-labelled fluorodeoxyglucose (2-[^{18}F]FDG)

A.16.1. Biokinetic information

(A 86) ^{18}F-labelled fluorodeoxyglucose, or 2-deoxy-2-[^{18}F]-fluoro-D-glucose (2-[^{18}F]FDG), is a glucose analogue used in the characterisation of glucose metabolism for diagnosis or follow-up of cancer, and for investigation of cerebral and myocardial glucose metabolism. Following intravenous administration, 2-[^{18}F]FDG is rapidly cleared from blood and distributed to other body organs and tissues. It is excreted via kidneys-urinary path thus showing a substantial uptake in urinary bladder contents. In addition to urinary bladder contents, the following organs and tissues are known to have a notable uptake of 2-[^{18}F]FDG higher than the general level of ^{18}F activity in the body: heart wall, brain, liver, lungs, pancreas, spleen and kidneys.

(A 87) The data used for the definition of the biokinetic model of 2-[^{18}F]FDG are primarily measurements of ^{18}F retention and excretion published by different authors (Mejia et al., 1991; Deloar et al., 1998; Hays and Segall, 1999; Hays et al., 2002). Specifically, for heart wall, liver, lungs activities of 2-[^{18}F]FDG measured by Hays and Segall (1999) were employed. For brain, kidneys, spleen and pancreas the data reported by Mejia et al. (1991) and Deloar et al. (1998) were considered. In addition to the data provided for plasma and erythrocytes by Hays and Segall (1999), time-activity data of 2-[^{18}F]FDG in blood obtained within the study by Brix et al. (2020) were used to describe the clearance of ^{18}F activity from the circulation. To model the urinary excretion of 2-[^{18}F]FDG, the data published by Hays et al. (2002), Mejia et al. (1991) and Bach-Gansmo et al. (2012) were employed. Due to substantial variations in these data, additional data were collected at Skåne University Hospital Malmö, Sweden and used to validate the urinary excretion of 2-[^{18}F]FDG predicted by the biokinetic model.

(A 88) Blood is explicitly included as the central exchange compartment in the biokinetic model. It is modelled by two sub-compartments — (1) plasma that transports 2-[^{18}F]FDG to other body organs and tissues and (2) erythrocytes, analogously to (Hays and Segall, 1999). Besides blood, heart wall, brain, liver, lungs, pancreas, spleen, kidneys and urinary bladder contents are considered as source regions in the model. To account for 2-[^{18}F]FDG transported by plasma to body tissues besides these explicitly modelled source regions, an additional source region 'other' is included. Two sub-compartments are used for heart wall and the source region 'other' to model a short- and a long-term retention of 2-[^{18}F]FDG. It is assumed that biodistribution of 2-[^{18}F]FDG can be described as a first-order-kinetics process. Recycling is also considered, allowing for material to flow back and forth between compartments. A detailed description of the biokinetic model for 2-[^{18}F]FDG is given in (Kamp et al., 2023).

A.16.2. Biokinetic model

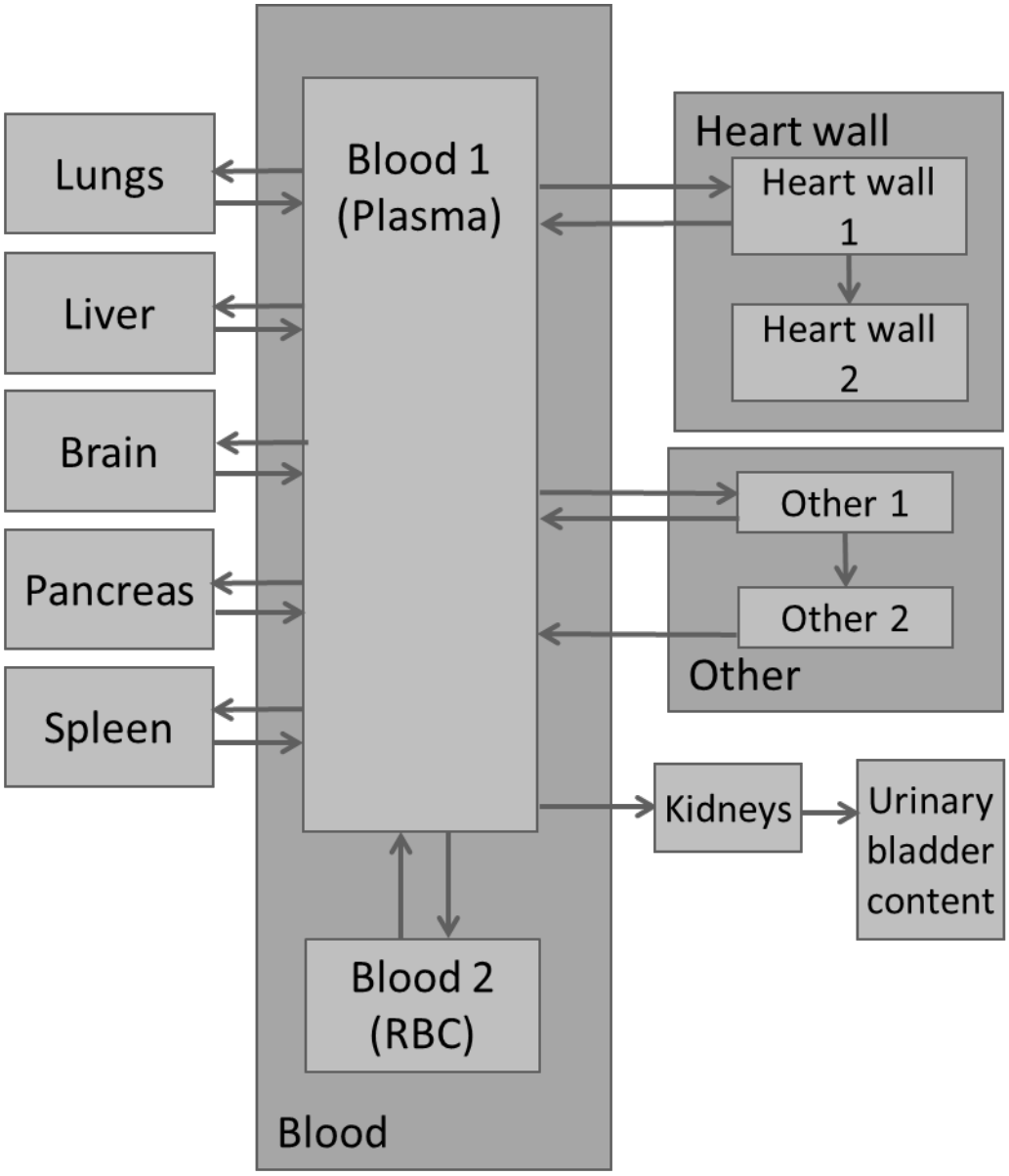

Fig. A.16.1. Biokinetic model for ^{18}F-labelled fluorodeoxyglucose.

Table A.16.1. Values of the transfer coefficients (h^{-1}).

From	To	All age groups
Blood 1	Blood 2	2.01E+02
Blood 1	Brain	1.12E+00
Blood 1	Lungs	4.30E-01
Blood 1	Liver	8.08E+00
Blood 1	Heart Wall 1	1.19E+00
Blood 1	Other 1	2.54E+01
Blood 1	Kidneys	1.32E+00
Blood 1	Pancreas	3.90E-01
Blood 1	Spleen	2.80E-01
Blood 2	Blood 1	4.41E+2
Brain	Blood 1	8.00E-1
Heart Wall 1	Blood 1	2.06E+0
Heart Wall 1	Heart Wall 2	2.00E-1
Kidneys	UB Contents	9.20E+0
Liver	Blood 1	2.10E+1
Lungs	Blood 1	9.59E+0
Other 1	Blood 1	5.30E+0
Other 1	Other 2	8.40E-1
Other 2	Blood 1	7.80E-1
Pancreas	Blood 1	1.12E+1
Spleen	Blood 1	7.73E+0

Radioactive half-life of ^{18}F: 109.77 min

A.16.3. Specific assumptions for the calculations

(A 89) The calculations were performed under the assumption that the patients emptied their bladder before the first scan, at 1 hour after injection. The subsequent voidings occur when the bladder is full according to the dynamic bladder model.

A.16.4. References for ^{18}F-labelled fluorodeoxyglucose

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Table A.16.2. Time-integrated activity coefficients for ^{18}F-labelled fluorodeoxyglucose (h).

Organs		
Blood		2.78E-01
Brain		1.82E-01
Lung tissue		8.25E-03
Liver		7.23E-02
Heart wall		1.32E-01
Kidneys		2.63E-02
Pancreas		6.44E-03
Spleen		6.60E-03
Urinary bladder contents	Adult male	3.00E-01
	Adult female	3.20E-01
	15-year-old male	3.20E-01
	15-year-old female	3.00E-01
	10-year-old male/female	3.11E-01
	5-year-old male/female	3.03E-01
	1-year-old male/female	2.84E-01
	Infant male/female	2.42E-01
Other		1.28E+00

2337 Table A.16.3. Dose coefficients for ^{18}F-labelled fluorodeoxyglucose.

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	1.4E-02	1.6E-02	1.2E-02	1.3E-02	2.0E-02	2.0E-02	3.4E-02	3.4E-02	6.5E-02	6.5E-02	8.4E-02	8.3E-02
Brain	3.0E-02	3.3E-02	3.5E-02	3.8E-02	3.7E-02	4.1E-02	4.1E-02	4.5E-02	5.6E-02	5.6E-02	8.0E-02	8.0E-02
Breast	7.6E-03	9.7E-03	9.2E-03	1.0E-02	1.4E-02	1.4E-02	2.5E-02	2.4E-02	4.2E-02	4.2E-02	7.4E-02	7.3E-02
Colon wall	1.2E-02	1.5E-02	1.5E-02	1.4E-02	2.2E-02	2.2E-02	3.7E-02	3.5E-02	7.2E-02	7.0E-02	9.9E-02	9.7E-02
Endosteum (bone surface)	1.0E-02	1.2E-02	1.6E-02	1.6E-02	2.4E-02	2.4E-02	4.5E-02	4.4E-02	8.9E-02	8.9E-02	1.2E-01	1.2E-01
ET region	7.6E-03	8.5E-03	2.0E-02	2.0E-02	2.5E-02	2.5E-02	2.9E-02	2.9E-02	4.0E-02	4.0E-02	5.8E-02	5.8E-02
Gall bladder wall	1.1E-02	1.3E-02	1.1E-02	1.4E-02	1.8E-02	1.8E-02	2.9E-02	2.9E-02	4.9E-02	5.0E-02	7.2E-02	7.2E-02
Heart wall	6.5E-02	8.4E-02	8.3E-02	9.1E-02	1.4E-01	1.4E-01	2.2E-01	2.2E-01	3.9E-01	3.9E-01	5.8E-01	5.8E-01
Kidneys	2.0E-02	2.3E-02	2.2E-02	2.4E-02	3.2E-02	3.2E-02	5.3E-02	5.3E-02	8.9E-02	8.9E-02	1.3E-01	1.3E-01
Liver	1.5E-02	1.8E-02	1.7E-02	2.0E-02	2.8E-02	2.8E-02	4.2E-02	4.3E-02	7.4E-02	7.4E-02	1.0E-01	1.0E-01
Lung	1.3E-02	1.7E-02	1.3E-02	1.4E-02	2.0E-02	2.0E-02	3.0E-02	3.0E-02	5.8E-02	5.8E-02	8.6E-02	8.6E-02
Lymphatic nodes	1.3E-02	1.4E-02	1.2E-02	1.2E-02	1.8E-02	1.8E-02	3.0E-02	3.0E-02	5.1E-02	5.1E-02	7.4E-02	7.4E-02
Muscle	8.3E-03	1.0E-02	9.7E-03	1.0E-02	1.6E-02	1.6E-02	2.6E-02	2.5E-02	4.8E-02	4.8E-02	7.2E-02	7.2E-02
Oesophagus	1.5E-02	1.7E-02	1.6E-02	1.6E-02	2.5E-02	2.5E-02	4.0E-02	4.0E-02	6.7E-02	6.7E-02	9.5E-02	9.5E-02
Oral mucosa	8.8E-03	9.9E-03	2.0E-02	2.0E-02	2.7E-02	2.7E-02	3.3E-02	3.3E-02	5.0E-02	5.0E-02	8.4E-02	8.5E-02
Ovaries	-	2.4E-02	-	3.7E-02	-	5.0E-02	-	7.3E-02	-	1.2E-01	-	1.3E-01
Pancreas	1.6E-02	1.8E-02	1.7E-02	1.9E-02	2.8E-02	2.8E-02	4.5E-02	4.5E-02	7.9E-02	7.9E-02	1.2E-01	1.2E-01
Prostate	2.7E-02	-	3.0E-02	-	5.2E-02	-	7.4E-02	-	1.4E-01	-	1.5E-01	-
Red marrow	1.5E-02	1.8E-02	1.8E-02	1.9E-02	2.5E-02	2.5E-02	3.9E-02	3.8E-02	6.8E-02	6.8E-02	1.0E-01	1.0E-01
Salivary glands	7.8E-03	9.7E-03	2.1E-02	1.9E-02	2.5E-02	2.5E-02	3.3E-02	3.3E-02	5.2E-02	5.2E-02	8.9E-02	8.9E-02
Skin	6.3E-03	7.6E-03	8.0E-03	8.6E-03	1.3E-02	1.3E-02	2.2E-02	2.2E-02	4.2E-02	4.2E-02	6.3E-02	6.3E-02
Small intestine wall	1.3E-02	1.7E-02	1.2E-02	1.3E-02	1.8E-02	1.9E-02	3.3E-02	3.5E-02	6.3E-02	6.3E-02	8.8E-02	8.6E-02
Spleen	1.4E-02	1.7E-02	1.4E-02	1.6E-02	2.3E-02	2.3E-02	3.8E-02	3.8E-02	7.0E-02	7.0E-02	1.0E-01	1.0E-01
Stomach wall	1.2E-02	1.3E-02	1.1E-02	1.3E-02	1.8E-02	1.8E-02	3.1E-02	3.1E-02	5.8E-02	5.8E-02	8.1E-02	8.1E-02
Testes	8.6E-03	-	1.9E-02	-	2.4E-02	-	3.9E-02	-	5.5E-02	-	7.2E-02	-
Thymus	9.8E-03	1.2E-02	1.4E-02	1.5E-02	2.2E-02	2.2E-02	3.6E-02	3.6E-02	7.0E-02	7.0E-02	1.0E-01	1.0E-01
Thyroid	9.1E-03	1.1E-02	1.3E-02	1.3E-02	1.9E-02	1.8E-02	3.2E-02	3.2E-02	5.4E-02	5.3E-02	7.7E-02	7.7E-02
Urinary bladder wall	7.3E-02	8.9E-02	8.8E-02	8.9E-02	1.4E-01	1.4E-01	1.8E-01	1.8E-01	2.6E-01	2.6E-01	3.4E-01	3.4E-01
Uterus/ cervix	-	3.2E-02	-	8.9E-02	-	1.2E-01	-	8.6E-02	-	3.2E-01	-	3.1E-01
Effective dose (mSv/MBq)	1.7E-02		2.0E-02		2.9E-02		4.3E-02		7.5E-02		1.1E-01	

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A.17. ^{68}Ga-labelled DOTANOC

A.17.1. Biokinetic information

(A 90) ^{68}Ga-labelled somatostatin derivatives such as ^{68}Ga-DOTANOC are of a high interest for imaging of cancer tumors showing an overexpression of somatostatin receptors. The latter have been identified in neuroendocrine tumors, brain tumors, prostate cancer, breast cancer, small cell lung cancer and malignant lymphoma (Pettinato et al., 2008; Prasad and Baum, 2010).

A.17.2. Biokinetic model

(A 91) The biokinetic model for ^{68}Ga-DOTANOC was developed based on the distribution of ^{68}Ga after an intravenous injection of approximately 2.5 MBq kg^{-1} of ^{68}Ga-DOTANOC reported by Pettinato et al. (2008). The distribution study included nine subjects (six male and three female), all being cancer patients with different types of neuroendocrine tumors.

(A 92) Blood was included as the central exchange compartment in the model. A recycling structure was assumed allowing the transfer of material from blood to the source regions and back. Spleen, liver, lungs, kidneys, urinary bladder contents, pituitary gland and 'other' were considered as source regions for ^{68}Ga-DOTANOC besides blood.

(A 93) Regional blood volumes (ICRP, 2002) were included in the model for each source region. Source region 'heart content' considered by Pettinato et al. (2008) was associated to total blood and assumed to account for 9 % of it (ICRP, 2002). From the fit of the model to the experimental data it was deduced that the activity of ^{68}Ga measured in the lungs corresponds to the activity in blood in this tissue, so no lung compartment is present in the final model.

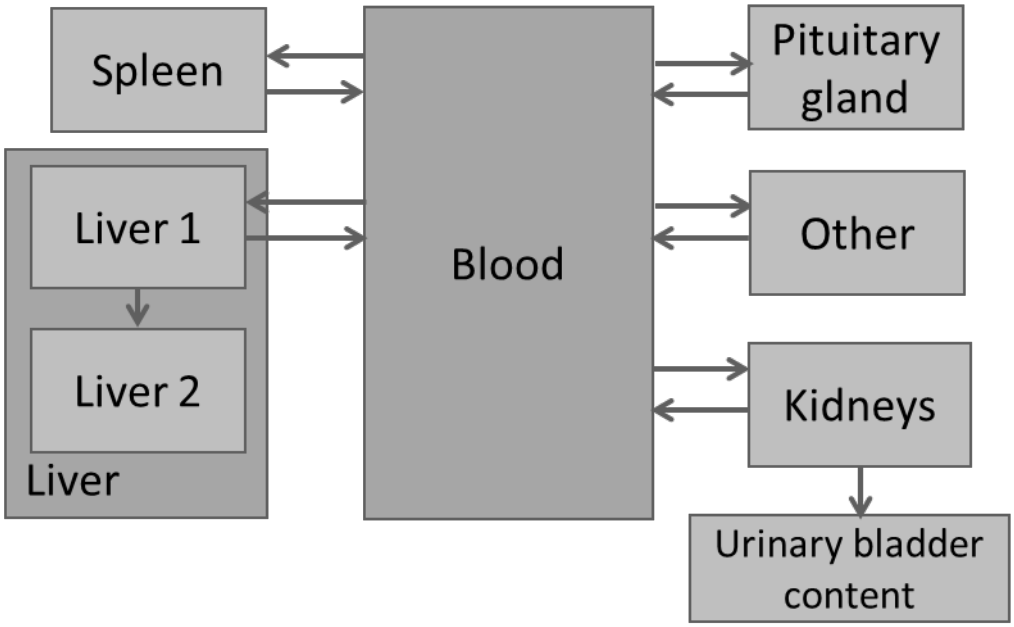

Fig. A.17.1. Biokinetic model for ^{68}Ga-labelled DOTANOC.

Table A.17.1. Values of the transfer coefficients (h^{-1}).

From	To	All age groups
Blood	Kidneys	5.34E+00
Blood	Liver 1	6.27E+00
Blood	Pituitary gland	1.55E-05
Blood	Spleen	2.60E-01
Blood	Other	1.89E+01
Liver 1	Liver 2	1.74E-01
Liver 1	Blood	1.33E+01
Kidneys	Blood	1.27E+01
Pituitary gland	Blood	1.62E+00
Spleen	Blood	1.43E+00
Other	Blood	1.89E+00
Kidneys	Urinary bladder contents	2.88E+00

Radioactive half-life of ^{68}Ga: 67.71 min

A.17.3. Specific assumptions for the calculations

(A 94) None.

A.17.4. References for ^{68}Ga-labelled DOTANOC

ICRP, 2002. Basic anatomical and physiological data for use in radiological protection reference values. ICRP Publication 89. Ann. ICRP 32(3-4).

Pettinato, C., Sarnelli, A., Di Donna, M., et al., 2008. ^{68}Ga-DOTANOC: biodistribution and dosimetry in patients affected by neuroendocrine tumors. Eur. J. Nucl. Med. Mol. Imaging 35(1), 72-9.

Prasad, V., Baum, R.P., 2010. Biodistribution of the Ga-68 labeled somatostatin analogue DOTA-NOC in patients with neuroendocrine tumors: characterization of uptake in normal organs and tumor lesions. Q. J. Nucl. Med. Mol. Imaging 54(1), 61-7.

A.18. ^{68}Ga-labelled DOTATATE

A.18.1. Biokinetic information

(A 95) ^{68}Ga-labelled DOTATATE is another agent used in cancer imaging of somatostatin receptor-expressing tumors (Sandström et al., 2013; Walker et al., 2013; Bodei et al., 2017). The distribution data reported by Sandström et al. (2013) and Walker et al. (2013) were used to develop the biokinetic model of ^{68}Ga-labelled DOTATATE.

A.18.2. Biokinetic model

(A 96) The source regions included blood as the central compartment, liver, spleen, red marrow, adrenals, lungs, kidneys, urinary bladder contents and 'other'. For those source regions for which the time-activity data were not available, the time-integrated activity coefficients were employed in the model fit. The time-activity data for spleen reported by Walker et al. (2013) and Sandström et al. (2013) showed substantial differences. The latter were used in the modelling.

(A 97) Gallium-68-labelled DOTATATE is excreted mainly via kidneys (Bodei et al., 2017). The human alimentary tract model with reference transfer coefficients (ICRP, 2006) was included to consider the alimentary tract excretion route.

(A 98) Regional blood volumes (ICRP, 2002) were included in the model for each source region. For several organs and tissues the transfer coefficients back to blood reached zero during the model fit, meaning an infinite retention in the corresponding source regions. Analogously to ^{68}Ga-labelled DOTANOC, the measured activity of ^{68}Ga in lungs occurred to correspond to the activity in blood inside the lungs.

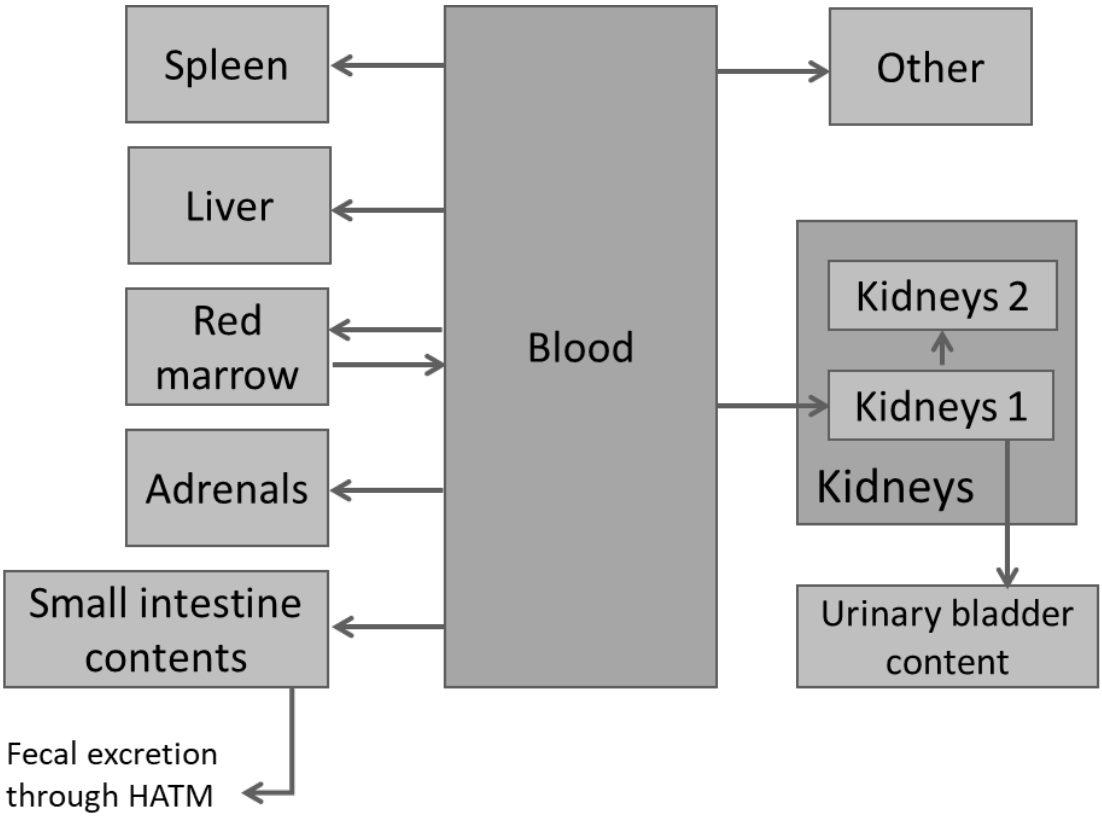

Fig. A.18.1. Biokinetic model for ^{68}Ga-labelled DOTATATE.

Table A.18.1. Values of the transfer coefficients (h^{-1}).

From	To	All age groups
Blood	Adrenals	3.79E-02
Blood	Liver	1.91E+00
Blood	Spleen	4.56E-01
Blood	Small intestine contents	4.24E-01
Blood	Red (active) bone marrow	5.46E-01
Blood	Kidneys 1	1.86E+00
Blood	Other	1.46E+01
Red (active) bone marrow	Blood	2.92E-01
Kidneys 1	Kidneys 2	8.17E+00
Kidneys 1	Urinary bladder contents	1.48E+01
Small intestine contents	Right colon contents	2.50E-01

Radioactive half-life of ^{68}Ga: 67.71 min

A.18.3. Specific assumptions for the calculations

(A 99) None.

A.18.4. References for ^{68}Ga-labelled DOTATATE

Bodei, L., Ambrosini, V., Herrmann, K., et al., 2017. Current Concepts in ^{68}Ga-DOTATATE Imaging of Neuroendocrine Neoplasms: Interpretation, Biodistribution, Dosimetry, and Molecular Strategies. J. Nucl. Med. 58(11), 1718-1726.

ICRP, 2002. Basic anatomical and physiological data for use in radiological protection reference values. ICRP Publication 89. Ann. ICRP 32(3-4).

ICRP, 2006. Human alimentary tract model for radiological protection. ICRP Publication 100. Ann. ICRP 36(1-2).

Sandström, M., Velikyan, I., Garske-Roman, U., et al., 2013. Comparative biodistribution and radiation dosimetry of ^{68}Ga-DOTATOC and ^{68}Ga-DOTATATE in patients with neuroendocrine tumors. J. Nucl. Med. 54(10), 1755-9.

Walker, R.C., Smith, G.T., Liu, E., et al., 2013. Measured human dosimetry of ^{68}Ga-DOTATATE. J. Nucl. Med. 54(6), 855-60.

A.19. ^{68}Ga-labelled HIGH-AFFINITY DOTATATE

A.19.1. Biokinetic information

(A 100) Gallium-68-labelled DOTA-3-iodo-Tyr3-Thr8-octreotide analogues, termed 'high-affinity DOTATATEs (HA-DOTATATEs)', have proved to have superior binding characteristics compared with other ^{68}Ga-labelled somatostatin analogues (Schottelius et al., 2015), and have been recommended as substitutes (Brogsitter et al., 2013, 2014).

(A 101) Hartmann et al. (2014) published a detailed investigation of the biodistribution and radiation dosimetry of ^{68}Ga-labelled HA-DOTATATE in seven male patients. Blood activity curves in blood, liver, spleen, adrenals, and kidneys, as well as calculated values of the time-integrated activities (cumulated activities), are given here.

A.19.2. Biokinetic model

(A 102) Based on the above data, the proposed biokinetic model assumes that clearance from blood has two components with half-times of 0.83 min (60%) and 7 min (40%). The first component is distributed to the kidneys (5%), liver (15%), spleen (4.4%), red marrow (1.9%), adrenals (0.08%), and rest of the body (28.62%), and the remaining 5% is excreted by the renal system according to the kidney–bladder model (renal transit time 5 min). The second component is distributed to the liver (12%), spleen (3.6%), red marrow (1.6%), adrenals (0.07%), and rest of the body (22.73%). Once taken up by the organs and tissues, the activity is considered to stay there indefinitely.

(A 103) This model is not applicable to ^{68}Ga-labelled DOTATATE.

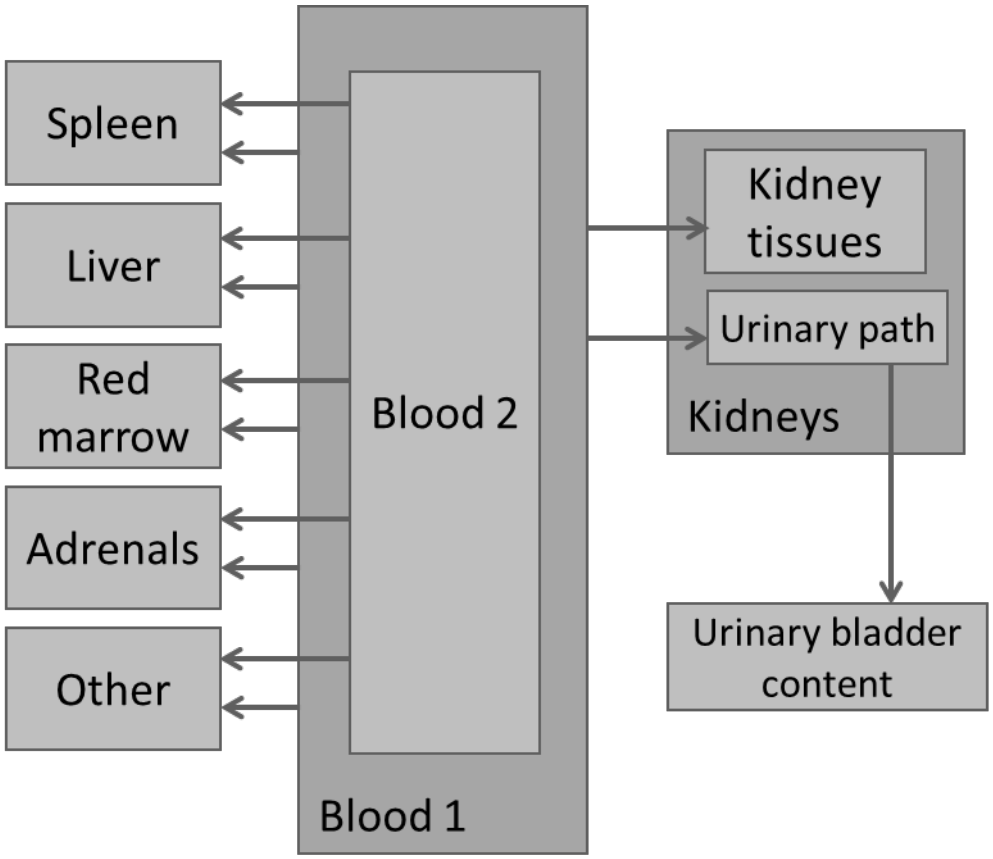

Fig. A.19.1. Biokinetic model for ^{68}Ga-labelled high-affinity dotatate.

Table A.19.1. Values of the transfer coefficients (h^{-1}).

From	To	All age groups
Blood 1	Adrenals	6.68E-02
Blood 1	Kidney tissues	4.18E+00
Blood 1	Liver	1.25E+01
Blood 1	Red Marrow	1.59E+00
Blood 1	Spleen	3.67E+00
Blood 1	Other	2.39E+01
Blood 1	Urinary Path	4.18E+00
Blood 2	Adrenals	1.04E-02
Blood 2	Liver	1.78E+00
Blood 2	Red Marrow	2.38E-01
Blood 2	Spleen	5.35E-01
Blood 2	Other	3.38E+00
Urinary Path	Urinary bladder contents	1.20E+01

Radioactive half-life of ^{68}Ga: 67.71 min

A.19.3. Specific assumptions for the calculations

(A 104) None.

A.19.4. References for ^{68}Ga-labelled high-affinity dotatate

Brogsitter, C., Schottelius, M., Zo¨ phel, K., et al., 2013. Twins in spirit: DOTATATE and high-affinity DOTATATE. Eur. J. Nucl. Med. Mol. Imaging 40, 1789.

Brogsitter, C., Zöphel, K., Hartmann, H., et al., 2014. Twins in spirit part II: DOTATATE and high-affinity DOTATATE – the clinical experience. Eur. J. Nucl. Med. Mol. Imaging 41, 1158–1165.

Hartmann, H., Freudenberg, R., Oehme, L., et al., 2014. Dosimetric measurements of ^{68}Ga-high affinity DOTATATE. Twins in spirit part III. Nuklearmedizin 53, 211–216.

Schottelius, M., Šimeček, J., Hoffmann, F., et al., 2015. Twins in spirit – episode I: comparative preclinical evaluation of [^{68}Ga]DOTATATE and [^{68}Ga]HA-DOTATATE. EJNMMI Res. 5, 22.

A.20. ^{68}Ga-labelled DOTATOC

A.20.1. Biokinetic information

(A 105) An alternative ^{68}Ga-labelled somatostatin derivative used for imaging of cancer tumors showing an overexpression of somatostatin receptors is ^{68}Ga-DOTATOC. Hartmann et al. (2009) and Sandström et al. (2013) investigated the distribution and dosimetry of ^{68}Ga-DOTATOC, their data were used to set up a compartmental biokinetic model.

A.20.2. Biokinetic model

(A 106) Since only the concentration of ^{68}Ga activity in blood was reported (Hartmann et al., 2009), the total blood volume of the reference male (ICRP, 2002) was assumed. Besides blood, the following source regions were considered: spleen, liver, red marrow, lungs, adrenals, kidneys, urinary bladder contents, thyroid, pituitary gland, 'other' and the regions of the human alimentary tract model (ICRP, 2006).

(A 107) For each source region, the regional blood volumes (ICRP, 2002) were included. An infinite retention was assumed for spleen, red marrow, adrenals, thyroid and pituitary gland. As in case of ^{68}Ga-DOTANOC and ^{68}Ga-DOTATATE, the activity of ^{68}Ga measured in lungs corresponded to the blood activity in lung tissues.

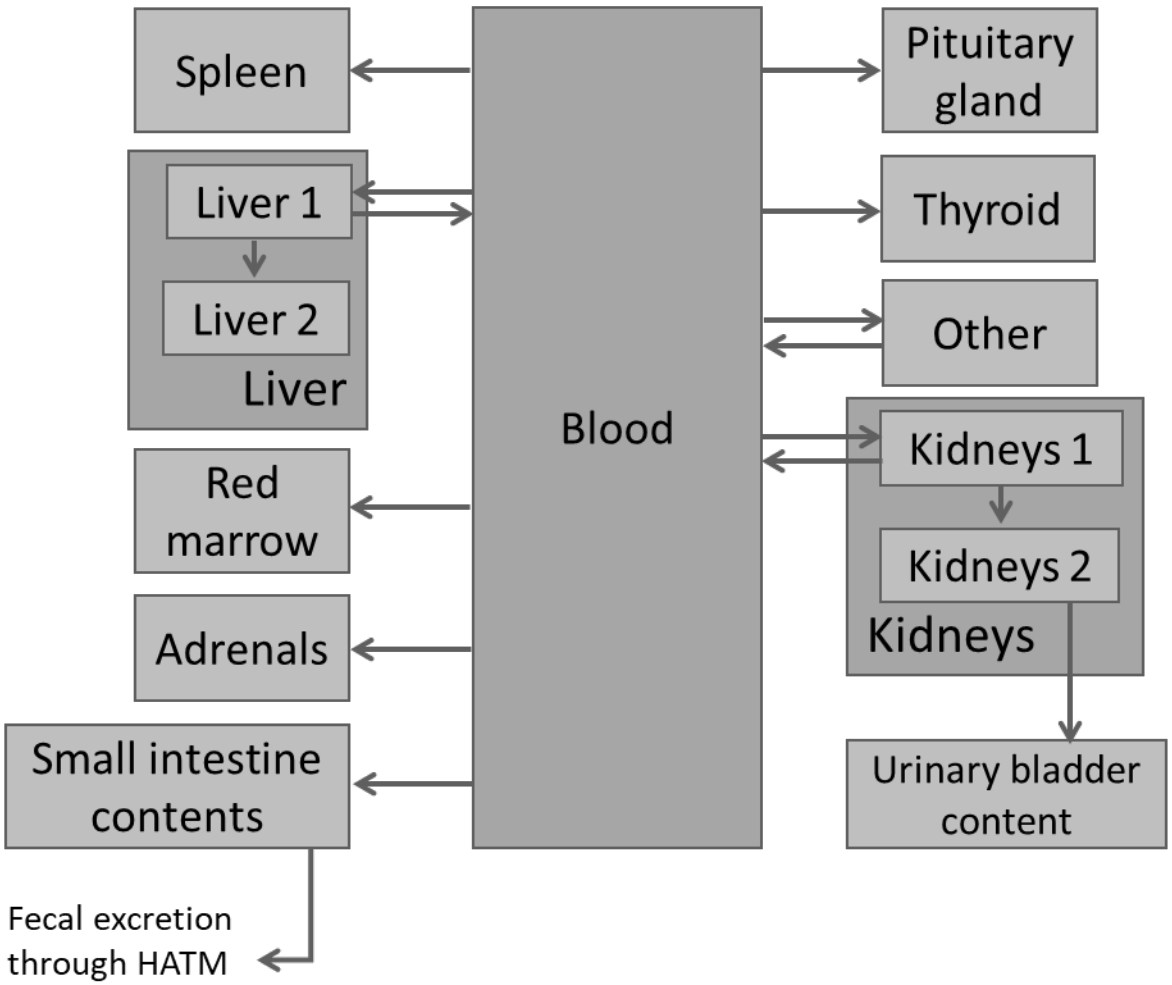

Fig. A.20.1. Biokinetic model for ^{68}Ga-labelled DOTATOC.

Table A.20.1. Values of the transfer coefficients (h^{-1}).

From	To	All age groups
Blood	Adrenals	1.70E-02
Blood	Kidneys 1	4.38E+00
Blood	Liver 1	2.25E+00
Blood	Pituitary gland	1.01E-03
Blood	Red (active) bone marrow	3.25E-01
Blood	Spleen	4.19E-01
Blood	Small intestine contents	2.55E-01
Blood	Thyroid	2.14E-02
Blood	Other	1.53E+01
Liver 1	Blood	5.48E+00
Liver 1	Liver 2	8.82E+00
Kidneys 1	Blood	5.98E+00
Kidneys 1	Kidneys 2	2.57E+00
Kidneys 2	Urinary bladder contents	3.59E-01
Other	Blood	2.69E-01
Small intestine contents	Right colon contents	2.50E-01

Radioactive half-life of ^{68}Ga: 67.71 min

A.20.3. Specific assumptions for the calculations

(A 108) None.

A.20.4. References for ^{68}Ga-DOTATOC

Hartmann, H., Zophel, K., Freudenberg, R., et al., 2009. Radiation exposure of patients during ^{68}Ga-DOTATOC PET/CT examinations. Nuklearmedizin 48(5), 201-207.

ICRP, 2002. Basic anatomical and physiological data for use in radiological protection reference values. ICRP Publication 89. Ann. ICRP 32(3-4).

ICRP, 2006. Human alimentary tract model for radiological protection. ICRP Publication 100. Ann. ICRP 36(1-2).

Sandström, M., Velikyan, I., Garske-Roman, U., et al., 2013. Comparative biodistribution and radiation dosimetry of ^{68}Ga-DOTATOC and ^{68}Ga-DOTATATE in patients with neuroendocrine tumors. J. Nucl. Med. 54(10), 1755-1759.

A.21. ^{99m}Tc-labelled small colloids (intratumoural injection)

A.21.1. Biokinetic information

(A 109) The typical procedure is to inject ^{99m}Tc-labelled small colloids immediately adjacent to the breast tumour that is later to be removed. The patient is investigated with a gamma camera 4 h after injection and then operated on for the removal of the tumour very shortly afterwards. If no uptake of ^{99m}Tc in the lymph nodes is seen on the scan, the tumour and the site(s) of injection of the radioactivity are removed surgically. If lymph node uptake of activity is found, a more radical operation is performed. For more detailed information, the reader is referred to Bronskill (1983), Eshima et al. (2000), and Wilhelm et al. (1999).

(A 110) In either situation, the injected activity is removed in its entirety by approximately 6 h after injection. This may be extended to the following day in some circumstances. In this case, it is assumed to occur 18 hours after the injection, as in *Publication 128*. By this time nearly 90% of the injected activity has decayed.

A.21.2. Specific assumptions for the calculations

(A 111) The contribution of the daughter nuclide ^{99}Tc to the dose is considered negligible and not included in the calculation.

(A 112) The doses presented here have been calculated assuming that the activity was located in the breast region and remained there until removal of the tumour. The dose to the lung was taken as a surrogate for the dose received by the remaining breast tissues.

(A 113) In the model, it is assumed that no leakage occurs from the injection site. Should it happen, such leakage would be covered by the existing model for ^{99m}Tc-colloid model.

(A 114) The organs which receive the higher doses are heart wall, lung (also attributed to the remaining breast tissue), liver, stomach wall, oesophagus and thymus, with some differences between groups of patients ascribable to the characteristics of the phantoms used.

(A 115) As this examination is predominantly performed in female patients, the dose coefficient for a collective of female patients only is also given in the footnotes of Tables A12.2 (a) and (b).

(A 116) The calculations for the reference patient consider the activity equally distributed between the two breasts. Additional calculations were performed for female patients, considering the activity source located in one breast region only. Due to the irradiation geometry, absorbed doses to the target organs are indeed different depending whether the ^{99m}Tc-labelled small colloids have been injected into the left or the right breast. Organ dose coefficients for the cases of intratumoural injection into the left or in the right breast are given separately in Tables A.21.2(c) and (d).

(A 117) For a few organs like gallbladder wall, heart wall, liver, spleen and stomach wall the differences due to the injection into the left or the right breast are remarkable (up to a factor 2.5). For the other organs the deviations are in the order of a few percent.

A.21.3. References for ^{99m}Tc-labelled small colloids (intratumoural injection)

Bronskill, M.J., 1983. Radiation dose estimates for interstitial radiocolloid lymphoscintigraphy. Small colloids. Semin. Nucl. Med. 13, 20–25.

Eshima, D., Fauconnier, T., Eshima, L., et al., 2000. Radiopharmaceuticals for lymphoscintigraphy; including dosimetry and radiation considerations. Semin. Nucl. Med. 30, 25–32.

Wilhelm, A.J., Mijnhout, G.S., Franssen, J., 1999. Radiopharmaceuticals in sentinel lymphnode detection – an overview. Eur. J. Nucl. Med. 26(Suppl.), S36–S42.

Table A.21.1. Time-integrated activity coefficients for ^{99m}Tc-labelled small colloids (intratumoural injection).

	All age groups	
Organs	Removal after 6 h	Removal after 18 h
Breast	4.33E+00	7.59E+00

Radioactive half-life of ^{99m}Tc: 6.015 h

Table A.21.2. Dose coefficients for ^{99m}Tc-labelled small colloids (intratumoural injection).
(a) Default assumptions – removal after 6 h.

	Absorbed dose (mGy/MBq)			
	Adults		15 years	
Organs	Male	Female	Male	Female
Adrenals	1.3E-03	1.6E-03	1.7E-03	1.3E-03
Brain	7.8E-05	2.2E-04	8.6E-05	1.2E-04
Breast*	4.1E-03	5.6E-03	2.4E-03	2.9E-03
Colon wall	7.8E-04	1.4E-04	3.2E-04	4.3E-04
Endosteum (bone surface)	4.7E-04	8.1E-04	4.8E-04	5.7E-04
ET region	3.3E-04	9.8E-04	3.0E-04	3.6E-04
Gall bladder wall	2.2E-03	1.9E-03	2.1E-03	2.1E-03
Heart wall	4.9E-03	8.5E-03	5.4E-03	6.2E-03
Kidneys	9.1E-04	8.4E-04	7.8E-04	6.6E-04
Liver	3.4E-03	3.0E-03	3.6E-03	3.4E-03
Lung	4.1E-03	5.6E-03	2.4E-03	2.9E-03
Lymphatic nodes	1.2E-03	1.8E-03	2.7E-03	1.8E-03
Muscle	6.0E-04	7.4E-04	6.7E-04	7.4E-04
Oesophagus	1.7E-03	3.4E-03	1.7E-03	1.8E-03
Oral mucosa	4.5E-04	1.3E-03	6.1E-04	7.3E-04
Ovaries	-	2.4E-05	-	8.2E-05
Pancreas	1.8E-03	1.2E-03	1.3E-03	1.2E-03
Prostate	1.5E-05	-	2.0E-05	-
Red marrow	1.0E-03	1.7E-03	6.9E-04	7.5E-04
Salivary glands	3.2E-04	1.0E-03	2.9E-04	4.6E-04
Skin	1.0E-03	1.2E-03	1.2E-03	1.3E-03
Small intestine wall	5.4E-04	3.4E-04	3.9E-04	4.8E-04
Spleen	1.9E-03	1.8E-03	1.4E-03	1.5E-03
Stomach wall	3.7E-03	2.1E-03	2.5E-03	2.8E-03
Testes	2.5E-06	-	2.1E-05	-
Thymus	1.6E-03	5.1E-03	1.3E-03	1.7E-03
Thyroid	7.0E-04	2.2E-03	5.5E-04	7.7E-04
Urinary bladder wall	2.6E-05	1.8E-05	5.1E-05	5.9E-05
Uterus/cervix	-	1.7E-05	-	6.7E-05
Effective dose (mSv/MBq)	2.2E-03		1.5E-03	
$\sum_T w_T H_T^F$ (mSv/MBq)†	2.4E-03		1.6E-03	

*Dose to the remaining breast tissue has been assumed to be equal to the dose to the lungs
†Calculated for a female patient collective

(b) Default assumptions – removal after 18 h.

	Absorbed dose (mGy/MBq)			
	Adults		15 years	
Organs	Male	Female	Male	Female
Adrenals	2.2E-03	2.7E-03	2.9E-03	2.3E-03
Brain	1.4E-04	3.8E-04	1.5E-04	2.2E-04
Breast*	7.2E-03	9.7E-03	4.1E-03	5.1E-03
Colon wall	1.4E-03	2.5E-04	5.6E-04	7.5E-04
Endosteum (bone surface)	8.3E-04	1.4E-03	8.4E-04	1.0E-03
ET region	5.9E-04	1.7E-03	5.2E-04	6.3E-04
Gall bladder wall	3.9E-03	3.2E-03	3.7E-03	3.7E-03
Heart wall	8.6E-03	1.5E-02	9.5E-03	1.1E-02
Kidneys	1.6E-03	1.5E-03	1.4E-03	1.2E-03
Liver	6.0E-03	5.2E-03	6.4E-03	6.0E-03
Lung	7.2E-03	9.7E-03	4.1E-03	5.1E-03
Lymphatic nodes	2.2E-03	3.1E-03	4.8E-03	3.2E-03
Muscle	1.1E-03	1.3E-03	1.2E-03	1.3E-03
Oesophagus	3.0E-03	5.9E-03	3.0E-03	3.2E-03
Oral mucosa	7.9E-04	2.4E-03	1.1E-03	1.3E-03
Ovaries	-	4.3E-05	-	1.4E-04
Pancreas	3.1E-03	2.0E-03	2.2E-03	2.1E-03
Prostate	2.6E-05	-	3.5E-05	-
Red marrow	1.8E-03	2.9E-03	1.2E-03	1.3E-03
Salivary glands	5.7E-04	1.8E-03	5.1E-04	8.1E-04
Skin	1.8E-03	2.0E-03	2.2E-03	2.2E-03
Small intestine wall	9.5E-04	6.0E-04	6.9E-04	8.5E-04
Spleen	3.3E-03	3.1E-03	2.4E-03	2.6E-03
Stomach wall	6.5E-03	3.6E-03	4.4E-03	5.0E-03
Testes	4.3E-06	-	3.7E-05	-
Thymus	2.8E-03	9.0E-03	2.2E-03	2.9E-03
Thyroid	1.2E-03	3.8E-03	9.7E-04	1.4E-03
Urinary bladder wall	4.5E-05	3.1E-05	8.9E-05	1.0E-04
Uterus/cervix	-	3.0E-05	-	1.2E-04
Effective dose (mSv/MBq)	3.9E-03		2.7E-03	
$\sum_T w_T \, H_T^F$ (mSv/MBq)†	4.2E-03		2.8E-03	

*Dose to the remaining breast tissue has been assumed to be equal to the dose to the lungs

†Calculated for a female patient collective

(c) Activity injected in one breast only - Female patients – removal after 6 h

	Absorbed dose (mGy/MBq)			
Age group	Adult		15 years	
Source	Left breast	Right breast	Left breast	Right breast
Organs				
Adrenals	1.4E-03	1.7E-03	1.2E-03	1.4E-03
Brain	2.1E-04	2.2E-04	2.8E-03	2.9E-03
Breast*	4.9E-03	6.2E-03	2.6E-03	3.2E-03
Colon wall	1.3E-04	1.6E-04	3.9E-04	4.7E-04
Endosteum (bone surface)	7.7E-04	8.5E-04	1.2E-04	1.3E-04
ET region	9.8E-04	9.8E-04	5.7E-04	5.7E-04
Gall bladder wall	1.4E-03	2.3E-03	1.6E-03	2.6E-03
Heart wall	1.1E-02	5.6E-03	8.2E-03	4.1E-03
Kidneys	8.3E-04	8.5E-04	6.5E-04	6.7E-04
Liver	2.0E-03	4.0E-03	2.2E-03	4.6E-03
Lung	4.9E-03	6.2E-03	2.6E-03	3.2E-03
Lymphatic nodes	1.8E-03	1.7E-03	1.9E-03	1.7E-03
Muscle	7.4E-04	7.4E-04	7.4E-04	7.4E-04
Oesophagus	3.4E-03	3.3E-03	1.9E-03	1.8E-03
Oral mucosa	1.3E-03	1.4E-03	7.3E-04	7.4E-04
Ovaries	2.2E-05	2.7E-05	7.2E-05	9.1E-05
Pancreas	1.2E-03	1.2E-03	1.2E-03	1.2E-03
Red marrow	1.6E-03	1.7E-03	7.2E-04	7.8E-04
Salivary glands	1.0E-03	1.0E-03	4.6E-04	4.7E-04
Skin	1.1E-03	1.2E-03	1.3E-03	1.3E-03
Small intestine wall	3.7E-04	3.2E-04	5.2E-04	4.5E-04
Spleen	2.6E-03	9.9E-04	2.1E-03	8.2E-04
Stomach wall	2.9E-03	1.2E-03	4.0E-03	1.6E-03
Thymus	5.0E-03	5.2E-03	1.6E-03	1.7E-03
Thyroid	2.1E-03	2.2E-03	7.5E-04	8.0E-04
Urinary bladder wall	1.6E-05	1.9E-05	5.4E-05	6.4E-05
Uterus/cervix	1.6E-05	1.8E-05	6.3E-05	7.0E-05
$\sum_T w_T H_T^F$ (mSv/MBq)†	2.3E-03	2.5E-03	1.7E-03	1.6E-03

*Dose to the remaining breast tissue has been assumed to be equal to the dose to the lungs

†Calculated for a female patient collective

(d) Activity injected in one breast only - Female patients – removal after 18 h

	Absorbed dose (mGy/MBq)			
Age group	Adult		15 years	
Source	Left breast	Right breast	Left breast	Right breast
Organs				
Adrenals	2.4E-03	3.0E-03	2.0E-03	2.5E-03
Brain	3.7E-04	3.9E-04	5.0E-03	5.2E-03
Breast*	8.6E-03	1.1E-02	4.5E-03	5.6E-03
Colon wall	2.2E-04	2.7E-04	6.8E-04	8.2E-04
Endosteum (bone surface)	1.3E-03	1.5E-03	2.1E-04	2.3E-04
ET region	1.7E-03	1.7E-03	1.0E-03	1.0E-03
Gall bladder wall	2.5E-03	4.0E-03	2.8E-03	4.6E-03
Heart wall	2.0E-02	9.8E-03	1.4E-02	7.2E-03
Kidneys	1.4E-03	1.5E-03	1.1E-03	1.2E-03
Liver	3.5E-03	7.0E-03	3.9E-03	8.0E-03
Lung	8.6E-03	1.1E-02	4.5E-03	5.6E-03
Lymphatic nodes	3.2E-03	2.9E-03	3.4E-03	3.0E-03
Muscle	1.3E-03	1.3E-03	1.3E-03	1.3E-03
Oesophagus	5.9E-03	5.8E-03	3.3E-03	3.2E-03
Oral mucosa	2.3E-03	2.4E-03	1.3E-03	1.3E-03
Ovaries	3.8E-05	4.7E-05	1.3E-04	1.6E-04
Pancreas	2.0E-03	2.0E-03	2.1E-03	2.1E-03
Red marrow	2.8E-03	3.0E-03	1.3E-03	1.4E-03
Salivary glands	1.7E-03	1.8E-03	8.0E-04	8.2E-04
Skin	2.0E-03	2.0E-03	2.2E-03	2.2E-03
Small intestine wall	6.4E-04	5.6E-04	9.0E-04	7.9E-04
Spleen	4.5E-03	1.7E-03	3.7E-03	1.4E-03
Stomach wall	5.1E-03	2.1E-03	7.1E-03	2.9E-03
Thymus	8.8E-03	9.1E-03	2.9E-03	3.0E-03
Thyroid	3.6E-03	3.9E-03	1.3E-03	1.4E-03
Urinary bladder wall	2.8E-05	3.4E-05	9.4E-05	1.1E-04
Uterus/cervix	2.8E-05	3.2E-05	1.1E-04	1.2E-04
$\sum_T w_T \, H_T^F$ (mSv/MBq)†	4.1E-03	4.3E-03	2.9E-03	2.8E-03

*Dose to the remaining breast tissue has been assumed to be equal to the dose to the lungs

†Calculated for a female patient collective

A.22. ^{99m}Tc-labelled mercaptoacetyl triglycine (MAG_3)

A.22.1. Biokinetic information

(A 118) ^{99m}Tc-labelled mercaptoacetyl triglycine (MAG_3) has been developed for investigation of renal function in patients with renal disorders (Bubeck et al., 1990; Kabasakal et al., 1995) and is used to identify acute renal transplant rejection and measure its severity (Russell et al., 1996).

(A 119) In the normal case, following intravenous administration of ^{99m}Tc-MAG3, the substance is rapidly distributed in the extracellular fluid and excreted entirely by the renal system. According to Stabin et al. (1992), total body retention is described by tri-exponential functions. The renal transit time is assumed to be 4 min. The reader is referred to Bubeck et al. (1990), Jafri et al. (1988), and Taylor et al. (1986) for further information.

(A 120) Schofer et al. (1995) investigated the kinetics of ^{99m}Tc-labelled MAG_3 in children aged 7 days to 9 years. Results showed increasing clearance values for infants during the first months of life, approaching the value for children and adults between 7 and 12 months of age. Data on biokinetics and dosimetry in paediatric patients have been presented also by Vásquez Arteaga et al. (2018) and Soares Machado et al. (2018, 2021).

A.22.2. Biokinetic model

(A 121) In the previous ICRP reports ^{99m}Tc-labelled MAG_3 was assumed to be retained in the body with half-lives of 0.028 h (40%), 0.053 h (40%) and 0.72 h (20%). The model presented in this report assumes similarly that ^{99m}Tc-labelled MAG_3 is rapidly distributed from the blood to three compartments, corresponding to the three components of the body retention, in the same proportion and with the same retention half-lives as assumed in the previous reports. The material is then transferred back to blood and from there excreted via the renal pathway with a renal transit time of 4 min.

(A 122) Two special cases are considered here. In the case of bilaterally impaired renal function, a fraction of 0.04 is assumed to be taken up in the liver, the clearance rates from the tissue compartments is assumed to be one-tenth of that for the normal case, and the renal transit time is increased to 20 min, as assumed in the previous ICRP reports. In the case of acute unilateral renal blockage, it is assumed that a fraction of 0.5 of the administered radiopharmaceutical excreted via the renal pathway is taken up by the blocked kidney and slowly released back to the blood with a half-time of 5 days.

(A 123) A four-compartment model to evaluate the kinetics of ^{99m}Tc-labelled MAG_3 separately in the normal and blocked kidney had also been presented by Curti et al. (1988).

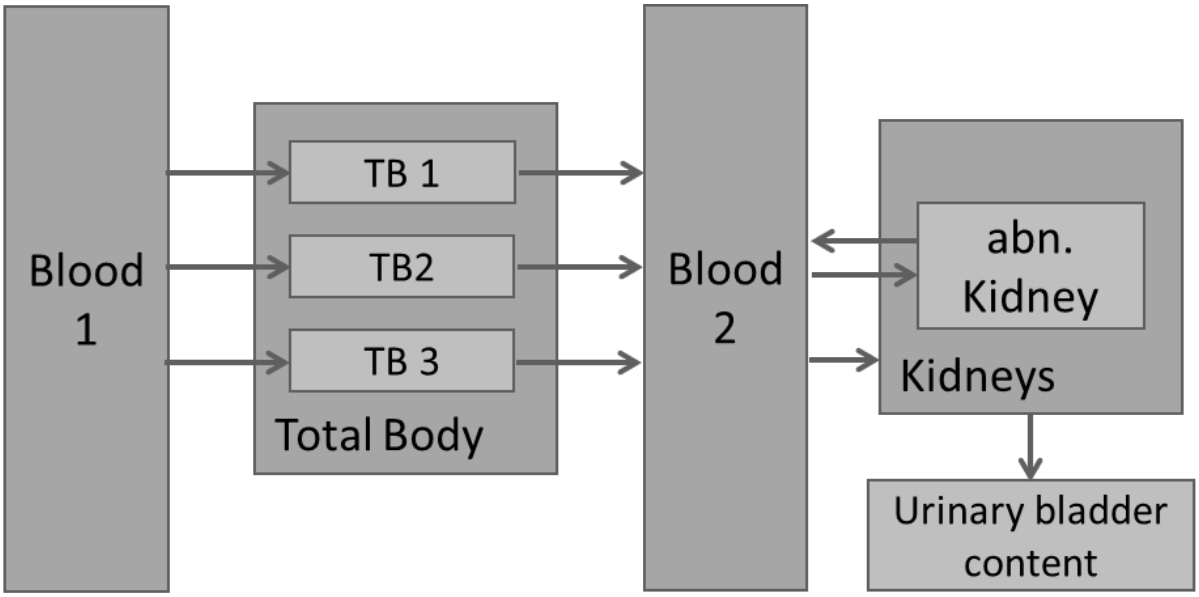

Fig. A.22.1. Biokinetic model for ^{99m}Tc-labelled mercaptoacetyl triglycine (MAG_3).

Table A.22.1. Values of the transfer coefficients (h^{-1}).

From	To	Normal renal function	Impaired renal function	Acute unilateral renal blockage
Blood 1	Total Body 1	8.32E+00	8.32E+00	8.32E+00
Blood 1	Total Body 2	8.32E+00	8.32E+00	8.32E+00
Blood 1	Total Body 3	4.16E+00	4.16E+00	4.16E+00
Total Body 1	Blood 2	2.48E+01	2.48E+00	2.48E+01
Total Body 2	Blood 2	1.31E+01	1.31E+00	1.31E+01
Total Body 3	Blood 2	9.60E-01	9.60E-02	9.60E-01
Blood 2	Kidneys	1.20E+02	1.20E+02	6.00E+01
Blood 2	Kidney (abn.)	0.00E+00	0.00E+00	6.00E+01
Kidney (abn.)	Blood 2	0.00E+00	0.00E+00	5.78E-03
Kidneys	UB Contents	1.50E+01	3.00E+00	1.50E+01

Radioactive half-life of ^{99m}Tc: 6.015 h

A.22.3. Specific assumptions for the calculations

(A 124) The contribution of the daughter nuclide ^{99}Tc to the dose is considered negligible and not included in the calculation.

(A 125) In the case of acute unilateral renal blockage, the activity is not distributed uniformly between the two kidneys, but it remains much longer in the blocked kidney, and consequently the number of decays (time-integrated activity coefficient) and the self-dose will be higher for the blocked kidney than in the other one.

(A 126) The organ doses reported in Table A.15.3(c) have been calculated assuming the activity uniformly distributed between the two kidneys. In the footnote to the Table, also the organ absorbed doses for the normal and the blocked kidneys are given separately.

A.22.4. References for ^{99m}Tc-labelled mercaptoacetyl triglycine (MAG_3)

Bubeck, B., Brandau, W., Weber, E., Kälble, T., Parek, N., Georgi, P., 1990. Pharmacokinetics of technetium-99m-MAG_3 in humans. J. Nucl. Med. 31, 1285-1293.

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Vásquez Arteaga, M., Murillo Caballero, V., Marín Rengifo, K., 2018. Dosimetry of ^{99m}Tc (DTPA, DMSA and MAG3) used in renal function studies of newborns and children. Appl. Radiat. Isot. 138, 25-28.

Table A.22.2. Time-integrated activity coefficients for ^{99m}Tc-labelled mercaptoacetyl triglycine (MAG_3) (h).

Organs		Normal renal function	Impaired renal function	Acute unilateral renal blockage
Blood		5.59E-02	6.17E-02	5.61E-02
Liver		-	5.48E-02	-
Kidneys	Normal	6.40E-02	2.68E-01	3.28E-02
	blocked	-	-	4.09E+00
Urinary bladder contents	Adult male	1.37E+00	1.28E+00	7.14E-01
	Adult female	1.40E+00	1.34E+00	7.50E-01
	15-year-old male	1.44E+00	1.34E+00	7.50E-01
	15-year-old female	1.38E+00	1.30E+00	7.21E-01
	10-year-old male/female	1.49E+00	1.38E+00	7.79E-01
	5-year-old male/female	1.41E+00	1.31E+00	7.39E-01
	1-year-old male/female	1.24E+00	1.19E+00	6.50E-01
	Infant male/female	1.08E+00	1.13E+00	5.60E-01
Other		2.31E-01	1.32E+00	2.31E-01

Table A.22.3. Dose coefficients for ^{99m}Tc-labelled mercaptoacetyl triglycine (MAG_3).
(a) Normal renal function.

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	8.3E-04	7.6E-04	6.2E-04	6.2E-04	8.8E-04	9.0E-04	1.4E-03	1.4E-03	2.2E-03	2.2E-03	3.0E-03	2.9E-03
Brain	1.2E-04	1.4E-04	2.3E-04	2.4E-04	3.4E-04	3.4E-04	4.8E-04	4.9E-04	7.7E-04	7.7E-04	1.1E-03	1.1E-03
Breast	1.1E-04	1.4E-04	1.4E-04	1.6E-04	2.1E-04	2.0E-04	3.9E-04	3.8E-04	7.2E-04	7.1E-04	1.1E-03	1.1E-03
Colon wall	1.9E-03	3.0E-03	2.9E-03	2.1E-03	3.3E-03	3.0E-03	5.9E-03	4.9E-03	1.2E-02	1.1E-02	1.1E-02	9.5E-03
Endosteum (bone surface)	9.0E-04	1.0E-03	1.4E-03	1.5E-03	2.0E-03	1.8E-03	2.6E-03	2.3E-03	4.9E-03	4.7E-03	4.6E-03	4.4E-03
ET region	9.9E-05	1.2E-04	3.2E-04	3.0E-04	3.9E-04	3.9E-04	4.8E-04	4.8E-04	6.9E-04	6.9E-04	9.6E-04	9.5E-04
Gall bladder wall	3.9E-04	5.3E-04	4.5E-04	5.1E-04	6.8E-04	7.1E-04	1.6E-03	1.7E-03	2.9E-03	2.8E-03	3.5E-03	3.3E-03
Heart wall	2.7E-04	3.1E-04	2.0E-04	2.3E-04	3.5E-04	3.6E-04	6.1E-04	6.1E-04	1.2E-03	1.2E-03	1.6E-03	1.5E-03
Kidneys	2.6E-03	3.1E-03	3.2E-03	3.5E-03	4.5E-03	4.5E-03	7.3E-03	7.3E-03	1.3E-02	1.3E-02	2.0E-02	1.9E-02
Liver	3.6E-04	4.2E-04	3.7E-04	4.3E-04	6.0E-04	6.2E-04	1.1E-03	1.1E-03	2.1E-03	2.1E-03	2.7E-03	2.6E-03
Lung	2.2E-04	2.6E-04	2.2E-04	2.5E-04	3.6E-04	3.6E-04	5.7E-04	5.7E-04	1.2E-03	1.2E-03	1.7E-03	1.6E-03
Lymphatic nodes	1.8E-03	1.6E-03	1.0E-03	1.0E-03	1.7E-03	1.7E-03	2.9E-03	2.9E-03	4.0E-03	4.0E-03	4.7E-03	4.7E-03
Muscle	6.7E-04	8.1E-04	8.3E-04	7.0E-04	1.1E-03	1.1E-03	1.6E-03	1.5E-03	2.3E-03	2.3E-03	3.1E-03	3.0E-03
Oesophagus	2.3E-04	2.6E-04	2.9E-04	3.1E-04	4.5E-04	4.6E-04	7.5E-04	7.5E-04	1.2E-03	1.2E-03	1.8E-03	1.7E-03
Oral mucosa	1.2E-04	1.4E-04	3.1E-04	3.1E-04	4.1E-04	4.1E-04	4.6E-04	4.6E-04	7.3E-04	7.3E-04	1.2E-03	1.2E-03
Ovaries	-	8.0E-03	-	1.7E-02	-	2.3E-02	-	3.1E-02	-	4.0E-02	-	3.4E-02
Pancreas	5.2E-04	7.1E-04	7.7E-04	7.3E-04	9.5E-04	1.0E-03	1.8E-03	1.8E-03	3.3E-03	3.2E-03	4.1E-03	3.8E-03
Prostate	1.2E-02	-	1.4E-02	-	2.5E-02	-	3.2E-02	-	5.3E-02	-	5.2E-02	-
Red marrow	1.4E-03	1.4E-03	1.8E-03	1.9E-03	2.3E-03	2.1E-03	2.3E-03	2.0E-03	3.7E-03	3.7E-03	4.0E-03	3.8E-03
Salivary glands	1.0E-04	1.3E-04	3.4E-04	3.0E-04	3.9E-04	3.9E-04	5.1E-04	5.0E-04	8.1E-04	8.1E-04	1.3E-03	1.3E-03
Skin	2.7E-04	3.5E-04	3.5E-04	3.7E-04	5.7E-04	5.6E-04	9.3E-04	9.6E-04	1.5E-03	1.5E-03	2.0E-03	2.0E-03
Small intestine wall	2.5E-03	3.8E-03	2.3E-03	1.9E-03	2.3E-03	2.8E-03	5.3E-03	6.5E-03	9.7E-03	9.8E-03	1.1E-02	1.1E-02
Spleen	3.8E-04	4.6E-04	3.9E-04	4.3E-04	6.1E-04	6.2E-04	1.1E-03	1.1E-03	1.8E-03	1.8E-03	2.6E-03	2.5E-03
Stomach wall	3.3E-04	4.5E-04	4.6E-04	4.4E-04	6.5E-04	6.8E-04	1.1E-03	1.1E-03	2.4E-03	2.4E-03	3.2E-03	3.0E-03
Testes	8.6E-04	-	7.0E-03	-	6.3E-03	-	1.1E-02	-	9.4E-03	-	1.1E-02	-
Thymus	1.3E-04	1.6E-04	1.9E-04	2.0E-04	3.1E-04	3.1E-04	5.1E-04	5.2E-04	1.0E-03	1.0E-03	1.4E-03	1.4E-03
Thyroid	1.5E-04	1.8E-04	2.2E-04	2.2E-04	3.1E-04	3.1E-04	5.2E-04	5.2E-04	9.1E-04	9.1E-04	1.3E-03	1.3E-03
Urinary bladder wall	3.2E-02	3.8E-02	3.8E-02	3.8E-02	6.1E-02	6.1E-02	6.8E-02	6.8E-02	7.9E-02	7.9E-02	1.2E-01	1.2E-01
Uterus/ cervix	-	1.4E-02	-	2.1E-02	-	3.2E-02	-	3.8E-02	-	1.1E-01	-	8.5E-02
Effective dose (mSv/MBq)	2.6E-03		3.4E-03		4.9E-03		6.2E-03		8.8E-03		1.1E-02	

(b) Impaired renal function.

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	1.4E-03	1.5E-03	1.2E-03	1.3E-03	1.9E-03	1.9E-03	3.0E-03	3.0E-03	5.0E-03	5.0E-03	6.6E-03	6.5E-03
Brain	6.2E-04	7.2E-04	1.2E-03	1.3E-03	1.8E-03	1.8E-03	2.6E-03	2.6E-03	4.1E-03	4.1E-03	5.9E-03	5.9E-03
Breast	5.1E-04	6.4E-04	5.9E-04	7.0E-04	9.2E-04	9.1E-04	1.7E-03	1.7E-03	2.9E-03	2.9E-03	5.0E-03	4.9E-03
Colon wall	2.4E-03	3.5E-03	3.3E-03	2.6E-03	4.0E-03	3.6E-03	6.9E-03	6.0E-03	1.4E-02	1.3E-02	1.5E-02	1.3E-02
Endosteum (bone surface)	1.4E-03	1.7E-03	2.3E-03	2.4E-03	3.4E-03	3.3E-03	5.0E-03	4.7E-03	8.7E-03	8.6E-03	9.5E-03	9.2E-03
ET region	5.4E-04	6.7E-04	1.7E-03	1.6E-03	2.1E-03	2.1E-03	2.5E-03	2.5E-03	3.4E-03	3.4E-03	4.8E-03	4.8E-03
Gall bladder wall	1.1E-03	1.4E-03	1.2E-03	1.4E-03	1.8E-03	1.9E-03	3.3E-03	3.3E-03	5.7E-03	5.7E-03	7.6E-03	7.4E-03
Heart wall	8.3E-04	9.5E-04	8.4E-04	9.6E-04	1.4E-03	1.4E-03	2.3E-03	2.3E-03	4.1E-03	4.1E-03	5.8E-03	5.8E-03
Kidneys	2.8E-03	3.2E-03	3.2E-03	3.5E-03	4.5E-03	4.5E-03	7.4E-03	7.4E-03	1.3E-02	1.3E-02	2.0E-02	1.9E-02
Liver	1.1E-03	1.3E-03	1.2E-03	1.4E-03	1.9E-03	1.9E-03	3.0E-03	3.0E-03	5.2E-03	5.2E-03	7.0E-03	6.9E-03
Lung	7.3E-04	8.6E-04	7.8E-04	8.6E-04	1.2E-03	1.2E-03	1.9E-03	1.9E-03	3.6E-03	3.6E-03	5.1E-03	5.0E-03
Lymphatic nodes	2.2E-03	2.2E-03	1.7E-03	1.6E-03	2.5E-03	2.6E-03	4.2E-03	4.3E-03	6.5E-03	6.5E-03	8.7E-03	8.7E-03
Muscle	1.2E-03	1.4E-03	1.4E-03	1.3E-03	2.0E-03	1.9E-03	3.0E-03	2.9E-03	5.1E-03	5.0E-03	7.3E-03	7.1E-03
Oesophagus	8.2E-04	9.2E-04	1.0E-03	1.1E-03	1.6E-03	1.6E-03	2.6E-03	2.7E-03	4.4E-03	4.4E-03	6.1E-03	6.1E-03
Oral mucosa	6.3E-04	7.2E-04	1.7E-03	1.6E-03	2.1E-03	2.1E-03	2.4E-03	2.4E-03	3.4E-03	3.4E-03	5.6E-03	5.6E-03
Ovaries	-	8.3E-03	-	1.7E-02	-	2.3E-02	-	3.0E-02	-	4.1E-02	-	3.9E-02
Pancreas	1.2E-03	1.4E-03	1.4E-03	1.4E-03	2.0E-03	2.0E-03	3.3E-03	3.4E-03	5.9E-03	5.9E-03	8.1E-03	7.9E-03
Prostate	1.2E-02	-	1.4E-02	-	2.4E-02	-	3.1E-02	-	5.3E-02	-	5.8E-02	-
Red marrow	1.9E-03	2.1E-03	2.5E-03	2.6E-03	3.3E-03	3.1E-03	4.0E-03	3.7E-03	6.6E-03	6.5E-03	8.1E-03	7.9E-03
Salivary glands	5.6E-04	7.0E-04	1.9E-03	1.6E-03	2.1E-03	2.1E-03	2.7E-03	2.7E-03	4.0E-03	4.0E-03	6.4E-03	6.4E-03
Skin	6.3E-04	7.8E-04	7.9E-04	8.5E-04	1.3E-03	1.3E-03	2.1E-03	2.1E-03	3.7E-03	3.7E-03	5.3E-03	5.3E-03
Small intestine wall	2.9E-03	4.3E-03	2.7E-03	2.5E-03	3.0E-03	3.5E-03	6.4E-03	7.5E-03	1.2E-02	1.2E-02	1.6E-02	1.5E-02
Spleen	9.1E-04	1.1E-03	9.0E-04	1.1E-03	1.5E-03	1.5E-03	2.5E-03	2.5E-03	4.4E-03	4.4E-03	6.3E-03	6.2E-03
Stomach wall	9.0E-04	1.1E-03	1.0E-03	1.1E-03	1.6E-03	1.6E-03	2.6E-03	2.6E-03	5.0E-03	5.0E-03	6.9E-03	6.8E-03
Testes	1.4E-03	-	7.1E-03	-	6.7E-03	-	1.1E-02	-	1.1E-02	-	1.4E-02	-
Thymus	6.7E-04	8.1E-04	9.2E-04	9.6E-04	1.4E-03	1.4E-03	2.2E-03	2.2E-03	4.2E-03	4.2E-03	5.9E-03	5.9E-03
Thyroid	6.8E-04	8.1E-04	1.0E-03	1.0E-03	1.5E-03	1.5E-03	2.5E-03	2.5E-03	4.0E-03	4.0E-03	5.6E-03	5.6E-03
Urinary bladder wall	3.1E-02	3.8E-02	3.8E-02	3.7E-02	5.9E-02	5.9E-02	6.7E-02	6.7E-02	8.2E-02	8.2E-02	1.3E-01	1.3E-01
Uterus/ cervix	-	1.4E-02	-	2.0E-02	-	3.1E-02	-	3.7E-02	-	1.1E-01	-	9.2E-02
Effective dose (mSv/MBq)	3.1E-03		4.0E-03		5.6E-03		7.4E-03		1.1E-02		1.5E-02	

(c) Acute unilateral renal blockage.

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	3.7E-02	3.0E-02	2.1E-02	2.1E-02	2.9E-02	2.9E-02	3.6E-02	3.6E-02	4.6E-02	4.6E-02	5.9E-02	5.9E-02
Brain	1.3E-04	1.5E-04	2.4E-04	2.6E-04	3.8E-04	3.8E-04	5.6E-04	5.7E-04	9.8E-04	9.8E-04	1.4E-03	1.4E-03
Breast	7.8E-04	7.9E-04	7.4E-04	6.6E-04	9.2E-04	9.1E-04	2.2E-03	2.2E-03	3.6E-03	3.6E-03	4.5E-03	4.5E-03
Colon wall	6.5E-03	5.8E-03	4.3E-03	3.5E-03	5.8E-03	5.6E-03	1.0E-02	9.6E-03	1.7E-02	1.7E-02	2.2E-02	2.2E-02
Endosteum (bone surface)	1.8E-03	2.3E-03	3.0E-03	3.3E-03	4.8E-03	4.7E-03	7.4E-03	7.2E-03	1.3E-02	1.3E-02	1.4E-02	1.4E-02
ET region	1.4E-04	1.8E-04	3.4E-04	3.4E-04	4.6E-04	4.5E-04	6.2E-04	6.2E-04	1.1E-03	1.1E-03	1.5E-03	1.5E-03
Gall bladder wall	9.6E-03	1.8E-02	7.5E-03	8.2E-03	1.1E-02	1.1E-02	3.3E-02	3.3E-02	4.4E-02	4.4E-02	4.4E-02	4.4E-02
Heart wall	2.3E-03	2.3E-03	1.5E-03	1.7E-03	2.7E-03	2.8E-03	4.9E-03	4.9E-03	8.4E-03	8.3E-03	8.9E-03	8.9E-03
Kidneys	1.5E-01	1.8E-01	1.8E-01	2.0E-01	2.5E-01	2.5E-01	4.0E-01	4.0E-01	6.8E-01	6.8E-01	1.1E+00	1.1E+00
Liver	7.5E-03	9.4E-03	4.5E-03	5.1E-03	8.3E-03	8.3E-03	1.4E-02	1.4E-02	2.4E-02	2.3E-02	2.7E-02	2.7E-02
Lung	1.6E-03	1.7E-03	1.2E-03	1.4E-03	1.9E-03	1.9E-03	2.9E-03	2.9E-03	7.1E-03	7.1E-03	7.9E-03	7.9E-03
Lymphatic nodes	3.8E-03	5.5E-03	5.6E-03	2.8E-03	6.4E-03	6.4E-03	9.0E-03	9.0E-03	1.6E-02	1.6E-02	2.8E-02	2.8E-02
Muscle	1.6E-03	2.1E-03	1.5E-03	1.2E-03	2.1E-03	2.1E-03	2.9E-03	2.9E-03	4.4E-03	4.4E-03	6.8E-03	6.7E-03
Oesophagus	2.1E-03	1.9E-03	2.0E-03	2.5E-03	3.3E-03	3.5E-03	4.9E-03	4.9E-03	6.7E-03	6.7E-03	9.0E-03	9.0E-03
Oral mucosa	1.6E-04	2.1E-04	3.6E-04	3.8E-04	5.0E-04	5.1E-04	6.7E-04	6.7E-04	1.3E-03	1.3E-03	2.1E-03	2.1E-03
Ovaries	-	4.7E-03	-	1.0E-02	-	1.4E-02	-	2.0E-02	-	2.8E-02	-	3.2E-02
Pancreas	1.1E-02	2.1E-02	1.8E-02	1.9E-02	2.1E-02	2.1E-02	4.0E-02	4.0E-02	5.0E-02	5.0E-02	6.6E-02	6.5E-02
Prostate	6.6E-03	-	7.7E-03	-	1.4E-02	-	1.8E-02	-	3.1E-02	-	3.3E-02	-
Red marrow	3.5E-03	4.3E-03	4.7E-03	4.7E-03	5.2E-03	5.1E-03	6.1E-03	5.9E-03	1.1E-02	1.1E-02	1.3E-02	1.3E-02
Salivary glands	1.5E-04	1.8E-04	3.9E-04	3.7E-04	5.3E-04	5.3E-04	8.0E-04	7.9E-04	1.7E-03	1.7E-03	2.4E-03	2.4E-03
Skin	7.6E-04	9.0E-04	8.6E-04	1.0E-03	1.4E-03	1.4E-03	2.2E-03	2.2E-03	3.9E-03	3.9E-03	5.7E-03	5.7E-03
Small intestine wall	7.2E-03	1.0E-02	7.8E-03	7.4E-03	8.1E-03	8.4E-03	1.4E-02	1.5E-02	2.4E-02	2.4E-02	3.5E-02	3.4E-02
Spleen	1.0E-02	1.3E-02	8.2E-03	8.8E-03	1.3E-02	1.3E-02	2.0E-02	2.0E-02	2.4E-02	2.4E-02	3.2E-02	3.2E-02
Stomach wall	5.7E-03	1.1E-02	7.0E-03	5.9E-03	9.7E-03	9.7E-03	1.5E-02	1.5E-02	3.1E-02	3.1E-02	3.6E-02	3.5E-02
Testes	5.3E-04	-	4.0E-03	-	3.7E-03	-	6.5E-03	-	6.8E-03	-	8.5E-03	-
Thymus	5.4E-04	6.0E-04	5.4E-04	5.8E-04	1.1E-03	1.1E-03	1.9E-03	1.9E-03	4.3E-03	4.3E-03	4.9E-03	4.9E-03
Thyroid	3.9E-04	3.9E-04	4.1E-04	4.5E-04	6.6E-04	6.6E-04	1.2E-03	1.2E-03	3.1E-03	3.1E-03	3.5E-03	3.5E-03
Urinary bladder wall	1.7E-02	2.1E-02	2.1E-02	2.0E-02	3.3E-02	3.3E-02	3.8E-02	3.8E-02	4.7E-02	4.7E-02	7.2E-02	7.1E-02
Uterus/ cervix	-	7.8E-03	-	1.3E-02	-	1.9E-02	-	2.3E-02	-	6.4E-02	-	5.6E-02
Effective dose (mSv/MBq)	6.3E-03		6.3E-03		8.8E-03		1.3E-02		2.2E-02		2.9E-02	

	Absorbed dose (mGy/MBq) in the kidneys											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Kidney normal	2.4E-03	2.8E-03	2.8E-03	3.2E-03	4.0E-03	4.0E-03	6.3E-03	6.3E-03	1.1E-02	1.1E-02	1.7E-02	1.7E-02
Kidney blocked	3.0E-01	3.5E-01	3.6E-01	4.0E-01	5.0E-01	5.0E-01	7.9E-01	7.9E-01	1.4E+00	1.4E+00	2.1E+00	2.1E+00

A.23. ^{99m}Tc-labelled methoxy-isobutyl-isonitrile (MIBI, Sestamibi, Hexamibi)

A.23.1. Biokinetic information

(A 127) Technetium-methyl oxy-isobutyl-isonitrile (MIBI, Sestamibi, Hexamibi) is a cationic complex prepared from a lyophilised kit (Cardiolite). It is used for studies of myocardial perfusion and cardiac ventricular function.

(A 128) ^{99m}Tc MIBI is accumulated in viable myocardial tissue in proportion to regional blood flow in a manner similar to thallous chloride. After intravenous injection, the substance is cleared rapidly from the blood and taken up predominantly in muscular tissues (including heart), liver, and kidneys, with a smaller amount in salivary glands and thyroid. Other organs and tissues show low uptake with a uniform distribution. When the substance is injected in conjunction with a stress test, there is a considerable increase of uptake in heart and skeletal muscles, with correspondingly lower uptake in all other organs and tissues. No redistribution takes place, and there is no evidence of any metabolism of the substance. The principal pathway for excretion is via the hepatobiliary system to the gastrointestinal tract, with some additional excretion via the kidneys. Results of animal studies do not indicate direct uptake and excretion via the gastrointestinal wall (Andersson et al., 1990). The major part of the injected substance is excreted within 48 h.

A.23.2. Biokinetic model

(A 129) The model proposed here is a compartmental version of the descriptive one presented in (ICRP, 2015). This was based on reports by Wackers et al. (1988) and Leide et al. (1992).

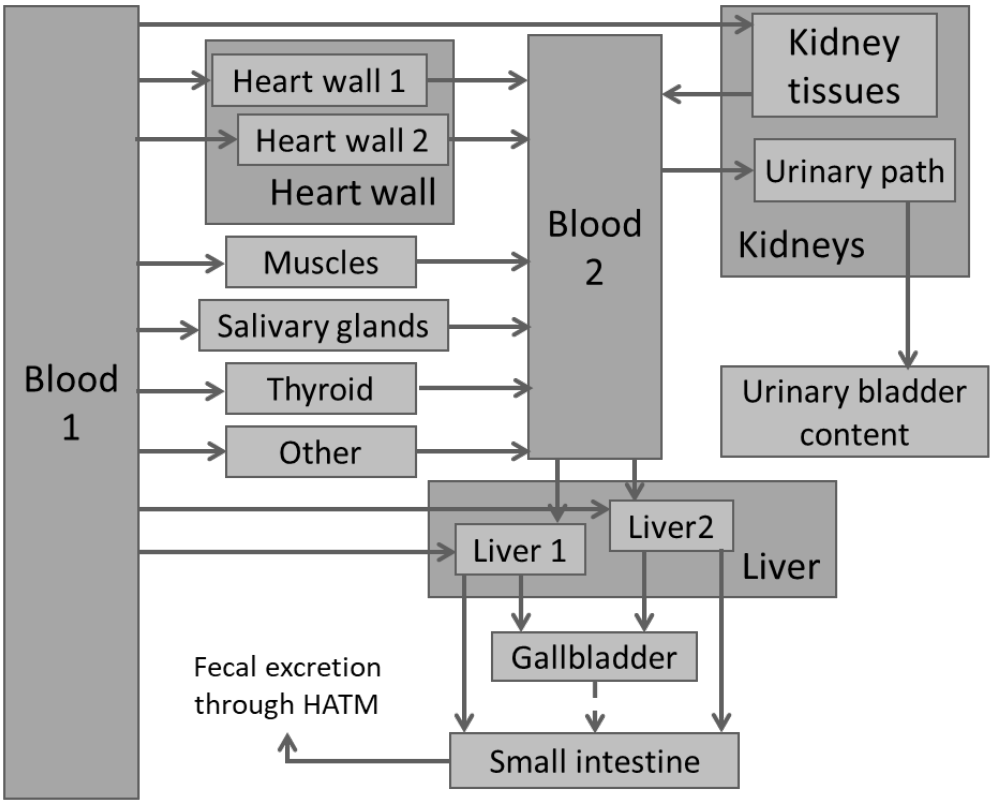

Fig. A.23.1. Biokinetic model for ^{99m}Tc-labelled methoxy-isobutyl-isonitrile .

Table A.23.1. Values of the transfer coefficients (h^{-1}).

From	To	Resting subject	Exercise
Blood 1	Heart Wall 1	2.09E-01	2.79E-01
Blood 1	Heart Wall 2	1.03E-01	1.37E-01
Blood 1	Muscles	4.16E+00	8.32E+00
Blood 1	Salivary glands	3.12E-01	2.08E-01
Blood 1	Thyroid	6.24E-02	4.16E-02
Blood 1	Liver 1	3.18E+00	1.77E+00
Blood 1	Liver 2	5.61E-01	3.12E-01
Blood 1	Kidney tissues	2.91E+00	2.08E+00
Heart Wall 1	Blood 2	5.33E-01	5.33E-01
Heart Wall 2	Blood 2	2.89E-02	2.89E-02
Muscles	Blood 2	2.89E-02	2.89E-02
Salivary glands	Blood 2	2.89E-02	2.89E-02
Thyroid	Blood 2	3.47E-01	3.47E-01
Kidney tissues	Blood 2	9.90E-02	9.90E-02
Liver 1	Small intestine	3.55E-01	3.55E-01
Liver 1	Gallbladder	1.78E-01	1.78E-01
Liver 2	Small intestine	1.93E-02	1.93E-02
Liver 2	Gallbladder	9.63E-03	9.63E-03
Blood 2	Urinary Path	3.00E+01	3.00E+01
Blood 2	Liver 1	7.65E+01	7.65E+01
Blood 2	Liver 2	1.35E+01	1.35E+01
Urinary Path	Urinary Bladder Content	1.20E+01	1.20E+01

Radioactive half-life of ^{99m}Tc: 6.015 h

A.23.3. Specific assumptions for the calculations

(A 130) Activity in liver is excreted according to the liver-biliary model (see A.6.3), with 25% of the activity being transferred to the gallbladder.

(A 131) The contribution of the daughter nuclide ^{99}Tc to the dose is considered negligible and not included in the calculations.

A.23.4. References for ^{99m}Tc-labelled methoxy-isobutyl-isonitrile

Andersson, L., Jönsson, B-A., Leide, S., et al., 1990. Biodistribution and retention of Tc-99m-HEXA-MIBI evaluated in the rat, Eur. J. Nucl. Med. 16(Suppl.), S105.

ICRP, 2015. Radiation dose to patients from radiopharmaceuticals: a compendium of current information related to frequently used substances. ICRP Publication 128. Ann. ICRP 44(2S).

Leide, S., Diemer, H., Ahlgren, L., et al., 1992. In vivo distribution and dosimetry of Tc-99m MIBI in man. In: S-Stelson, A., Watson, E.E. (Eds.), Fifth International Radiopharmaceutical Dosimetry Symposium, Oak Ridge, TN, USA, May 7–10, 1992. CONF-910529. Oak Ridge Associated Universities, Oak Ridge, TN. pp. 483–497.

Wackers, F.J.T., Berman, D.S., Maddahi, J., et al., 1989. Technetium-99m hexakis-2 methoxyisobutyl isonitrile; human biodistribution, dosimetry, safety, preliminary comparison to Tl-201 for myocardial perfusion imaging. J. Nucl. Med. 30, 301–311.

A.24. ^{99m}Tc-labelled pertechnetate

A.24.1. Biokinetic information

(A 132) The MIRD Dose Estimate Report No. 8 (MIRD, 1976) presents two sets of biological parameters based on a compartmental model and constructed using data from measurements on different groups of subjects. The two groups are possibly related to different levels of physical activity (resting and non-resting). For most organs and tissues, the difference in absorbed dose per unit administered activity between the two groups is small (less than a factor of two).

(A 133) The model presented in the previous reports on radiopharmaceuticals (ICRP, 2015) was based on mean values for the parameters in the two MIRD groups. Data published by Dayton et al. (1969) on renal clearance, by Beasley et al. (1966) on distribution in humans, and by Andros et al. (1965) were used. All published studies demonstrated early active uptake in the thyroid, salivary glands, and stomach, and delayed uptake in the colon.

A.24.2. Biokinetic model

(A 134) The model used in this report is a slight modification of the one presented by Leggett and Giussani (2015) and adopted by ICRP in its Report Series on Occupational Intake of Radionuclides (ICRP, 2016).

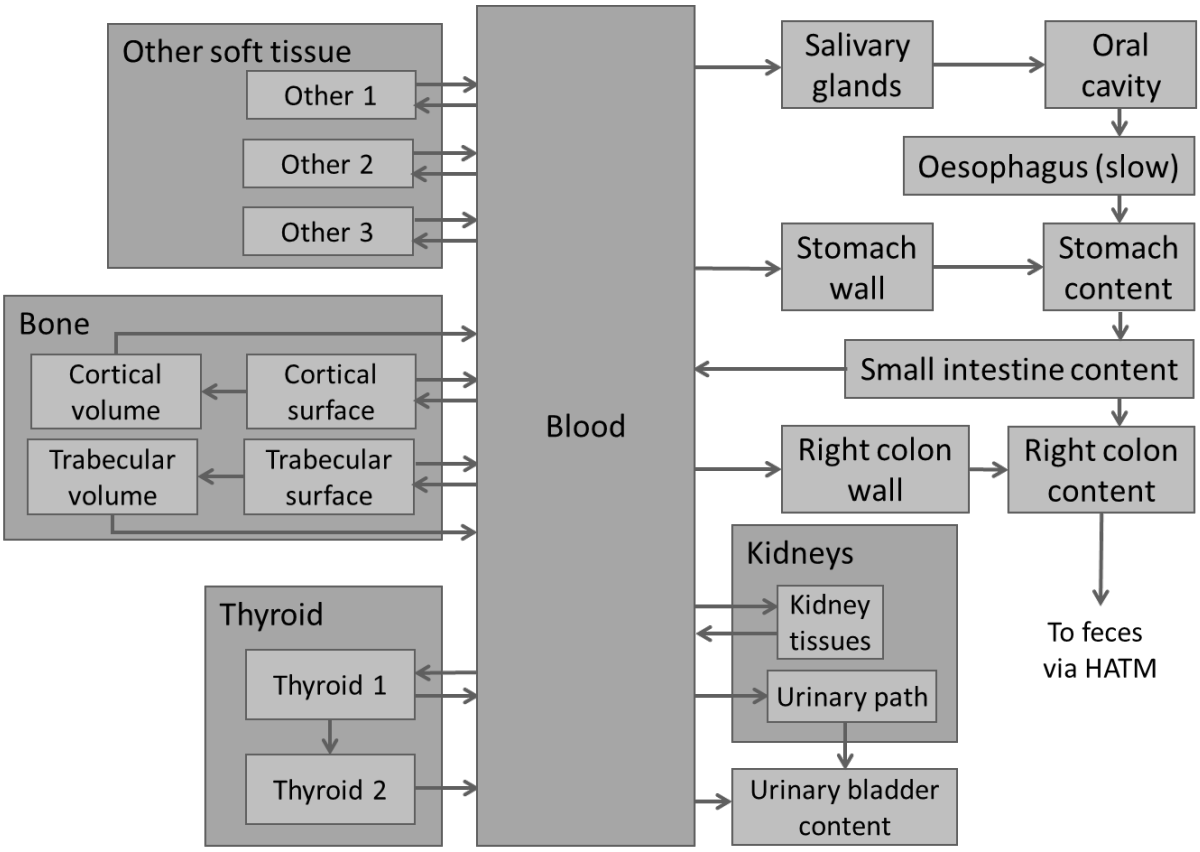

Fig. A.24.1. Biokinetic model for ^{99m}Tc-labelled pertechnetate.

(A 135) This model is primarily based on human biokinetic data for pertechnetate. Details on the model development and on the underlying data and assumptions are given in the original publications. Differently than in the OIR model, the liver compartments have been removed

from the model used here. Patients administered with pertechnetate do not actually show any uptake in liver, and, when such an uptake is observed, then it is a sign of molybdate impurities in the administered radiopharmaceutical. Re-evaluating the data used in the development of the OIR model and suggesting uptake in the liver, it was observed that they date back to a time when radionuclidic purity of the administered pertechnetate was (much) lower than it is today.

(A 136) Pre-treatment with blocking agents such as perchlorate or iodide inhibits active uptake and diminishes whole-body retention (Coffey et al., 1984). For the calculation of the dose coefficients in the case of administration with blocking agent, the thyroid is removed from the biokinetic model and is also not considered as a source organ.

Table A.24.1. Values of the transfer coefficients (h^{-1})

From	To	Adults	15 years	10 years	5 years	1 year	infant
Blood	Thyroid_1	2.92E-01	2.92E-01	2.92E-01	2.92E-01	2.92E-01	2.92E-01
Blood	Other 1	2.99E+00	2.99E+00	2.99E+00	2.99E+00	2.99E+00	2.99E+00
Blood	Other 2	1.85E-01	1.85E-01	1.85E-01	1.85E-01	1.85E-01	1.85E-01
Blood	Other 3	1.25E-01	1.25E-01	1.25E-01	1.25E-01	1.25E-01	1.25E-01
Blood	UB-contents	7.08E-02	7.08E-02	7.08E-02	7.08E-02	7.08E-02	7.08E-02
Blood	Salivary glands	1.08E-01	1.08E-01	1.08E-01	1.08E-01	1.08E-01	1.08E-01
Blood	Stomach wall	1.79E-01	1.79E-01	1.79E-01	1.79E-01	1.79E-01	1.79E-01
Blood	Kidneys 1	2.92E-02	2.92E-02	2.92E-02	2.92E-02	2.92E-02	2.92E-02
Blood	Kidneys 2	1.67E-03	1.67E-03	1.67E-03	1.67E-03	1.67E-03	1.67E-03
Blood	Right colon wall	1.42E-01	1.42E-01	1.42E-01	1.42E-01	1.42E-01	1.42E-01
Blood	Cortical bone surface	1.46E-02	1.46E-02	1.46E-02	1.46E-02	1.46E-02	1.46E-02
Blood	Trabecular bone surface	1.46E-02	1.46E-02	1.46E-02	1.46E-02	1.46E-02	1.46E-02
Thyroid 1	Blood	4.17E+00	4.17E+00	4.17E+00	4.17E+00	4.17E+00	4.17E+00
Thyroid 1	Thyroid2	4.17E-02	4.17E-02	4.17E-02	4.17E-02	4.17E-02	4.17E-02
Thyroid 2	Blood	4.17E-02	4.17E-02	4.17E-02	4.17E-02	4.17E-02	4.17E-02
Other 1	Blood	2.08E+00	2.08E+00	2.08E+00	2.08E+00	2.08E+00	2.08E+00
Other 2	Blood	3.46E-01	3.46E-01	3.46E-01	3.46E-01	3.46E-01	3.46E-01
Other 3	Blood	1.92E-02	1.92E-02	1.92E-02	1.92E-02	1.92E-02	1.92E-02
Salivary glands	Oral cavity	2.08E+00	2.08E+00	2.08E+00	2.08E+00	2.08E+00	2.08E+00
Stomach wall	Stomach contents	2.08E+00	2.08E+00	2.08E+00	2.08E+00	2.08E+00	2.08E+00
Kidneys 1	Urinary bladder contents	3.47E-01	3.47E-01	3.47E-01	3.47E-01	3.47E-01	3.47E-01
Kidneys 2	Blood	1.45E-03	1.45E-03	1.45E-03	1.45E-03	1.45E-03	1.45E-03
Right colon wall	Right colon contents	5.79E-02	5.79E-02	5.79E-02	5.79E-02	5.79E-02	5.79E-02
Cortical bone surface	Blood	1.90E-02	1.90E-02	1.90E-02	1.90E-02	1.90E-02	1.90E-02
Cortical bone surface	Cortical bone volume	1.92E-04	1.92E-04	1.92E-04	1.92E-04	1.92E-04	1.92E-04
Trabecular bone surface	Blood	1.90E-02	1.90E-02	1.90E-02	1.90E-02	1.90E-02	1.90E-02
Trabecular bone surface	Trabecular bone volume	1.92E-04	1.92E-04	1.92E-04	1.92E-04	1.92E-04	1.92E-04
Cortical bone volume	Blood	3.42E-06	2.17E-05	3.77E-05	6.38E-05	1.20E-04	3.43E-04
Trabecular bone volume	Blood	2.05E-05	4.00E-05	5.50E-05	7.54E-05	1.20E-04	3.43E-04

Radioactive half-life of ^{99m}Tc: 6.015 h

A.24.3. Specific assumptions for the calculations

(A 137) The simplified alimentary tract model presented in Section 4 is used with the parameters given in Table 4.2. A fraction of the ^{99m}Tc present in the systemic circulation is also transferred to the oral cavity from the salivary glands; this systemic technetium proceeds to the stomach only through the slow oesophagus compartment.

(A 138) The intestinal fractional absorption is taken to be 0.9, as indicated in the OIR Report (ICRP, 2016) and in agreement with the results for pertechnetate obtained by McAfee et al. (1964) and Beasley et al. (1966) in humans.

(A 139) The contribution of the daughter nuclide ^{99}Tc to the dose is considered negligible and not included in the calculations.

A.24.4. References for ^{99m}Tc-labelled pertechnetate

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MIRD, 1976. Summary of current radiation dose estimates to normal humans from ^{99m}Tc as sodium pertechnetate. Dose Estimate Report No. 8. J. Nucl. Med. 17, 74–77.

2758 Table A.24.2. Time-integrated activity coefficients for ^{99m}Tc-labelled pertechnetate (h). (i.v.
2759 administration.)

	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Blood	1.30E+00	1.30E+00	1.30E+00		1.30E+00		1.30E+00		1.30E+00		1.31E+00	
Oral cavity	7.42E-05	7.42E-05	7.42E-05		7.42E-05		7.42E-05		7.42E-05		7.50E-05	
Oesophagus slow	1.11E-03	1.11E-03	1.11E-03		1.11E-03		1.11E-03		1.11E-03		1.12E-03	
Stomach contents	1.67E-01	1.67E-01	1.67E-01		1.67E-01		1.67E-01		1.67E-01		5.86E-02	
Small intestine contents	1.28E-01	1.28E-01	1.28E-01		1.28E-01		1.28E-01		1.28E-01		1.34E-01	
Right colon contents	4.71E-01	5.25E-01	4.53E-01		4.53E-01		4.53E-01		4.33E-01		3.97E-01	
Left colon contents	1.98E-01	1.85E-01	2.00E-01		2.00E-01		2.00E-01		2.02E-01		2.08E-01	
Recto-sigmoid colon content	8.29E-02	6.49E-02	8.81E-02		8.81E-02		8.81E-02		9.36E-02		1.08E-01	
Thyroid	1.11E-01	1.11E-01	1.11E-01		1.11E-01		1.11E-01		1.11E-01		1.12E-01	
Other	3.50E+00	3.50E+00	3.50E+00		3.50E+00		3.50E+00		3.50E+00		3.53E+00	
Salivary glands	6.39E-02	6.39E-02	6.39E-02		6.39E-02		6.39E-02		6.39E-02		6.47E-02	
Stomach wall	1.06E-01	1.06E-01	1.06E-01		1.06E-01		1.06E-01		1.06E-01		1.07E-01	
Kidneys	1.01E-01	1.01E-01	1.01E-01		1.01E-01		1.01E-01		1.01E-01		1.02E-01	
Right colon wall	1.06E+00	1.06E+00	1.06E+00		1.06E+00		1.06E+00		1.06E+00		1.08E+00	
Cortical bone mineral surface	1.41E-01	1.41E-01	1.41E-01		1.41E-01		1.41E-01		1.41E-01		1.43E-01	
Trabecular bone mineral surface	1.41E-01	1.41E-01	1.41E-01		1.41E-01		1.41E-01		1.41E-01		1.43E-01	
Cortical bone mineral volume	2.35E-04	2.35E-04	2.35E-04		2.35E-04		2.35E-04		2.35E-04		2.38E-04	
Trabecular bone mineral volume	2.35E-04	2.35E-04	2.35E-04		2.35E-04		2.35E-04		2.35E-04		2.38E-04	
Urinary bladder contents	2.76E-01	2.94E-01	2.94E-01	2.87E-01	3.02E-01		2.93E-01		2.58E-01		1.83E-01	

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2761 Table A.24.3. Dose coefficients for ^{99m}Tc-labelled pertechnetate. (i.v. administration.)

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	6.9E-03	7.3E-03	5.5E-03	5.7E-03	8.2E-03	8.2E-03	1.3E-02	1.3E-02	2.4E-02	2.4E-02	3.0E-02	3.0E-02
Brain	2.1E-03	2.5E-03	4.1E-03	4.2E-03	6.0E-03	6.1E-03	8.5E-03	8.6E-03	1.3E-02	1.3E-02	1.9E-02	1.9E-02
Breast	2.3E-03	2.4E-03	2.3E-03	2.7E-03	3.7E-03	3.2E-03	5.9E-03	5.7E-03	1.0E-02	9.9E-03	1.7E-02	1.7E-02
Colon wall	3.5E-02	4.0E-02	4.3E-02	4.7E-02	6.4E-02	6.4E-02	1.0E-01	1.0E-01	2.4E-01	2.4E-01	3.6E-01	3.6E-01
Endosteum (bone surface)	6.1E-03	8.1E-03	8.9E-03	9.5E-03	1.0E-02	1.0E-02	2.0E-02	2.0E-02	4.0E-02	4.0E-02	5.2E-02	5.2E-02
ET region	2.1E-03	2.9E-03	5.8E-03	5.6E-03	7.1E-03	7.1E-03	8.8E-03	8.8E-03	1.3E-02	1.3E-02	1.8E-02	1.8E-02
Gall bladder wall	1.0E-02	5.9E-03	6.3E-03	7.3E-03	9.8E-03	9.8E-03	1.6E-02	1.6E-02	2.9E-02	2.9E-02	4.3E-02	4.3E-02
Heart wall	5.9E-03	6.1E-03	3.4E-03	4.0E-03	5.9E-03	5.9E-03	9.3E-03	9.3E-03	1.7E-02	1.7E-02	2.3E-02	2.3E-02
Kidneys	1.1E-02	1.2E-02	9.1E-03	9.5E-03	1.3E-02	1.3E-02	2.2E-02	2.2E-02	3.5E-02	3.5E-02	4.9E-02	4.8E-02
Liver	7.1E-03	6.3E-03	5.8E-03	6.8E-03	9.6E-03	9.6E-03	1.5E-02	1.5E-02	2.6E-02	2.6E-02	3.6E-02	3.6E-02
Lung	4.4E-03	5.1E-03	4.5E-03	5.0E-03	7.0E-03	7.0E-03	1.1E-02	1.1E-02	2.2E-02	2.2E-02	3.0E-02	3.0E-02
Lymphatic nodes	5.6E-03	6.7E-03	5.8E-03	6.3E-03	8.2E-03	8.2E-03	1.4E-02	1.4E-02	2.4E-02	2.4E-02	2.8E-02	2.8E-02
Muscle	2.9E-03	3.7E-03	3.1E-03	3.1E-03	4.7E-03	4.7E-03	7.2E-03	7.2E-03	1.3E-02	1.3E-02	2.0E-02	1.9E-02
Oesophagus	5.7E-03	6.2E-03	5.7E-03	6.0E-03	8.8E-03	8.9E-03	1.4E-02	1.4E-02	2.4E-02	2.4E-02	3.2E-02	3.2E-02
Oral mucosa	2.5E-03	3.2E-03	6.0E-03	6.3E-03	7.6E-03	7.7E-03	8.5E-03	8.5E-03	1.3E-02	1.4E-02	2.4E-02	2.4E-02
Ovaries	-	7.9E-03	-	9.2E-03	-	1.3E-02	-	2.0E-02	-	3.8E-02	-	4.4E-02
Pancreas	1.1E-02	9.7E-03	7.5E-03	7.7E-03	1.1E-02	1.1E-02	1.5E-02	1.5E-02	2.8E-02	2.8E-02	3.6E-02	3.6E-02
Prostate	5.5E-03	-	5.8E-03	-	9.5E-03	-	1.4E-02	-	2.7E-02	-	3.1E-02	-
Red marrow	5.9E-03	8.3E-03	7.0E-03	7.7E-03	9.5E-03	9.5E-03	1.4E-02	1.4E-02	2.7E-02	2.7E-02	4.3E-02	4.3E-02
Salivary glands	9.9E-03	1.2E-02	1.6E-02	1.6E-02	2.2E-02	2.2E-02	2.7E-02	2.7E-02	3.9E-02	3.9E-02	7.3E-02	7.3E-02
Skin	2.0E-03	2.4E-03	2.4E-03	2.6E-03	4.0E-03	4.0E-03	6.4E-03	6.4E-03	1.1E-02	1.1E-02	1.7E-02	1.7E-02
Small intestine wall	8.8E-03	1.1E-02	1.0E-02	1.1E-02	1.4E-02	1.4E-02	2.4E-02	2.4E-02	4.2E-02	4.2E-02	5.2E-02	5.2E-02
Spleen	5.7E-03	6.7E-03	4.9E-03	5.8E-03	8.1E-03	8.1E-03	1.3E-02	1.3E-02	2.4E-02	2.4E-02	3.2E-02	3.2E-02
Stomach wall	1.4E-02	1.5E-02	1.5E-02	1.6E-02	2.3E-02	2.3E-02	3.4E-02	3.4E-02	7.4E-02	7.4E-02	1.0E-01	1.0E-01
Testes	2.5E-03	-	4.5E-03	-	6.2E-03	-	9.1E-03	-	1.4E-02	-	1.7E-02	-
Thymus	3.5E-03	3.7E-03	4.3E-03	5.0E-03	6.2E-03	6.2E-03	9.7E-03	9.7E-03	2.0E-02	2.0E-02	2.7E-02	2.7E-02
Thyroid	5.7E-02	6.9E-02	9.2E-02	9.6E-02	1.4E-01	1.4E-01	3.1E-01	3.1E-01	5.9E-01	5.9E-01	6.6E-01	6.6E-01
Urinary bladder wall	9.9E-03	1.3E-02	1.3E-02	1.2E-02	1.9E-02	1.9E-02	2.5E-02	2.5E-02	3.9E-02	3.9E-02	4.9E-02	4.7E-02
Uterus/ cervix	-	7.9E-03	-	4.0E-02	-	5.3E-02	-	2.1E-02	-	9.9E-02	-	1.1E-01
Effective dose (mSv/MBq)	1.3E-02		1.6E-02		2.2E-02		3.8E-02		7.8E-02		1.1E-01	

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Table A.24.4. Time-integrated activity coefficients for ^{99m}Tc-labelled pertechnetate (h). (i.v. administration with blocking agent.)

	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Blood	1.32E+00	1.32E+00	1.32E+00		1.32E+00		1.32E+00		1.32E+00		1.33E+00	
Oral cavity	7.50E-05	7.50E-05	7.50E-05		7.50E-05		7.50E-05		7.50E-05		7.58E-05	
Oesophagus slow	1.13E-03	1.13E-03	1.13E-03		1.13E-03		1.13E-03		1.13E-03		1.14E-03	
Stomach contents	1.69E-01	1.69E-01	1.69E-01		1.69E-01		1.69E-01		1.69E-01		5.92E-02	
Small intestine contents	1.30E-01	1.29E-01	1.29E-01		1.29E-01		1.29E-01		1.29E-01		1.36E-01	
Right colon contents	4.77E-01	5.33E-01	4.58E-01		4.58E-01		4.58E-01		4.39E-01		4.03E-01	
Left colon contents	2.00E-01	1.88E-01	2.03E-01		2.03E-01		2.03E-01		2.04E-01		2.10E-01	
Recto-sigmoid colon content	8.40E-02	6.58E-02	9.28E-02		9.28E-02		9.28E-02		1.03E-01		1.32E-01	
Thyroid	0.00E+00	0.00E+00	0.00E+00		0.00E+00		0.00E+00		0.00E+00		0.00E+00	
Other	3.54E+00	3.56E+00	3.56E+00		3.56E+00		3.56E+00		3.56E+00		3.58E+00	
Salivary glands	6.48E-02	6.47E-02	6.47E-02		6.47E-02		6.47E-02		6.47E-02		6.56E-02	
Stomach wall	1.07E-01	1.07E-01	1.07E-01		1.07E-01		1.07E-01		1.07E-01		1.08E-01	
Kidneys	1.02E-01	1.02E-01	1.02E-01		1.02E-01		1.02E-01		1.02E-01		1.03E-01	
Right colon wall	1.08E+00	1.08E+00	1.08E+00		1.08E+00		1.08E+00		1.08E+00		1.09E+00	
Cortical bone mineral surface	1.43E-01	1.43E-01	1.43E-01		1.43E-01		1.43E-01		1.43E-01		1.44E-01	
Trabecular bone mineral surface	1.43E-01	1.43E-01	1.43E-01		1.43E-01		1.43E-01		1.43E-01		1.44E-01	
Cortical bone mineral volume	2.38E-04	2.38E-04	2.38E-04		2.38E-04		2.38E-04		2.38E-04		2.41E-04	
Trabecular bone mineral volume	2.38E-04	2.38E-04	2.38E-04		2.38E-04		2.38E-04		2.38E-04		2.41E-04	
Urinary bladder contents	2.79E-01	2.97E-01	2.97E-01	2.91E-01	3.06E-01		2.96E-01		2.61E-01		1.85E-01	

Table A.24.5. Dose coefficients for ^{99m}Tc-labelled pertechnetate. (i.v. administration with blocking agent.)

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	6.9E-03	7.4E-03	5.5E-03	5.8E-03	8.3E-03	8.3E-03	1.3E-02	1.3E-02	2.4E-02	2.4E-02	3.0E-02	3.0E-02
Brain	2.1E-03	2.5E-03	4.1E-03	4.2E-03	6.0E-03	6.1E-03	8.5E-03	8.6E-03	1.4E-02	1.4E-02	1.9E-02	1.9E-02
Breast	2.3E-03	2.4E-03	2.3E-03	2.7E-03	3.7E-03	3.2E-03	5.9E-03	5.8E-03	1.0E-02	1.0E-02	1.7E-02	1.7E-02
Colon wall	3.6E-02	4.1E-02	4.4E-02	4.8E-02	6.5E-02	6.5E-02	1.0E-01	1.0E-01	2.4E-01	2.4E-01	3.6E-01	3.6E-01
Endosteum (bone surface)	6.2E-03	8.2E-03	9.0E-03	9.6E-03	1.0E-02	1.0E-02	2.0E-02	2.0E-02	4.0E-02	4.0E-02	5.3E-02	5.3E-02
ET region	1.9E-03	2.6E-03	5.7E-03	5.5E-03	7.0E-03	6.9E-03	8.7E-03	8.6E-03	1.3E-02	1.3E-02	1.7E-02	1.7E-02
Gall bladder wall	1.0E-02	5.9E-03	6.3E-03	7.3E-03	9.9E-03	9.9E-03	1.7E-02	1.7E-02	2.9E-02	2.9E-02	4.3E-02	4.3E-02
Heart wall	5.9E-03	6.1E-03	3.3E-03	4.0E-03	5.9E-03	5.9E-03	9.2E-03	9.3E-03	1.7E-02	1.7E-02	2.3E-02	2.3E-02
Kidneys	1.1E-02	1.2E-02	9.2E-03	9.7E-03	1.4E-02	1.4E-02	2.2E-02	2.2E-02	3.5E-02	3.5E-02	4.9E-02	4.9E-02
Liver	7.2E-03	6.4E-03	5.8E-03	6.9E-03	9.7E-03	9.7E-03	1.5E-02	1.5E-02	2.6E-02	2.6E-02	3.6E-02	3.6E-02
Lung	4.4E-03	5.0E-03	4.1E-03	4.7E-03	6.6E-03	6.6E-03	9.9E-03	1.0E-02	1.9E-02	1.9E-02	2.8E-02	2.8E-02
Lymphatic nodes	5.3E-03	6.5E-03	5.7E-03	6.2E-03	8.2E-03	8.2E-03	1.3E-02	1.3E-02	2.4E-02	2.4E-02	2.8E-02	2.8E-02
Muscle	2.9E-03	3.8E-03	3.1E-03	3.2E-03	4.8E-03	4.8E-03	7.2E-03	7.2E-03	1.3E-02	1.3E-02	1.9E-02	1.9E-02
Oesophagus	4.8E-03	5.1E-03	5.3E-03	5.6E-03	8.4E-03	8.4E-03	1.3E-02	1.3E-02	2.1E-02	2.1E-02	3.0E-02	3.0E-02
Oral mucosa	2.4E-03	3.0E-03	5.8E-03	6.1E-03	7.5E-03	7.5E-03	8.4E-03	8.4E-03	1.3E-02	1.3E-02	2.3E-02	2.3E-02
Ovaries	-	8.0E-03	-	9.4E-03	-	1.3E-02	-	2.0E-02	-	3.8E-02	-	4.4E-02
Pancreas	1.1E-02	9.9E-03	7.6E-03	7.8E-03	1.1E-02	1.1E-02	1.5E-02	1.5E-02	2.8E-02	2.8E-02	3.6E-02	3.6E-02
Prostate	5.5E-03	-	5.9E-03	-	9.6E-03	-	1.4E-02	-	2.7E-02	-	3.2E-02	-
Red marrow	5.9E-03	8.3E-03	7.0E-03	7.8E-03	9.5E-03	9.5E-03	1.4E-02	1.4E-02	2.7E-02	2.7E-02	4.4E-02	4.4E-02
Salivary glands	9.9E-03	1.2E-02	1.6E-02	1.6E-02	2.1E-02	2.1E-02	2.7E-02	2.7E-02	3.8E-02	3.8E-02	7.2E-02	7.2E-02
Skin	2.0E-03	2.4E-03	2.4E-03	2.7E-03	4.0E-03	4.0E-03	6.4E-03	6.4E-03	1.1E-02	1.1E-02	1.7E-02	1.7E-02
Small intestine wall	8.9E-03	1.1E-02	1.0E-02	1.1E-02	1.4E-02	1.5E-02	2.4E-02	2.4E-02	4.2E-02	4.2E-02	5.2E-02	5.2E-02
Spleen	5.8E-03	6.8E-03	5.0E-03	5.9E-03	8.2E-03	8.2E-03	1.3E-02	1.3E-02	2.4E-02	2.4E-02	3.3E-02	3.3E-02
Stomach wall	1.5E-02	1.5E-02	1.5E-02	1.7E-02	2.3E-02	2.3E-02	3.5E-02	3.5E-02	7.5E-02	7.5E-02	1.0E-01	1.0E-01
Testes	2.5E-03	-	4.5E-03	-	6.3E-03	-	9.2E-03	-	1.4E-02	-	1.8E-02	-
Thymus	2.4E-03	2.7E-03	3.4E-03	3.6E-03	5.5E-03	5.5E-03	8.7E-03	8.8E-03	1.7E-02	1.7E-02	2.4E-02	2.4E-02
Thyroid	2.3E-03	2.8E-03	3.2E-03	3.2E-03	4.5E-03	4.5E-03	7.1E-03	7.1E-03	1.1E-02	1.1E-02	1.8E-02	1.8E-02
Urinary bladder wall	1.0E-02	1.3E-02	1.3E-02	1.3E-02	1.9E-02	1.9E-02	2.6E-02	2.5E-02	4.0E-02	3.9E-02	4.9E-02	4.8E-02
Uterus/ cervix	-	8.0E-03	-	4.0E-02	-	5.3E-02	-	2.1E-02	-	1.0E-01	-	1.1E-01
Effective dose (mSv/MBq)	1.0E-02		1.2E-02		1.7E-02		2.6E-02		5.5E-02		8.0E-02	

2770 Table A.24.6. Time-integrated activity coefficients for ^{99m}Tc-labelled pertechnetate (h). (oral
2771 administration.)

	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Blood	1.06E+00	1.06E+00	1.06E+00		1.06E+00		1.06E+00		1.06E+00		1.11e+00	
Oral cavity	6.16E-04	6.16E-04	6.16E-04		6.16E-04		6.16E-04		6.16E-04		6.19e-04	
Oesophagus fast	1.25E-03	1.25E-03	1.25E-03		1.25E-03		1.25E-03		1.25E-03		1.00E-03	
Oesophagus slow	1.74E-03	1.74E-03	1.74E-03		1.74E-03		1.74E-03		1.74E-03		1.78E-03	
Stomach contents	6.09E-01	6.09E-01	6.09E-01		6.09E-01		6.09E-01		6.09E-01		2.13E-01	
Small intestine contents	4.65E-01	4.65E-01	4.65E-01		4.65E-01		4.65E-01		4.65E-01		4.89E-01	
Right colon contents	8.38E-01	9.36E-01	8.07E-01		8.07E-01		8.07E-01		7.73E-01		7.28E-01	
Left colon contents	3.52E-01	3.29E-01	3.56E-01		3.56E-01		3.56E-01		3.59E-01		3.78E-01	
Recto-sigmoid colon content	1.48E-01	1.16E-01	1.57E-01		1.57E-01		1.57E-01		1.67E-01		1.97E-01	
Thyroid	9.02E-02	9.02E-02	9.02E-02		9.02E-02		9.02E-02		9.02E-02		9.47E-02	
Other	2.85E+00	2.85E+00	2.85E+00		2.85E+00		2.85E+00		2.85E+00		2.99E+00	
Salivary glands	5.20E-02	5.20E-02	5.20E-02		5.20E-02		5.20E-02		5.20E-02		5.47E-02	
Stomach wall	8.61E-02	8.61E-02	8.61E-02		8.61E-02		8.61E-02		8.61E-02		9.04E-02	
Kidneys	8.18E-02	8.18E-02	8.18E-02		8.18E-02		8.18E-02		8.18E-02		8.58E-02	
Right colon wall	8.64E-01	8.64E-01	8.64E-01		8.64E-01		8.64E-01		8.64E-01		9.06E-01	
Cortical bone mineral surface	1.15E-01	1.15E-01	1.15E-01		1.15E-01		1.15E-01		1.15E-01		1.20E-01	
Trabecular bone mineral surface	1.15E-01	1.15E-01	1.15E-01		1.15E-01		1.15E-01		1.15E-01		1.20E-01	
Cortical bone mineral volume	1.91E-04	1.91E-04	1.91E-04		1.91E-04		1.91E-04		1.91E-04		2.01E-04	
Trabecular bone mineral volume	1.91E-04	1.91E-04	1.91E-04		1.91E-04		1.91E-04		1.91E-04		2.01E-04	
Urinary bladder contents	2.28E-01	2.43E-01	2.43E-01	2.38E-01	2.51E-01		2.42E-01		2.13E-01		1.50E-01	

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Table A.24.7. - Dose coefficients for ^{99m}Tc-labelled pertechnetate. (oral administration.)

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	7.8E-03	8.4E-03	6.2E-03	6.4E-03	8.7E-03	8.8E-03	1.3E-02	1.3E-02	2.4E-02	2.4E-02	2.9E-02	2.9E-02
Brain	1.7E-03	2.0E-03	3.3E-03	3.4E-03	4.9E-03	4.9E-03	6.9E-03	7.0E-03	1.1E-02	1.1E-02	1.6E-02	1.6E-02
Breast	2.4E-03	2.2E-03	2.1E-03	2.5E-03	3.4E-03	3.1E-03	5.7E-03	5.6E-03	9.6E-03	9.5E-03	1.6E-02	1.5E-02
Colon wall	3.4E-02	3.9E-02	4.2E-02	4.6E-02	6.2E-02	6.2E-02	9.6E-02	9.5E-02	2.2E-01	2.2E-01	3.2E-01	3.2E-01
Endosteum (bone surface)	5.3E-03	7.2E-03	7.9E-03	8.5E-03	9.2E-03	9.2E-03	1.8E-02	1.8E-02	3.6E-02	3.6E-02	4.7E-02	4.6E-02
ET region	1.8E-03	2.4E-03	4.7E-03	4.5E-03	5.8E-03	5.8E-03	7.2E-03	7.2E-03	1.0E-02	1.0E-02	1.5E-02	1.5E-02
Gall bladder wall	1.2E-02	7.2E-03	8.6E-03	9.4E-03	1.1E-02	1.1E-02	1.8E-02	1.8E-02	3.3E-02	3.3E-02	4.7E-02	4.7E-02
Heart wall	6.6E-03	6.2E-03	3.2E-03	4.0E-03	5.9E-03	5.9E-03	9.4E-03	9.4E-03	1.7E-02	1.7E-02	2.2E-02	2.2E-02
Kidneys	1.1E-02	1.3E-02	9.2E-03	9.5E-03	1.3E-02	1.3E-02	2.2E-02	2.2E-02	3.5E-02	3.5E-02	4.8E-02	4.8E-02
Liver	7.9E-03	6.8E-03	6.1E-03	7.3E-03	1.0E-02	1.0E-02	1.5E-02	1.5E-02	2.7E-02	2.7E-02	3.6E-02	3.6E-02
Lung	4.3E-03	4.6E-03	3.9E-03	4.4E-03	6.2E-03	6.2E-03	9.4E-03	9.4E-03	1.9E-02	1.9E-02	2.7E-02	2.7E-02
Lymphatic nodes	6.3E-03	7.5E-03	6.3E-03	6.7E-03	8.6E-03	8.6E-03	1.4E-02	1.4E-02	2.6E-02	2.6E-02	3.0E-02	3.0E-02
Muscle	2.7E-03	3.6E-03	2.9E-03	2.9E-03	4.4E-03	4.4E-03	6.7E-03	6.7E-03	1.2E-02	1.2E-02	1.8E-02	1.8E-02
Oesophagus	5.9E-03	6.0E-03	5.3E-03	5.7E-03	8.4E-03	8.5E-03	1.3E-02	1.3E-02	2.2E-02	2.2E-02	3.0E-02	3.0E-02
Oral mucosa	2.1E-03	2.6E-03	5.0E-03	5.2E-03	6.4E-03	6.4E-03	7.1E-03	7.1E-03	1.1E-02	1.1E-02	2.0E-02	2.0E-02
Ovaries	-	8.3E-03	-	9.5E-03	-	1.3E-02	-	2.2E-02	-	4.3E-02	-	5.2E-02
Pancreas	1.4E-02	1.3E-02	1.1E-02	1.1E-02	1.5E-02	1.5E-02	2.0E-02	2.0E-02	3.6E-02	3.6E-02	4.1E-02	4.1E-02
Prostate	4.7E-03	-	5.4E-03	-	8.5E-03	-	1.3E-02	-	2.6E-02	-	3.1E-02	-
Red marrow	5.5E-03	7.9E-03	6.6E-03	7.3E-03	8.7E-03	8.7E-03	1.3E-02	1.3E-02	2.4E-02	2.4E-02	3.9E-02	3.9E-02
Salivary glands	8.0E-03	1.0E-02	1.3E-02	1.3E-02	1.8E-02	1.8E-02	2.2E-02	2.2E-02	3.2E-02	3.2E-02	6.2E-02	6.2E-02
Skin	1.8E-03	2.2E-03	2.2E-03	2.4E-03	3.7E-03	3.7E-03	5.8E-03	5.8E-03	1.0E-02	1.0E-02	1.5E-02	1.5E-02
Small intestine wall	1.1E-02	1.4E-02	1.3E-02	1.4E-02	1.9E-02	1.9E-02	3.1E-02	3.1E-02	5.3E-02	5.3E-02	6.6E-02	6.6E-02
Spleen	7.3E-03	9.2E-03	5.4E-03	6.7E-03	9.1E-03	9.2E-03	1.6E-02	1.6E-02	2.8E-02	2.8E-02	3.3E-02	3.3E-02
Stomach wall	2.1E-02	2.1E-02	2.1E-02	2.4E-02	3.5E-02	3.5E-02	4.9E-02	4.9E-02	9.1E-02	9.1E-02	1.0E-01	1.0E-01
Testes	2.1E-03	-	4.1E-03	-	5.4E-03	-	8.4E-03	-	1.3E-02	-	1.7E-02	-
Thymus	3.0E-03	3.2E-03	3.6E-03	4.2E-03	5.3E-03	5.3E-03	8.4E-03	8.4E-03	1.7E-02	1.7E-02	2.4E-02	2.4E-02
Thyroid	4.7E-02	5.6E-02	7.5E-02	7.8E-02	1.1E-01	1.1E-01	2.5E-01	2.5E-01	4.8E-01	4.8E-01	5.6E-01	5.6E-01
Urinary bladder wall	8.8E-03	1.2E-02	1.2E-02	1.2E-02	1.7E-02	1.7E-02	2.4E-02	2.4E-02	4.0E-02	4.0E-02	5.1E-02	4.9E-02
Uterus/ cervix	-	8.5E-03	-	3.4E-02	-	4.6E-02	-	2.3E-02	-	9.1E-02	-	1.0E-01
Effective dose (mSv/MBq)	1.3E-02		1.5E-02		2.2E-02		3.6E-02		7.3E-02		9.7E-02	

A.25. ^{99m}Tc-labelled Technegas

A.25.1. Biokinetic information

(A 140) Technegas is used for ventilation lung scintigraphy. It is an aerosol incorporating ^{99m}Tc atoms that is prepared by evaporating sodium ^{99m}Tc-labelled sodium pertechnetate in normal saline to dryness in a graphite crucible. The crucible is then heated at 2500°C for 15 s in an atmosphere of pure argon (Burch et al., 1986). Technegas appears to consist of ^{99m}Tc atoms attached to carbon particles with a median diameter of 140–160nm (Strong and Agnew, 1989; Lloyd et al., 1995; Isawa et al., 1996). Following inhalation, Technegas shows good penetration to the lung periphery, and the material is deposited on the lung parenchyma, where it is retained with a half-time that is long compared with the physical half-life of ^{99m}Tc (Burch et al., 1986; Isawa et al., 1991). The observed deposition of Technegas in the bronchial airways is approximately 5% (Lloyd et al., 1995), and the biological retention in the pulmonary tissue amounts to 85% at 24 h (Isawa et al., 1991).

(A 141) The model description presented in *Publication 128* for Technegas assumes that 95% of the inhaled material is deposited in the lungs, with 5% in the main bronchial airways. The inhaled material is assumed to be lost from the pulmonary tissue with a biological half-time of 4 days. The material deposited in the bronchii is assumed to be elevated by the ciliary escalator and swallowed. The material absorbed from the alimentary tract is assumed to behave as orally administered ^{99m}Tc-pertechnetate.

A.25.2. Biokinetic model

(A 142) The model for Technegas is based on the one for pertechnetate presented in A.24.4. This model is expanded including a very simplified version of the Human Respiratory Tract Model (ICRP, 2015). Consistently with the description in *Publication 128*, 95% of the inhaled activity is deposited in the lung tissues and from there it is eliminated with a biological half-time of 4 days. The remaining 5% is deposited in the compartment Bronchii, and from there it is transported to the extrathoracic compartment ET'$_2$ (corresponding to the region including posterior nasal passage, larynx and pharynx) and then enters the alimentary tract through the oesophagus.

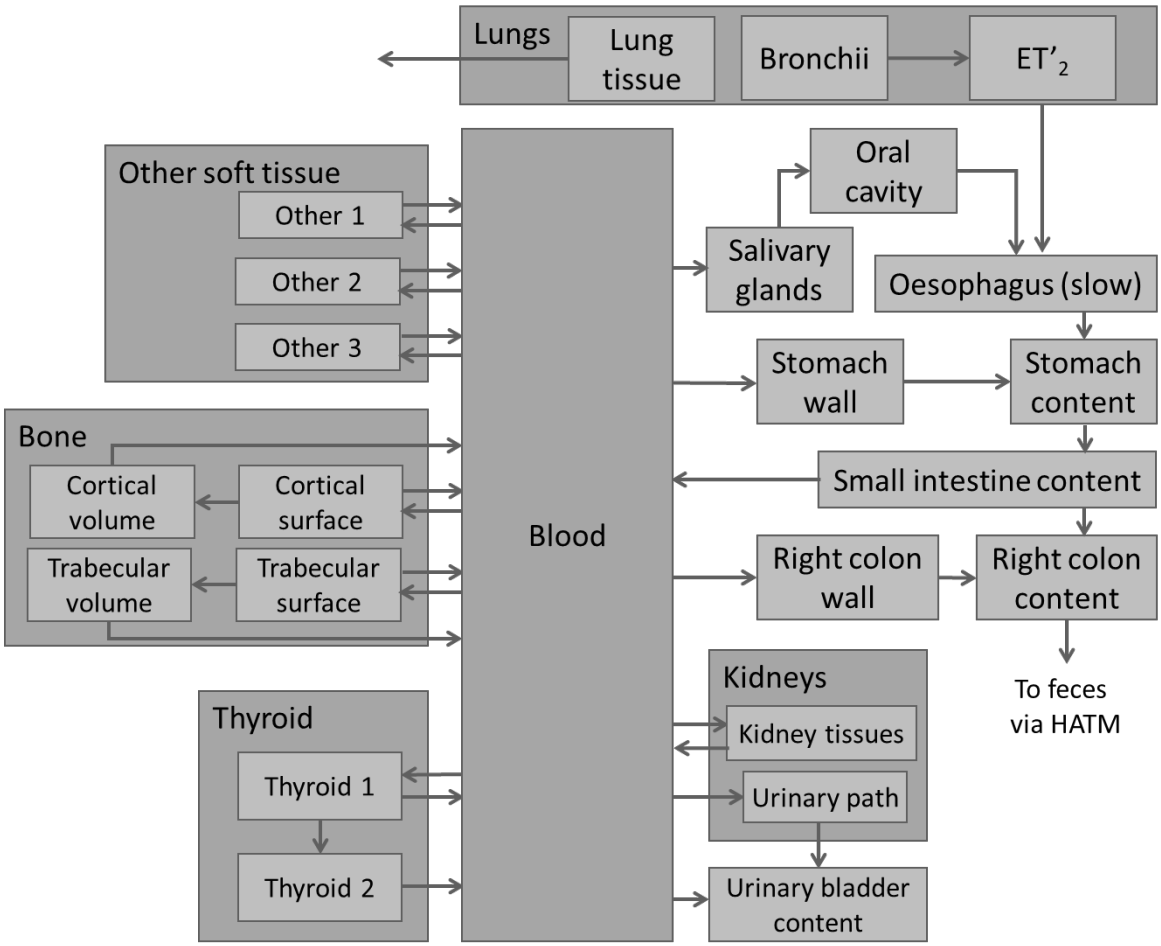

Fig. A.25.1. Biokinetic model for ^{99m}Tc-labelled Technegas.

2806 Table A.25.1. Values of the transfer coefficients (h^{-1}).

From	To	Adults	15 years	10 years	5 years	1 year
Lung tissue	Out					
Bronchii	ET'_2					
ET'_2	Oesophagus					
Blood	Thyroid_1	2.92E-01	2.92E-01	2.92E-01	2.92E-01	2.92E-01
Blood	Other 1	2.99E+00	2.99E+00	2.99E+00	2.99E+00	2.99E+00
Blood	Other 2	1.85E-01	1.85E-01	1.85E-01	1.85E-01	1.85E-01
Blood	Other 3	1.25E-01	1.25E-01	1.25E-01	1.25E-01	1.25E-01
Blood	UB-contents	7.08E-02	7.08E-02	7.08E-02	7.08E-02	7.08E-02
Blood	Salivary glands	1.08E-01	1.08E-01	1.08E-01	1.08E-01	1.08E-01
Blood	Stomach wall	1.79E-01	1.79E-01	1.79E-01	1.79E-01	1.79E-01
Blood	Kidneys 1	2.92E-02	2.92E-02	2.92E-02	2.92E-02	2.92E-02
Blood	Kidneys 2	1.67E-03	1.67E-03	1.67E-03	1.67E-03	1.67E-03
Blood	Right colon wall	1.42E-01	1.42E-01	1.42E-01	1.42E-01	1.42E-01
Blood	Cortical bone surface	1.46E-02	1.46E-02	1.46E-02	1.46E-02	1.46E-02
Blood	Trabecular bone surface	1.46E-02	1.46E-02	1.46E-02	1.46E-02	1.46E-02
Thyroid 1	Blood	4.17E+00	4.17E+00	4.17E+00	4.17E+00	4.17E+00
Thyroid 1	Thyroid2	4.17E-02	4.17E-02	4.17E-02	4.17E-02	4.17E-02
Thyroid 2	Blood	4.17E-02	4.17E-02	4.17E-02	4.17E-02	4.17E-02
Other 1	Blood	2.08E+00	2.08E+00	2.08E+00	2.08E+00	2.08E+00
Other 2	Blood	3.46E-01	3.46E-01	3.46E-01	3.46E-01	3.46E-01
Other 3	Blood	1.92E-02	1.92E-02	1.92E-02	1.92E-02	1.92E-02
Salivary glands	Oral cavity	2.08E+00	2.08E+00	2.08E+00	2.08E+00	2.08E+00
Stomach wall	Stomach contents	2.08E+00	2.08E+00	2.08E+00	2.08E+00	2.08E+00
Kidneys 1	Urinary bladder contents	3.47E-01	3.47E-01	3.47E-01	3.47E-01	3.47E-01
Kidneys 2	Blood	1.45E-03	1.45E-03	1.45E-03	1.45E-03	1.45E-03
Right colon wall	Right colon contents	5.79E-02	5.79E-02	5.79E-02	5.79E-02	5.79E-02
Cortical bone surface	Blood	1.90E-02	1.90E-02	1.90E-02	1.90E-02	1.90E-02
Cortical bone surface	Cortical bone volume	1.92E-04	1.92E-04	1.92E-04	1.92E-04	1.92E-04
Trabecular bone surface	Blood	1.90E-02	1.90E-02	1.90E-02	1.90E-02	1.90E-02
Trabecular bone surface	Trabecular bone volume	1.92E-04	1.92E-04	1.92E-04	1.92E-04	1.92E-04
Cortical bone volume	Blood	3.42E-06	2.17E-05	3.77E-05	6.38E-05	1.20E-04
Trabecular bone volume	Blood	2.05E-05	4.00E-05	5.50E-05	7.54E-05	1.20E-04

2807 Radioactive half-life of ^{99m}Tc: 6.015 h

2808 **A.25.3. Specific assumptions for the calculations**

2809 (A 143) Doses are calculated for all age-groups but infant.
2810 (A 144) The contribution of the daughter nuclide ^{99}Tc to the dose is considered negligible
2811 and not included in the calculation.

2812 **A.25.4. References for ^{99m}Tc-labelled Technegas**

Burch, W.M., Sullivan, P.J., McLaren, C.J., 1986. Technegas – a new ventilation agent for lung scanning. Nucl. Med. Commun. 7, 865–871.

ICRP, 2015. Radiation dose to patients from radiopharmaceuticals: a compendium of current information related to frequently used substances. ICRP Publication 128. Ann. ICRP 44(2S).

Isawa, T., Teshima, T., Anazawa, Y., et al., 1991. Technegas for inhalation lung imaging. Nucl. Med. Commun. 12, 47–55.

Isawa, T., Lee, B.T., Hiraga, K., 1996. High-resolution electron microscopy of Technegas and Pertechnegas. Nucl. Med. Commun. 17, 147–152.

Lloyd, J.J., Shields, R.A., Taylor, C.J., et al., 1995. Technegas and Pertechnegas particle size distribution. Eur. J. Nucl. Med. 22, 473–476.

Strong, J.C., Agnew, J.E., 1989. The particle size distribution of Technegas and its influence on regional lung deposition. Nucl. Med. Comm. 10, 425–430.

A.26. ^{99m}Tc-labelled Pertechnegas

A.26.1. Biokinetic information

(A 145) Pertechnegas is a ^{99m}Tc-labelled sodium chloride aerosol that is soluble because it lacks the carbon coating of Technegas, and has a median particle diameter of 167nm (Lloyd et al., 1995). Pertechnegas is thus a modified form of Technegas, produced by heating ^{99m}Tc-labelled pertechnetate in argon containing 3% oxygen. Following inhalation, Pertechnegas shows lung clearance properties similar to those of a ^{99m}Tc-labelled pertechnetate aerosol.

(A 146) Approximately 75% of inhaled Pertechnegas is lost from the lungs with a half-time of 9–11 min in both smokers and non-smokers. The remainder of the material appears to leave the lungs with a half-time of 2–3 h (Isawa et al., 1996; Kotzerke et al., 1996).

A.26.2. Biokinetic model

(A 147) The systemic model for ^{99m}Tc-labelled Pertechnegas is based on the one for ^{99m}Tc-labelled pertechnetate presented in A.16.4.

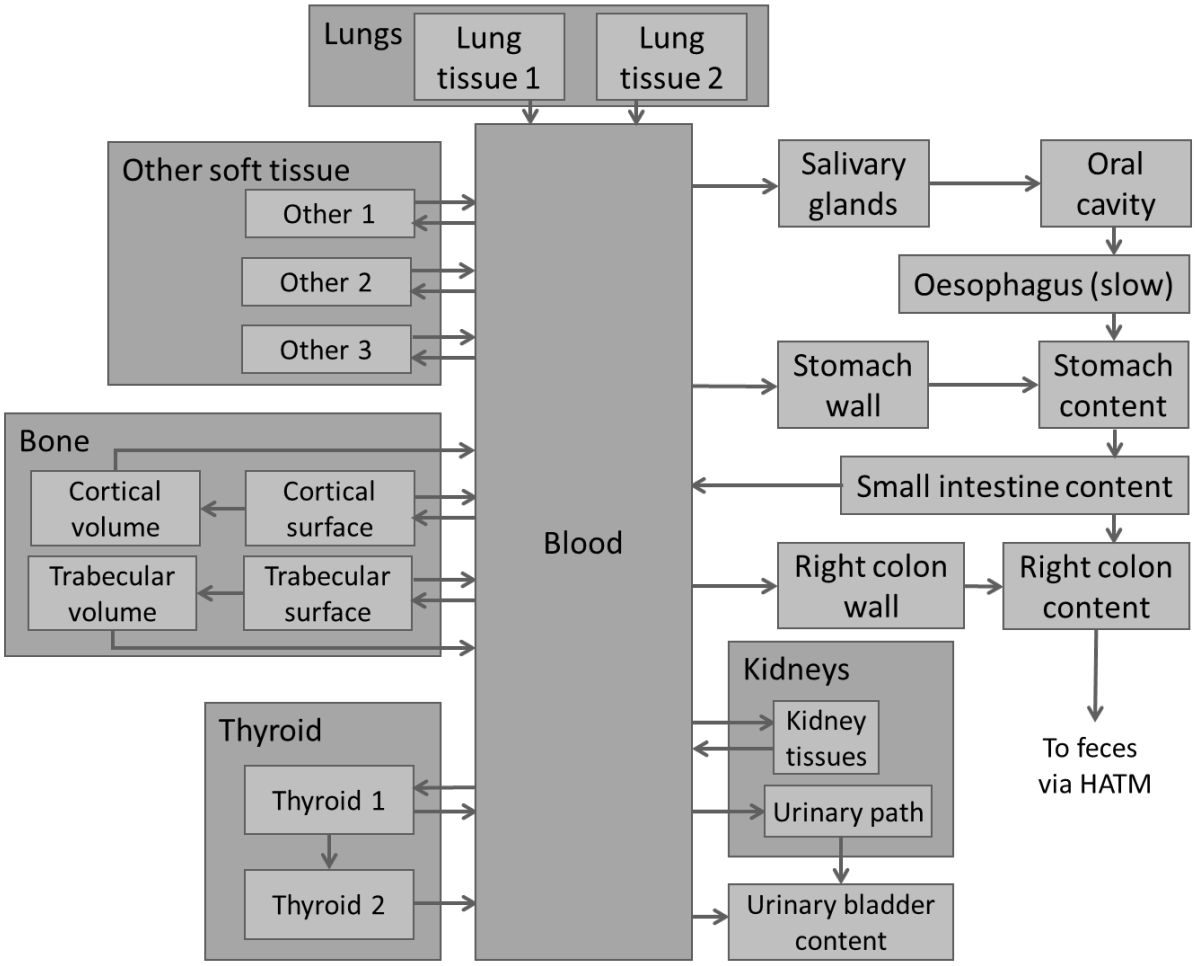

Fig. A.26.1. Biokinetic model for ^{99m}Tc-labelled Pertechnegas.

Table A.26.1. Values of the transfer coefficients (h^{-1}).

From	To	Adults	15 years	10 years	5 years	1 year
Lung tissue 1	Blood	4.08E+00	4.08E+00	4.08E+00	4.08E+00	4.08E+00
Lung tissue 2	Blood	2.57E-01	2.57E-01	2.57E-01	2.57E-01	2.57E-01
Blood	Thyroid_1	2.92E-01	2.92E-01	2.92E-01	2.92E-01	2.92E-01
Blood	Other 1	2.99E+00	2.99E+00	2.99E+00	2.99E+00	2.99E+00
Blood	Other 2	1.85E-01	1.85E-01	1.85E-01	1.85E-01	1.85E-01
Blood	Other 3	1.25E-01	1.25E-01	1.25E-01	1.25E-01	1.25E-01
Blood	UB-contents	7.08E-02	7.08E-02	7.08E-02	7.08E-02	7.08E-02
Blood	Salivary glands	1.08E-01	1.08E-01	1.08E-01	1.08E-01	1.08E-01
Blood	Stomach wall	1.79E-01	1.79E-01	1.79E-01	1.79E-01	1.79E-01
Blood	Kidneys 1	2.92E-02	2.92E-02	2.92E-02	2.92E-02	2.92E-02
Blood	Kidneys 2	1.67E-03	1.67E-03	1.67E-03	1.67E-03	1.67E-03
Blood	Right colon wall	1.42E-01	1.42E-01	1.42E-01	1.42E-01	1.42E-01
Blood	Cortical bone surface	1.46E-02	1.46E-02	1.46E-02	1.46E-02	1.46E-02
Blood	Trabecular bone surface	1.46E-02	1.46E-02	1.46E-02	1.46E-02	1.46E-02
Thyroid 1	Blood	4.17E+00	4.17E+00	4.17E+00	4.17E+00	4.17E+00
Thyroid 1	Thyroid2	4.17E-02	4.17E-02	4.17E-02	4.17E-02	4.17E-02
Thyroid 2	Blood	4.17E-02	4.17E-02	4.17E-02	4.17E-02	4.17E-02
Other 1	Blood	2.08E+00	2.08E+00	2.08E+00	2.08E+00	2.08E+00
Other 2	Blood	3.46E-01	3.46E-01	3.46E-01	3.46E-01	3.46E-01
Other 3	Blood	1.92E-02	1.92E-02	1.92E-02	1.92E-02	1.92E-02
Salivary glands	Oral cavity	2.08E+00	2.08E+00	2.08E+00	2.08E+00	2.08E+00
Stomach wall	Stomach contents	2.08E+00	2.08E+00	2.08E+00	2.08E+00	2.08E+00
Kidneys 1	Urinary bladder contents	3.47E-01	3.47E-01	3.47E-01	3.47E-01	3.47E-01
Kidneys 2	Blood	1.45E-03	1.45E-03	1.45E-03	1.45E-03	1.45E-03
Right colon wall	Right colon contents	5.79E-02	5.79E-02	5.79E-02	5.79E-02	5.79E-02
Cortical bone surface	Blood	1.90E-02	1.90E-02	1.90E-02	1.90E-02	1.90E-02
Cortical bone surface	Cortical bone volume	1.92E-04	1.92E-04	1.92E-04	1.92E-04	1.92E-04
Trabecular bone surface	Blood	1.90E-02	1.90E-02	1.90E-02	1.90E-02	1.90E-02
Trabecular bone surface	Trabecular bone volume	1.92E-04	1.92E-04	1.92E-04	1.92E-04	1.92E-04
Cortical bone volume	Blood	3.42E-06	2.17E-05	3.77E-05	6.38E-05	1.20E-04
Trabecular bone volume	Blood	2.05E-05	4.00E-05	5.50E-05	7.54E-05	1.20E-04

Radioactive half-life of ^{99m}Tc: 6.015 h

A.26.3. Specific assumptions for the calculations

(A 148) The biokinetic model for Pertechnegas assumes that 75% of the total inhaled activity is deposited in the compartment Lung tissue 1 and leaves the lungs with a half-time of 10 min; the remaining 25% is deposited in the compartment Lung tissue 2 and leaves the lungs with a half-time of 160 min.

(A 149) All of the activity leaving the lungs is assumed to be absorbed to blood and to behave as intravenously injected ^{99m}Tc-labelled pertechnetate.

(A 150) Doses are calculated for all age-groups but infant.

(A 151) The contribution of the daughter nuclide ^{99}Tc to the dose is considered negligible and not included in the calculation.

A.26.4. References for ^{99m}Tc-labelled Pertechnegas

Isawa, T., Lee, B.T., Hiraga, K., 1996. High-resolution electron microscopy of Technegas and Pertechnegas. Nucl. Med. Commun. 17, 147–152.

Kotzerke, J., van den Hoff, J., Burchert, W., et al., 1996. A compartmental model for alveolar clearance of Pertechnegas. J. Nucl. Med. 37, 2066–2071.

Lloyd, J.J., Shields, R.A., Taylor, C.J., et al., 1995. Technegas and Pertechnegas particle size distribution. Eur. J. Nucl. Med. 22, 473–476.

2863 Table A.26.2. Time-integrated activity coefficients for ^{99m}Tc-labelled Pertechnegas (h).

Organs		
Lung tissue		8.51E-01
Blood		1.17E+00
Oral cavity		6.68E-05
Oesophagus slow		1.00E-03
Stomach contents		1.51E-01
Small intestine contents		1.15E-01
Right colon contents		4.25E-01
Left colon contents		1.78E-01
Recto-sigmoid colon content		7.48E-02
Thyroid		1.00E-01
Salivary glands		5.77E-02
Stomach wall		9.55E-02
Kidneys		9.07E-02
Right colon wall		9.58E-01
Cortical bone mineral surface		1.27E-01
Trabecular bone mineral surface		1.27E-01
Cortical bone mineral volume		2.12E-04
Trabecular bone mineral volume		2.12E-04
Urinary bladder contents	Adult male	2.54E-01
	Adult female	2.71E-01
	15-year-old male	2.71E-01
	15-year-old female	2.66E-01
	10-year-old male/female	2.80E-01
	5-year-old male/female	2.71E-01
	1-year-old male/female	2.73E-01
Other		3.16E+00

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2865 Table A.26.3. Dose coefficients for ^{99m}Tc-labelled Pertechnegas.

	Adults		15 years		10 years		5 years		1 year	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	6.8E-03	7.2E-03	5.6E-03	5.8E-03	8.3E-03	8.3E-03	1.3E-02	1.3E-02	2.6E-02	2.6E-02
Brain	1.9E-03	2.3E-03	3.7E-03	3.9E-03	5.5E-03	5.6E-03	7.9E-03	8.0E-03	1.2E-02	1.2E-02
Breast	2.8E-03	3.2E-03	2.6E-03	3.0E-03	3.9E-03	3.5E-03	6.4E-03	6.2E-03	1.1E-02	1.1E-02
Colon wall	3.2E-02	3.6E-02	3.9E-02	4.3E-02	5.8E-02	5.8E-02	9.2E-02	9.1E-02	2.2E-01	2.2E-01
Endosteum (bone surface)	5.8E-03	7.7E-03	8.4E-03	9.0E-03	1.0E-02	9.9E-03	1.9E-02	1.9E-02	3.8E-02	3.8E-02
ET region	2.1E-03	2.9E-03	5.4E-03	5.2E-03	6.7E-03	6.6E-03	8.3E-03	8.3E-03	1.2E-02	1.2E-02
Gall bladder wall	9.5E-03	5.8E-03	6.1E-03	7.1E-03	9.5E-03	9.5E-03	1.6E-02	1.6E-02	2.8E-02	2.8E-02
Heart wall	7.6E-03	8.3E-03	4.9E-03	5.6E-03	8.4E-03	8.4E-03	1.2E-02	1.2E-02	2.3E-02	2.3E-02
Kidneys	9.8E-03	1.1E-02	8.4E-03	8.9E-03	1.2E-02	1.2E-02	2.0E-02	2.0E-02	3.3E-02	3.3E-02
Liver	7.4E-03	6.7E-03	5.9E-03	7.0E-03	9.8E-03	9.8E-03	1.5E-02	1.5E-02	2.7E-02	2.7E-02
Lung	1.8E-02	2.2E-02	1.5E-02	1.8E-02	2.6E-02	2.6E-02	4.1E-02	4.1E-02	8.7E-02	8.8E-02
Lymphatic nodes	5.8E-03	7.1E-03	5.5E-03	6.0E-03	7.9E-03	7.9E-03	1.3E-02	1.3E-02	2.3E-02	2.3E-02
Muscle	2.8E-03	3.7E-03	3.1E-03	3.1E-03	4.7E-03	4.7E-03	7.1E-03	7.1E-03	1.3E-02	1.3E-02
Oesophagus	7.0E-03	8.1E-03	7.5E-03	7.9E-03	1.2E-02	1.2E-02	1.8E-02	1.8E-02	3.0E-02	3.0E-02
Oral mucosa	2.4E-03	3.1E-03	5.7E-03	6.0E-03	7.2E-03	7.2E-03	8.1E-03	8.1E-03	1.3E-02	1.3E-02
Ovaries	-	7.2E-03	-	8.5E-03	-	1.1E-02	-	1.8E-02	-	3.4E-02
Pancreas	1.0E-02	9.1E-03	7.1E-03	7.3E-03	1.1E-02	1.1E-02	1.4E-02	1.4E-02	2.6E-02	2.6E-02
Prostate	5.0E-03	-	5.3E-03	-	8.7E-03	-	1.3E-02	-	2.5E-02	-
Red marrow	5.9E-03	8.3E-03	6.8E-03	7.6E-03	9.4E-03	9.4E-03	1.4E-02	1.4E-02	2.6E-02	2.6E-02
Salivary glands	9.0E-03	1.1E-02	1.4E-02	1.4E-02	2.0E-02	2.0E-02	2.5E-02	2.5E-02	3.6E-02	3.6E-02
Skin	1.9E-03	2.3E-03	2.3E-03	2.5E-03	3.8E-03	3.8E-03	6.1E-03	6.1E-03	1.1E-02	1.1E-02
Small intestine wall	8.1E-03	1.0E-02	9.2E-03	9.6E-03	1.3E-02	1.3E-02	2.1E-02	2.2E-02	3.8E-02	3.8E-02
Spleen	6.3E-03	7.2E-03	5.0E-03	6.0E-03	8.2E-03	8.2E-03	1.3E-02	1.3E-02	2.5E-02	2.5E-02
Stomach wall	1.4E-02	1.4E-02	1.4E-02	1.5E-02	2.2E-02	2.2E-02	3.2E-02	3.2E-02	7.0E-02	7.0E-02
Testes	2.3E-03	-	4.1E-03	-	5.7E-03	-	8.3E-03	-	1.3E-02	-
Thymus	5.0E-03	5.9E-03	6.6E-03	7.0E-03	1.0E-02	1.0E-02	1.4E-02	1.4E-02	2.7E-02	2.7E-02
Thyroid	5.3E-02	6.4E-02	8.5E-02	8.8E-02	1.3E-01	1.3E-01	2.8E-01	2.8E-01	5.4E-01	5.4E-01
Urinary bladder wall	9.1E-03	1.2E-02	1.2E-02	1.1E-02	1.7E-02	1.7E-02	2.3E-02	2.3E-02	3.6E-02	3.6E-02
Uterus/cervix	-	7.2E-03	-	3.6E-02	-	4.8E-02	-	1.9E-02	-	9.0E-02
Effective dose (mSv/MBq)	1.4E-02		1.6E-02		2.3E-02		3.9E-02		8.1E-02	

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A.27. ^{123}I, ^{124}I, ^{125}I and ^{131}I-labelled iodide

A.27.1. Biokinetic information

(A 152) The kinetic behaviour of iodide has been studied extensively, and several biokinetic models have been suggested (Riggs, 1952; Berman et al., 1968; MIRD, 1975; Smith, 1988; Zanzonico, 2000; Johansson et al., 2003; Leggett, 2010). These may be described either as compartment models or in terms of fractional uptakes and half-times.

(A 153) The model originally presented in *Publication 53* (ICRP, 1988) was a highly simplified kinetic model presenting the absorbed dose for different thyroid uptakes, expressed as the fractional distribution of iodide in the thyroid, Fs, in the range 0.05–0.55.

(A 154) In *Publication 128* a complex compartmental model was adopted, developed from the structure presented by Leggett (2010). It is described as a compartment model including inorganic iodide as well as organically bound iodine released to the body tissues following discharge from the thyroid. The model was slightly modified adding an additional compartment "kidneys 3" in accordance to the kidney-bladder model used to describe the urinary excretion.

(A 155) Other models had been published by ICRP for members of the public and for workers in *Publications 56* and *67* (ICRP, 1990, 1993). Similarly, in the most recent publications of the OIR and EIR series these models have been replaced by the detailed model of Leggett (2010).

(A 156) In addition to these models, *Publication 88* (ICRP, 2001) presents a more complex compartment model for the biokinetics of iodine in a pregnant mother and the fetus, with the aim of calculating the dose to the embryo and fetus.

A.27.2. Biokinetic model

(A 157) The biokinetic model adopted for the present report is similarly based on the Leggett model. A comprehensive description and discussion of the model can be found in the original paper (Leggett, 2010).

(A 158) There is no significant age dependence of uptake in the thyroid after the first few days after birth. However, for organically bound iodine, the biological halftime of thyroid to blood shows distinct age dependence. The biological half-time in adults is 90 days, and 65, 50, 30, and 15 days for 15, 10, 5, and 1 year olds, respectively (Leggett, 2017). In general, the turnover rate of organically bound iodine, also between other compartments, may be assumed to be faster (Leggett, 2017) with a transfer coefficient approximately 50% larger for the youngest ages. The age dependent parameters presented in Table A.27.1 correspond to those adopted for the exposure of the public (publication in production).

(A 159) The value of the transfer coefficient describing the passage of iodide from blood into the thyroid results in 26% uptake of ^{131}I in the thyroid 24 h after administration. This case is referred to as the situation with medium uptake. As already in *Publication 128*, two other cases are considered here, indicated as low and high uptake, respectively. They were introduced to take into account the effects on iodine uptake due regional variations in dietary intake (Stanbury et al., 1954; Zvonova, 1989). This has been accomplished by adjusting the transfer coefficient for thyroid uptake (i.e. from blood to thyroid), aiming at 24-h uptake of 16% (low) and 36% (high), respectively, for ^{131}I.

(A 160) Furthermore, two other situations were considered here: when the thyroid has been blocked and when the thyroid has been removed. In the first case, it is assumed that no organification of iodide occurs in the thyroid. This case was called ‘thyroid blocked’ in *Publication 128* and referred to as ‘uptake 0%’. However this was misleading, since there is still uptake in the thyroid; simply the fate of iodide taken up by the thyroid is different from

the cause when the thyroid has not been blocked. In this publication the case is referred to as 'Saturated thyroid'.

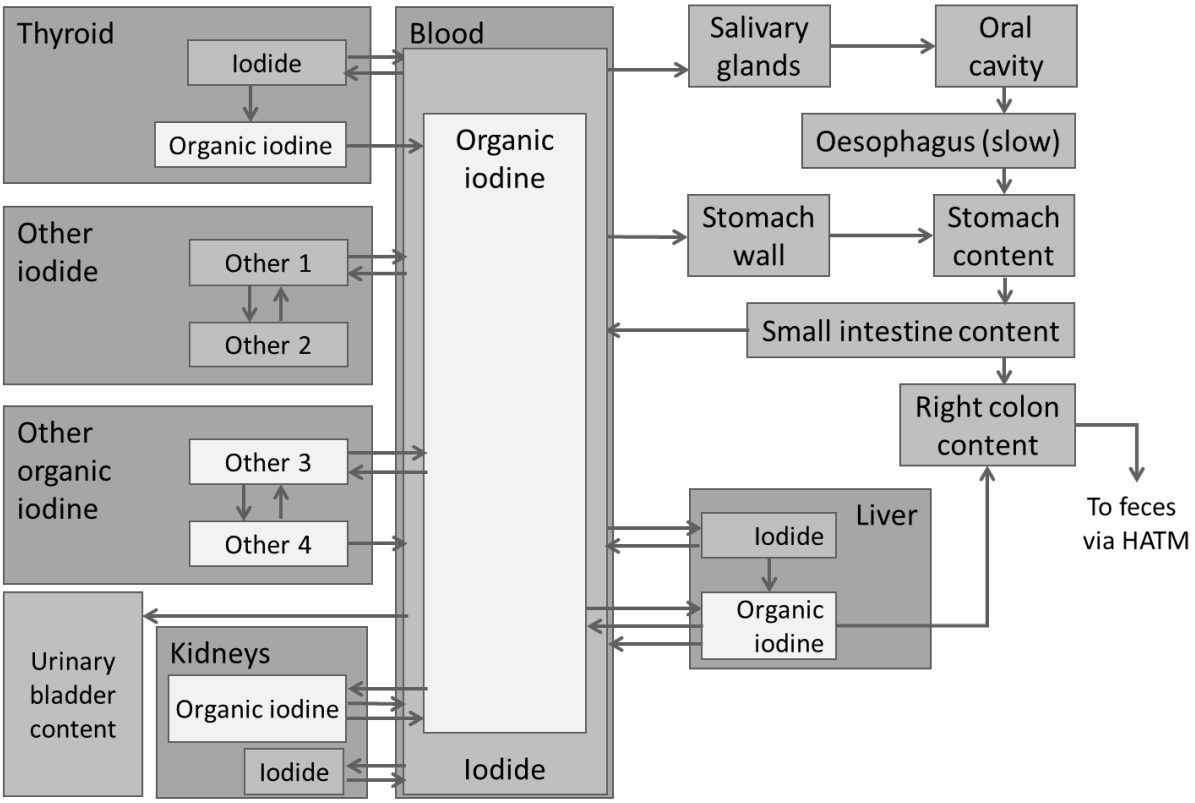

Fig. A.27.1. Biokinetic model for iodide. (adapted from Leggett, 2010)

Table A.27.1. Values of the transfer coefficients (h^{-1}).

From	To	Adults	15 years	10 years	5 years	1 year	infant
Blood iodide	Kidneys iodide	1.04E+00	1.04E+00	1.04E+00	1.04E+00	1.04E+00	1.04E+00
Blood iodide	Liver iodide	6.25E-01	6.25E-01	6.25E-01	6.25E-01	6.25E-01	6.25E-01
Blood iodide	Other 1	2.50E+01	2.50E+01	2.50E+01	2.50E+01	2.50E+01	2.50E+01
Blood iodide	Salivary glands	2.15E-01	2.15E-01	2.15E-01	2.15E-01	2.15E-01	2.15E-01
Blood iodide	Stomach wall	3.58E-01	3.58E-01	3.58E-01	3.58E-01	3.58E-01	3.58E-01
Blood iodide	Urinary Bladder contents	4.93E-01	4.93E-01	4.93E-01	4.93E-01	4.93E-01	4.93E-01
Blood organic	Kidneys organic	1.50E-01	1.75E-01	1.91E-01	2.10E-01	2.33E-01	2.63E-01
Blood organic	Liver organic	8.75E-01	1.02E+00	1.11E+00	1.23E+00	1.36E+00	1.53E+00
Blood organic	Other 3	6.25E-01	7.29E-01	7.96E-01	8.75E-01	9.71E-01	1.10E+00
Kidneys iodide	Blood iodide	4.17E+00	4.17E+00	4.17E+00	4.17E+00	4.17E+00	4.17E+00
Kidneys organic	Blood iodide	5.83E-03	6.79E-03	7.42E-03	8.17E-03	9.08E-03	1.02E-02
Kidneys organic	Blood organic	8.75E-01	1.02E+00	1.11E+00	1.23E+00	1.36E+00	1.53E+00
Liver iodide	Blood iodide	4.17E+00	4.17E+00	4.17E+00	4.17E+00	4.17E+00	4.17E+00
Liver organic	Blood iodide	5.83E-03	6.79E-03	7.42E-03	8.17E-03	9.08E-03	1.02E-02
Liver organic	Blood organic	8.75E-01	1.02E+00	1.11E+00	1.23E+00	1.36E+00	1.53E+00
Liver organic	Right Colon contents	3.33E-03	3.89E-03	4.25E-03	4.67E-03	5.17E-03	5.83E-03
Other 1	Blood iodide	1.38E+01	1.38E+01	1.38E+01	1.38E+01	1.38E+01	1.38E+01
Other 1	Other 2	1.46E+00	1.46E+00	1.46E+00	1.46E+00	1.46E+00	1.46E+00
Other 2	Other 1	2.33E+00	2.33E+00	2.33E+00	2.33E+00	2.33E+00	2.33E+00
Other 3	Blood organic	8.75E-01	1.02E+00	1.11E+00	1.23E+00	1.36E+00	1.53E+00
Other 3	Other 4	5.00E-02	5.83E-02	6.38E-02	7.00E-02	7.79E-02	8.75E-02
Other 4	Blood organic	5.83E-03	6.79E-03	7.42E-03	8.17E-03	9.08E-03	1.02E-02
Other 4	Other 3	2.58E-02	3.01E-02	3.29E-02	3.62E-02	4.02E-02	4.54E-02
Salivary glands	Oral cavity	2.08E+00	2.08E+00	2.08E+00	2.08E+00	2.08E+00	2.08E+00
Stomach wall	Stomach contents	2.08E+00	2.08E+00	2.08E+00	2.08E+00	2.08E+00	2.08E+00
Thyroid iodide	Blood iodide	1.50E+00	1.50E+00	1.50E+00	1.50E+00	1.50E+00	1.50E+00
Thyroid iodide	Thyroid organic (**)	3.96E+00	3.96E+00	3.96E+00	3.96E+00	3.96E+00	3.96E+00
Thyroid organic	Blood organic	3.21E-04	4.46E-04	5.79E-04	9.63E-04	1.93E-03	2.89E-03

		Adults	15 years	10 years	5 years	1 year	infant
Blood iodide	Thyroid iodide						
Medium uptake		3.03E-01	3.03E-01	3.03E-01	3.03E-01	3.03E-01	3.03E-01
Low uptake		1.70E-01	1.70E-01	1.70E-01	1.70E-01	1.70E-01	1.70E-01
High uptake		4.80E-01	4.80E-01	4.80E-01	4.80E-01	4.80E-01	4.80E-01

Radioactive half-life of ^{123}I: 13.27 h

Radioactive half-life of ^{124}I: 4.1760 days

Radioactive half-life of ^{125}I: 59.400 days

Radioactive half-life of ^{131}I: 8.02070 days

A.27.3. Specific assumptions for the calculations

(A 161) The transfer between the compartments representing inorganic iodide in the thyroid to the compartment for organically bound iodine is set to zero for the case ‘Saturated thyroid’.

(A 162) For the ‘removed thyroid’ scenario, not only the transfer from Blood iodide to Thyroid iodide is set to zero, but additionally, the thyroid is removed from the list of the target organs. This reflect the actual case (the patient has no thyroid), but, strictly speaking, this also means a modification of the method for calculating the effective dose, because one of the terms of the calculation is missing (the thyroid is one of the tissues which have an explicit weighting factor). This is indicated in the respective Tables.

(A 163) The simplified alimentary tract model presented in Section 4 is used with the parameters given in Table 4.2. A fraction of the radioiodide present in the systemic circulation is also transferred to the oral cavity from the salivary glands; this systemic iodide proceeds to the stomach only through the slow oesophagus compartment.

(A 164) The intestinal fractional absorption is taken to be 1.0 for all ages.

A.27.4. References for iodide

Berman, M., Hoff, E., Barandes, M., et al., 1968. Iodine kinetics in man – a model. J. Clin. Endocrinol. Metab. 28, 1–14.

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Table A.27.2. Time-integrated activity coefficients for ^{123}I-labelled iodide (h).

(a) i.v. administration, low uptake.

	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Oral cavity	1.33E-04	1.33E-04	1.33E-04		1.33E-04		1.33E-04		1.33E-04		1.34E-04	
Oesophagus	1.99E-03	1.99E-03	1.99E-03		1.99E-03		1.99E-03		1.99E-03		2.01E-03	
Stomach contents	3.11E-01	3.11E-01	3.11E-01		3.11E-01		3.11E-01		3.11E-01		1.06E-01	
Small intestine contents	2.48E-02	2.48E-02	2.48E-02		2.48E-02		2.48E-02		2.48E-02		2.55E-02	
Right colon contents	4.58E-02	5.41E-02	4.35E-02		4.35E-02		4.37E-02		4.16E-02		3.72E-02	
Left colon contents	2.82E-02	2.95E-02	2.76E-02		2.76E-02		2.78E-02		2.73E-02		2.62E-02	
Recto-sigmoidal	1.73E-02	1.61E-02	1.85E-02		1.85E-02		1.86E-02		2.01E-02		2.42E-02	
Blood	1.14E+00	1.14E+00	1.15E+00		1.15E+00		1.15E+00		1.17E+00		1.19E+00	
Thyroid	2.68E+00	2.68E+00	2.68E+00		2.67E+00		2.65E+00		2.61E+00		2.59E+00	
Salivary Glands	1.15E-01	1.15E-01	1.15E-01		1.15E-01		1.15E-01		1.15E-01		1.16E-01	
Stomach walls	1.91E-01	1.91E-01	1.91E-01		1.91E-01		1.91E-01		1.91E-01		1.93E-01	
Liver	1.73E-01	1.73E-01	1.75E-01		1.77E-01		1.82E-01		1.93E-01		2.07E-01	
Other	3.32E+00	3.32E+00	3.33E+00		3.33E+00		3.33E+00		3.35E+00		3.40E+00	
Kidneys	2.82E-01	2.82E-01	2.82E-01		2.83E-01		2.84E-01		2.86E-01		2.91E-01	
Urinary bladder contents	1.50E+00	1.62E+00	1.62E+00	1.58E+00	1.68E+00		1.62E+00		1.38E+00		9.60E-01	

(b) i.v. administration, medium uptake.

	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Oral cavity	1.20E-04	1.20E-04	1.20E-04		1.20E-04		1.20E-04		1.20E-04		1.21E-04	
Oesophagus	1.79E-03	1.79E-03	1.79E-03		1.79E-03		1.79E-03		1.79E-03		1.81E-03	
Stomach contents	2.80E-01	2.80E-01	2.80E-01		2.80E-01		2.80E-01		2.80E-01		9.59E-02	
Small intestine contents	2.23E-02	2.23E-02	2.23E-02		2.23E-02		2.23E-02		2.23E-02		2.30E-02	
Right colon contents	4.14E-02	4.89E-02	3.93E-02		3.94E-02		3.97E-02		3.80E-02		3.43E-02	
Left colon contents	2.54E-02	2.66E-02	2.49E-02		2.50E-02		2.52E-02		2.50E-02		2.42E-02	
Recto-sigmoidal	1.56E-02	1.45E-02	1.67E-02		1.68E-02		1.69E-02		1.84E-02		2.23E-02	
Blood	1.03E+00	1.03E+00	1.04E+00		1.04E+00		1.05E+00		1.07E+00		1.10E+00	
Thyroid	4.30E+00	4.30E+00	4.29E+00		4.28E+00		4.25E+00		4.18E+00		4.15E+00	
Salivary Glands	1.03E-01	1.03E-01	1.03E-01		1.03E-01		1.03E-01		1.03E-01		1.04E-01	
Stomach walls	1.72E-01	1.72E-01	1.72E-01		1.72E-01		1.72E-01		1.72E-01		1.74E-01	
Liver	1.59E-01	1.59E-01	1.62E-01		1.65E-01		1.73E-01		1.92E-01		2.11E-01	
Other	3.00E+00	3.00E+00	3.00E+00		3.00E+00		3.02E+00		3.04E+00		3.09E+00	
Kidneys	2.55E-01	2.55E-01	2.55E-01		2.56E-01		2.57E-01		2.60E-01		2.66E-01	
Urinary bladder contents	1.34E+00	1.44E+00	1.44E+00	1.41E+00	1.50E+00		1.44E+00		1.24E+00		8.63E-01	

2972 ^{123}I

2973 (c) i.v. administration, high uptake.

	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Oral cavity	1.06E-04	1.06E-04	1.06E-04		1.06E-04		1.06E-04		1.06E-04		1.07E-04	
Oesophagus	1.58E-03	1.58E-03	1.58E-03		1.58E-03		1.58E-03		1.58E-03		1.60E-03	
Stomach contents	2.47E-01	2.47E-01	2.47E-01		2.47E-01		2.47E-01		2.47E-01		8.46E-02	
Small intestine contents	1.97E-02	1.97E-02	1.97E-02		1.97E-02		1.97E-02		1.97E-02		2.03E-02	
Right colon contents	3.66E-02	4.33E-02	3.48E-02		3.50E-02		3.54E-02		3.43E-02		3.12E-02	
Left colon contents	2.25E-02	2.36E-02	2.21E-02		2.22E-02		2.25E-02		2.25E-02		2.20E-02	
Recto-sigmoidal	1.38E-02	1.28E-02	1.48E-02		1.49E-02		1.51E-02		1.66E-02		2.03E-02	
Blood	9.17E-01	9.17E-01	9.21E-01		9.25E-01		9.37E-01		9.65E-01		9.99E-01	
Thyroid	6.03E+00	6.03E+00	6.01E+00		6.00E+00		5.96E+00		5.85E+00		5.81E+00	
Salivary Glands	9.13E-02	9.13E-02	9.13E-02		9.13E-02		9.13E-02		9.13E-02		9.22E-02	
Stomach walls	1.52E-01	1.52E-01	1.52E-01		1.52E-01		1.52E-01		1.52E-01		1.54E-01	
Liver	1.44E-01	1.44E-01	1.48E-01		1.52E-01		1.63E-01		1.90E-01		2.16E-01	
Other	2.65E+00	2.65E+00	2.66E+00		2.66E+00		2.68E+00		2.71E+00		2.77E+00	
Kidneys	2.26E-01	2.26E-01	2.26E-01		2.27E-01		2.29E-01		2.34E-01		2.40E-01	
Urinary bladder contents	1.17E+00	1.26E+00	1.26E+00	1.22E+00	1.30E+00		1.25E+00		1.08E+00		7.60E-01	

2974

2975 (d) i.v. administration, saturated thyroid.

	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Oral cavity	1,53E-04	1,53E-04	1,53E-04		1,53E-04		1,53E-04		1,53E-04		1,54E-04	
Oesophagus	2,29E-03	2,29E-03	2,29E-03		2,29E-03		2,29E-03		2,29E-03		2,31E-03	
Stomach contents	3,57E-01	3,57E-01	3,57E-01		3,57E-01		3,57E-01		3,57E-01		1,22E-01	
Small intestine contents	2,85E-02	2,85E-02	2,85E-02		2,85E-02		2,85E-02		2,85E-02		2,93E-02	
Right colon contents	5,25E-02	6,20E-02	4,97E-02		4,97E-02		4,97E-02		4,68E-02		4,14E-02	
Left colon contents	3,23E-02	3,38E-02	3,16E-02		3,16E-02		3,16E-02		3,07E-02		2,92E-02	
Recto-sigmoidal	1,98E-02	1,84E-02	2,12E-02		2,12E-02		2,12E-02		2,27E-02		2,69E-02	
Blood	1,31E+00	1,31E+00	1,31E+00		1,31E+00		1,31E+00		1,31E+00		1,32E+00	
Thyroid	2,55E-01	2,55E-01	2,55E-01		2,55E-01		2,55E-01		2,55E-01		2,58E-01	
Salivary Glands	1,32E-01	1,32E-01	1,32E-01		1,32E-01		1,32E-01		1,32E-01		1,33E-01	
Stomach walls	2,20E-01	2,20E-01	2,20E-01		2,20E-01		2,20E-01		2,20E-01		2,22E-01	
Liver	1,94E-01	1,94E-01	1,94E-01		1,94E-01		1,94E-01		1,94E-01		1,96E-01	
Other	3,81E+00	3,81E+00	3,81E+00		3,81E+00		3,81E+00		3,81E+00		3,86E+00	
Kidneys	3,23E-01	3,23E-01	3,23E-01		3,23E-01		3,23E-01		3,23E-01		3,27E-01	
Urinary bladder contents	1,73E+00	1,88E+00	1,88E+00	1,84E+00	1,95E+00		1,88E+00		1,60E+00		1,11E+00	

2976

^{123}I

(e) i.v. administration, removed thyroid.

	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Oral cavity	1.55E-04	1.55E-04	1.55E-04		1.55E-04		1.55E-04		1.55E-04		1.56E-04	
Oesophagus	2.32E-03	2.32E-03	2.32E-03		2.32E-03		2.32E-03		2.32E-03		2.35E-03	
Stomach contents	3.61E-01	3.61E-01	3.61E-01		3.61E-01		3.61E-01		3.61E-01		1.24E-01	
Small intestine contents	2.89E-02	2.89E-02	2.89E-02		2.89E-02		2.89E-02		2.89E-02		2.97E-02	
Right colon contents	5.32E-02	6.29E-02	5.04E-02		5.04E-02		5.04E-02		4.74E-02		4.19E-02	
Left colon contents	3.27E-02	3.43E-02	3.20E-02		3.20E-02		3.20E-02		3.11E-02		2.96E-02	
Recto-sigmoidal	2.01E-02	1.87E-02	2.15E-02		2.15E-02		2.15E-02		2.30E-02		2.73E-02	
Blood	1.33E+00	1.33E+00	1.33E+00		1.33E+00		1.33E+00		1.33E+00		1.34E+00	
Salivary Glands	1.34E-01	1.34E-01	1.34E-01		1.34E-01		1.34E-01		1.34E-01		1.35E-01	
Stomach walls	2.23E-01	2.23E-01	2.23E-01		2.23E-01		2.23E-01		2.23E-01		2.25E-01	
Liver	1.97E-01	1.97E-01	1.97E-01		1.97E-01		1.97E-01		1.97E-01		1.99E-01	
Other	3.86E+00	3.86E+00	3.86E+00		3.86E+00		3.86E+00		3.86E+00		3.91E+00	
Kidneys	3.28E-01	3.28E-01	3.28E-01		3.28E-01		3.28E-01		3.28E-01		3.32E-01	
Urinary bladder contents	1.76E+00	1.90E+00	1.90E+00	1.86E+00	1.98E+00		1.90E+00		1.62E+00		1.12E+00	

(f) oral administration, low uptake.

	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Oral cavity	6.83E-04	6.83E-04	6.83E-04		6.83E-04		6.83E-04		6.83E-04		6.87E-04	
Oesophagus	4.00E-03	4.00E-03	4.00E-03		4.00E-03		4.00E-03		4.00E-03		3.80E-03	
Stomach contents	7.86E-01	7.86E-01	7.86E-01		7.86E-01		7.86E-01		7.86E-01		2.69E-01	
Small intestine contents	6.28E-02	6.28E-02	6.28E-02		6.28E-02		6.28E-02		6.28E-02		6.45E-02	
Right colon contents	1.16E-01	1.37E-01	1.10E-01		1.10E-01		1.10E-01		1.04E-01		9.22E-02	
Left colon contents	7.12E-02	7.46E-02	6.97E-02		6.98E-02		6.99E-02		6.82E-02		6.50E-02	
Recto-sigmoidal	4.38E-02	4.06E-02	4.68E-02		4.68E-02		4.69E-02		5.03E-02		6.00E-02	
Blood	1.10E+00	1.10E+00	1.10E+00		1.11E+00		1.11E+00		1.12E+00		1.17E+00	
Thyroid	2.58E+00	2.58E+00	2.58E+00		2.57E+00		2.55E+00		2.51E+00		2.53E+00	
Salivary Glands	1.10E-01	1.10E-01	1.10E-01		1.10E-01		1.10E-01		1.10E-01		1.14E-01	
Stomach walls	1.84E-01	1.84E-01	1.84E-01		1.84E-01		1.84E-01		1.84E-01		1.89E-01	
Liver	1.67E-01	1.67E-01	1.68E-01		1.70E-01		1.75E-01		1.86E-01		2.02E-01	
Other	3.20E+00	3.20E+00	3.20E+00		3.20E+00		3.21E+00		3.22E+00		3.33E+00	
Kidneys	2.72E-01	2.72E-01	2.72E-01		2.72E-01		2.73E-01		2.75E-01		2.85E-01	
Urinary bladder contents	1.47E+00	1.59E+00	1.59E+00	1.55E+00	1.65E+00		1.59E+00		1.35E+00		9.32E-01	

2982 ^{123}I

2983 (g) oral administration, medium uptake.

	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Oral cavity	6.71E-04	6.71E-04	6.71E-04		6.71E-04		6.71E-04		6.71E-04		6.74E-04	
Oesophagus	3.81E-03	3.81E-03	3.81E-03		3.81E-03		3.81E-03		3.81E-03		3.61E-03	
Stomach contents	7.57E-01	7.57E-01	7.57E-01		7.57E-01		7.57E-01		7.57E-01		2.59E-01	
Small intestine contents	6.04E-02	6.04E-02	6.04E-02		6.04E-02		6.04E-02		6.04E-02		6.21E-02	
Right colon contents	1.12E-01	1.32E-01	1.06E-01		1.06E-01		1.06E-01		1.00E-01		8.94E-02	
Left colon contents	6.86E-02	7.18E-02	6.72E-02		6.72E-02		6.74E-02		6.60E-02		6.30E-02	
Recto-sigmoidal	4.21E-02	3.91E-02	4.50E-02		4.51E-02		4.52E-02		4.87E-02		5.81E-02	
Blood	9.96E-01	9.96E-01	9.99E-01		1.00E+00		1.01E+00		1.03E+00		1.07E+00	
Thyroid	4.14E+00	4.14E+00	4.13E+00		4.12E+00		4.09E+00		4.02E+00		4.06E+00	
Salivary Glands	9.95E-02	9.95E-02	9.95E-02		9.95E-02		9.95E-02		9.96E-02		1.02E-01	
Stomach walls	1.66E-01	1.66E-01	1.66E-01		1.66E-01		1.66E-01		1.66E-01		1.71E-01	
Liver	1.53E-01	1.53E-01	1.56E-01		1.59E-01		1.66E-01		1.85E-01		2.07E-01	
Other	2.89E+00	2.89E+00	2.89E+00		2.89E+00		2.90E+00		2.93E+00		3.03E+00	
Kidneys	2.45E-01	2.45E-01	2.46E-01		2.46E-01		2.47E-01		2.51E-01		2.61E-01	
Urinary bladder contents	1.31E+00	1.42E+00	1.42E+00	1.38E+00	1.47E+00		1.41E+00		1.21E+00		8.38E-01	

2984

2985 (h) oral administration, high uptake.

	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Oral cavity	6.57E-04	6.57E-04	6.57E-04		6.57E-04		6.57E-04		6.57E-04		6.60E-04	
Oesophagus	3.61E-03	3.61E-03	3.61E-03		3.61E-03		3.61E-03		3.61E-03		3.40E-03	
Stomach contents	7.25E-01	7.25E-01	7.25E-01		7.25E-01		7.25E-01		7.25E-01		2.48E-01	
Small intestine contents	5.79E-02	5.79E-02	5.79E-02		5.79E-02		5.79E-02		5.79E-02		5.94E-02	
Right colon contents	1.07E-01	1.26E-01	1.01E-01		1.02E-01		1.02E-01		9.69E-02		8.64E-02	
Left colon contents	6.58E-02	6.89E-02	6.44E-02		6.45E-02		6.48E-02		6.36E-02		6.09E-02	
Recto-sigmoidal	4.04E-02	3.75E-02	4.32E-02		4.33E-02		4.34E-02		4.69E-02		5.62E-02	
Blood	8.83E-01	8.83E-01	8.87E-01		8.91E-01		9.02E-01		9.29E-01		9.79E-01	
Thyroid	5.80E+00	5.80E+00	5.79E+00		5.77E+00		5.73E+00		5.64E+00		5.69E+00	
Salivary Glands	8.79E-02	8.79E-02	8.79E-02		8.79E-02		8.79E-02		8.79E-02		9.03E-02	
Stomach walls	1.46E-01	1.46E-01	1.46E-01		1.46E-01		1.46E-01		1.47E-01		1.50E-01	
Liver	1.39E-01	1.39E-01	1.43E-01		1.46E-01		1.57E-01		1.83E-01		2.12E-01	
Other	2.55E+00	2.55E+00	2.56E+00		2.56E+00		2.58E+00		2.61E+00		2.71E+00	
Kidneys	2.17E-01	2.17E-01	2.18E-01		2.18E-01		2.20E-01		2.25E-01		2.35E-01	
Urinary bladder contents	1.15E+00	1.23E+00	1.23E+00	1.20E+00	1.28E+00		1.23E+00		1.06E+00		7.39E-01	

2986

2987 ^{123}I

2988 (i) oral administration, saturated thyroid.

	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Oral cavity	7.02E-04	7.02E-04	7.02E-04		7.02E-04		7.02E-04		7.02E-04		7.07E-04	
Oesophagus	4.28E-03	4.28E-03	4.28E-03		4.28E-03		4.28E-03		4.28E-03		4.10E-03	
Stomach contents	8.31E-01	8.31E-01	8.31E-01		8.31E-01		8.31E-01		8.31E-01		2.85E-01	
Small intestine contents	6.63E-02	6.63E-02	6.63E-02		6.63E-02		6.63E-02		6.63E-02		6.83E-02	
Right colon contents	1.22E-01	1.44E-01	1.16E-01		1.16E-01		1.16E-01		1.09E-01		9.63E-02	
Left colon contents	7.52E-02	7.87E-02	7.35E-02		7.35E-02		7.35E-02		7.15E-02		6.79E-02	
Recto-sigmoidal	4.62E-02	4.29E-02	4.93E-02		4.93E-02		4.93E-02		5.28E-02		6.26E-02	
Blood	1.26E+00	1.26E+00	1.26E+00		1.26E+00		1.26E+00		1.26E+00		1.30E+00	
Thyroid	2.46E-01	2.46E-01	2.46E-01		2.46E-01		2.46E-01		2.46E-01		2.53E-01	
Salivary Glands	1.27E-01	1.27E-01	1.27E-01		1.27E-01		1.27E-01		1.27E-01		1.31E-01	
Stomach walls	2.11E-01	2.11E-01	2.11E-01		2.11E-01		2.11E-01		2.11E-01		2.18E-01	
Liver	1.87E-01	1.87E-01	1.87E-01		1.87E-01		1.87E-01		1.87E-01		1.92E-01	
Other	3.67E+00	3.67E+00	3.67E+00		3.67E+00		3.67E+00		3.67E+00		3.78E+00	
Kidneys	3.11E-01	3.11E-01	3.11E-01		3.11E-01		3.11E-01		3.11E-01		3.20E-01	
Urinary bladder contents	1.69E+00	1.84E+00	1.84E+00	1.80E+00	1.91E+00		1.84E+00		1.56E+00		1.07E+00	

2989

2990 (j) oral administration, removed thyroid

	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Oral cavity	7.04E-04	7.04E-04	7.04E-04		7.04E-04		7.04E-04		7.04E-04		7.09E-04	
Oesophagus	4.31E-03	4.31E-03	4.31E-03		4.31E-03		4.31E-03		4.31E-03		4.13E-03	
Stomach contents	8.35E-01	8.35E-01	8.35E-01		8.35E-01		8.35E-01		8.35E-01		2.87E-01	
Small intestine contents	6.67E-02	6.67E-02	6.67E-02		6.67E-02		6.67E-02		6.67E-02		6.87E-02	
Right colon contents	1.23E-01	1.45E-01	1.16E-01		1.16E-01		1.16E-01		1.09E-01		9.69E-02	
Left colon contents	7.56E-02	7.91E-02	7.40E-02		7.40E-02		7.40E-02		7.19E-02		6.83E-02	
Recto-sigmoidal	4.65E-02	4.31E-02	4.96E-02		4.96E-02		4.96E-02		5.31E-02		6.30E-02	
Blood	1.28E+00	1.28E+00	1.28E+00		1.28E+00		1.28E+00		1.28E+00		1.32E+00	
Salivary Glands	1.29E-01	1.29E-01	1.29E-01		1.29E-01		1.29E-01		1.29E-01		1.32E-01	
Stomach walls	2.14E-01	2.14E-01	2.14E-01		2.14E-01		2.14E-01		2.14E-01		2.21E-01	
Liver	1.89E-01	1.89E-01	1.89E-01		1.89E-01		1.89E-01		1.89E-01		1.95E-01	
Other	3.72E+00	3.72E+00	3.72E+00		3.72E+00		3.72E+00		3.72E+00		3.83E+00	
Kidneys	3.15E-01	3.15E-01	3.15E-01		3.15E-01		3.15E-01		3.15E-01		3.25E-01	
Urinary bladder contents	1.72E+00	1.86E+00	1.86E+00	1.82E+00	1.93E+00		1.86E+00		1.58E+00		1.09E+00	

2991

Table A.27.3. Time-integrated activity coefficients for ^{124}I-labelled iodide (h).

(a) i.v. administration, low uptake.

	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Oral cavity	1.82E-04	1.82E-04	1.82E-04		1.82E-04		1.83E-04		1.84E-04		1.86E-04	
Oesophagus	2.72E-03	2.72E-03	2.73E-03		2.73E-03		2.74E-03		2.76E-03		2.78E-03	
Stomach contents	4.34E-01	4.34E-01	4.35E-01		4.35E-01		4.37E-01		4.40E-01		1.48E-01	
Small intestine contents	3.47E-02	3.47E-02	3.48E-02		3.48E-02		3.49E-02		3.52E-02		3.56E-02	
Right colon contents	1.04E-01	1.35E-01	9.90E-02		1.02E-01		1.12E-01		1.21E-01		1.13E-01	
Left colon contents	9.56E-02	1.21E-01	9.20E-02		9.53E-02		1.04E-01		1.13E-01		1.07E-01	
Recto-sigmoidal	8.83E-02	1.09E-01	9.26E-02		9.60E-02		1.05E-01		1.26E-01		1.48E-01	
Blood	1.73E+00	1.73E+00	1.79E+00		1.85E+00		2.01E+00		2.36E+00		2.60E+00	
Thyroid	2.60E+01	2.60E+01	2.56E+01		2.52E+01		2.40E+01		2.16E+01		1.96E+01	
Salivary Glands	1.57E-01	1.57E-01	1.57E-01		1.57E-01		1.58E-01		1.59E-01		1.60E-01	
Stomach walls	2.62E-01	2.62E-01	2.62E-01		2.62E-01		2.63E-01		2.65E-01		2.67E-01	
Liver	4.27E-01	4.27E-01	4.83E-01		5.40E-01		7.01E-01		1.03E+00		1.26E+00	
Other	4.82E+00	4.82E+00	4.92E+00		5.03E+00		5.32E+00		5.92E+00		6.36E+00	
Kidneys	4.15E-01	4.15E-01	4.25E-01		4.35E-01		4.64E-01		5.24E-01		5.66E-01	
Urinary bladder contents	1.88E+00	2.08E+00	2.08E+00	2.06E+00	2.17E+00		2.12E+00		1.76E+00		9.24E-01	

(b) i.v. administration, medium uptake.

	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Oral cavity	1.59E-04	1.59E-04	1.59E-04		1.59E-04		1.60E-04		1.62E-04		1.64E-04	
Oesophagus	2.38E-03	2.38E-03	2.38E-03		2.39E-03		2.40E-03		2.43E-03		2.46E-03	
Stomach contents	3.79E-01	3.79E-01	3.80E-01		3.81E-01		3.83E-01		3.87E-01		1.31E-01	
Small intestine contents	3.03E-02	3.03E-02	3.04E-02		3.05E-02		3.06E-02		3.10E-02		3.14E-02	
Right colon contents	9.55E-02	1.24E-01	9.34E-02		9.89E-02		1.13E-01		1.33E-01		1.31E-01	
Left colon contents	8.81E-02	1.12E-01	8.68E-02		9.19E-02		1.05E-01		1.25E-01		1.24E-01	
Recto-sigmoidal	8.14E-02	1.01E-01	8.74E-02		9.26E-02		1.06E-01		1.38E-01		1.72E-01	
Blood	1.65E+00	1.65E+00	1.74E+00		1.83E+00		2.09E+00		2.64E+00		3.02E+00	
Thyroid	4.04E+01	4.04E+01	3.98E+01		3.92E+01		3.75E+01		3.38E+01		3.09E+01	
Salivary Glands	1.37E-01	1.37E-01	1.37E-01		1.38E-01		1.38E-01		1.40E-01		1.42E-01	
Stomach walls	2.28E-01	2.28E-01	2.29E-01		2.29E-01		2.31E-01		2.33E-01		2.36E-01	
Liver	5.08E-01	5.08E-01	5.95E-01		6.84E-01		9.37E-01		1.46E+00		1.83E+00	
Other	4.43E+00	4.43E+00	4.59E+00		4.75E+00		5.20E+00		6.14E+00		6.82E+00	
Kidneys	3.86E-01	3.86E-01	4.01E-01		4.17E-01		4.62E-01		5.56E-01		6.22E-01	
Urinary bladder contents	1.64E+00	1.81E+00	1.81E+00	1.79E+00	1.88E+00		1.84E+00		1.53E+00		8.06E-01	

^{124}I

(c) i.v. administration, high uptake

	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Oral cavity	1.36E-04	1.36E-04	1.36E-04		1.36E-04		1.37E-04		1.40E-04		1.42E-04	
Oesophagus	2.03E-03	2.03E-03	2.04E-03		2.05E-03		2.06E-03		2.09E-03		2.13E-03	
Stomach contents	3.24E-01	3.24E-01	3.25E-01		3.26E-01		3.28E-01		3.34E-01		1.13E-01	
Small intestine contents	2.59E-02	2.59E-02	2.60E-02		2.61E-02		2.63E-02		2.67E-02		2.72E-02	
Right colon contents	8.73E-02	1.14E-01	8.78E-02		9.52E-02		1.15E-01		1.45E-01		1.50E-01	
Left colon contents	8.07E-02	1.02E-01	8.16E-02		8.85E-02		1.07E-01		1.36E-01		1.42E-01	
Recto-sigmoidal	7.45E-02	9.21E-02	8.22E-02		8.92E-02		1.08E-01		1.51E-01		1.97E-01	
Blood	1.57E+00	1.57E+00	1.69E+00		1.81E+00		2.17E+00		2.92E+00		3.45E+00	
Thyroid	5.48E+01	5.48E+01	5.41E+01		5.32E+01		5.10E+01		4.62E+01		4.23E+01	
Salivary Glands	1.17E-01	1.17E-01	1.18E-01		1.18E-01		1.19E-01		1.21E-01		1.23E-01	
Stomach walls	1.95E-01	1.95E-01	1.96E-01		1.96E-01		1.98E-01		2.01E-01		2.04E-01	
Liver	5.89E-01	5.89E-01	7.07E-01		8.29E-01		1.17E+00		1.89E+00		2.40E+00	
Other	4.04E+00	4.04E+00	4.26E+00		4.48E+00		5.08E+00		6.36E+00		7.30E+00	
Kidneys	3.56E-01	3.56E-01	3.77E-01		3.99E-01		4.60E-01		5.88E-01		6.79E-01	
Urinary bladder contents	1.39E+00	1.53E+00	1.53E+00	1.51E+00	1.59E+00		1.55E+00		1.30E+00		6.88E-01	

(d) i.v. administration, saturated thyroid.

	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Oral cavity	2.22E-04	2.22E-04	2.22E-04		2.22E-04		2.22E-04		2.22E-04		2.23E-04	
Oesophagus	3.34E-03	3.34E-03	3.34E-03		3.34E-03		3.34E-03		3.34E-03		3.34E-03	
Stomach contents	5.32E-01	5.32E-01	5.32E-01		5.32E-01		5.32E-01		5.32E-01		1.78E-01	
Small intestine contents	4.25E-02	4.25E-02	4.25E-02		4.25E-02		4.25E-02		4.25E-02		4.27E-02	
Right colon contents	1.18E-01	1.53E-01	1.09E-01		1.09E-01		1.09E-01		9.95E-02		8.10E-02	
Left colon contents	1.09E-01	1.38E-01	1.01E-01		1.01E-01		1.01E-01		9.30E-02		7.68E-02	
Recto-sigmoidal	1.00E-01	1.24E-01	1.02E-01		1.02E-01		1.02E-01		1.03E-01		1.06E-01	
Blood	1.87E+00	1.87E+00	1.87E+00		1.87E+00		1.87E+00		1.87E+00		1.87E+00	
Thyroid	3.75E-01	3.75E-01	3.75E-01		3.75E-01		3.75E-01		3.75E-01		3.76E-01	
Salivary Glands	1.92E-01	1.92E-01	1.92E-01		1.92E-01		1.92E-01		1.92E-01		1.93E-01	
Stomach walls	3.20E-01	3.20E-01	3.20E-01		3.20E-01		3.20E-01		3.20E-01		3.21E-01	
Liver	2.80E-01	2.80E-01	2.80E-01		2.80E-01		2.80E-01		2.80E-01		2.80E-01	
Other	5.51E+00	5.51E+00	5.51E+00		5.51E+00		5.51E+00		5.51E+00		5.52E+00	
Kidneys	4.66E-01	4.66E-01	4.66E-01		4.66E-01		4.66E-01		4.66E-01		4.67E-01	
Urinary bladder contents	2.30E+00	2.55E+00	2.55E+00	2.53E+00	2.66E+00		2.60E+00		2.15E+00		1.13E+00	

3002 ^{124}I

3003 (e) i.v. administration, removed thyroid.

	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Oral cavity	2.23E-04	2.23E-04	2.23E-04		2.23E-04		2.23E-04		2.23E-04		2.24E-04	
Oesophagus	3.35E-03	3.35E-03	3.35E-03		3.35E-03		3.35E-03		3.35E-03		3.35E-03	
Stomach contents	5.33E-01	5.33E-01	5.33E-01		5.33E-01		5.33E-01		5.33E-01		1.79E-01	
Small intestine contents	4.27E-02	4.27E-02	4.27E-02		4.27E-02		4.27E-02		4.27E-02		4.29E-02	
Right colon contents	1.18E-01	1.54E-01	1.09E-01		1.09E-01		1.09E-01		9.97E-02		8.12E-02	
Left colon contents	1.09E-01	1.38E-01	1.01E-01		1.01E-01		1.01E-01		9.33E-02		7.70E-02	
Recto-sigmoidal	1.01E-01	1.25E-01	1.02E-01		1.02E-01		1.02E-01		1.03E-01		1.07E-01	
Blood	1.87E+00	1.87E+00	1.87E+00		1.87E+00		1.87E+00		1.87E+00		1.88E+00	
Salivary Glands	1.93E-01	1.93E-01	1.93E-01		1.93E-01		1.93E-01		1.93E-01		1.93E-01	
Stomach walls	3.21E-01	3.21E-01	3.21E-01		3.21E-01		3.21E-01		3.21E-01		3.22E-01	
Liver	2.81E-01	2.81E-01	2.81E-01		2.81E-01		2.81E-01		2.81E-01		2.81E-01	
Other	5.52E+00	5.52E+00	5.52E+00		5.52E+00		5.52E+00		5.52E+00		5.54E+00	
Kidneys	4.68E-01	4.68E-01	4.68E-01		4.68E-01		4.68E-01		4.68E-01		4.69E-01	
Urinary bladder contents	2.31E+00	2.56E+00	2.56E+00	2.54E+00	2.67E+00		2.61E+00		2.15E+00		1.14E+00	

3004

3005 (f) oral administration, low uptake

	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Oral cavity	7.35E-04	7.35E-04	7.35E-04		7.35E-04		7.36E-04		7.37E-04		7.39E-04	
Oesophagus	4.77E-03	4.77E-03	4.77E-03		4.78E-03		4.79E-03		4.81E-03		4.59E-03	
Stomach contents	9.27E-01	9.27E-01	9.27E-01		9.28E-01		9.29E-01		9.32E-01		3.13E-01	
Small intestine contents	7.41E-02	7.41E-02	7.42E-02		7.42E-02		7.43E-02		7.46E-02		7.51E-02	
Right colon contents	2.13E-01	2.76E-01	1.99E-01		2.03E-01		2.12E-01		2.13E-01		1.87E-01	
Left colon contents	1.96E-01	2.49E-01	1.85E-01		1.89E-01		1.97E-01		1.99E-01		1.78E-01	
Recto-sigmoidal	1.81E-01	2.24E-01	1.87E-01		1.90E-01		1.99E-01		2.20E-01		2.46E-01	
Blood	1.70E+00	1.70E+00	1.76E+00		1.82E+00		1.99E+00		2.33E+00		2.58E+00	
Thyroid	2.56E+01	2.56E+01	2.52E+01		2.48E+01		2.37E+01		2.13E+01		1.94E+01	
Salivary Glands	1.55E-01	1.55E-01	1.55E-01		1.55E-01		1.56E-01		1.57E-01		1.59E-01	
Stomach walls	2.58E-01	2.58E-01	2.58E-01		2.59E-01		2.59E-01		2.61E-01		2.64E-01	
Liver	4.21E-01	4.21E-01	4.76E-01		5.33E-01		6.92E-01		1.02E+00		1.25E+00	
Other	4.76E+00	4.76E+00	4.86E+00		4.96E+00		5.24E+00		5.84E+00		6.28E+00	
Kidneys	4.09E-01	4.09E-01	4.19E-01		4.29E-01		4.58E-01		5.17E-01		5.60E-01	
Urinary bladder contents	1.89E+00	2.09E+00	2.09E+00	2.08E+00	2.18E+00		2.14E+00		1.76E+00		9.20E-01	

3006

3007 ^{124}I

3008 (g) oral administration, medium uptake.

	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Oral cavity	7.12E-04	7.12E-04	7.12E-04		7.13E-04		7.13E-04		7.15E-04		7.18E-04	
Oesophagus	4.43E-03	4.43E-03	4.43E-03		4.44E-03		4.45E-03		4.48E-03		4.26E-03	
Stomach contents	8.72E-01	8.72E-01	8.73E-01		8.74E-01		8.76E-01		8.80E-01		2.96E-01	
Small intestine contents	6.98E-02	6.98E-02	6.98E-02		6.99E-02		7.01E-02		7.04E-02		7.10E-02	
Right colon contents	2.05E-01	2.66E-01	1.94E-01		1.99E-01		2.14E-01		2.25E-01		2.05E-01	
Left colon contents	1.89E-01	2.39E-01	1.80E-01		1.85E-01		1.99E-01		2.10E-01		1.95E-01	
Recto-sigmoidal	1.74E-01	2.16E-01	1.82E-01		1.87E-01		2.00E-01		2.33E-01		2.70E-01	
Blood	1.62E+00	1.62E+00	1.71E+00		1.80E+00		2.06E+00		2.60E+00		2.99E+00	
Thyroid	3.99E+01	3.99E+01	3.93E+01		3.86E+01		3.70E+01		3.33E+01		3.05E+01	
Salivary Glands	1.35E-01	1.35E-01	1.35E-01		1.36E-01		1.36E-01		1.38E-01		1.40E-01	
Stomach walls	2.25E-01	2.25E-01	2.26E-01		2.26E-01		2.27E-01		2.30E-01		2.33E-01	
Liver	5.01E-01	5.01E-01	5.87E-01		6.75E-01		9.24E-01		1.44E+00		1.80E+00	
Other	4.37E+00	4.37E+00	4.53E+00		4.69E+00		5.13E+00		6.05E+00		6.75E+00	
Kidneys	3.80E-01	3.80E-01	3.96E-01		4.12E-01		4.56E-01		5.48E-01		6.15E-01	
Urinary bladder contents	1.65E+00	1.82E+00	1.82E+00	1.81E+00	1.90E+00		1.86E+00		1.54E+00		8.04E-01	

3009

3010 (h) oral administration, high uptake.

	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Oral cavity	6.89E-04	6.89E-04	6.90E-04		6.90E-04		6.91E-04		6.93E-04		6.96E-04	
Oesophagus	4.09E-03	4.09E-03	4.10E-03		4.10E-03		4.11E-03		4.15E-03		3.94E-03	
Stomach contents	8.18E-01	8.18E-01	8.19E-01		8.20E-01		8.22E-01		8.27E-01		2.78E-01	
Small intestine contents	6.54E-02	6.54E-02	6.55E-02		6.56E-02		6.58E-02		6.62E-02		6.68E-02	
Right colon contents	1.97E-01	2.56E-01	1.88E-01		1.96E-01		2.15E-01		2.37E-01		2.24E-01	
Left colon contents	1.81E-01	2.30E-01	1.75E-01		1.82E-01		2.00E-01		2.21E-01		2.12E-01	
Recto-sigmoidal	1.68E-01	2.07E-01	1.76E-01		1.83E-01		2.01E-01		2.45E-01		2.94E-01	
Blood	1.54E+00	1.54E+00	1.66E+00		1.79E+00		2.14E+00		2.88E+00		3.41E+00	
Thyroid	5.41E+01	5.41E+01	5.33E+01		5.25E+01		5.03E+01		4.56E+01		4.19E+01	
Salivary Glands	1.16E-01	1.16E-01	1.16E-01		1.16E-01		1.17E-01		1.19E-01		1.21E-01	
Stomach walls	1.93E-01	1.93E-01	1.93E-01		1.94E-01		1.95E-01		1.98E-01		2.02E-01	
Liver	5.81E-01	5.81E-01	6.98E-01		8.18E-01		1.16E+00		1.87E+00		2.37E+00	
Other	3.99E+00	3.99E+00	4.20E+00		4.42E+00		5.01E+00		6.28E+00		7.22E+00	
Kidneys	3.52E-01	3.52E-01	3.72E-01		3.94E-01		4.54E-01		5.80E-01		6.71E-01	
Urinary bladder contents	1.40E+00	1.54E+00	1.54E+00	1.53E+00	1.61E+00		1.57E+00		1.31E+00		6.87E-01	

3011

3012 ^{124}I

3013 (i) oral administration, saturated thyroid.

	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Oral cavity	7.75E-04	7.75E-04	7.75E-04		7.75E-04		7.75E-04		7.75E-04		7.76E-04	
Oesophagus	5.37E-03	5.37E-03	5.37E-03		5.37E-03		5.37E-03		5.37E-03		5.14E-03	
Stomach contents	1.02E+00	1.02E+00	1.02E+00		1.02E+00		1.02E+00		1.02E+00		3.43E-01	
Small intestine contents	8.18E-02	8.18E-02	8.18E-02		8.18E-02		8.18E-02		8.18E-02		8.22E-02	
Right colon contents	2.27E-01	2.95E-01	2.09E-01		2.09E-01		2.09E-01		1.91E-01		1.56E-01	
Left colon contents	2.09E-01	2.65E-01	1.94E-01		1.94E-01		1.94E-01		1.79E-01		1.48E-01	
Recto-sigmoidal	1.93E-01	2.39E-01	1.96E-01		1.96E-01		1.96E-01		1.98E-01		2.04E-01	
Blood	1.84E+00	1.84E+00	1.84E+00		1.84E+00		1.84E+00		1.84E+00		1.85E+00	
Thyroid	3.70E-01	3.70E-01	3.70E-01		3.70E-01		3.70E-01		3.70E-01		3.72E-01	
Salivary Glands	1.90E-01	1.90E-01	1.90E-01		1.90E-01		1.90E-01		1.90E-01		1.90E-01	
Stomach walls	3.16E-01	3.16E-01	3.16E-01		3.16E-01		3.16E-01		3.16E-01		3.17E-01	
Liver	2.76E-01	2.76E-01	2.76E-01		2.76E-01		2.76E-01		2.76E-01		2.77E-01	
Other	5.43E+00	5.43E+00	5.43E+00		5.43E+00		5.43E+00		5.43E+00		5.46E+00	
Kidneys	4.60E-01	4.60E-01	4.60E-01		4.60E-01		4.60E-01		4.60E-01		4.62E-01	
Urinary bladder contents	2.30E+00	2.55E+00	2.55E+00	2.53E+00	2.66E+00		2.61E+00		2.15E+00		1.13E+00	

3014

3015 (j) oral administration, removed thyroid.

	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Oral cavity	7.76E-04	7.76E-04	7.76E-04		7.76E-04		7.76E-04		7.76E-04		7.77E-04	
Oesophagus	5.38E-03	5.38E-03	5.38E-03		5.38E-03		5.38E-03		5.38E-03		5.15E-03	
Stomach contents	1.02E+00	1.02E+00	1.02E+00		1.02E+00		1.02E+00		1.02E+00		3.43E-01	
Small intestine contents	8.19E-02	8.19E-02	8.19E-02		8.19E-02		8.19E-02		8.19E-02		8.23E-02	
Right colon contents	2.27E-01	2.95E-01	2.09E-01		2.09E-01		2.09E-01		1.92E-01		1.56E-01	
Left colon contents	2.10E-01	2.66E-01	1.95E-01		1.95E-01		1.95E-01		1.79E-01		1.48E-01	
Recto-sigmoidal	1.93E-01	2.39E-01	1.96E-01		1.96E-01		1.96E-01		1.99E-01		2.05E-01	
Blood	1.85E+00	1.85E+00	1.85E+00		1.85E+00		1.85E+00		1.85E+00		1.86E+00	
Salivary Glands	1.90E-01	1.90E-01	1.90E-01		1.90E-01		1.90E-01		1.90E-01		1.91E-01	
Stomach walls	3.17E-01	3.17E-01	3.17E-01		3.17E-01		3.17E-01		3.17E-01		3.18E-01	
Liver	2.77E-01	2.77E-01	2.77E-01		2.77E-01		2.77E-01		2.77E-01		2.78E-01	
Other	5.45E+00	5.45E+00	5.45E+00		5.45E+00		5.45E+00		5.45E+00		5.47E+00	
Kidneys	4.61E-01	4.61E-01	4.61E-01		4.61E-01		4.61E-01		4.61E-01		4.63E-01	
Urinary bladder contents	2.31E+00	2.57E+00	2.57E+00	2.55E+00	2.68E+00		2.62E+00		2.16E+00		1.13E+00	

3016

Table A.27.4. Time-integrated activity coefficients for ^{125}I-labelled iodide (h)

(a) oral administration, low uptake.

	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Oral cavity	7.56E-04	7.56E-04	7.58E-04		7.61E-04		7.65E-04		7.70E-04		7.72E-04	
Oesophagus	5.09E-03	5.09E-03	5.13E-03		5.16E-03		5.22E-03		5.29E-03		5.08E-03	
Stomach contents	9.80E-01	9.80E-01	9.87E-01		9.92E-01		1.00E+00		1.01E+00		3.40E-01	
Small intestine contents	7.84E-02	7.84E-02	7.89E-02		7.94E-02		8.01E-02		8.11E-02		8.15E-02	
Right colon contents	4.09E-01	5.45E-01	4.15E-01		4.48E-01		5.09E-01		5.26E-01		4.48E-01	
Left colon contents	4.07E-01	5.41E-01	4.13E-01		4.45E-01		5.06E-01		5.24E-01		4.46E-01	
Recto-sigmoidal	4.05E-01	5.37E-01	4.48E-01		4.83E-01		5.49E-01		6.25E-01		6.65E-01	
Blood	6.14E+00	6.14E+00	6.44E+00		6.73E+00		7.48E+00		8.18E+00		8.01E+00	
Thyroid	2.56E+02	2.56E+02	2.25E+02		1.99E+02		1.49E+02		9.17E+01		6.63E+01	
Salivary Glands	1.73E-01	1.73E-01	1.75E-01		1.77E-01		1.81E-01		1.85E-01		1.87E-01	
Stomach walls	2.88E-01	2.88E-01	2.92E-01		2.95E-01		3.01E-01		3.08E-01		3.12E-01	
Liver	4.67E+00	4.67E+00	4.94E+00		5.22E+00		5.93E+00		6.59E+00		6.41E+00	
Other	1.30E+01	1.30E+01	1.36E+01		1.42E+01		1.55E+01		1.68E+01		1.66E+01	
Kidneys	1.18E+00	1.18E+00	1.23E+00		1.28E+00		1.41E+00		1.53E+00		1.51E+00	
Urinary bladder contents	1.95E+00	2.17E+00	2.17E+00	2.16E+00	2.26E+00		2.22E+00		1.83E+00		8.91E-01	

(b) oral administration, medium uptake.

	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Oral cavity	7.35E-04	7.35E-04	7.39E-04		7.42E-04		7.48E-04		7.55E-04		7.59E-04	
Oesophagus	4.77E-03	4.77E-03	4.83E-03		4.88E-03		4.97E-03		5.08E-03		4.89E-03	
Stomach contents	9.30E-01	9.30E-01	9.39E-01		9.47E-01		9.62E-01		9.80E-01		3.29E-01	
Small intestine contents	7.44E-02	7.44E-02	7.51E-02		7.58E-02		7.69E-02		7.84E-02		7.91E-02	
Right colon contents	5.02E-01	6.68E-01	5.26E-01		5.80E-01		6.84E-01		7.35E-01		6.35E-01	
Left colon contents	4.99E-01	6.63E-01	5.23E-01		5.77E-01		6.81E-01		7.31E-01		6.32E-01	
Recto-sigmoidal	4.96E-01	6.57E-01	5.67E-01		6.26E-01		7.38E-01		8.72E-01		9.43E-01	
Blood	8.62E+00	8.62E+00	9.14E+00		9.67E+00		1.10E+01		1.23E+01		1.21E+01	
Thyroid	4.08E+02	4.08E+02	3.61E+02		3.21E+02		2.44E+02		1.52E+02		1.11E+02	
Salivary Glands	1.55E-01	1.55E-01	1.58E-01		1.61E-01		1.66E-01		1.73E-01		1.76E-01	
Stomach walls	2.58E-01	2.58E-01	2.64E-01		2.68E-01		2.77E-01		2.88E-01		2.93E-01	
Liver	7.26E+00	7.26E+00	7.76E+00		8.25E+00		9.52E+00		1.08E+01		1.05E+01	
Other	1.73E+01	1.73E+01	1.83E+01		1.93E+01		2.17E+01		2.41E+01		2.38E+01	
Kidneys	1.59E+00	1.59E+00	1.68E+00		1.77E+00		2.00E+00		2.22E+00		2.19E+00	
Urinary bladder contents	1.69E+00	1.88E+00	1.88E+00	1.87E+00	1.95E+00		1.92E+00		1.59E+00		7.74E-01	

3022 ^{125}I

3023 (c) oral administration, high uptake.

	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Oral cavity	6.57E-04	6.57E-04	6.57E-04		6.57E-04		6.57E-04		6.57E-04		6.60E-04	
Oesophagus	3.61E-03	3.61E-03	3.61E-03		3.61E-03		3.61E-03		3.61E-03		3.40E-03	
Stomach contents	7.25E-01	7.25E-01	7.25E-01		7.25E-01		7.25E-01		7.25E-01		2.48E-01	
Small intestine contents	5.79E-02	5.79E-02	5.79E-02		5.79E-02		5.79E-02		5.79E-02		5.94E-02	
Right colon contents	1.07E-01	1.26E-01	1.01E-01		1.02E-01		1.02E-01		9.69E-02		8.64E-02	
Left colon contents	6.58E-02	6.89E-02	6.44E-02		6.45E-02		6.48E-02		6.36E-02		6.09E-02	
Recto-sigmoidal	4.04E-02	3.75E-02	4.32E-02		4.33E-02		4.34E-02		4.69E-02		5.62E-02	
Blood	8.83E-01	8.83E-01	8.87E-01		8.91E-01		9.02E-01		9.29E-01		9.79E-01	
Thyroid	5.80E+00	5.80E+00	5.79E+00		5.77E+00		5.73E+00		5.64E+00		5.69E+00	
Salivary Glands	8.79E-02	8.79E-02	8.79E-02		8.79E-02		8.79E-02		8.79E-02		9.03E-02	
Stomach walls	1.46E-01	1.46E-01	1.46E-01		1.46E-01		1.46E-01		1.47E-01		1.50E-01	
Liver	1.39E-01	1.39E-01	1.43E-01		1.46E-01		1.57E-01		1.83E-01		2.12E-01	
Other	2.55E+00	2.55E+00	2.56E+00		2.56E+00		2.58E+00		2.61E+00		2.71E+00	
Kidneys	2.17E-01	2.17E-01	2.18E-01		2.18E-01		2.20E-01		2.25E-01		2.35E-01	
Urinary bladder contents	1.15E+00	1.23E+00	1.23E+00	1.20E+00	1.28E+00		1.23E+00		1.06E+00		7.39E-01	

3024

3025 (d) oral administration, saturated thyroid

	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Oral cavity	7.91E-04	7.91E-04	7.91E-04		7.91E-04		7.91E-04		7.91E-04		7.91E-04	
Oesophagus	5.61E-03	5.61E-03	5.61E-03		5.61E-03		5.61E-03		5.61E-03		5.36E-03	
Stomach contents	1.06E+00	1.06E+00	1.06E+00		1.06E+00		1.06E+00		1.06E+00		3.55E-01	
Small intestine contents	8.52E-02	8.52E-02	8.52E-02		8.52E-02		8.52E-02		8.52E-02		8.52E-02	
Right colon contents	2.54E-01	3.38E-01	2.33E-01		2.33E-01		2.33E-01		2.12E-01		1.70E-01	
Left colon contents	2.53E-01	3.35E-01	2.32E-01		2.32E-01		2.32E-01		2.11E-01		1.69E-01	
Recto-sigmoidal	2.51E-01	3.33E-01	2.51E-01		2.51E-01		2.51E-01		2.52E-01		2.52E-01	
Blood	1.97E+00	1.97E+00	1.97E+00		1.97E+00		1.97E+00		1.97E+00		1.97E+00	
Thyroid	3.97E-01	3.97E-01	3.97E-01		3.97E-01		3.97E-01		3.97E-01		3.97E-01	
Salivary Glands	2.03E-01	2.03E-01	2.03E-01		2.03E-01		2.03E-01		2.03E-01		2.03E-01	
Stomach walls	3.39E-01	3.39E-01	3.39E-01		3.39E-01		3.39E-01		3.39E-01		3.39E-01	
Liver	2.96E-01	2.96E-01	2.96E-01		2.96E-01		2.96E-01		2.96E-01		2.96E-01	
Other	5.82E+00	5.82E+00	5.82E+00		5.82E+00		5.82E+00		5.82E+00		5.82E+00	
Kidneys	4.93E-01	4.93E-01	4.93E-01		4.93E-01		4.93E-01		4.93E-01		4.93E-01	
Urinary bladder contents	2.40E+00	2.67E+00	2.67E+00	2.66E+00	2.78E+00		2.74E+00		2.24E+00		1.10E+00	

3026

^{125}I

(e) oral administration, removed thyroid.

	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Oral cavity	7.91E-04	7.91E-04	7.91E-04		7.91E-04		7.91E-04		7.91E-04		7.91E-04	
Oesophagus	5.61E-03	5.61E-03	5.61E-03		5.61E-03		5.61E-03		5.61E-03		5.36E-03	
Stomach contents	1.06E+00	1.06E+00	1.06E+00		1.06E+00		1.06E+00		1.06E+00		3.55E-01	
Small intestine contents	8.52E-02	8.52E-02	8.52E-02		8.52E-02		8.52E-02		8.52E-02		8.52E-02	
Right colon contents	2.54E-01	3.38E-01	2.33E-01		2.33E-01		2.33E-01		2.12E-01		1.70E-01	
Left colon contents	2.53E-01	3.35E-01	2.32E-01		2.32E-01		2.32E-01		2.11E-01		1.69E-01	
Recto-sigmoidal	2.51E-01	3.33E-01	2.51E-01		2.51E-01		2.51E-01		2.52E-01		2.52E-01	
Blood	1.97E+00	1.97E+00	1.97E+00		1.97E+00		1.97E+00		1.97E+00		1.97E+00	
Salivary Glands	2.03E-01	2.03E-01	2.03E-01		2.03E-01		2.03E-01		2.03E-01		2.03E-01	
Stomach walls	3.39E-01	3.39E-01	3.39E-01		3.39E-01		3.39E-01		3.39E-01		3.39E-01	
Liver	2.96E-01	2.96E-01	2.96E-01		2.96E-01		2.96E-01		2.96E-01		2.96E-01	
Other	5.82E+00	5.82E+00	5.82E+00		5.82E+00		5.82E+00		5.82E+00		5.82E+00	
Kidneys	4.93E-01	4.93E-01	4.93E-01		4.93E-01		4.93E-01		4.93E-01		4.93E-01	
Urinary bladder contents	2.40E+00	2.67E+00	2.67E+00	2.67E+00	2.79E+00		2.75E+00		2.25E+00		1.11E+00	

Table A.27.5. Time-integrated activity coefficients for ^{131}I-labelled iodide (h).

(a) oral administration, low uptake.

	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Oral cavity	7.41E-04	7.41E-04	7.41E-04		7.42E-04		7.43E-04		7.46E-04		7.49E-04	
Oesophagus	4.86E-03	4.86E-03	4.87E-03		4.88E-03		4.90E-03		4.94E-03		4.73E-03	
Stomach contents	9.43E-01	9.43E-01	9.44E-01		9.45E-01		9.48E-01		9.55E-01		3.21E-01	
Small intestine contents	7.54E-02	7.54E-02	7.55E-02		7.56E-02		7.59E-02		7.64E-02		7.70E-02	
Right colon contents	2.37E-01	3.11E-01	2.26E-01		2.34E-01		2.55E-01		2.71E-01		2.44E-01	
Left colon contents	2.27E-01	2.94E-01	2.17E-01		2.25E-01		2.46E-01		2.61E-01		2.37E-01	
Recto-sigmoidal	2.17E-01	2.78E-01	2.27E-01		2.36E-01		2.57E-01		3.01E-01		3.41E-01	
Blood	2.08E+00	2.08E+00	2.21E+00		2.34E+00		2.69E+00		3.35E+00		3.72E+00	
Thyroid	4.88E+01	4.88E+01	4.74E+01		4.61E+01		4.25E+01		3.56E+01		3.08E+01	
Salivary Glands	1.60E-01	1.60E-01	1.60E-01		1.61E-01		1.62E-01		1.64E-01		1.67E-01	
Stomach walls	2.67E-01	2.67E-01	2.67E-01		2.68E-01		2.70E-01		2.74E-01		2.78E-01	
Liver	7.52E-01	7.52E-01	8.75E-01		1.00E+00		1.34E+00		1.97E+00		2.32E+00	
Other	5.47E+00	5.47E+00	5.71E+00		5.95E+00		6.58E+00		7.76E+00		8.44E+00	
Kidneys	4.77E-01	4.77E-01	4.99E-01		5.22E-01		5.83E-01		6.96E-01		7.61E-01	
Urinary bladder contents	1.92E+00	2.13E+00	2.13E+00	2.12E+00	2.22E+00		2.18E+00		1.80E+00		9.05E-01	

3033 ^{131}I

3034 (b) oral administration, medium uptake.

	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Oral cavity	7.17E-04	7.17E-04	7.18E-04		7.19E-04		7.20E-04		7.24E-04		7.28E-04	
Oesophagus	4.51E-03	4.51E-03	4.52E-03		4.53E-03		4.56E-03		4.62E-03		4.42E-03	
Stomach contents	8.86E-01	8.86E-01	8.88E-01		8.90E-01		8.94E-01		9.03E-01		3.04E-01	
Small intestine contents	7.09E-02	7.09E-02	7.10E-02		7.12E-02		7.15E-02		7.23E-02		7.30E-02	
Right colon contents	2.35E-01	3.09E-01	2.29E-01		2.42E-01		2.75E-01		3.11E-01		2.91E-01	
Left colon contents	2.25E-01	2.92E-01	2.20E-01		2.33E-01		2.64E-01		3.00E-01		2.83E-01	
Recto-sigmoidal	2.16E-01	2.76E-01	2.30E-01		2.43E-01		2.76E-01		3.45E-01		4.07E-01	
Blood	2.17E+00	2.17E+00	2.37E+00		2.58E+00		3.14E+00		4.18E+00		4.78E+00	
Thyroid	7.58E+01	7.58E+01	7.38E+01		7.18E+01		6.65E+01		5.62E+01		4.89E+01	
Salivary Glands	1.40E-01	1.40E-01	1.40E-01		1.41E-01		1.43E-01		1.46E-01		1.49E-01	
Stomach walls	2.33E-01	2.33E-01	2.34E-01		2.35E-01		2.38E-01		2.43E-01		2.48E-01	
Liver	1.01E+00	1.01E+00	1.20E+00		1.40E+00		1.94E+00		2.94E+00		3.51E+00	
Other	5.38E+00	5.38E+00	5.75E+00		6.12E+00		7.12E+00		8.98E+00		1.01E+01	
Kidneys	4.77E-01	4.77E-01	5.12E-01		5.47E-01		6.43E-01		8.23E-01		9.27E-01	
Urinary bladder contents	1.67E+00	1.85E+00	1.85E+00	1.84E+00	1.93E+00		1.89E+00		1.56E+00		7.88E-01	

3035

3036 (c) oral administration, high uptake.

	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Oral cavity	6.94E-04	6.94E-04	6.94E-04		6.95E-04		6.98E-04		7.02E-04		7.06E-04	
Oesophagus	4.15E-03	4.15E-03	4.17E-03		4.18E-03		4.21E-03		4.28E-03		4.09E-03	
Stomach contents	8.30E-01	8.30E-01	8.32E-01		8.34E-01		8.39E-01		8.50E-01		2.87E-01	
Small intestine contents	6.64E-02	6.64E-02	6.65E-02		6.67E-02		6.71E-02		6.80E-02		6.89E-02	
Right colon contents	2.33E-01	3.06E-01	2.32E-01		2.49E-01		2.94E-01		3.52E-01		3.41E-01	
Left colon contents	2.23E-01	2.89E-01	2.23E-01		2.40E-01		2.83E-01		3.40E-01		3.32E-01	
Recto-sigmoidal	2.14E-01	2.74E-01	2.33E-01		2.51E-01		2.96E-01		3.91E-01		4.77E-01	
Blood	2.27E+00	2.27E+00	2.54E+00		2.82E+00		3.59E+00		5.04E+00		5.89E+00	
Thyroid	1.03E+02	1.03E+02	1.00E+02		9.77E+01		9.09E+01		7.75E+01		6.79E+01	
Salivary Glands	1.19E-01	1.19E-01	1.20E-01		1.21E-01		1.23E-01		1.27E-01		1.30E-01	
Stomach walls	1.99E-01	1.99E-01	2.00E-01		2.01E-01		2.04E-01		2.11E-01		2.17E-01	
Liver	1.27E+00	1.27E+00	1.53E+00		1.80E+00		2.54E+00		3.95E+00		4.76E+00	
Other	5.30E+00	5.30E+00	5.79E+00		6.30E+00		7.66E+00		1.02E+01		1.18E+01	
Kidneys	4.77E-01	4.77E-01	5.24E-01		5.72E-01		7.04E-01		9.54E-01		1.10E+00	
Urinary bladder contents	1.42E+00	1.56E+00	1.56E+00	1.55E+00	1.62E+00		1.60E+00		1.33E+00		6.71E-01	

3037

3038 ^{131}I

3039 (d) oral administration, saturated thyroid.

	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Oral cavity	7.83E-04	7.83E-04	7.83E-04		7.83E-04		7.83E-04		7.83E-04		7.83E-04	
Oesophagus	5.49E-03	5.49E-03	5.49E-03		5.49E-03		5.49E-03		5.49E-03		5.25E-03	
Stomach contents	1.04E+00	1.04E+00	1.04E+00		1.04E+00		1.04E+00		1.04E+00		3.49E-01	
Small intestine contents	8.35E-02	8.35E-02	8.35E-02		8.35E-02		8.35E-02		8.35E-02		8.37E-02	
Right colon contents	2.40E-01	3.16E-01	2.21E-01		2.21E-01		2.21E-01		2.01E-01		1.63E-01	
Left colon contents	2.30E-01	2.99E-01	2.12E-01		2.12E-01		2.12E-01		1.94E-01		1.58E-01	
Recto-sigmoidal	2.21E-01	2.82E-01	2.22E-01		2.22E-01		2.22E-01		2.24E-01		2.27E-01	
Blood	1.91E+00	1.91E+00	1.91E+00		1.91E+00		1.91E+00		1.91E+00		1.91E+00	
Thyroid	3.84E-01	3.84E-01	3.84E-01		3.84E-01		3.84E-01		3.84E-01		3.85E-01	
Salivary Glands	1.96E-01	1.96E-01	1.96E-01		1.96E-01		1.96E-01		1.96E-01		1.97E-01	
Stomach walls	3.27E-01	3.27E-01	3.27E-01		3.27E-01		3.27E-01		3.27E-01		3.28E-01	
Liver	2.86E-01	2.86E-01	2.86E-01		2.86E-01		2.86E-01		2.86E-01		2.86E-01	
Other	5.63E+00	5.63E+00	5.63E+00		5.63E+00		5.63E+00		5.63E+00		5.64E+00	
Kidneys	4.76E-01	4.76E-01	4.76E-01		4.76E-01		4.76E-01		4.76E-01		4.77E-01	
Urinary bladder contents	2.35E+00	2.61E+00	2.61E+00	2.60E+00	2.72E+00		2.67E+00		2.19E+00		1.11E+00	

3040

3041 (e) oral administration, removed thyroid.

	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Oral cavity	7.83E-04	7.83E-04	7.83E-04		7.83E-04		7.83E-04		7.83E-04		7.84E-04	
Oesophagus	5.50E-03	5.50E-03	5.50E-03		5.50E-03		5.50E-03		5.50E-03		5.26E-03	
Stomach contents	1.04E+00	1.04E+00	1.04E+00		1.04E+00		1.04E+00		1.04E+00		3.49E-01	
Small intestine contents	8.35E-02	8.35E-02	8.35E-02		8.35E-02		8.35E-02		8.35E-02		8.38E-02	
Right colon contents	2.40E-01	3.16E-01	2.21E-01		2.21E-01		2.21E-01		2.02E-01		1.63E-01	
Left colon contents	2.30E-01	2.99E-01	2.13E-01		2.13E-01		2.13E-01		1.95E-01		1.58E-01	
Recto-sigmoidal	2.21E-01	2.82E-01	2.22E-01		2.22E-01		2.22E-01		2.24E-01		2.28E-01	
Blood	1.91E+00	1.91E+00	1.91E+00		1.91E+00		1.91E+00		1.91E+00		1.91E+00	
Thyroid	0.00E+00	0.00E+00	0.00E+00		0.00E+00		0.00E+00		0.00E+00		0.00E+00	
Salivary Glands	1.97E-01	1.97E-01	1.97E-01		1.97E-01		1.97E-01		1.97E-01		1.97E-01	
Stomach walls	3.28E-01	3.28E-01	3.28E-01		3.28E-01		3.28E-01		3.28E-01		3.29E-01	
Liver	2.86E-01	2.86E-01	2.86E-01		2.86E-01		2.86E-01		2.86E-01		2.87E-01	
Other	5.64E+00	5.64E+00	5.64E+00		5.64E+00		5.64E+00		5.64E+00		5.65E+00	
Kidneys	4.77E-01	4.77E-01	4.77E-01		4.77E-01		4.77E-01		4.77E-01		4.78E-01	
Urinary bladder contents	2.36E+00	2.62E+00	2.62E+00	2.61E+00	2.73E+00		2.68E+00		2.20E+00		1.12E+00	

3042

Table A.27.6. Dose coefficients for ^{123}I-labelled iodide.

(a) i.v. administration, low uptake.

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	1.2E-02	1.3E-02	1.0E-02	1.0E-02	1.5E-02	1.5E-02	2.3E-02	2.3E-02	4.7E-02	4.7E-02	5.6E-02	5.5E-02
Brain	3.6E-03	4.6E-03	6.5E-03	6.9E-03	1.0E-02	1.0E-02	1.5E-02	1.5E-02	2.4E-02	2.4E-02	3.7E-02	3.7E-02
Breast	3.6E-03	5.1E-03	3.8E-03	4.5E-03	6.0E-03	5.5E-03	1.0E-02	1.0E-02	1.8E-02	1.8E-02	3.0E-02	3.0E-02
Colon wall	1.0E-02	1.2E-02	1.3E-02	1.1E-02	1.9E-02	1.8E-02	2.9E-02	2.7E-02	5.9E-02	5.7E-02	7.4E-02	7.1E-02
Endosteum (bone surface)	6.4E-03	8.2E-03	9.8E-03	1.0E-02	1.5E-02	1.4E-02	2.5E-02	2.5E-02	5.1E-02	5.0E-02	7.5E-02	7.5E-02
ET region	1.3E-02	1.9E-02	1.2E-02	1.3E-02	1.8E-02	1.8E-02	2.2E-02	2.2E-02	2.9E-02	2.9E-02	6.0E-02	6.0E-02
Gall bladder wall	7.2E-03	9.3E-03	1.0E-02	1.1E-02	1.1E-02	1.1E-02	2.0E-02	2.0E-02	3.7E-02	3.7E-02	5.1E-02	5.1E-02
Heart wall	1.2E-02	1.3E-02	7.9E-03	9.1E-03	1.2E-02	1.2E-02	2.0E-02	2.0E-02	4.2E-02	4.2E-02	5.5E-02	5.5E-02
Kidneys	2.5E-02	3.0E-02	2.9E-02	3.2E-02	4.2E-02	4.2E-02	6.7E-02	6.7E-02	1.2E-01	1.2E-01	1.7E-01	1.7E-01
Liver	9.4E-03	1.1E-02	9.6E-03	1.1E-02	1.6E-02	1.6E-02	2.5E-02	2.5E-02	4.7E-02	4.7E-02	6.3E-02	6.3E-02
Lung	1.1E-02	1.3E-02	2.7E-02	2.5E-02	3.1E-02	3.1E-02	5.5E-02	5.5E-02	1.6E-01	1.6E-01	1.6E-01	1.6E-01
Lymphatic nodes	2.4E-02	2.7E-02	1.3E-02	1.3E-02	1.6E-02	1.6E-02	3.0E-02	3.0E-02	5.0E-02	5.0E-02	6.4E-02	6.4E-02
Muscle	5.4E-03	7.0E-03	5.9E-03	5.8E-03	9.1E-03	9.0E-03	1.5E-02	1.5E-02	3.0E-02	2.9E-02	4.4E-02	4.4E-02
Oesophagus	5.1E-02	6.1E-02	2.9E-02	3.1E-02	3.8E-02	3.8E-02	7.5E-02	7.5E-02	1.7E-01	1.7E-01	1.8E-01	1.8E-01
Oral mucosa	6.5E-03	1.3E-02	1.8E-02	2.2E-02	1.8E-02	1.9E-02	2.2E-02	2.2E-02	3.0E-02	3.0E-02	8.5E-02	8.5E-02
Ovaries	-	2.0E-02	-	4.0E-02	-	5.5E-02	-	7.8E-02	-	1.1E-01	-	9.4E-02
Pancreas	1.1E-02	1.4E-02	1.3E-02	1.3E-02	1.9E-02	1.9E-02	2.9E-02	2.9E-02	5.0E-02	5.0E-02	6.3E-02	6.3E-02
Prostate	2.6E-02	-	3.0E-02	-	5.7E-02	-	7.8E-02	-	1.4E-01	-	1.2E-01	-
Red marrow	1.0E-02	1.3E-02	1.1E-02	1.2E-02	1.6E-02	1.6E-02	2.3E-02	2.2E-02	4.3E-02	4.3E-02	6.9E-02	6.9E-02
Salivary glands	3.4E-02	4.5E-02	4.8E-02	5.0E-02	7.9E-02	7.9E-02	9.6E-02	9.6E-02	1.4E-01	1.4E-01	2.9E-01	2.9E-01
Skin	3.5E-03	4.4E-03	4.3E-03	4.8E-03	7.2E-03	7.2E-03	1.2E-02	1.2E-02	2.0E-02	2.0E-02	3.0E-02	3.0E-02
Small intestine wall	1.1E-02	1.5E-02	1.0E-02	1.0E-02	1.4E-02	1.5E-02	2.6E-02	2.8E-02	4.9E-02	4.9E-02	6.3E-02	6.1E-02
Spleen	9.7E-03	1.4E-02	8.9E-03	1.1E-02	1.5E-02	1.5E-02	2.7E-02	2.7E-02	5.0E-02	5.0E-02	6.3E-02	6.3E-02
Stomach wall	3.5E-02	3.9E-02	3.9E-02	4.5E-02	6.4E-02	6.4E-02	9.9E-02	9.9E-02	2.1E-01	2.1E-01	2.8E-01	2.8E-01
Testes	4.3E-03	-	1.5E-02	-	1.7E-02	-	2.9E-02	-	3.4E-02	-	3.8E-02	-
Thymus	5.0E-02	4.8E-02	4.7E-02	6.8E-02	3.9E-02	3.9E-02	6.1E-02	6.1E-02	1.8E-01	1.8E-01	1.8E-01	1.8E-01
Thyroid	2.5E+00	2.9E+00	3.9E+00	4.1E+00	5.9E+00	5.9E+00	1.3E+01	1.3E+01	2.5E+01	2.5E+01	2.7E+01	2.7E+01
Urinary bladder wall	7.3E-02	9.3E-02	9.3E-02	9.3E-02	1.5E-01	1.5E-01	1.8E-01	1.8E-01	2.1E-01	2.1E-01	2.6E-01	2.6E-01
Uterus/ cervix	-	3.1E-02	-	8.0E-02	-	1.2E-01	-	9.4E-02	-	3.4E-01	-	2.7E-01
Effective dose (mSv/MBq)	1.3E-01		1.8E-01		2.7E-01		5.7E-01		1.1E+00		1.2E+00	

3046 ^{123}I

3047 (b) i.v. administration, medium uptake.

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	1.1E-02	1.2E-02	9.4E-03	9.5E-03	1.4E-02	1.4E-02	2.2E-02	2.2E-02	4.5E-02	4.5E-02	5.4E-02	5.4E-02
Brain	3.6E-03	4.7E-03	6.4E-03	6.8E-03	1.0E-02	1.1E-02	1.5E-02	1.5E-02	2.4E-02	2.4E-02	3.7E-02	3.7E-02
Breast	3.6E-03	5.6E-03	3.7E-03	4.4E-03	6.0E-03	5.6E-03	1.0E-02	1.0E-02	1.9E-02	1.8E-02	3.0E-02	3.0E-02
Colon wall	9.4E-03	1.1E-02	1.2E-02	1.0E-02	1.7E-02	1.6E-02	2.7E-02	2.5E-02	5.4E-02	5.2E-02	6.8E-02	6.6E-02
Endosteum (bone surface)	6.7E-03	8.6E-03	9.8E-03	1.0E-02	1.5E-02	1.4E-02	2.6E-02	2.5E-02	5.2E-02	5.2E-02	7.8E-02	7.8E-02
ET region	1.9E-02	2.8E-02	1.4E-02	1.6E-02	2.1E-02	2.1E-02	2.7E-02	2.7E-02	3.4E-02	3.4E-02	7.7E-02	7.7E-02
Gall bladder wall	6.8E-03	8.6E-03	9.5E-03	1.1E-02	1.1E-02	1.1E-02	1.8E-02	1.8E-02	3.5E-02	3.5E-02	4.9E-02	4.9E-02
Heart wall	1.3E-02	1.3E-02	9.1E-03	1.0E-02	1.3E-02	1.3E-02	2.2E-02	2.2E-02	4.8E-02	4.8E-02	6.2E-02	6.2E-02
Kidneys	2.3E-02	2.7E-02	2.6E-02	2.9E-02	3.8E-02	3.8E-02	6.1E-02	6.1E-02	1.1E-01	1.1E-01	1.6E-01	1.6E-01
Liver	8.9E-03	1.1E-02	9.0E-03	1.1E-02	1.5E-02	1.5E-02	2.4E-02	2.4E-02	4.6E-02	4.6E-02	6.3E-02	6.3E-02
Lung	1.3E-02	1.5E-02	4.0E-02	3.5E-02	4.2E-02	4.2E-02	7.7E-02	7.7E-02	2.4E-01	2.4E-01	2.3E-01	2.3E-01
Lymphatic nodes	3.2E-02	3.6E-02	1.6E-02	1.6E-02	1.9E-02	1.9E-02	3.6E-02	3.6E-02	5.9E-02	5.9E-02	7.6E-02	7.6E-02
Muscle	5.7E-03	7.5E-03	5.9E-03	5.9E-03	9.3E-03	9.2E-03	1.6E-02	1.6E-02	3.2E-02	3.2E-02	5.0E-02	4.9E-02
Oesophagus	7.7E-02	9.1E-02	4.0E-02	4.4E-02	5.1E-02	5.1E-02	1.1E-01	1.1E-01	2.5E-01	2.5E-01	2.6E-01	2.6E-01
Oral mucosa	7.8E-03	1.7E-02	2.3E-02	2.8E-02	2.1E-02	2.1E-02	2.6E-02	2.6E-02	3.3E-02	3.3E-02	1.1E-01	1.1E-01
Ovaries	-	1.8E-02	-	3.6E-02	-	4.9E-02	-	7.0E-02	-	1.0E-01	-	8.6E-02
Pancreas	1.0E-02	1.3E-02	1.2E-02	1.2E-02	1.8E-02	1.8E-02	2.6E-02	2.7E-02	4.6E-02	4.6E-02	5.9E-02	5.9E-02
Prostate	2.3E-02	-	2.7E-02	-	5.0E-02	-	7.0E-02	-	1.2E-01	-	1.1E-01	-
Red marrow	1.1E-02	1.4E-02	1.2E-02	1.2E-02	1.6E-02	1.6E-02	2.3E-02	2.3E-02	4.6E-02	4.6E-02	7.2E-02	7.2E-02
Salivary glands	3.3E-02	4.6E-02	4.8E-02	5.0E-02	8.5E-02	8.5E-02	1.0E-01	1.0E-01	1.5E-01	1.5E-01	3.2E-01	3.2E-01
Skin	3.6E-03	4.6E-03	4.4E-03	5.0E-03	7.4E-03	7.4E-03	1.2E-02	1.2E-02	2.0E-02	2.0E-02	3.1E-02	3.1E-02
Small intestine wall	9.6E-03	1.3E-02	9.3E-03	9.4E-03	1.2E-02	1.3E-02	2.3E-02	2.6E-02	4.5E-02	4.5E-02	5.8E-02	5.6E-02
Spleen	9.2E-03	1.3E-02	8.2E-03	1.0E-02	1.4E-02	1.4E-02	2.5E-02	2.5E-02	4.8E-02	4.8E-02	6.0E-02	6.0E-02
Stomach wall	3.2E-02	3.6E-02	3.6E-02	4.1E-02	5.8E-02	5.8E-02	9.0E-02	9.0E-02	1.9E-01	1.9E-01	2.5E-01	2.5E-01
Testes	3.9E-03	-	1.4E-02	-	1.5E-02	-	2.6E-02	-	3.0E-02	-	3.4E-02	-
Thymus	7.8E-02	7.4E-02	7.1E-02	1.1E-01	5.7E-02	5.7E-02	8.8E-02	8.8E-02	2.6E-01	2.6E-01	2.6E-01	2.6E-01
Thyroid	3.9E+00	4.7E+00	6.3E+00	6.6E+00	9.5E+00	9.5E+00	2.1E+01	2.1E+01	3.9E+01	3.9E+01	4.3E+01	4.3E+01
Urinary bladder wall	6.5E-02	8.3E-02	8.3E-02	8.3E-02	1.4E-01	1.4E-01	1.6E-01	1.6E-01	1.9E-01	1.9E-01	2.4E-01	2.4E-01
Uterus/ cervix	-	2.7E-02	-	7.2E-02	-	1.1E-01	-	8.4E-02	-	3.1E-01	-	2.5E-01
Effective dose (mSv/MBq)	1.9E-01		2.8E-01		4.1E-01		8.9E-01		1.7E+00		1.8E+00	

3048

3049 ^{123}I

3050 (c) i.v. administration, high uptake.

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	1.0E-02	1.1E-02	8.6E-03	8.8E-03	1.3E-02	1.3E-02	2.0E-02	2.0E-02	4.4E-02	4.4E-02	5.2E-02	5.2E-02
Brain	3.6E-03	4.8E-03	6.2E-03	6.8E-03	1.1E-02	1.1E-02	1.5E-02	1.5E-02	2.4E-02	2.4E-02	3.8E-02	3.8E-02
Breast	3.6E-03	6.2E-03	3.5E-03	4.3E-03	6.0E-03	5.6E-03	1.0E-02	1.0E-02	1.9E-02	1.9E-02	3.1E-02	3.0E-02
Colon wall	8.4E-03	9.6E-03	1.1E-02	8.8E-03	1.5E-02	1.4E-02	2.4E-02	2.2E-02	4.8E-02	4.7E-02	6.2E-02	6.0E-02
Endosteum (bone surface)	7.0E-03	8.9E-03	9.8E-03	1.0E-02	1.5E-02	1.5E-02	2.6E-02	2.6E-02	5.3E-02	5.3E-02	8.2E-02	8.1E-02
ET region	2.5E-02	3.7E-02	1.5E-02	1.8E-02	2.5E-02	2.5E-02	3.2E-02	3.2E-02	3.9E-02	3.9E-02	9.6E-02	9.6E-02
Gall bladder wall	6.3E-03	7.9E-03	8.6E-03	9.6E-03	9.7E-03	9.8E-03	1.7E-02	1.7E-02	3.3E-02	3.3E-02	4.6E-02	4.6E-02
Heart wall	1.4E-02	1.4E-02	1.0E-02	1.2E-02	1.5E-02	1.5E-02	2.4E-02	2.4E-02	5.5E-02	5.5E-02	7.0E-02	7.0E-02
Kidneys	2.0E-02	2.4E-02	2.3E-02	2.6E-02	3.4E-02	3.4E-02	5.5E-02	5.5E-02	9.7E-02	9.7E-02	1.5E-01	1.4E-01
Liver	8.4E-03	1.0E-02	8.4E-03	1.0E-02	1.4E-02	1.5E-02	2.2E-02	2.3E-02	4.5E-02	4.5E-02	6.3E-02	6.3E-02
Lung	1.5E-02	1.7E-02	5.3E-02	4.6E-02	5.5E-02	5.5E-02	1.0E-01	1.0E-01	3.2E-01	3.2E-01	2.9E-01	2.9E-01
Lymphatic nodes	4.1E-02	4.6E-02	1.8E-02	1.9E-02	2.2E-02	2.2E-02	4.2E-02	4.2E-02	6.9E-02	6.9E-02	8.8E-02	8.8E-02
Muscle	6.0E-03	8.0E-03	6.0E-03	5.9E-03	9.5E-03	9.4E-03	1.7E-02	1.7E-02	3.5E-02	3.5E-02	5.5E-02	5.5E-02
Oesophagus	1.0E-01	1.2E-01	5.3E-02	5.7E-02	6.5E-02	6.5E-02	1.4E-01	1.4E-01	3.3E-01	3.3E-01	3.4E-01	3.4E-01
Oral mucosa	9.2E-03	2.1E-02	2.8E-02	3.4E-02	2.5E-02	2.5E-02	3.0E-02	3.0E-02	3.7E-02	3.7E-02	1.4E-01	1.4E-01
Ovaries	-	1.6E-02	-	3.1E-02	-	4.3E-02	-	6.1E-02	-	8.8E-02	-	7.7E-02
Pancreas	9.1E-03	1.2E-02	1.1E-02	1.1E-02	1.6E-02	1.6E-02	2.4E-02	2.4E-02	4.2E-02	4.2E-02	5.4E-02	5.4E-02
Prostate	2.0E-02	-	2.4E-02	-	4.4E-02	-	6.1E-02	-	1.1E-01	-	9.9E-02	-
Red marrow	1.2E-02	1.5E-02	1.2E-02	1.3E-02	1.6E-02	1.6E-02	2.4E-02	2.3E-02	4.8E-02	4.8E-02	7.6E-02	7.6E-02
Salivary glands	3.2E-02	4.7E-02	4.7E-02	5.0E-02	9.1E-02	9.1E-02	1.1E-01	1.1E-01	1.6E-01	1.6E-01	3.5E-01	3.5E-01
Skin	3.7E-03	4.8E-03	4.5E-03	5.3E-03	7.6E-03	7.6E-03	1.3E-02	1.3E-02	2.0E-02	2.0E-02	3.1E-02	3.1E-02
Small intestine wall	8.5E-03	1.2E-02	8.3E-03	8.4E-03	1.1E-02	1.2E-02	2.1E-02	2.3E-02	4.0E-02	4.1E-02	5.3E-02	5.1E-02
Spleen	8.6E-03	1.2E-02	7.5E-03	9.2E-03	1.3E-02	1.3E-02	2.3E-02	2.3E-02	4.5E-02	4.5E-02	5.7E-02	5.7E-02
Stomach wall	2.9E-02	3.2E-02	3.2E-02	3.6E-02	5.2E-02	5.2E-02	8.0E-02	8.0E-02	1.7E-01	1.7E-01	2.3E-01	2.3E-01
Testes	3.4E-03	-	1.2E-02	-	1.3E-02	-	2.3E-02	-	2.7E-02	-	3.1E-02	-
Thymus	1.1E-01	1.0E-01	9.8E-02	1.5E-01	7.6E-02	7.6E-02	1.2E-01	1.2E-01	3.6E-01	3.6E-01	3.5E-01	3.5E-01
Thyroid	5.5E+00	6.6E+00	8.8E+00	9.2E+00	1.3E+01	1.3E+01	2.9E+01	2.9E+01	5.5E+01	5.5E+01	6.0E+01	6.0E+01
Urinary bladder wall	5.7E-02	7.2E-02	7.2E-02	7.2E-02	1.2E-01	1.2E-01	1.4E-01	1.4E-01	1.7E-01	1.7E-01	2.1E-01	2.1E-01
Uterus/ cervix	-	2.4E-02	-	6.3E-02	-	9.3E-02	-	7.3E-02	-	2.7E-01	-	2.2E-01
Effective dose (mSv/MBq)	2.6E-01		3.8E-01		5.6E-01		1.2E+00		2.3E+00		2.5E+00	

3051

3052 ^{123}I

3053 (d) i.v. administration, saturated thyroid.

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	1.4E-02	1.5E-02	1.1E-02	1.1E-02	1.7E-02	1.7E-02	2.5E-02	2.5E-02	4.8E-02	4.8E-02	5.8E-02	5.8E-02
Brain	3.7E-03	4.4E-03	6.7E-03	7.0E-03	1.0E-02	1.0E-02	1.5E-02	1.5E-02	2.4E-02	2.4E-02	3.6E-02	3.6E-02
Breast	3.7E-03	4.2E-03	3.9E-03	4.5E-03	6.1E-03	5.5E-03	1.0E-02	1.0E-02	1.8E-02	1.7E-02	2.9E-02	2.9E-02
Colon wall	1.2E-02	1.4E-02	1.5E-02	1.3E-02	2.1E-02	2.0E-02	3.4E-02	3.1E-02	6.7E-02	6.5E-02	8.3E-02	8.0E-02
Endosteum (bone surface)	6.0E-03	7.7E-03	9.7E-03	1.0E-02	1.4E-02	1.4E-02	2.5E-02	2.4E-02	4.9E-02	4.9E-02	7.0E-02	7.0E-02
ET region	4.4E-03	6.5E-03	9.7E-03	9.8E-03	1.3E-02	1.3E-02	1.6E-02	1.6E-02	2.3E-02	2.3E-02	3.4E-02	3.4E-02
Gall bladder wall	7.9E-03	1.0E-02	1.1E-02	1.3E-02	1.2E-02	1.2E-02	2.2E-02	2.2E-02	3.9E-02	3.9E-02	5.5E-02	5.5E-02
Heart wall	1.1E-02	1.1E-02	6.0E-03	7.3E-03	1.1E-02	1.1E-02	1.8E-02	1.8E-02	3.3E-02	3.3E-02	4.4E-02	4.4E-02
Kidneys	2.9E-02	3.4E-02	3.3E-02	3.6E-02	4.7E-02	4.7E-02	7.5E-02	7.5E-02	1.3E-01	1.3E-01	1.9E-01	1.9E-01
Liver	1.0E-02	1.2E-02	1.0E-02	1.2E-02	1.8E-02	1.8E-02	2.6E-02	2.6E-02	4.8E-02	4.8E-02	6.3E-02	6.3E-02
Lung	7.7E-03	9.2E-03	8.9E-03	9.8E-03	1.3E-02	1.3E-02	2.1E-02	2.2E-02	4.9E-02	4.9E-02	6.3E-02	6.3E-02
Lymphatic nodes	1.1E-02	1.2E-02	8.8E-03	8.4E-03	1.2E-02	1.2E-02	2.1E-02	2.1E-02	3.6E-02	3.6E-02	4.7E-02	4.7E-02
Muscle	4.9E-03	6.2E-03	5.8E-03	5.8E-03	8.9E-03	8.8E-03	1.4E-02	1.4E-02	2.5E-02	2.5E-02	3.7E-02	3.6E-02
Oesophagus	1.3E-02	1.5E-02	1.2E-02	1.2E-02	1.8E-02	1.8E-02	3.1E-02	3.1E-02	5.5E-02	5.5E-02	7.1E-02	7.1E-02
Oral mucosa	4.4E-03	6.5E-03	1.2E-02	1.3E-02	1.4E-02	1.4E-02	1.6E-02	1.6E-02	2.5E-02	2.5E-02	4.6E-02	4.6E-02
Ovaries	-	2.3E-02	-	4.6E-02	-	6.4E-02	-	9.1E-02	-	1.3E-01	-	1.1E-01
Pancreas	1.2E-02	1.6E-02	1.5E-02	1.5E-02	2.2E-02	2.2E-02	3.2E-02	3.2E-02	5.5E-02	5.5E-02	7.0E-02	6.9E-02
Prostate	2.9E-02	-	3.5E-02	-	6.6E-02	-	9.1E-02	-	1.6E-01	-	1.4E-01	-
Red marrow	9.2E-03	1.2E-02	1.1E-02	1.2E-02	1.6E-02	1.5E-02	2.2E-02	2.1E-02	4.0E-02	4.0E-02	6.3E-02	6.3E-02
Salivary glands	3.5E-02	4.4E-02	4.9E-02	5.0E-02	7.1E-02	7.1E-02	8.9E-02	8.9E-02	1.3E-01	1.3E-01	2.4E-01	2.4E-01
Skin	3.3E-03	4.2E-03	4.1E-03	4.5E-03	6.9E-03	6.9E-03	1.1E-02	1.2E-02	2.0E-02	2.0E-02	3.0E-02	3.0E-02
Small intestine wall	1.2E-02	1.7E-02	1.2E-02	1.2E-02	1.6E-02	1.7E-02	2.9E-02	3.3E-02	5.5E-02	5.6E-02	7.0E-02	6.8E-02
Spleen	1.1E-02	1.5E-02	9.9E-03	1.2E-02	1.7E-02	1.7E-02	3.0E-02	3.0E-02	5.3E-02	5.3E-02	6.7E-02	6.7E-02
Stomach wall	4.0E-02	4.5E-02	4.5E-02	5.1E-02	7.3E-02	7.3E-02	1.1E-01	1.1E-01	2.4E-01	2.4E-01	3.2E-01	3.1E-01
Testes	5.0E-03	-	1.7E-02	-	2.0E-02	-	3.4E-02	-	3.8E-02	-	4.3E-02	-
Thymus	8.4E-03	8.7E-03	9.6E-03	1.2E-02	1.2E-02	1.2E-02	2.0E-02	2.0E-02	4.5E-02	4.5E-02	5.8E-02	5.8E-02
Thyroid	2.4E-01	2.8E-01	3.8E-01	3.9E-01	5.7E-01	5.7E-01	1.3E+00	1.3E+00	2.4E+00	2.4E+00	2.7E+00	2.7E+00
Urinary bladder wall	8.4E-02	1.1E-01	1.1E-01	1.1E-01	1.8E-01	1.8E-01	2.1E-01	2.1E-01	2.4E-01	2.4E-01	3.0E-01	3.0E-01
Uterus/ cervix	-	3.5E-02	-	9.2E-02	-	1.4E-01	-	1.1E-01	-	3.9E-01	-	3.1E-01
Effective dose (mSv/MBq)	2.8E-02		3.6E-02		5.4E-02		9.5E-02		1.8E-01		2.1E-01	

3054

^{123}I

(e) i.v. administration, removed thyroid.

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	1.4E-02	1.5E-02	1.1E-02	1.1E-02	1.7E-02	1.7E-02	2.5E-02	2.5E-02	4.9E-02	4.9E-02	5.9E-02	5.8E-02
Brain	3.7E-03	4.3E-03	6.7E-03	7.0E-03	1.0E-02	1.0E-02	1.5E-02	1.5E-02	2.4E-02	2.4E-02	3.6E-02	3.6E-02
Breast	3.7E-03	4.1E-03	4.0E-03	4.6E-03	6.1E-03	5.5E-03	1.0E-02	1.0E-02	1.7E-02	1.7E-02	2.9E-02	2.9E-02
Colon wall	1.2E-02	1.4E-02	1.6E-02	1.3E-02	2.1E-02	2.0E-02	3.4E-02	3.1E-02	6.7E-02	6.5E-02	8.4E-02	8.1E-02
Endosteum (bone surface)	6.0E-03	7.7E-03	9.7E-03	1.0E-02	1.4E-02	1.4E-02	2.5E-02	2.4E-02	4.9E-02	4.9E-02	6.9E-02	6.9E-02
ET region	3.5E-03	5.1E-03	9.5E-03	9.4E-03	1.2E-02	1.2E-02	1.5E-02	1.5E-02	2.2E-02	2.2E-02	3.1E-02	3.1E-02
Gall bladder wall	8.0E-03	1.0E-02	1.2E-02	1.3E-02	1.2E-02	1.2E-02	2.2E-02	2.2E-02	4.0E-02	4.0E-02	5.5E-02	5.5E-02
Heart wall	1.1E-02	1.1E-02	5.9E-03	7.1E-03	1.0E-02	1.0E-02	1.7E-02	1.7E-02	3.2E-02	3.2E-02	4.2E-02	4.2E-02
Kidneys	2.9E-02	3.5E-02	3.3E-02	3.7E-02	4.8E-02	4.8E-02	7.6E-02	7.6E-02	1.3E-01	1.3E-01	1.9E-01	1.9E-01
Liver	1.0E-02	1.3E-02	1.1E-02	1.2E-02	1.8E-02	1.8E-02	2.7E-02	2.7E-02	4.8E-02	4.8E-02	6.4E-02	6.4E-02
Lung	7.3E-03	8.8E-03	6.9E-03	8.2E-03	1.2E-02	1.2E-02	1.8E-02	1.8E-02	3.6E-02	3.6E-02	5.2E-02	5.2E-02
Lymphatic nodes	9.9E-03	1.1E-02	8.4E-03	7.9E-03	1.2E-02	1.2E-02	2.0E-02	2.0E-02	3.5E-02	3.5E-02	4.5E-02	4.5E-02
Muscle	4.9E-03	6.1E-03	5.7E-03	5.8E-03	8.8E-03	8.8E-03	1.4E-02	1.4E-02	2.5E-02	2.5E-02	3.6E-02	3.6E-02
Oesophagus	9.0E-03	9.9E-03	9.8E-03	1.1E-02	1.6E-02	1.6E-02	2.6E-02	2.6E-02	4.2E-02	4.2E-02	5.9E-02	5.8E-02
Oral mucosa	4.2E-03	5.9E-03	1.1E-02	1.2E-02	1.4E-02	1.4E-02	1.5E-02	1.5E-02	2.4E-02	2.4E-02	4.2E-02	4.2E-02
Ovaries	-	2.3E-02	-	4.7E-02	-	6.4E-02	-	9.2E-02	-	1.3E-01	-	1.1E-01
Pancreas	1.2E-02	1.6E-02	1.5E-02	1.5E-02	2.2E-02	2.2E-02	3.3E-02	3.3E-02	5.6E-02	5.6E-02	7.0E-02	7.0E-02
Prostate	3.0E-02	-	3.5E-02	-	6.6E-02	-	9.2E-02	-	1.6E-01	-	1.4E-01	-
Red marrow	9.1E-03	1.2E-02	1.1E-02	1.2E-02	1.6E-02	1.5E-02	2.2E-02	2.1E-02	4.0E-02	3.9E-02	6.3E-02	6.3E-02
Salivary glands	3.5E-02	4.3E-02	4.9E-02	5.0E-02	7.0E-02	7.0E-02	8.8E-02	8.8E-02	1.3E-01	1.3E-01	2.4E-01	2.4E-01
Skin	3.3E-03	4.1E-03	4.1E-03	4.5E-03	6.9E-03	6.9E-03	1.1E-02	1.1E-02	2.0E-02	2.0E-02	3.0E-02	3.0E-02
Small intestine wall	1.2E-02	1.7E-02	1.2E-02	1.2E-02	1.6E-02	1.7E-02	3.0E-02	3.3E-02	5.6E-02	5.6E-02	7.1E-02	6.9E-02
Spleen	1.1E-02	1.6E-02	1.0E-02	1.2E-02	1.7E-02	1.7E-02	3.0E-02	3.0E-02	5.4E-02	5.4E-02	6.7E-02	6.7E-02
Stomach wall	4.1E-02	4.5E-02	4.5E-02	5.2E-02	7.4E-02	7.4E-02	1.1E-01	1.1E-01	2.4E-01	2.4E-01	3.2E-01	3.2E-01
Testes	5.0E-03	-	1.8E-02	-	2.0E-02	-	3.4E-02	-	3.9E-02	-	4.3E-02	-
Thymus	4.0E-03	4.6E-03	5.7E-03	6.2E-03	9.4E-03	9.5E-03	1.6E-02	1.6E-02	3.1E-02	3.1E-02	4.5E-02	4.5E-02
Thyroid	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Urinary bladder wall	8.5E-02	1.1E-01	1.1E-01	1.1E-01	1.8E-01	1.8E-01	2.1E-01	2.1E-01	2.5E-01	2.5E-01	3.1E-01	3.1E-01
Uterus/ cervix	-	3.6E-02	-	9.3E-02	-	1.4E-01	-	1.1E-01	-	4.0E-01	-	3.2E-01
$\sum_T w_T \left[\frac{H_T^F + H_T^M}{2}\right]^{\#}$ (mSv/MBq) *	1.7E-02		2.1E-02		3.1E-02		4.4E-02		7.8E-02		1.0E-01	

* Strictly speaking, patients with removed thyroid do not correspond to the ICRP reference individual. So this value, calculated analogously to the effective dose but without the thyroid as a target organ, is formally not the effective dose as defined by ICRP. (see also § 59).

3061 ^{123}I

3062 (f) oral administration, low uptake.

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	1.4E-02	1.5E-02	1.1E-02	1.2E-02	1.7E-02	1.7E-02	2.5E-02	2.5E-02	5.1E-02	5.1E-02	5.8E-02	5.7E-02
Brain	3.5E-03	4.4E-03	6.3E-03	6.6E-03	9.9E-03	1.0E-02	1.4E-02	1.4E-02	2.3E-02	2.3E-02	3.6E-02	3.6E-02
Breast	4.1E-03	5.2E-03	3.9E-03	4.6E-03	6.3E-03	5.8E-03	1.1E-02	1.1E-02	1.9E-02	1.9E-02	3.0E-02	3.0E-02
Colon wall	1.3E-02	1.4E-02	1.7E-02	1.4E-02	2.3E-02	2.2E-02	3.4E-02	3.2E-02	6.7E-02	6.6E-02	8.2E-02	7.9E-02
Endosteum (bone surface)	6.4E-03	8.2E-03	9.7E-03	1.0E-02	1.4E-02	1.4E-02	2.5E-02	2.5E-02	5.0E-02	5.0E-02	7.4E-02	7.4E-02
ET region	1.3E-02	1.9E-02	1.2E-02	1.3E-02	1.7E-02	1.7E-02	2.2E-02	2.2E-02	2.8E-02	2.8E-02	5.9E-02	5.9E-02
Gall bladder wall	8.5E-03	1.1E-02	1.4E-02	1.5E-02	1.3E-02	1.3E-02	2.1E-02	2.1E-02	4.2E-02	4.2E-02	5.6E-02	5.6E-02
Heart wall	1.4E-02	1.4E-02	8.0E-03	9.5E-03	1.3E-02	1.3E-02	2.2E-02	2.2E-02	4.5E-02	4.5E-02	5.5E-02	5.5E-02
Kidneys	2.6E-02	3.1E-02	2.9E-02	3.2E-02	4.2E-02	4.2E-02	6.7E-02	6.7E-02	1.2E-01	1.2E-01	1.7E-01	1.7E-01
Liver	1.0E-02	1.3E-02	1.0E-02	1.3E-02	1.8E-02	1.8E-02	2.6E-02	2.6E-02	5.0E-02	5.0E-02	6.5E-02	6.5E-02
Lung	1.1E-02	1.3E-02	2.7E-02	2.4E-02	3.0E-02	3.0E-02	5.3E-02	5.3E-02	1.6E-01	1.6E-01	1.6E-01	1.6E-01
Lymphatic nodes	2.4E-02	2.7E-02	1.3E-02	1.3E-02	1.7E-02	1.7E-02	3.1E-02	3.1E-02	5.2E-02	5.2E-02	6.5E-02	6.5E-02
Muscle	5.4E-03	7.0E-03	5.9E-03	5.8E-03	9.1E-03	9.1E-03	1.5E-02	1.5E-02	2.9E-02	2.9E-02	4.4E-02	4.4E-02
Oesophagus	5.1E-02	6.0E-02	2.9E-02	3.1E-02	3.9E-02	3.8E-02	7.5E-02	7.5E-02	1.7E-01	1.7E-01	1.8E-01	1.8E-01
Oral mucosa	6.3E-03	1.2E-02	1.8E-02	2.1E-02	1.8E-02	1.8E-02	2.1E-02	2.1E-02	2.9E-02	2.9E-02	8.4E-02	8.4E-02
Ovaries	-	2.0E-02	-	4.0E-02	-	5.5E-02	-	7.9E-02	-	1.1E-01	-	9.8E-02
Pancreas	1.4E-02	1.8E-02	1.8E-02	1.8E-02	2.6E-02	2.6E-02	3.7E-02	3.7E-02	6.3E-02	6.3E-02	7.0E-02	7.0E-02
Prostate	2.5E-02	-	3.0E-02	-	5.6E-02	-	7.7E-02	-	1.4E-01	-	1.2E-01	-
Red marrow	1.0E-02	1.4E-02	1.1E-02	1.2E-02	1.6E-02	1.6E-02	2.2E-02	2.2E-02	4.3E-02	4.3E-02	6.8E-02	6.8E-02
Salivary glands	3.3E-02	4.3E-02	4.6E-02	4.8E-02	7.6E-02	7.6E-02	9.3E-02	9.3E-02	1.3E-01	1.3E-01	2.8E-01	2.8E-01
Skin	3.4E-03	4.4E-03	4.3E-03	4.8E-03	7.2E-03	7.2E-03	1.2E-02	1.2E-02	2.0E-02	2.0E-02	3.0E-02	3.0E-02
Small intestine wall	1.2E-02	1.7E-02	1.2E-02	1.2E-02	1.6E-02	1.7E-02	2.9E-02	3.2E-02	5.5E-02	5.5E-02	6.9E-02	6.7E-02
Spleen	1.2E-02	1.9E-02	1.0E-02	1.3E-02	1.8E-02	1.8E-02	3.4E-02	3.4E-02	6.3E-02	6.3E-02	6.8E-02	6.8E-02
Stomach wall	4.9E-02	5.3E-02	5.5E-02	6.3E-02	9.2E-02	9.2E-02	1.4E-01	1.4E-01	2.6E-01	2.6E-01	3.0E-01	3.0E-01
Testes	4.2E-03	-	1.5E-02	-	1.7E-02	-	2.9E-02	-	3.3E-02	-	3.8E-02	-
Thymus	4.9E-02	4.6E-02	4.5E-02	6.6E-02	3.8E-02	3.8E-02	5.9E-02	5.9E-02	1.7E-01	1.7E-01	1.8E-01	1.8E-01
Thyroid	2.4E+00	2.8E+00	3.8E+00	3.9E+00	5.7E+00	5.7E+00	1.3E+01	1.3E+01	2.4E+01	2.4E+01	2.6E+01	2.6E+01
Urinary bladder wall	7.2E-02	9.2E-02	9.2E-02	9.2E-02	1.5E-01	1.5E-01	1.8E-01	1.8E-01	2.1E-01	2.1E-01	2.6E-01	2.6E-01
Uterus/ cervix	-	3.1E-02	-	7.8E-02	-	1.2E-01	-	9.4E-02	-	3.4E-01	-	2.7E-01
Effective dose (mSv/MBq)	1.3E-01		1.8E-01		2.6E-01		5.6E-01		1.0E+00		1.2E+00	

3063

3064 ^{123}I

3065 (g) oral administration, medium uptake.

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	1.3E-02	1.4E-02	1.1E-02	1.1E-02	1.6E-02	1.6E-02	2.4E-02	2.4E-02	5.0E-02	5.0E-02	5.6E-02	5.6E-02
Brain	3.5E-03	4.5E-03	6.1E-03	6.6E-03	1.0E-02	1.0E-02	1.4E-02	1.4E-02	2.3E-02	2.3E-02	3.6E-02	3.6E-02
Breast	4.0E-03	5.7E-03	3.8E-03	4.5E-03	6.3E-03	5.8E-03	1.1E-02	1.1E-02	1.9E-02	1.9E-02	3.0E-02	3.0E-02
Colon wall	1.2E-02	1.3E-02	1.5E-02	1.3E-02	2.1E-02	2.0E-02	3.1E-02	2.9E-02	6.2E-02	6.1E-02	7.6E-02	7.4E-02
Endosteum (bone surface)	6.6E-03	8.6E-03	9.7E-03	1.0E-02	1.5E-02	1.4E-02	2.6E-02	2.5E-02	5.1E-02	5.1E-02	7.7E-02	7.7E-02
ET region	1.8E-02	2.7E-02	1.3E-02	1.5E-02	2.1E-02	2.1E-02	2.6E-02	2.6E-02	3.3E-02	3.3E-02	7.6E-02	7.6E-02
Gall bladder wall	8.1E-03	1.0E-02	1.3E-02	1.4E-02	1.2E-02	1.2E-02	2.0E-02	2.0E-02	4.0E-02	4.0E-02	5.3E-02	5.3E-02
Heart wall	1.5E-02	1.5E-02	9.2E-03	1.1E-02	1.4E-02	1.4E-02	2.4E-02	2.4E-02	5.1E-02	5.1E-02	6.2E-02	6.2E-02
Kidneys	2.3E-02	2.8E-02	2.6E-02	2.9E-02	3.8E-02	3.8E-02	6.2E-02	6.2E-02	1.1E-01	1.1E-01	1.6E-01	1.6E-01
Liver	1.0E-02	1.2E-02	9.8E-03	1.2E-02	1.7E-02	1.7E-02	2.5E-02	2.5E-02	4.9E-02	4.9E-02	6.5E-02	6.5E-02
Lung	1.3E-02	1.5E-02	3.9E-02	3.4E-02	4.1E-02	4.1E-02	7.5E-02	7.5E-02	2.4E-01	2.4E-01	2.2E-01	2.2E-01
Lymphatic nodes	3.2E-02	3.6E-02	1.6E-02	1.6E-02	1.9E-02	1.9E-02	3.7E-02	3.7E-02	6.1E-02	6.1E-02	7.6E-02	7.6E-02
Muscle	5.6E-03	7.5E-03	5.9E-03	5.8E-03	9.3E-03	9.2E-03	1.6E-02	1.6E-02	3.2E-02	3.2E-02	4.9E-02	4.9E-02
Oesophagus	7.5E-02	9.0E-02	4.0E-02	4.3E-02	5.1E-02	5.1E-02	1.0E-01	1.0E-01	2.5E-01	2.5E-01	2.6E-01	2.6E-01
Oral mucosa	7.6E-03	1.6E-02	2.2E-02	2.7E-02	2.1E-02	2.1E-02	2.5E-02	2.5E-02	3.3E-02	3.3E-02	1.1E-01	1.1E-01
Ovaries	-	1.8E-02	-	3.6E-02	-	4.9E-02	-	7.1E-02	-	1.0E-01	-	8.9E-02
Pancreas	1.3E-02	1.7E-02	1.7E-02	1.7E-02	2.5E-02	2.5E-02	3.5E-02	3.5E-02	6.0E-02	6.0E-02	6.6E-02	6.6E-02
Prostate	2.2E-02	-	2.7E-02	-	5.0E-02	-	6.9E-02	-	1.2E-01	-	1.1E-01	-
Red marrow	1.1E-02	1.4E-02	1.2E-02	1.2E-02	1.6E-02	1.6E-02	2.3E-02	2.3E-02	4.6E-02	4.5E-02	7.2E-02	7.2E-02
Salivary glands	3.2E-02	4.4E-02	4.6E-02	4.8E-02	8.2E-02	8.2E-02	9.8E-02	9.8E-02	1.4E-01	1.4E-01	3.1E-01	3.1E-01
Skin	3.6E-03	4.6E-03	4.4E-03	5.0E-03	7.3E-03	7.4E-03	1.2E-02	1.2E-02	2.0E-02	2.0E-02	3.1E-02	3.1E-02
Small intestine wall	1.1E-02	1.5E-02	1.1E-02	1.1E-02	1.5E-02	1.6E-02	2.7E-02	2.9E-02	5.1E-02	5.1E-02	6.4E-02	6.3E-02
Spleen	1.2E-02	1.8E-02	9.6E-03	1.2E-02	1.7E-02	1.7E-02	3.3E-02	3.3E-02	6.1E-02	6.1E-02	6.6E-02	6.5E-02
Stomach wall	4.6E-02	5.0E-02	5.1E-02	5.9E-02	8.6E-02	8.6E-02	1.3E-01	1.3E-01	2.4E-01	2.4E-01	2.7E-01	2.7E-01
Testes	3.8E-03	-	1.3E-02	-	1.5E-02	-	2.6E-02	-	3.0E-02	-	3.4E-02	-
Thymus	7.5E-02	7.1E-02	6.9E-02	1.0E-01	5.5E-02	5.5E-02	8.5E-02	8.5E-02	2.6E-01	2.6E-01	2.6E-01	2.6E-01
Thyroid	3.8E+00	4.5E+00	6.1E+00	6.3E+00	9.1E+00	9.1E+00	2.0E+01	2.0E+01	3.8E+01	3.8E+01	4.2E+01	4.2E+01
Urinary bladder wall	6.4E-02	8.2E-02	8.2E-02	8.3E-02	1.3E-01	1.3E-01	1.6E-01	1.6E-01	1.9E-01	1.9E-01	2.4E-01	2.4E-01
Uterus/ cervix	-	2.7E-02	-	7.0E-02	-	1.0E-01	-	8.4E-02	-	3.0E-01	-	2.5E-01
Effective dose (mSv/MBq)	1.9E-01		2.7E-01		4.0E-01		8.6E-01		1.6E+00		1.8E+00	

3066

^{123}I

(h) oral administration, high uptake.

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	1.2E-02	1.3E-02	1.0E-02	1.0E-02	1.5E-02	1.5E-02	2.2E-02	2.2E-02	4.9E-02	4.9E-02	5.4E-02	5.4E-02
Brain	3.5E-03	4.7E-03	6.0E-03	6.5E-03	1.0E-02	1.0E-02	1.4E-02	1.4E-02	2.3E-02	2.3E-02	3.7E-02	3.7E-02
Breast	4.0E-03	6.3E-03	3.6E-03	4.5E-03	6.2E-03	5.8E-03	1.1E-02	1.1E-02	2.0E-02	1.9E-02	3.1E-02	3.1E-02
Colon wall	1.1E-02	1.2E-02	1.4E-02	1.2E-02	1.9E-02	1.8E-02	2.8E-02	2.7E-02	5.7E-02	5.6E-02	7.0E-02	6.8E-02
Endosteum (bone surface)	6.9E-03	8.9E-03	9.7E-03	1.0E-02	1.5E-02	1.4E-02	2.6E-02	2.6E-02	5.3E-02	5.2E-02	8.1E-02	8.1E-02
ET region	2.4E-02	3.5E-02	1.5E-02	1.8E-02	2.4E-02	2.4E-02	3.0E-02	3.0E-02	3.7E-02	3.7E-02	9.4E-02	9.4E-02
Gall bladder wall	7.6E-03	9.5E-03	1.3E-02	1.3E-02	1.1E-02	1.1E-02	1.9E-02	1.9E-02	3.8E-02	3.8E-02	5.1E-02	5.1E-02
Heart wall	1.5E-02	1.6E-02	1.0E-02	1.2E-02	1.5E-02	1.5E-02	2.6E-02	2.6E-02	5.7E-02	5.7E-02	7.0E-02	7.0E-02
Kidneys	2.1E-02	2.6E-02	2.4E-02	2.6E-02	3.4E-02	3.4E-02	5.6E-02	5.6E-02	1.0E-01	1.0E-01	1.5E-01	1.5E-01
Liver	9.5E-03	1.1E-02	9.2E-03	1.1E-02	1.6E-02	1.6E-02	2.4E-02	2.4E-02	4.9E-02	4.9E-02	6.4E-02	6.4E-02
Lung	1.5E-02	1.7E-02	5.1E-02	4.4E-02	5.3E-02	5.3E-02	9.7E-02	9.7E-02	3.1E-01	3.1E-01	2.9E-01	2.9E-01
Lymphatic nodes	4.1E-02	4.6E-02	1.9E-02	1.9E-02	2.2E-02	2.2E-02	4.3E-02	4.3E-02	7.0E-02	7.0E-02	8.9E-02	8.9E-02
Muscle	5.9E-03	8.0E-03	6.0E-03	5.9E-03	9.5E-03	9.4E-03	1.7E-02	1.7E-02	3.5E-02	3.5E-02	5.5E-02	5.5E-02
Oesophagus	1.0E-01	1.2E-01	5.2E-02	5.6E-02	6.5E-02	6.4E-02	1.4E-01	1.4E-01	3.3E-01	3.3E-01	3.3E-01	3.3E-01
Oral mucosa	9.0E-03	2.0E-02	2.7E-02	3.3E-02	2.4E-02	2.4E-02	2.9E-02	2.9E-02	3.6E-02	3.6E-02	1.4E-01	1.4E-01
Ovaries	-	1.6E-02	-	3.1E-02	-	4.3E-02	-	6.2E-02	-	9.1E-02	-	8.0E-02
Pancreas	1.2E-02	1.6E-02	1.6E-02	1.6E-02	2.3E-02	2.3E-02	3.2E-02	3.3E-02	5.6E-02	5.6E-02	6.2E-02	6.2E-02
Prostate	2.0E-02	-	2.3E-02	-	4.3E-02	-	6.0E-02	-	1.1E-01	-	9.9E-02	-
Red marrow	1.2E-02	1.5E-02	1.2E-02	1.3E-02	1.6E-02	1.6E-02	2.4E-02	2.3E-02	4.8E-02	4.8E-02	7.6E-02	7.5E-02
Salivary glands	3.1E-02	4.5E-02	4.5E-02	4.8E-02	8.7E-02	8.7E-02	1.0E-01	1.0E-01	1.5E-01	1.5E-01	3.4E-01	3.4E-01
Skin	3.7E-03	4.7E-03	4.5E-03	5.2E-03	7.5E-03	7.6E-03	1.2E-02	1.3E-02	2.0E-02	2.0E-02	3.1E-02	3.1E-02
Small intestine wall	9.9E-03	1.4E-02	1.0E-02	1.0E-02	1.4E-02	1.4E-02	2.4E-02	2.6E-02	4.7E-02	4.7E-02	5.9E-02	5.8E-02
Spleen	1.1E-02	1.7E-02	8.9E-03	1.1E-02	1.6E-02	1.6E-02	3.1E-02	3.1E-02	5.9E-02	5.9E-02	6.3E-02	6.3E-02
Stomach wall	4.3E-02	4.6E-02	4.8E-02	5.5E-02	8.0E-02	8.0E-02	1.2E-01	1.2E-01	2.2E-01	2.2E-01	2.5E-01	2.5E-01
Testes	3.3E-03	-	1.2E-02	-	1.3E-02	-	2.3E-02	-	2.7E-02	-	3.1E-02	-
Thymus	1.0E-01	9.8E-02	9.4E-02	1.4E-01	7.4E-02	7.4E-02	1.1E-01	1.1E-01	3.5E-01	3.5E-01	3.4E-01	3.4E-01
Thyroid	5.3E+00	6.4E+00	8.5E+00	8.8E+00	1.3E+01	1.3E+01	2.8E+01	2.8E+01	5.3E+01	5.3E+01	5.9E+01	5.9E+01
Urinary bladder wall	5.6E-02	7.2E-02	7.2E-02	7.2E-02	1.2E-01	1.2E-01	1.4E-01	1.4E-01	1.7E-01	1.7E-01	2.1E-01	2.1E-01
Uterus/ cervix	-	2.4E-02	-	6.2E-02	-	9.2E-02	-	7.4E-02	-	2.7E-01	-	2.2E-01
Effective dose (mSv/MBq)	2.6E-01		3.7E-01		5.5E-01		1.2E+00		2.2E+00		2.5E+00	

3070 ^{123}I

3071 (i) oral administration, saturated thyroid.

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	1.5E-02	1.7E-02	1.2E-02	1.2E-02	1.8E-02	1.8E-02	2.7E-02	2.7E-02	5.3E-02	5.3E-02	6.0E-02	6.0E-02
Brain	3.6E-03	4.2E-03	6.4E-03	6.7E-03	9.7E-03	9.9E-03	1.4E-02	1.5E-02	2.4E-02	2.4E-02	3.5E-02	3.5E-02
Breast	4.1E-03	4.4E-03	4.0E-03	4.7E-03	6.3E-03	5.7E-03	1.1E-02	1.1E-02	1.8E-02	1.8E-02	2.9E-02	2.9E-02
Colon wall	1.4E-02	1.6E-02	1.9E-02	1.6E-02	2.5E-02	2.4E-02	3.8E-02	3.5E-02	7.5E-02	7.3E-02	9.0E-02	8.7E-02
Endosteum (bone surface)	6.0E-03	7.7E-03	9.7E-03	1.0E-02	1.4E-02	1.4E-02	2.5E-02	2.4E-02	4.9E-02	4.9E-02	6.9E-02	6.9E-02
ET region	4.2E-03	6.3E-03	9.4E-03	9.5E-03	1.2E-02	1.2E-02	1.5E-02	1.5E-02	2.2E-02	2.2E-02	3.3E-02	3.3E-02
Gall bladder wall	9.2E-03	1.2E-02	1.5E-02	1.6E-02	1.4E-02	1.4E-02	2.3E-02	2.3E-02	4.4E-02	4.4E-02	5.9E-02	5.9E-02
Heart wall	1.3E-02	1.3E-02	6.3E-03	7.7E-03	1.1E-02	1.1E-02	1.9E-02	1.9E-02	3.6E-02	3.6E-02	4.4E-02	4.4E-02
Kidneys	2.9E-02	3.5E-02	3.3E-02	3.6E-02	4.7E-02	4.7E-02	7.6E-02	7.6E-02	1.3E-01	1.3E-01	1.9E-01	1.9E-01
Liver	1.1E-02	1.4E-02	1.1E-02	1.3E-02	1.9E-02	1.9E-02	2.8E-02	2.8E-02	5.1E-02	5.1E-02	6.5E-02	6.5E-02
Lung	8.1E-03	9.4E-03	8.8E-03	9.7E-03	1.3E-02	1.3E-02	2.1E-02	2.2E-02	4.9E-02	4.9E-02	6.3E-02	6.3E-02
Lymphatic nodes	1.2E-02	1.3E-02	9.4E-03	8.9E-03	1.3E-02	1.3E-02	2.2E-02	2.2E-02	3.8E-02	3.8E-02	4.8E-02	4.8E-02
Muscle	4.9E-03	6.3E-03	5.8E-03	5.8E-03	8.9E-03	8.8E-03	1.4E-02	1.4E-02	2.5E-02	2.5E-02	3.7E-02	3.6E-02
Oesophagus	1.4E-02	1.6E-02	1.2E-02	1.3E-02	1.9E-02	2.0E-02	3.2E-02	3.2E-02	5.7E-02	5.7E-02	7.3E-02	7.3E-02
Oral mucosa	4.4E-03	6.4E-03	1.2E-02	1.2E-02	1.4E-02	1.4E-02	1.5E-02	1.5E-02	2.4E-02	2.4E-02	4.6E-02	4.6E-02
Ovaries	-	2.3E-02	-	4.6E-02	-	6.3E-02	-	9.1E-02	-	1.3E-01	-	1.1E-01
Pancreas	1.5E-02	2.0E-02	2.0E-02	2.0E-02	2.9E-02	2.9E-02	4.1E-02	4.1E-02	6.9E-02	6.9E-02	7.7E-02	7.6E-02
Prostate	2.9E-02	-	3.4E-02	-	6.4E-02	-	8.9E-02	-	1.6E-01	-	1.4E-01	-
Red marrow	9.3E-03	1.2E-02	1.1E-02	1.2E-02	1.6E-02	1.5E-02	2.2E-02	2.1E-02	4.0E-02	4.0E-02	6.3E-02	6.3E-02
Salivary glands	3.4E-02	4.2E-02	4.7E-02	4.8E-02	6.9E-02	6.8E-02	8.5E-02	8.5E-02	1.2E-01	1.2E-01	2.4E-01	2.4E-01
Skin	3.3E-03	4.2E-03	4.1E-03	4.5E-03	6.9E-03	6.9E-03	1.1E-02	1.2E-02	2.0E-02	2.0E-02	3.0E-02	3.0E-02
Small intestine wall	1.3E-02	1.9E-02	1.4E-02	1.4E-02	1.8E-02	1.9E-02	3.3E-02	3.6E-02	6.1E-02	6.1E-02	7.6E-02	7.4E-02
Spleen	1.3E-02	2.0E-02	1.1E-02	1.4E-02	2.0E-02	2.0E-02	3.7E-02	3.7E-02	6.7E-02	6.7E-02	7.2E-02	7.2E-02
Stomach wall	5.4E-02	5.9E-02	6.0E-02	6.9E-02	1.0E-01	1.0E-01	1.5E-01	1.5E-01	2.8E-01	2.8E-01	3.3E-01	3.3E-01
Testes	4.8E-03	-	1.7E-02	-	1.9E-02	-	3.3E-02	-	3.8E-02	-	4.3E-02	-
Thymus	8.2E-03	8.6E-03	9.3E-03	1.2E-02	1.2E-02	1.2E-02	2.0E-02	2.0E-02	4.5E-02	4.5E-02	5.8E-02	5.8E-02
Thyroid	2.3E-01	2.7E-01	3.7E-01	3.8E-01	5.5E-01	5.5E-01	1.2E+00	1.2E+00	2.3E+00	2.3E+00	2.7E+00	2.7E+00
Urinary bladder wall	8.3E-02	1.1E-01	1.1E-01	1.1E-01	1.7E-01	1.7E-01	2.1E-01	2.1E-01	2.4E-01	2.4E-01	3.0E-01	3.0E-01
Uterus/ cervix	-	3.5E-02	-	9.0E-02	-	1.3E-01	-	1.1E-01	-	3.9E-01	-	3.1E-01
Effective dose (mSv/MBq)	3.0E-02		3.8E-02		5.7E-02		9.9E-02		1.8E-01		2.1E-01	

3072

^{123}I

(j) oral administration, removed thyroid.

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	1.5E-02	1.7E-02	1.3E-02	1.3E-02	1.8E-02	1.8E-02	2.7E-02	2.7E-02	5.3E-02	5.3E-02	6.1E-02	6.0E-02
Brain	3.6E-03	4.2E-03	6.4E-03	6.7E-03	9.7E-03	9.9E-03	1.4E-02	1.5E-02	2.4E-02	2.4E-02	3.5E-02	3.5E-02
Breast	4.1E-03	4.3E-03	4.0E-03	4.7E-03	6.3E-03	5.7E-03	1.1E-02	1.1E-02	1.8E-02	1.8E-02	2.9E-02	2.9E-02
Colon wall	1.4E-02	1.6E-02	1.9E-02	1.6E-02	2.5E-02	2.4E-02	3.8E-02	3.6E-02	7.5E-02	7.3E-02	9.1E-02	8.8E-02
Endosteum (bone surface)	5.9E-03	7.7E-03	9.7E-03	1.0E-02	1.4E-02	1.4E-02	2.4E-02	2.4E-02	4.9E-02	4.8E-02	6.9E-02	6.9E-02
ET region	3.4E-03	5.0E-03	9.1E-03	9.1E-03	1.2E-02	1.2E-02	1.5E-02	1.4E-02	2.1E-02	2.1E-02	3.0E-02	3.0E-02
Gall bladder wall	9.3E-03	1.2E-02	1.5E-02	1.6E-02	1.4E-02	1.4E-02	2.3E-02	2.3E-02	4.5E-02	4.5E-02	6.0E-02	5.9E-02
Heart wall	1.2E-02	1.3E-02	6.1E-03	7.6E-03	1.1E-02	1.1E-02	1.9E-02	1.9E-02	3.5E-02	3.5E-02	4.3E-02	4.3E-02
Kidneys	2.9E-02	3.6E-02	3.3E-02	3.6E-02	4.8E-02	4.8E-02	7.7E-02	7.7E-02	1.3E-01	1.3E-01	1.9E-01	1.9E-01
Liver	1.1E-02	1.4E-02	1.1E-02	1.4E-02	1.9E-02	1.9E-02	2.8E-02	2.8E-02	5.2E-02	5.2E-02	6.6E-02	6.5E-02
Lung	7.8E-03	9.1E-03	6.9E-03	8.2E-03	1.2E-02	1.2E-02	1.8E-02	1.8E-02	3.7E-02	3.7E-02	5.2E-02	5.2E-02
Lymphatic nodes	1.1E-02	1.1E-02	9.0E-03	8.4E-03	1.2E-02	1.2E-02	2.1E-02	2.1E-02	3.7E-02	3.7E-02	4.6E-02	4.6E-02
Muscle	4.9E-03	6.2E-03	5.7E-03	5.8E-03	8.9E-03	8.8E-03	1.4E-02	1.4E-02	2.5E-02	2.5E-02	3.6E-02	3.6E-02
Oesophagus	1.0E-02	1.1E-02	1.0E-02	1.1E-02	1.7E-02	1.8E-02	2.8E-02	2.8E-02	4.5E-02	4.5E-02	6.1E-02	6.1E-02
Oral mucosa	4.2E-03	5.8E-03	1.1E-02	1.1E-02	1.3E-02	1.3E-02	1.5E-02	1.5E-02	2.4E-02	2.4E-02	4.2E-02	4.2E-02
Ovaries	-	2.3E-02	-	4.7E-02	-	6.4E-02	-	9.2E-02	-	1.3E-01	-	1.1E-01
Pancreas	1.5E-02	2.0E-02	2.0E-02	2.0E-02	2.9E-02	2.9E-02	4.1E-02	4.1E-02	6.9E-02	6.9E-02	7.7E-02	7.7E-02
Prostate	2.9E-02	-	3.5E-02	-	6.5E-02	-	9.0E-02	-	1.6E-01	-	1.4E-01	-
Red marrow	9.1E-03	1.2E-02	1.1E-02	1.2E-02	1.5E-02	1.5E-02	2.2E-02	2.1E-02	4.0E-02	3.9E-02	6.3E-02	6.2E-02
Salivary glands	3.4E-02	4.2E-02	4.7E-02	4.8E-02	6.8E-02	6.8E-02	8.5E-02	8.5E-02	1.2E-01	1.2E-01	2.3E-01	2.3E-01
Skin	3.3E-03	4.1E-03	4.1E-03	4.5E-03	6.9E-03	6.9E-03	1.1E-02	1.1E-02	2.0E-02	2.0E-02	3.0E-02	3.0E-02
Small intestine wall	1.4E-02	1.9E-02	1.4E-02	1.4E-02	1.8E-02	1.9E-02	3.3E-02	3.6E-02	6.2E-02	6.2E-02	7.7E-02	7.5E-02
Spleen	1.3E-02	2.1E-02	1.1E-02	1.4E-02	2.0E-02	2.0E-02	3.7E-02	3.7E-02	6.7E-02	6.7E-02	7.3E-02	7.3E-02
Stomach wall	5.4E-02	5.9E-02	6.1E-02	7.0E-02	1.0E-01	1.0E-01	1.5E-01	1.5E-01	2.9E-01	2.9E-01	3.4E-01	3.4E-01
Testes	4.9E-03	-	1.7E-02	-	1.9E-02	-	3.4E-02	-	3.8E-02	-	4.3E-02	-
Thymus	4.0E-03	4.6E-03	5.6E-03	6.1E-03	9.4E-03	9.4E-03	1.6E-02	1.6E-02	3.1E-02	3.1E-02	4.4E-02	4.4E-02
Thyroid	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Urinary bladder wall	8.4E-02	1.1E-01	1.1E-01	1.1E-01	1.8E-01	1.8E-01	2.1E-01	2.1E-01	2.4E-01	2.4E-01	3.0E-01	3.0E-01
Uterus/ cervix	-	3.6E-02	-	9.1E-02	-	1.4E-01	-	1.1E-01	-	3.9E-01	-	3.1E-01
$\sum_T w_T \left[\frac{H_T^F + H_T^M}{2}\right]^{\#}$ (mSv/MBq) *	2.0E-02		2.3E-02		3.5E-02		5.0E-02		8.5E-02		1.1E-01	

* Strictly speaking, patients with removed thyroid do not correspond to the ICRP reference individual. So this value, calculated analogously to the effective dose but without the thyroid as a target organ, is formally not the effective dose as defined by ICRP. (see also § 59).

Table A.27.7. Dose coefficients for ^{124}I-labelled iodide.
(a) i.v. administration, low uptake.

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	1.3E-01	1.4E-01	1.0E-01	1.1E-01	1.6E-01	1.6E-01	2.8E-01	2.8E-01	6.3E-01	6.3E-01	7.7E-01	7.7E-01
Brain	7.2E-02	1.0E-01	1.2E-01	1.3E-01	2.0E-01	2.0E-01	2.5E-01	2.6E-01	3.9E-01	3.9E-01	6.1E-01	6.1E-01
Breast	7.5E-02	1.5E-01	7.0E-02	8.6E-02	1.3E-01	1.2E-01	2.1E-01	2.0E-01	3.6E-01	3.6E-01	5.3E-01	5.2E-01
Colon wall	9.4E-02	1.1E-01	1.2E-01	1.0E-01	1.7E-01	1.6E-01	2.7E-01	2.6E-01	5.5E-01	5.4E-01	7.5E-01	7.4E-01
Endosteum (bone surface)	1.1E-01	1.4E-01	1.4E-01	1.5E-01	2.2E-01	2.2E-01	4.1E-01	4.1E-01	7.9E-01	7.9E-01	1.2E+00	1.2E+00
ET region	5.3E-01	7.8E-01	3.3E-01	3.9E-01	5.3E-01	5.3E-01	6.3E-01	6.3E-01	7.0E-01	7.0E-01	1.6E+00	1.6E+00
Gall bladder wall	9.2E-02	1.1E-01	1.0E-01	1.2E-01	1.3E-01	1.3E-01	2.3E-01	2.3E-01	4.7E-01	4.7E-01	6.9E-01	7.0E-01
Heart wall	2.5E-01	2.8E-01	2.1E-01	2.2E-01	2.7E-01	2.7E-01	4.3E-01	4.3E-01	9.0E-01	8.9E-01	1.1E+00	1.1E+00
Kidneys	2.2E-01	2.5E-01	2.5E-01	2.8E-01	3.7E-01	3.7E-01	6.3E-01	6.3E-01	1.2E+00	1.2E+00	1.9E+00	1.9E+00
Liver	1.2E-01	1.5E-01	1.3E-01	1.5E-01	2.3E-01	2.3E-01	3.9E-01	3.9E-01	8.6E-01	8.6E-01	1.3E+00	1.3E+00
Lung	2.8E-01	3.2E-01	9.6E-01	8.2E-01	9.7E-01	9.7E-01	1.7E+00	1.7E+00	6.0E+00	6.0E+00	4.9E+00	4.9E+00
Lymphatic nodes	1.1E+00	1.1E+00	3.3E-01	3.5E-01	3.7E-01	3.7E-01	7.2E-01	7.2E-01	1.2E+00	1.2E+00	1.5E+00	1.5E+00
Muscle	1.0E-01	1.5E-01	9.5E-02	9.3E-02	1.5E-01	1.5E-01	2.8E-01	2.8E-01	5.6E-01	5.6E-01	9.1E-01	9.1E-01
Oesophagus	2.3E+00	2.6E+00	9.8E-01	1.1E+00	1.2E+00	1.2E+00	2.4E+00	2.4E+00	5.0E+00	5.0E+00	4.7E+00	4.7E+00
Oral mucosa	2.2E-01	4.8E-01	5.9E-01	7.0E-01	5.6E-01	5.6E-01	6.6E-01	6.6E-01	7.0E-01	7.0E-01	2.5E+00	2.5E+00
Ovaries	-	1.4E-01	-	2.6E-01	-	3.4E-01	-	5.2E-01	-	7.6E-01	-	6.9E-01
Pancreas	1.1E-01	1.3E-01	1.1E-01	1.2E-01	1.7E-01	1.7E-01	2.7E-01	2.7E-01	5.1E-01	5.1E-01	7.0E-01	7.0E-01
Prostate	1.6E-01	-	1.9E-01	-	3.5E-01	-	5.1E-01	-	8.7E-01	-	7.5E-01	-
Red marrow	2.2E-01	2.7E-01	2.0E-01	2.1E-01	2.6E-01	2.6E-01	4.0E-01	4.0E-01	7.2E-01	7.2E-01	1.1E+00	1.1E+00
Salivary glands	4.6E-01	7.1E-01	6.8E-01	7.4E-01	1.4E+00	1.4E+00	1.6E+00	1.6E+00	2.1E+00	2.1E+00	4.4E+00	4.4E+00
Skin	6.3E-02	7.9E-02	7.4E-02	8.8E-02	1.2E-01	1.2E-01	1.9E-01	1.9E-01	3.1E-01	3.1E-01	4.6E-01	4.6E-01
Small intestine wall	8.6E-02	1.2E-01	8.4E-02	8.8E-02	1.2E-01	1.2E-01	2.2E-01	2.4E-01	4.4E-01	4.4E-01	5.8E-01	5.7E-01
Spleen	1.1E-01	1.3E-01	9.0E-02	1.1E-01	1.6E-01	1.6E-01	2.8E-01	2.8E-01	5.9E-01	5.9E-01	7.8E-01	7.8E-01
Stomach wall	3.5E-01	3.7E-01	4.1E-01	4.5E-01	6.5E-01	6.5E-01	9.8E-01	9.8E-01	1.9E+00	1.9E+00	1.9E+00	1.9E+00
Testes	3.6E-02	-	1.1E-01	-	1.3E-01	-	2.2E-01	-	2.8E-01	-	3.3E-01	-
Thymus	2.4E+00	2.0E+00	1.9E+00	3.1E+00	1.5E+00	1.5E+00	2.1E+00	2.1E+00	6.5E+00	6.5E+00	5.6E+00	5.6E+00
Thyroid	1.2E+02	1.5E+02	1.9E+02	2.0E+02	2.8E+02	2.8E+02	5.7E+02	5.7E+02	9.2E+02	9.2E+02	9.1E+02	9.1E+02
Urinary bladder wall	5.7E-01	7.7E-01	7.7E-01	8.0E-01	1.4E+00	1.4E+00	1.8E+00	1.8E+00	2.3E+00	2.3E+00	2.2E+00	2.2E+00
Uterus/ cervix	-	2.1E-01	-	6.1E-01	-	8.9E-01	-	6.4E-01	-	2.6E+00	-	2.2E+00
Effective dose (mSv/MBq)	5.6E+00		8.2E+00		1.2E+01		2.4E+01		3.8E+01		3.8E+01	

3082 ^{124}I

3083 (b) i.v. administration, medium uptake.

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	1.4E-01	1.5E-01	1.1E-01	1.2E-01	1.8E-01	1.8E-01	3.3E-01	3.3E-01	7.9E-01	7.9E-01	9.7E-01	9.7E-01
Brain	9.5E-02	1.4E-01	1.5E-01	1.7E-01	2.6E-01	2.6E-01	3.3E-01	3.3E-01	5.0E-01	5.0E-01	8.0E-01	8.0E-01
Breast	9.7E-02	2.1E-01	8.9E-02	1.1E-01	1.6E-01	1.6E-01	2.7E-01	2.7E-01	4.7E-01	4.7E-01	7.0E-01	7.0E-01
Colon wall	9.3E-02	1.1E-01	1.1E-01	1.0E-01	1.7E-01	1.6E-01	2.8E-01	2.7E-01	5.9E-01	5.8E-01	8.6E-01	8.5E-01
Endosteum (bone surface)	1.4E-01	1.8E-01	1.8E-01	2.0E-01	2.8E-01	2.8E-01	5.2E-01	5.2E-01	1.0E+00	1.0E+00	1.6E+00	1.6E+00
ET region	8.1E-01	1.2E+00	4.6E-01	5.6E-01	7.6E-01	7.6E-01	9.1E-01	9.1E-01	9.9E-01	9.9E-01	2.3E+00	2.3E+00
Gall bladder wall	1.1E-01	1.2E-01	1.1E-01	1.3E-01	1.6E-01	1.6E-01	2.7E-01	2.7E-01	5.8E-01	5.9E-01	8.7E-01	8.8E-01
Heart wall	3.4E-01	3.7E-01	3.0E-01	3.2E-01	3.7E-01	3.7E-01	5.9E-01	5.9E-01	1.3E+00	1.3E+00	1.6E+00	1.6E+00
Kidneys	2.1E-01	2.5E-01	2.4E-01	2.7E-01	3.7E-01	3.7E-01	6.6E-01	6.6E-01	1.4E+00	1.4E+00	2.2E+00	2.2E+00
Liver	1.5E-01	1.7E-01	1.6E-01	1.9E-01	2.8E-01	2.8E-01	4.9E-01	4.9E-01	1.1E+00	1.1E+00	1.8E+00	1.8E+00
Lung	4.1E-01	4.6E-01	1.5E+00	1.2E+00	1.5E+00	1.5E+00	2.6E+00	2.6E+00	9.3E+00	9.3E+00	7.4E+00	7.4E+00
Lymphatic nodes	1.6E+00	1.7E+00	4.8E-01	5.0E-01	5.2E-01	5.2E-01	1.0E+00	1.0E+00	1.8E+00	1.8E+00	2.1E+00	2.1E+00
Muscle	1.4E-01	2.0E-01	1.2E-01	1.2E-01	1.9E-01	1.9E-01	3.8E-01	3.8E-01	7.6E-01	7.6E-01	1.3E+00	1.3E+00
Oesophagus	3.5E+00	4.0E+00	1.5E+00	1.6E+00	1.7E+00	1.7E+00	3.6E+00	3.6E+00	7.6E+00	7.6E+00	7.1E+00	7.1E+00
Oral mucosa	3.3E-01	7.2E-01	8.6E-01	1.0E+00	7.9E-01	7.9E-01	9.4E-01	9.5E-01	9.7E-01	9.7E-01	3.7E+00	3.7E+00
Ovaries	-	1.3E-01	-	2.3E-01	-	3.1E-01	-	4.7E-01	-	7.3E-01	-	7.2E-01
Pancreas	1.1E-01	1.3E-01	1.1E-01	1.2E-01	1.8E-01	1.8E-01	2.9E-01	2.9E-01	5.7E-01	5.7E-01	8.1E-01	8.1E-01
Prostate	1.5E-01	-	1.7E-01	-	3.1E-01	-	4.6E-01	-	8.1E-01	-	7.5E-01	-
Red marrow	3.0E-01	3.6E-01	2.6E-01	2.7E-01	3.4E-01	3.4E-01	5.2E-01	5.2E-01	9.6E-01	9.6E-01	1.5E+00	1.5E+00
Salivary glands	5.7E-01	9.2E-01	8.5E-01	9.4E-01	1.9E+00	1.9E+00	2.1E+00	2.1E+00	2.8E+00	2.8E+00	6.0E+00	6.0E+00
Skin	8.3E-02	1.0E-01	9.6E-02	1.2E-01	1.5E-01	1.5E-01	2.5E-01	2.5E-01	3.9E-01	3.9E-01	5.9E-01	5.9E-01
Small intestine wall	8.3E-02	1.1E-01	8.2E-02	8.7E-02	1.2E-01	1.2E-01	2.3E-01	2.4E-01	4.7E-01	4.7E-01	6.5E-01	6.4E-01
Spleen	1.3E-01	1.4E-01	9.9E-02	1.2E-01	1.8E-01	1.8E-01	3.2E-01	3.2E-01	7.0E-01	7.0E-01	9.5E-01	9.5E-01
Stomach wall	3.4E-01	3.5E-01	3.8E-01	4.2E-01	6.1E-01	6.1E-01	9.3E-01	9.3E-01	1.8E+00	1.8E+00	1.9E+00	1.9E+00
Testes	3.3E-02	-	9.7E-02	-	1.2E-01	-	2.0E-01	-	2.8E-01	-	3.5E-01	-
Thymus	3.6E+00	3.1E+00	3.0E+00	4.8E+00	2.2E+00	2.2E+00	3.3E+00	3.3E+00	1.0E+01	1.0E+01	8.7E+00	8.7E+00
Thyroid	1.9E+02	2.3E+02	3.0E+02	3.1E+02	4.4E+02	4.4E+02	8.9E+02	8.9E+02	1.4E+03	1.4E+03	1.4E+03	1.4E+03
Urinary bladder wall	5.0E-01	6.7E-01	6.7E-01	7.0E-01	1.2E+00	1.2E+00	1.6E+00	1.6E+00	2.1E+00	2.1E+00	2.0E+00	2.0E+00
Uterus/ cervix	-	1.8E-01	-	5.7E-01	-	8.4E-01	-	5.8E-01	-	2.6E+00	-	2.4E+00
Effective dose (mSv/MBq)	1.6E-02		1.9E-02		2.7E-02		4.2E-02		8.1E-02		1.1E-01	

3084

3085 ^{124}I

3086 (c) i.v. administration, high uptake.

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	1.5E-01	1.6E-01	1.3E-01	1.4E-01	2.0E-01	2.1E-01	3.8E-01	3.8E-01	9.4E-01	9.4E-01	1.2E+00	1.2E+00
Brain	1.2E-01	1.8E-01	1.8E-01	2.0E-01	3.2E-01	3.2E-01	4.0E-01	4.0E-01	6.1E-01	6.1E-01	9.8E-01	9.8E-01
Breast	1.2E-01	2.7E-01	1.1E-01	1.3E-01	2.0E-01	2.0E-01	3.3E-01	3.3E-01	5.9E-01	5.9E-01	8.7E-01	8.7E-01
Colon wall	9.1E-02	9.8E-02	1.1E-01	9.7E-02	1.6E-01	1.6E-01	2.8E-01	2.7E-01	6.3E-01	6.2E-01	9.7E-01	9.7E-01
Endosteum (bone surface)	1.8E-01	2.3E-01	2.2E-01	2.4E-01	3.3E-01	3.3E-01	6.3E-01	6.3E-01	1.2E+00	1.2E+00	1.9E+00	1.9E+00
ET region	1.1E+00	1.6E+00	5.9E-01	7.3E-01	9.9E-01	9.8E-01	1.2E+00	1.2E+00	1.3E+00	1.3E+00	3.1E+00	3.1E+00
Gall bladder wall	1.2E-01	1.4E-01	1.2E-01	1.5E-01	1.8E-01	1.8E-01	3.1E-01	3.1E-01	7.0E-01	7.0E-01	1.1E+00	1.1E+00
Heart wall	4.3E-01	4.6E-01	3.9E-01	4.1E-01	4.7E-01	4.7E-01	7.6E-01	7.6E-01	1.6E+00	1.6E+00	2.0E+00	2.0E+00
Kidneys	2.1E-01	2.4E-01	2.4E-01	2.7E-01	3.7E-01	3.7E-01	6.8E-01	6.8E-01	1.5E+00	1.5E+00	2.4E+00	2.4E+00
Liver	1.8E-01	2.0E-01	1.8E-01	2.2E-01	3.3E-01	3.3E-01	5.9E-01	5.9E-01	1.4E+00	1.4E+00	2.3E+00	2.3E+00
Lung	5.3E-01	6.0E-01	2.0E+00	1.7E+00	2.0E+00	2.0E+00	3.5E+00	3.5E+00	1.3E+01	1.3E+01	1.0E+01	1.0E+01
Lymphatic nodes	2.1E+00	2.3E+00	6.3E-01	6.6E-01	6.8E-01	6.8E-01	1.4E+00	1.4E+00	2.3E+00	2.3E+00	2.8E+00	2.8E+00
Muscle	1.7E-01	2.5E-01	1.5E-01	1.4E-01	2.3E-01	2.3E-01	4.7E-01	4.7E-01	9.6E-01	9.6E-01	1.6E+00	1.6E+00
Oesophagus	4.8E+00	5.3E+00	2.0E+00	2.1E+00	2.3E+00	2.3E+00	4.8E+00	4.8E+00	1.0E+01	1.0E+01	9.6E+00	9.6E+00
Oral mucosa	4.3E-01	9.6E-01	1.1E+00	1.4E+00	1.0E+00	1.0E+00	1.2E+00	1.2E+00	1.3E+00	1.3E+00	5.0E+00	5.0E+00
Ovaries	-	1.1E-01	-	2.0E-01	-	2.7E-01	-	4.2E-01	-	7.0E-01	-	7.6E-01
Pancreas	1.2E-01	1.3E-01	1.1E-01	1.3E-01	1.9E-01	1.9E-01	3.1E-01	3.1E-01	6.3E-01	6.3E-01	9.2E-01	9.2E-01
Prostate	1.3E-01	-	1.5E-01	-	2.7E-01	-	4.0E-01	-	7.4E-01	-	7.4E-01	-
Red marrow	3.8E-01	4.5E-01	3.2E-01	3.4E-01	4.1E-01	4.1E-01	6.5E-01	6.4E-01	1.2E+00	1.2E+00	1.9E+00	1.9E+00
Salivary glands	6.8E-01	1.1E+00	1.0E+00	1.1E+00	2.3E+00	2.3E+00	2.6E+00	2.6E+00	3.4E+00	3.4E+00	7.5E+00	7.5E+00
Skin	1.0E-01	1.3E-01	1.2E-01	1.4E-01	1.9E-01	1.9E-01	3.0E-01	3.1E-01	4.7E-01	4.7E-01	7.2E-01	7.3E-01
Small intestine wall	8.1E-02	1.1E-01	7.9E-02	8.6E-02	1.2E-01	1.2E-01	2.3E-01	2.4E-01	5.1E-01	5.1E-01	7.3E-01	7.2E-01
Spleen	1.5E-01	1.5E-01	1.1E-01	1.3E-01	2.0E-01	2.0E-01	3.5E-01	3.6E-01	8.1E-01	8.1E-01	1.1E+00	1.1E+00
Stomach wall	3.2E-01	3.2E-01	3.5E-01	3.8E-01	5.6E-01	5.6E-01	8.7E-01	8.7E-01	1.8E+00	1.8E+00	1.9E+00	1.9E+00
Testes	3.0E-02	-	8.6E-02	-	1.1E-01	-	1.8E-01	-	2.8E-01	-	3.7E-01	-
Thymus	4.9E+00	4.2E+00	4.0E+00	6.5E+00	3.0E+00	3.0E+00	4.4E+00	4.4E+00	1.4E+01	1.4E+01	1.2E+01	1.2E+01
Thyroid	2.5E+02	3.1E+02	4.1E+02	4.2E+02	5.9E+02	5.9E+02	1.2E+03	1.2E+03	2.0E+03	2.0E+03	2.0E+03	2.0E+03
Urinary bladder wall	4.3E-01	5.7E-01	5.7E-01	5.9E-01	1.0E+00	1.0E+00	1.3E+00	1.3E+00	1.8E+00	1.8E+00	1.8E+00	1.8E+00
Uterus/ cervix	-	1.6E-01	-	5.3E-01	-	7.8E-01	-	5.2E-01	-	2.5E+00	-	2.5E+00
Effective dose (mSv/MBq)	1.2E+01		1.7E+01		2.4E+01		4.9E+01		8.1E+01		8.1E+01	

3087

3088 ^{124}I

3089 (d) i.v. administration, saturated thyroid.

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	1.1E-01	1.2E-01	8.2E-02	8.4E-02	1.3E-01	1.3E-01	1.9E-01	1.9E-01	3.6E-01	3.6E-01	4.4E-01	4.4E-01
Brain	3.1E-02	3.7E-02	5.9E-02	6.1E-02	8.6E-02	8.8E-02	1.2E-01	1.3E-01	2.0E-01	2.0E-01	2.9E-01	2.9E-01
Breast	3.6E-02	4.0E-02	3.8E-02	4.4E-02	5.8E-02	5.2E-02	9.5E-02	9.3E-02	1.5E-01	1.5E-01	2.3E-01	2.3E-01
Colon wall	9.7E-02	1.2E-01	1.2E-01	1.1E-01	1.7E-01	1.7E-01	2.6E-01	2.5E-01	4.8E-01	4.6E-01	5.6E-01	5.4E-01
Endosteum (bone surface)	4.8E-02	6.2E-02	7.7E-02	8.0E-02	1.2E-01	1.2E-01	2.2E-01	2.1E-01	4.2E-01	4.2E-01	5.4E-01	5.4E-01
ET region	3.5E-02	5.0E-02	9.8E-02	9.6E-02	1.3E-01	1.2E-01	1.5E-01	1.4E-01	2.0E-01	2.0E-01	3.0E-01	3.0E-01
Gall bladder wall	6.5E-02	8.4E-02	8.4E-02	9.2E-02	8.9E-02	9.1E-02	1.6E-01	1.6E-01	2.7E-01	2.8E-01	3.8E-01	3.9E-01
Heart wall	1.0E-01	1.2E-01	4.8E-02	5.7E-02	8.2E-02	8.2E-02	1.4E-01	1.4E-01	2.5E-01	2.5E-01	3.3E-01	3.3E-01
Kidneys	2.2E-01	2.7E-01	2.6E-01	2.8E-01	3.7E-01	3.7E-01	5.9E-01	5.9E-01	1.0E+00	1.0E+00	1.5E+00	1.5E+00
Liver	8.0E-02	9.7E-02	8.2E-02	9.7E-02	1.4E-01	1.4E-01	2.1E-01	2.1E-01	3.7E-01	3.7E-01	4.8E-01	4.8E-01
Lung	6.2E-02	7.4E-02	6.7E-02	7.4E-02	1.0E-01	1.0E-01	1.6E-01	1.7E-01	3.7E-01	3.7E-01	4.7E-01	4.7E-01
Lymphatic nodes	9.9E-02	1.1E-01	7.1E-02	6.8E-02	9.6E-02	9.6E-02	1.6E-01	1.6E-01	2.6E-01	2.6E-01	3.4E-01	3.4E-01
Muscle	4.1E-02	5.2E-02	4.8E-02	4.9E-02	7.4E-02	7.4E-02	1.2E-01	1.2E-01	2.1E-01	2.1E-01	3.0E-01	3.0E-01
Oesophagus	1.1E-01	1.2E-01	9.7E-02	1.0E-01	1.5E-01	1.5E-01	2.5E-01	2.5E-01	4.3E-01	4.3E-01	5.4E-01	5.4E-01
Oral mucosa	3.9E-02	5.5E-02	1.2E-01	1.2E-01	1.5E-01	1.5E-01	1.5E-01	1.5E-01	2.2E-01	2.2E-01	4.0E-01	4.1E-01
Ovaries	-	1.6E-01	-	3.0E-01	-	4.1E-01	-	6.0E-01	-	8.1E-01	-	6.2E-01
Pancreas	9.4E-02	1.2E-01	1.1E-01	1.1E-01	1.6E-01	1.6E-01	2.4E-01	2.4E-01	4.1E-01	4.1E-01	5.1E-01	5.1E-01
Prostate	2.0E-01	-	2.3E-01	-	4.2E-01	-	6.0E-01	-	9.7E-01	-	7.6E-01	-
Red marrow	8.0E-02	1.1E-01	9.5E-02	1.0E-01	1.3E-01	1.3E-01	1.9E-01	1.8E-01	3.2E-01	3.1E-01	4.8E-01	4.8E-01
Salivary glands	2.7E-01	3.4E-01	3.9E-01	4.0E-01	5.6E-01	5.6E-01	7.0E-01	7.0E-01	9.8E-01	9.8E-01	1.8E+00	1.8E+00
Skin	2.8E-02	3.4E-02	3.5E-02	3.9E-02	5.8E-02	5.8E-02	9.2E-02	9.3E-02	1.6E-01	1.6E-01	2.3E-01	2.3E-01
Small intestine wall	9.0E-02	1.3E-01	8.8E-02	8.9E-02	1.2E-01	1.2E-01	2.2E-01	2.4E-01	3.8E-01	3.8E-01	4.5E-01	4.4E-01
Spleen	8.0E-02	1.1E-01	7.5E-02	9.1E-02	1.3E-01	1.3E-01	2.2E-01	2.2E-01	4.0E-01	4.0E-01	5.0E-01	5.0E-01
Stomach wall	3.9E-01	4.2E-01	4.7E-01	5.1E-01	7.3E-01	7.3E-01	1.1E+00	1.1E+00	2.0E+00	2.0E+00	1.9E+00	1.9E+00
Testes	4.2E-02	-	1.3E-01	-	1.5E-01	-	2.4E-01	-	2.8E-01	-	2.9E-01	-
Thymus	6.7E-02	6.8E-02	7.4E-02	9.6E-02	9.7E-02	9.7E-02	1.6E-01	1.6E-01	3.5E-01	3.5E-01	4.5E-01	4.5E-01
Thyroid	1.8E+00	2.1E+00	2.9E+00	3.0E+00	4.2E+00	4.2E+00	9.0E+00	9.0E+00	1.6E+01	1.6E+01	1.8E+01	1.8E+01
Urinary bladder wall	6.9E-01	9.4E-01	9.3E-01	9.7E-01	1.7E+00	1.6E+00	2.2E+00	2.2E+00	2.7E+00	2.7E+00	2.5E+00	2.5E+00
Uterus/ cervix	-	2.5E-01	-	6.8E-01	-	9.8E-01	-	7.5E-01	-	2.8E+00	-	2.0E+00
Effective dose (mSv/MBq)	2.3E-01		3.0E-01		4.4E-01		7.5E-01		1.3E+00		1.4E+00	

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(e) i.v. administration, removed thyroid.

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	1.1E-01	1.2E-01	8.2E-02	8.4E-02	1.2E-01	1.3E-01	1.9E-01	1.9E-01	3.6E-01	3.6E-01	4.3E-01	4.3E-01
Brain	3.0E-02	3.6E-02	5.8E-02	6.0E-02	8.5E-02	8.6E-02	1.2E-01	1.2E-01	2.0E-01	2.0E-01	2.9E-01	2.9E-01
Breast	3.5E-02	3.8E-02	3.7E-02	4.3E-02	5.7E-02	5.1E-02	9.3E-02	9.2E-02	1.5E-01	1.5E-01	2.3E-01	2.2E-01
Colon wall	9.7E-02	1.2E-01	1.3E-01	1.1E-01	1.7E-01	1.7E-01	2.7E-01	2.5E-01	4.8E-01	4.7E-01	5.6E-01	5.4E-01
Endosteum (bone surface)	4.8E-02	6.1E-02	7.6E-02	7.9E-02	1.2E-01	1.2E-01	2.1E-01	2.1E-01	4.1E-01	4.1E-01	5.3E-01	5.3E-01
ET region	2.8E-02	4.0E-02	9.4E-02	9.2E-02	1.2E-01	1.2E-01	1.4E-01	1.4E-01	1.9E-01	1.9E-01	2.8E-01	2.8E-01
Gall bladder wall	6.5E-02	8.4E-02	8.4E-02	9.2E-02	8.9E-02	9.0E-02	1.6E-01	1.6E-01	2.7E-01	2.7E-01	3.8E-01	3.9E-01
Heart wall	1.0E-01	1.2E-01	4.6E-02	5.5E-02	7.9E-02	8.0E-02	1.3E-01	1.3E-01	2.4E-01	2.4E-01	3.2E-01	3.2E-01
Kidneys	2.2E-01	2.7E-01	2.6E-01	2.8E-01	3.7E-01	3.7E-01	5.9E-01	5.9E-01	1.0E+00	1.0E+00	1.5E+00	1.5E+00
Liver	7.9E-02	9.7E-02	8.2E-02	9.6E-02	1.4E-01	1.4E-01	2.1E-01	2.1E-01	3.7E-01	3.7E-01	4.8E-01	4.8E-01
Lung	5.9E-02	7.1E-02	5.4E-02	6.3E-02	8.8E-02	8.8E-02	1.4E-01	1.4E-01	2.7E-01	2.7E-01	3.9E-01	3.9E-01
Lymphatic nodes	8.5E-02	9.2E-02	6.8E-02	6.4E-02	9.2E-02	9.2E-02	1.6E-01	1.6E-01	2.5E-01	2.5E-01	3.2E-01	3.2E-01
Muscle	4.1E-02	5.1E-02	4.8E-02	4.8E-02	7.3E-02	7.3E-02	1.2E-01	1.2E-01	2.1E-01	2.1E-01	2.9E-01	2.9E-01
Oesophagus	7.9E-02	8.8E-02	8.4E-02	8.9E-02	1.4E-01	1.4E-01	2.1E-01	2.1E-01	3.5E-01	3.5E-01	4.6E-01	4.6E-01
Oral mucosa	3.7E-02	4.8E-02	1.1E-01	1.1E-01	1.4E-01	1.4E-01	1.5E-01	1.5E-01	2.1E-01	2.1E-01	3.6E-01	3.7E-01
Ovaries	-	1.6E-01	-	3.1E-01	-	4.1E-01	-	6.0E-01	-	8.1E-01	-	6.3E-01
Pancreas	9.4E-02	1.2E-01	1.1E-01	1.1E-01	1.6E-01	1.6E-01	2.4E-01	2.4E-01	4.1E-01	4.1E-01	5.1E-01	5.1E-01
Prostate	2.0E-01	-	2.3E-01	-	4.2E-01	-	6.0E-01	-	9.8E-01	-	7.7E-01	-
Red marrow	7.8E-02	1.0E-01	9.4E-02	1.0E-01	1.3E-01	1.3E-01	1.8E-01	1.8E-01	3.1E-01	3.1E-01	4.7E-01	4.7E-01
Salivary glands	2.7E-01	3.4E-01	3.9E-01	3.9E-01	5.5E-01	5.5E-01	6.8E-01	6.8E-01	9.6E-01	9.6E-01	1.7E+00	1.7E+00
Skin	2.7E-02	3.3E-02	3.4E-02	3.8E-02	5.7E-02	5.7E-02	9.0E-02	9.1E-02	1.6E-01	1.6E-01	2.3E-01	2.3E-01
Small intestine wall	9.0E-02	1.3E-01	8.8E-02	9.0E-02	1.2E-01	1.2E-01	2.2E-01	2.4E-01	3.8E-01	3.8E-01	4.5E-01	4.4E-01
Spleen	8.0E-02	1.1E-01	7.5E-02	9.1E-02	1.3E-01	1.3E-01	2.2E-01	2.2E-01	4.0E-01	4.0E-01	5.0E-01	5.0E-01
Stomach wall	3.9E-01	4.2E-01	4.7E-01	5.1E-01	7.3E-01	7.4E-01	1.1E+00	1.1E+00	2.0E+00	2.0E+00	1.9E+00	1.9E+00
Testes	4.2E-02	-	1.3E-01	-	1.5E-01	-	2.4E-01	-	2.8E-01	-	2.9E-01	-
Thymus	3.4E-02	3.9E-02	4.7E-02	5.1E-02	7.6E-02	7.7E-02	1.3E-01	1.3E-01	2.4E-01	2.5E-01	3.5E-01	3.5E-01
Thyroid	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Urinary bladder wall	6.9E-01	9.4E-01	9.3E-01	9.8E-01	1.7E+00	1.7E+00	2.2E+00	2.2E+00	2.7E+00	2.7E+00	2.5E+00	2.5E+00
Uterus/ cervix	-	2.5E-01	-	6.9E-01	-	9.8E-01	-	7.5E-01	-	2.8E+00	-	2.0E+00
$\sum_T w_T \left[\frac{H_T^F + H_T^M}{2}\right]^{\#}$ (mSv/MBq) *	1.5E-01		1.8E-01		2.7E-01		3.9E-01		6.4E-01		6.9E-01	

* Strictly speaking, patients with removed thyroid do not correspond to the ICRP reference individual. So this value, calculated analogously to the effective dose but without the thyroid as a target organ, is formally not the effective dose as defined by ICRP. (see also § 59).

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(f) oral administration, low uptake.

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	1.4E-01	1.5E-01	1.1E-01	1.2E-01	1.7E-01	1.7E-01	2.9E-01	2.9E-01	6.6E-01	6.6E-01	7.8E-01	7.8E-01
Brain	7.1E-02	1.0E-01	1.1E-01	1.3E-01	1.9E-01	1.9E-01	2.5E-01	2.5E-01	3.8E-01	3.8E-01	6.0E-01	6.0E-01
Breast	7.8E-02	1.5E-01	7.1E-02	8.8E-02	1.3E-01	1.2E-01	2.1E-01	2.1E-01	3.6E-01	3.6E-01	5.3E-01	5.2E-01
Colon wall	1.2E-01	1.4E-01	1.5E-01	1.3E-01	2.1E-01	2.1E-01	3.3E-01	3.1E-01	6.4E-01	6.3E-01	8.4E-01	8.3E-01
Endosteum (bone surface)	1.1E-01	1.4E-01	1.4E-01	1.5E-01	2.2E-01	2.2E-01	4.1E-01	4.1E-01	7.9E-01	7.9E-01	1.2E+00	1.2E+00
ET region	5.2E-01	7.7E-01	3.2E-01	3.9E-01	5.2E-01	5.2E-01	6.3E-01	6.3E-01	7.0E-01	7.0E-01	1.6E+00	1.6E+00
Gall bladder wall	1.0E-01	1.2E-01	1.2E-01	1.4E-01	1.4E-01	1.4E-01	2.4E-01	2.4E-01	5.0E-01	5.0E-01	7.1E-01	7.2E-01
Heart wall	2.6E-01	2.9E-01	2.1E-01	2.3E-01	2.7E-01	2.7E-01	4.4E-01	4.4E-01	9.0E-01	9.0E-01	1.1E+00	1.1E+00
Kidneys	2.2E-01	2.6E-01	2.5E-01	2.8E-01	3.8E-01	3.8E-01	6.4E-01	6.4E-01	1.3E+00	1.3E+00	1.9E+00	1.9E+00
Liver	1.3E-01	1.5E-01	1.3E-01	1.6E-01	2.3E-01	2.4E-01	4.0E-01	4.0E-01	8.8E-01	8.8E-01	1.3E+00	1.3E+00
Lung	2.8E-01	3.2E-01	9.5E-01	8.1E-01	9.6E-01	9.6E-01	1.7E+00	1.7E+00	6.0E+00	6.0E+00	4.8E+00	4.8E+00
Lymphatic nodes	1.1E+00	1.1E+00	3.3E-01	3.5E-01	3.7E-01	3.7E-01	7.2E-01	7.2E-01	1.2E+00	1.2E+00	1.5E+00	1.5E+00
Muscle	1.0E-01	1.5E-01	9.5E-02	9.3E-02	1.5E-01	1.5E-01	2.8E-01	2.8E-01	5.6E-01	5.6E-01	9.1E-01	9.1E-01
Oesophagus	2.3E+00	2.6E+00	9.8E-01	1.1E+00	1.2E+00	1.2E+00	2.4E+00	2.4E+00	4.9E+00	4.9E+00	4.7E+00	4.7E+00
Oral mucosa	2.2E-01	4.8E-01	5.9E-01	6.9E-01	5.5E-01	5.5E-01	6.5E-01	6.5E-01	6.9E-01	6.9E-01	2.5E+00	2.5E+00
Ovaries	-	1.5E-01	-	2.6E-01	-	3.6E-01	-	5.4E-01	-	8.0E-01	-	7.3E-01
Pancreas	1.2E-01	1.5E-01	1.4E-01	1.4E-01	2.1E-01	2.1E-01	3.1E-01	3.2E-01	5.8E-01	5.8E-01	7.4E-01	7.4E-01
Prostate	1.7E-01	-	1.9E-01	-	3.6E-01	-	5.2E-01	-	8.9E-01	-	7.6E-01	-
Red marrow	2.2E-01	2.7E-01	2.0E-01	2.1E-01	2.6E-01	2.6E-01	4.0E-01	4.0E-01	7.2E-01	7.2E-01	1.1E+00	1.1E+00
Salivary glands	4.6E-01	7.0E-01	6.7E-01	7.3E-01	1.4E+00	1.4E+00	1.6E+00	1.6E+00	2.1E+00	2.1E+00	4.4E+00	4.4E+00
Skin	6.3E-02	7.9E-02	7.4E-02	8.8E-02	1.2E-01	1.2E-01	1.9E-01	1.9E-01	3.1E-01	3.1E-01	4.6E-01	4.6E-01
Small intestine wall	9.7E-02	1.4E-01	9.9E-02	1.0E-01	1.4E-01	1.4E-01	2.5E-01	2.7E-01	4.9E-01	4.9E-01	6.3E-01	6.2E-01
Spleen	1.2E-01	1.6E-01	9.7E-02	1.2E-01	1.8E-01	1.8E-01	3.2E-01	3.2E-01	6.5E-01	6.5E-01	8.1E-01	8.1E-01
Stomach wall	5.3E-01	5.5E-01	6.4E-01	7.0E-01	1.0E+00	1.0E+00	1.5E+00	1.5E+00	2.6E+00	2.6E+00	2.2E+00	2.2E+00
Testes	3.6E-02	-	1.1E-01	-	1.4E-01	-	2.2E-01	-	2.9E-01	-	3.3E-01	-
Thymus	2.3E+00	2.0E+00	1.9E+00	3.1E+00	1.4E+00	1.4E+00	2.1E+00	2.1E+00	6.4E+00	6.4E+00	5.6E+00	5.6E+00
Thyroid	1.2E+02	1.4E+02	1.9E+02	2.0E+02	2.8E+02	2.8E+02	5.6E+02	5.6E+02	9.0E+02	9.0E+02	9.0E+02	9.0E+02
Urinary bladder wall	5.8E-01	7.8E-01	7.8E-01	8.1E-01	1.4E+00	1.4E+00	1.8E+00	1.8E+00	2.4E+00	2.4E+00	2.2E+00	2.2E+00
Uterus/ cervix	-	2.2E-01	-	6.2E-01	-	9.0E-01	-	6.7E-01	-	2.7E+00	-	2.2E+00
Effective dose (mSv/MBq)	5.6E+00		8.1E+00		1.2E+01		2.3E+01		3.8E+01		3.8E+01	

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3101 (g) oral administration, medium uptake.

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	1.5E-01	1.6E-01	1.2E-01	1.3E-01	1.9E-01	1.9E-01	3.4E-01	3.4E-01	8.1E-01	8.1E-01	9.7E-01	9.7E-01
Brain	9.4E-02	1.4E-01	1.5E-01	1.6E-01	2.5E-01	2.5E-01	3.2E-01	3.3E-01	4.9E-01	4.9E-01	7.9E-01	7.9E-01
Breast	1.0E-01	2.1E-01	8.9E-02	1.1E-01	1.7E-01	1.6E-01	2.7E-01	2.7E-01	4.8E-01	4.7E-01	6.9E-01	6.9E-01
Colon wall	1.2E-01	1.4E-01	1.4E-01	1.3E-01	2.1E-01	2.0E-01	3.3E-01	3.2E-01	6.8E-01	6.7E-01	9.5E-01	9.4E-01
Endosteum (bone surface)	1.4E-01	1.8E-01	1.8E-01	2.0E-01	2.8E-01	2.8E-01	5.2E-01	5.2E-01	1.0E+00	1.0E+00	1.5E+00	1.5E+00
ET region	8.0E-01	1.2E+00	4.5E-01	5.5E-01	7.5E-01	7.5E-01	9.0E-01	9.0E-01	9.8E-01	9.8E-01	2.3E+00	2.3E+00
Gall bladder wall	1.2E-01	1.3E-01	1.3E-01	1.5E-01	1.6E-01	1.6E-01	2.8E-01	2.8E-01	6.1E-01	6.1E-01	8.9E-01	9.0E-01
Heart wall	3.5E-01	3.7E-01	3.0E-01	3.2E-01	3.7E-01	3.7E-01	6.0E-01	6.0E-01	1.3E+00	1.3E+00	1.6E+00	1.6E+00
Kidneys	2.2E-01	2.6E-01	2.5E-01	2.7E-01	3.8E-01	3.8E-01	6.7E-01	6.7E-01	1.4E+00	1.4E+00	2.2E+00	2.2E+00
Liver	1.6E-01	1.8E-01	1.6E-01	1.9E-01	2.8E-01	2.8E-01	5.0E-01	5.0E-01	1.2E+00	1.2E+00	1.8E+00	1.8E+00
Lung	4.1E-01	4.6E-01	1.4E+00	1.2E+00	1.5E+00	1.5E+00	2.6E+00	2.6E+00	9.2E+00	9.2E+00	7.4E+00	7.4E+00
Lymphatic nodes	1.6E+00	1.7E+00	4.8E-01	5.0E-01	5.2E-01	5.2E-01	1.0E+00	1.0E+00	1.8E+00	1.8E+00	2.1E+00	2.1E+00
Muscle	1.4E-01	2.0E-01	1.2E-01	1.2E-01	1.9E-01	1.9E-01	3.8E-01	3.8E-01	7.5E-01	7.5E-01	1.3E+00	1.3E+00
Oesophagus	3.5E+00	3.9E+00	1.5E+00	1.6E+00	1.7E+00	1.7E+00	3.5E+00	3.5E+00	7.5E+00	7.5E+00	7.1E+00	7.1E+00
Oral mucosa	3.2E-01	7.1E-01	8.5E-01	1.0E+00	7.8E-01	7.8E-01	9.4E-01	9.4E-01	9.6E-01	9.7E-01	3.7E+00	3.7E+00
Ovaries	-	1.3E-01	-	2.3E-01	-	3.2E-01	-	4.9E-01	-	7.7E-01	-	7.7E-01
Pancreas	1.3E-01	1.5E-01	1.4E-01	1.5E-01	2.2E-01	2.2E-01	3.3E-01	3.3E-01	6.4E-01	6.4E-01	8.4E-01	8.4E-01
Prostate	1.5E-01	-	1.7E-01	-	3.2E-01	-	4.6E-01	-	8.2E-01	-	7.6E-01	-
Red marrow	3.0E-01	3.6E-01	2.6E-01	2.7E-01	3.4E-01	3.4E-01	5.2E-01	5.2E-01	9.5E-01	9.5E-01	1.5E+00	1.5E+00
Salivary glands	5.7E-01	9.1E-01	8.3E-01	9.3E-01	1.8E+00	1.8E+00	2.1E+00	2.1E+00	2.7E+00	2.7E+00	5.9E+00	5.9E+00
Skin	8.3E-02	1.0E-01	9.6E-02	1.2E-01	1.5E-01	1.5E-01	2.5E-01	2.5E-01	3.9E-01	3.9E-01	5.9E-01	5.9E-01
Small intestine wall	9.5E-02	1.3E-01	9.6E-02	1.0E-01	1.4E-01	1.4E-01	2.6E-01	2.7E-01	5.2E-01	5.2E-01	7.0E-01	7.0E-01
Spleen	1.4E-01	1.7E-01	1.1E-01	1.3E-01	1.9E-01	1.9E-01	3.5E-01	3.5E-01	7.6E-01	7.6E-01	9.7E-01	9.7E-01
Stomach wall	5.2E-01	5.3E-01	6.1E-01	6.6E-01	9.8E-01	9.8E-01	1.4E+00	1.4E+00	2.5E+00	2.5E+00	2.2E+00	2.2E+00
Testes	3.3E-02	-	9.9E-02	-	1.2E-01	-	2.0E-01	-	2.9E-01	-	3.5E-01	-
Thymus	3.6E+00	3.1E+00	2.9E+00	4.8E+00	2.2E+00	2.2E+00	3.2E+00	3.2E+00	9.9E+00	9.9E+00	8.6E+00	8.6E+00
Thyroid	1.8E+02	2.2E+02	3.0E+02	3.1E+02	4.3E+02	4.3E+02	8.8E+02	8.8E+02	1.4E+03	1.4E+03	1.4E+03	1.4E+03
Urinary bladder wall	5.1E-01	6.9E-01	6.8E-01	7.1E-01	1.2E+00	1.2E+00	1.6E+00	1.6E+00	2.1E+00	2.1E+00	2.0E+00	2.0E+00
Uterus/ cervix	-	2.0E-01	-	5.8E-01	-	8.5E-01	-	6.1E-01	-	2.6E+00	-	2.4E+00
Effective dose (mSv/MBq)	8.6E+00		1.3E+01		1.8E+01		3.6E+01		5.9E+01		5.9E+01	

3102

3103 ^{124}I

3104 (h) oral administration, high uptake.

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	1.6E-01	1.7E-01	1.3E-01	1.4E-01	2.1E-01	2.1E-01	3.9E-01	3.9E-01	9.6E-01	9.6E-01	1.2E+00	1.2E+00
Brain	1.2E-01	1.8E-01	1.8E-01	2.0E-01	3.1E-01	3.2E-01	4.0E-01	4.0E-01	6.0E-01	6.0E-01	9.7E-01	9.7E-01
Breast	1.2E-01	2.7E-01	1.1E-01	1.4E-01	2.0E-01	2.0E-01	3.3E-01	3.3E-01	5.9E-01	5.9E-01	8.7E-01	8.7E-01
Colon wall	1.2E-01	1.3E-01	1.4E-01	1.3E-01	2.1E-01	2.0E-01	3.3E-01	3.2E-01	7.2E-01	7.1E-01	1.1E+00	1.1E+00
Endosteum (bone surface)	1.8E-01	2.3E-01	2.2E-01	2.4E-01	3.3E-01	3.3E-01	6.3E-01	6.3E-01	1.2E+00	1.2E+00	1.9E+00	1.9E+00
ET region	1.1E+00	1.6E+00	5.8E-01	7.2E-01	9.7E-01	9.7E-01	1.2E+00	1.2E+00	1.3E+00	1.3E+00	3.0E+00	3.0E+00
Gall bladder wall	1.3E-01	1.5E-01	1.4E-01	1.6E-01	1.9E-01	1.9E-01	3.2E-01	3.2E-01	7.2E-01	7.3E-01	1.1E+00	1.1E+00
Heart wall	4.3E-01	4.6E-01	3.9E-01	4.1E-01	4.7E-01	4.7E-01	7.6E-01	7.6E-01	1.6E+00	1.6E+00	2.0E+00	2.0E+00
Kidneys	2.1E-01	2.5E-01	2.4E-01	2.7E-01	3.8E-01	3.8E-01	6.9E-01	6.9E-01	1.5E+00	1.5E+00	2.4E+00	2.4E+00
Liver	1.8E-01	2.1E-01	1.9E-01	2.2E-01	3.3E-01	3.3E-01	6.0E-01	6.0E-01	1.4E+00	1.4E+00	2.3E+00	2.3E+00
Lung	5.3E-01	6.0E-01	1.9E+00	1.6E+00	1.9E+00	1.9E+00	3.4E+00	3.4E+00	1.3E+01	1.3E+01	1.0E+01	1.0E+01
Lymphatic nodes	2.1E+00	2.3E+00	6.2E-01	6.6E-01	6.8E-01	6.8E-01	1.4E+00	1.4E+00	2.3E+00	2.3E+00	2.8E+00	2.8E+00
Muscle	1.7E-01	2.5E-01	1.5E-01	1.4E-01	2.3E-01	2.3E-01	4.7E-01	4.7E-01	9.5E-01	9.5E-01	1.6E+00	1.6E+00
Oesophagus	4.7E+00	5.3E+00	2.0E+00	2.1E+00	2.3E+00	2.3E+00	4.7E+00	4.7E+00	1.0E+01	1.0E+01	9.6E+00	9.6E+00
Oral mucosa	4.3E-01	9.5E-01	1.1E+00	1.3E+00	1.0E+00	1.0E+00	1.2E+00	1.2E+00	1.2E+00	1.2E+00	4.9E+00	4.9E+00
Ovaries	-	1.2E-01	-	2.1E-01	-	2.8E-01	-	4.5E-01	-	7.4E-01	-	8.0E-01
Pancreas	1.4E-01	1.5E-01	1.4E-01	1.5E-01	2.2E-01	2.3E-01	3.5E-01	3.5E-01	7.0E-01	7.0E-01	9.5E-01	9.5E-01
Prostate	1.3E-01	-	1.5E-01	-	2.7E-01	-	4.1E-01	-	7.6E-01	-	7.5E-01	-
Red marrow	3.8E-01	4.5E-01	3.2E-01	3.4E-01	4.1E-01	4.1E-01	6.4E-01	6.4E-01	1.2E+00	1.2E+00	1.9E+00	1.9E+00
Salivary glands	6.7E-01	1.1E+00	1.0E+00	1.1E+00	2.3E+00	2.3E+00	2.6E+00	2.6E+00	3.4E+00	3.4E+00	7.5E+00	7.5E+00
Skin	1.0E-01	1.3E-01	1.2E-01	1.4E-01	1.9E-01	1.9E-01	3.0E-01	3.0E-01	4.7E-01	4.7E-01	7.2E-01	7.2E-01
Small intestine wall	9.2E-02	1.2E-01	9.4E-02	1.0E-01	1.4E-01	1.4E-01	2.6E-01	2.7E-01	5.6E-01	5.6E-01	7.8E-01	7.7E-01
Spleen	1.6E-01	1.8E-01	1.1E-01	1.4E-01	2.1E-01	2.1E-01	3.9E-01	3.9E-01	8.7E-01	8.7E-01	1.1E+00	1.1E+00
Stomach wall	5.0E-01	5.0E-01	5.8E-01	6.3E-01	9.3E-01	9.3E-01	1.4E+00	1.4E+00	2.5E+00	2.5E+00	2.2E+00	2.2E+00
Testes	3.0E-02	-	8.8E-02	-	1.1E-01	-	1.9E-01	-	2.9E-01	-	3.7E-01	-
Thymus	4.9E+00	4.2E+00	4.0E+00	6.4E+00	3.0E+00	3.0E+00	4.3E+00	4.3E+00	1.3E+01	1.3E+01	1.2E+01	1.2E+01
Thyroid	2.5E+02	3.0E+02	4.0E+02	4.2E+02	5.8E+02	5.8E+02	1.2E+03	1.2E+03	1.9E+03	1.9E+03	1.9E+03	1.9E+03
Urinary bladder wall	4.3E-01	5.9E-01	5.8E-01	6.1E-01	1.0E+00	1.0E+00	1.4E+00	1.4E+00	1.9E+00	1.9E+00	1.8E+00	1.8E+00
Uterus/ cervix	-	1.7E-01	-	5.4E-01	-	7.9E-01	-	5.4E-01	-	2.6E+00	-	2.5E+00
Effective dose (mSv/MBq)	1.2E+01		1.7E+01		2.4E+01		4.9E+01		8.0E+01		8.0E+01	

3105

3106 ^{124}I

3107 (i) oral administration, saturated thyroid.

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	1.2E-01	1.3E-01	8.9E-02	9.2E-02	1.4E-01	1.4E-01	2.1E-01	2.1E-01	3.9E-01	3.9E-01	4.5E-01	4.5E-01
Brain	3.1E-02	3.7E-02	5.8E-02	6.1E-02	8.5E-02	8.7E-02	1.2E-01	1.2E-01	2.0E-01	2.0E-01	2.9E-01	2.9E-01
Breast	4.0E-02	4.2E-02	3.9E-02	4.6E-02	6.1E-02	5.5E-02	1.0E-01	1.0E-01	1.6E-01	1.6E-01	2.3E-01	2.3E-01
Colon wall	1.2E-01	1.6E-01	1.5E-01	1.4E-01	2.1E-01	2.1E-01	3.2E-01	3.0E-01	5.7E-01	5.6E-01	6.5E-01	6.3E-01
Endosteum (bone surface)	4.9E-02	6.4E-02	7.8E-02	8.1E-02	1.2E-01	1.2E-01	2.2E-01	2.2E-01	4.2E-01	4.2E-01	5.4E-01	5.4E-01
ET region	3.5E-02	5.0E-02	9.7E-02	9.5E-02	1.2E-01	1.2E-01	1.4E-01	1.4E-01	2.0E-01	2.0E-01	3.0E-01	3.0E-01
Gall bladder wall	7.4E-02	9.4E-02	1.0E-01	1.1E-01	9.9E-02	1.0E-01	1.7E-01	1.7E-01	3.0E-01	3.0E-01	4.1E-01	4.1E-01
Heart wall	1.1E-01	1.3E-01	5.0E-02	6.1E-02	8.8E-02	8.8E-02	1.5E-01	1.5E-01	2.7E-01	2.7E-01	3.4E-01	3.3E-01
Kidneys	2.3E-01	2.7E-01	2.6E-01	2.9E-01	3.8E-01	3.8E-01	6.0E-01	6.0E-01	1.0E+00	1.0E+00	1.5E+00	1.5E+00
Liver	8.7E-02	1.1E-01	8.8E-02	1.0E-01	1.5E-01	1.5E-01	2.2E-01	2.2E-01	3.9E-01	3.9E-01	4.9E-01	4.9E-01
Lung	6.6E-02	7.7E-02	6.8E-02	7.5E-02	1.0E-01	1.0E-01	1.7E-01	1.7E-01	3.8E-01	3.8E-01	4.7E-01	4.7E-01
Lymphatic nodes	1.1E-01	1.1E-01	7.6E-02	7.3E-02	1.0E-01	1.0E-01	1.7E-01	1.7E-01	2.8E-01	2.8E-01	3.5E-01	3.5E-01
Muscle	4.2E-02	5.4E-02	4.9E-02	5.0E-02	7.6E-02	7.5E-02	1.2E-01	1.2E-01	2.2E-01	2.1E-01	3.1E-01	3.1E-01
Oesophagus	1.2E-01	1.3E-01	1.1E-01	1.1E-01	1.7E-01	1.7E-01	2.7E-01	2.7E-01	4.6E-01	4.6E-01	5.7E-01	5.7E-01
Oral mucosa	4.0E-02	5.5E-02	1.2E-01	1.2E-01	1.5E-01	1.5E-01	1.5E-01	1.6E-01	2.2E-01	2.2E-01	4.1E-01	4.1E-01
Ovaries	-	1.7E-01	-	3.1E-01	-	4.2E-01	-	6.2E-01	-	8.5E-01	-	6.7E-01
Pancreas	1.1E-01	1.5E-01	1.4E-01	1.4E-01	1.9E-01	1.9E-01	2.8E-01	2.8E-01	4.8E-01	4.8E-01	5.5E-01	5.5E-01
Prostate	2.0E-01	-	2.3E-01	-	4.3E-01	-	6.1E-01	-	9.9E-01	-	7.7E-01	-
Red marrow	8.2E-02	1.1E-01	9.7E-02	1.1E-01	1.3E-01	1.3E-01	1.9E-01	1.9E-01	3.2E-01	3.2E-01	4.8E-01	4.8E-01
Salivary glands	2.7E-01	3.4E-01	3.9E-01	3.9E-01	5.6E-01	5.6E-01	6.9E-01	6.9E-01	9.7E-01	9.7E-01	1.8E+00	1.8E+00
Skin	2.8E-02	3.5E-02	3.6E-02	4.0E-02	5.9E-02	5.9E-02	9.4E-02	9.5E-02	1.7E-01	1.6E-01	2.3E-01	2.3E-01
Small intestine wall	1.0E-01	1.5E-01	1.0E-01	1.0E-01	1.4E-01	1.4E-01	2.5E-01	2.7E-01	4.3E-01	4.4E-01	5.0E-01	4.9E-01
Spleen	9.4E-02	1.4E-01	8.2E-02	1.0E-01	1.4E-01	1.4E-01	2.6E-01	2.6E-01	4.7E-01	4.7E-01	5.3E-01	5.3E-01
Stomach wall	5.7E-01	6.0E-01	7.0E-01	7.5E-01	1.1E+00	1.1E+00	1.6E+00	1.6E+00	2.7E+00	2.7E+00	2.2E+00	2.2E+00
Testes	4.1E-02	-	1.3E-01	-	1.5E-01	-	2.5E-01	-	2.8E-01	-	2.9E-01	-
Thymus	6.8E-02	6.8E-02	7.4E-02	9.5E-02	9.7E-02	9.8E-02	1.6E-01	1.6E-01	3.5E-01	3.5E-01	4.4E-01	4.5E-01
Thyroid	1.7E+00	2.1E+00	2.8E+00	2.9E+00	4.2E+00	4.2E+00	8.9E+00	8.9E+00	1.6E+01	1.6E+01	1.7E+01	1.7E+01
Urinary bladder wall	7.0E-01	9.5E-01	9.4E-01	9.8E-01	1.7E+00	1.7E+00	2.2E+00	2.2E+00	2.8E+00	2.8E+00	2.5E+00	2.5E+00
Uterus/ cervix	-	2.6E-01	-	6.9E-01	-	9.9E-01	-	7.8E-01	-	2.8E+00	-	2.0E+00
Effective dose (mSv/MBq)	2.6E-01		3.3E-01		4.9E-01		8.2E-01		1.4E+00		1.5E+00	

3108

^{124}I

(j) oral administration, removed thyroid.

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	1.2E-01	1.3E-01	8.9E-02	9.2E-02	1.4E-01	1.4E-01	2.1E-01	2.1E-01	3.9E-01	3.9E-01	4.5E-01	4.5E-01
Brain	3.0E-02	3.6E-02	5.8E-02	6.0E-02	8.4E-02	8.5E-02	1.2E-01	1.2E-01	2.0E-01	2.0E-01	2.9E-01	2.9E-01
Breast	3.9E-02	4.0E-02	3.9E-02	4.5E-02	6.0E-02	5.4E-02	9.9E-02	9.8E-02	1.6E-01	1.6E-01	2.3E-01	2.3E-01
Colon wall	1.2E-01	1.6E-01	1.6E-01	1.4E-01	2.1E-01	2.1E-01	3.2E-01	3.0E-01	5.7E-01	5.6E-01	6.5E-01	6.3E-01
Endosteum (bone surface)	4.8E-02	6.3E-02	7.7E-02	8.0E-02	1.2E-01	1.2E-01	2.2E-01	2.1E-01	4.2E-01	4.2E-01	5.4E-01	5.3E-01
ET region	2.8E-02	4.0E-02	9.3E-02	9.1E-02	1.2E-01	1.2E-01	1.4E-01	1.4E-01	1.9E-01	1.9E-01	2.7E-01	2.7E-01
Gall bladder wall	7.4E-02	9.4E-02	1.0E-01	1.1E-01	9.8E-02	1.0E-01	1.7E-01	1.7E-01	3.0E-01	3.0E-01	4.1E-01	4.1E-01
Heart wall	1.1E-01	1.3E-01	4.8E-02	5.9E-02	8.5E-02	8.5E-02	1.4E-01	1.4E-01	2.6E-01	2.6E-01	3.2E-01	3.2E-01
Kidneys	2.3E-01	2.7E-01	2.6E-01	2.9E-01	3.8E-01	3.8E-01	6.0E-01	6.0E-01	1.0E+00	1.0E+00	1.5E+00	1.5E+00
Liver	8.6E-02	1.1E-01	8.7E-02	1.0E-01	1.5E-01	1.5E-01	2.2E-01	2.2E-01	3.9E-01	3.9E-01	4.9E-01	4.9E-01
Lung	6.3E-02	7.3E-02	5.5E-02	6.4E-02	9.0E-02	9.0E-02	1.4E-01	1.4E-01	2.8E-01	2.8E-01	3.9E-01	3.9E-01
Lymphatic nodes	9.3E-02	1.0E-01	7.3E-02	6.9E-02	9.8E-02	9.8E-02	1.7E-01	1.7E-01	2.7E-01	2.7E-01	3.3E-01	3.3E-01
Muscle	4.2E-02	5.3E-02	4.9E-02	4.9E-02	7.5E-02	7.4E-02	1.2E-01	1.2E-01	2.1E-01	2.1E-01	3.0E-01	3.0E-01
Oesophagus	9.1E-02	9.9E-02	9.2E-02	9.9E-02	1.5E-01	1.5E-01	2.4E-01	2.4E-01	3.8E-01	3.8E-01	5.0E-01	5.0E-01
Oral mucosa	3.7E-02	4.9E-02	1.1E-01	1.1E-01	1.4E-01	1.4E-01	1.5E-01	1.5E-01	2.1E-01	2.1E-01	3.7E-01	3.7E-01
Ovaries	-	1.7E-01	-	3.1E-01	-	4.2E-01	-	6.2E-01	-	8.5E-01	-	6.7E-01
Pancreas	1.1E-01	1.5E-01	1.4E-01	1.4E-01	1.9E-01	1.9E-01	2.8E-01	2.8E-01	4.8E-01	4.8E-01	5.5E-01	5.5E-01
Prostate	2.0E-01	-	2.3E-01	-	4.3E-01	-	6.1E-01	-	9.9E-01	-	7.7E-01	-
Red marrow	8.0E-02	1.1E-01	9.6E-02	1.1E-01	1.3E-01	1.3E-01	1.9E-01	1.8E-01	3.2E-01	3.1E-01	4.7E-01	4.7E-01
Salivary glands	2.7E-01	3.3E-01	3.8E-01	3.9E-01	5.4E-01	5.4E-01	6.7E-01	6.7E-01	9.5E-01	9.5E-01	1.7E+00	1.7E+00
Skin	2.8E-02	3.4E-02	3.5E-02	3.9E-02	5.8E-02	5.8E-02	9.2E-02	9.3E-02	1.6E-01	1.6E-01	2.3E-01	2.3E-01
Small intestine wall	1.0E-01	1.5E-01	1.0E-01	1.0E-01	1.4E-01	1.4E-01	2.5E-01	2.7E-01	4.3E-01	4.4E-01	5.0E-01	4.9E-01
Spleen	9.3E-02	1.4E-01	8.2E-02	1.0E-01	1.4E-01	1.4E-01	2.6E-01	2.6E-01	4.7E-01	4.7E-01	5.3E-01	5.3E-01
Stomach wall	5.7E-01	6.0E-01	7.0E-01	7.6E-01	1.1E+00	1.1E+00	1.6E+00	1.6E+00	2.7E+00	2.7E+00	2.2E+00	2.2E+00
Testes	4.2E-02	-	1.3E-01	-	1.5E-01	-	2.5E-01	-	2.9E-01	-	2.9E-01	-
Thymus	3.5E-02	4.0E-02	4.7E-02	5.1E-02	7.7E-02	7.8E-02	1.3E-01	1.3E-01	2.5E-01	2.5E-01	3.5E-01	3.5E-01
Thyroid	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Urinary bladder wall	7.0E-01	9.5E-01	9.5E-01	9.9E-01	1.7E+00	1.7E+00	2.2E+00	2.2E+00	2.8E+00	2.8E+00	2.5E+00	2.5E+00
Uterus/ cervix	-	2.6E-01	-	6.9E-01	-	9.9E-01	-	7.8E-01	-	2.8E+00	-	2.0E+00
$\sum_T w_T \left[\frac{H_T^F + H_T^M}{2}\right]^{\#}$ (mSv/MBq) *	1.8E-01		2.1E-01		3.2E-01		4.6E-01		7.4E-01		7.4E-01	

* Strictly speaking, patients with removed thyroid do not correspond to the ICRP reference individual. So this value, calculated analogously to the effective dose but without the thyroid as a target organ, is formally not the effective dose as defined by ICRP. (see also § 59).

Table A.27.8. Dose coefficients for ^{125}I-labelled iodide.
(a) oral administration, low uptake.

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	3.4E-02	3.7E-02	2.6E-02	2.6E-02	4.5E-02	4.5E-02	8.3E-02	8.3E-02	2.1E-01	2.1E-01	2.4E-01	2.4E-01
Brain	7.4E-03	9.4E-03	1.2E-02	1.4E-02	2.7E-02	2.7E-02	4.2E-02	4.3E-02	8.0E-02	8.0E-02	1.3E-01	1.3E-01
Breast	7.2E-03	2.4E-02	8.5E-03	1.1E-02	1.7E-02	1.6E-02	3.2E-02	3.2E-02	6.6E-02	6.6E-02	1.1E-01	1.1E-01
Colon wall	2.6E-02	3.2E-02	3.3E-02	3.2E-02	5.5E-02	5.4E-02	9.4E-02	9.1E-02	2.0E-01	2.0E-01	2.7E-01	2.7E-01
Endosteum (bone surface)	3.6E-02	4.6E-02	3.5E-02	4.0E-02	5.7E-02	5.7E-02	1.1E-01	1.1E-01	2.3E-01	2.3E-01	3.4E-01	3.4E-01
ET region	4.6E-01	6.3E-01	1.0E-01	1.6E-01	2.2E-01	2.2E-01	2.3E-01	2.3E-01	1.8E-01	1.8E-01	5.9E-01	5.9E-01
Gall bladder wall	3.4E-02	3.7E-02	3.8E-02	4.2E-02	5.9E-02	5.9E-02	1.0E-01	1.0E-01	2.0E-01	2.0E-01	2.7E-01	2.7E-01
Heart wall	6.7E-02	7.5E-02	5.5E-02	7.3E-02	7.3E-02	7.3E-02	1.5E-01	1.5E-01	3.4E-01	3.4E-01	3.7E-01	3.7E-01
Kidneys	7.4E-02	8.8E-02	8.7E-02	9.8E-02	1.4E-01	1.4E-01	2.4E-01	2.4E-01	4.7E-01	4.7E-01	6.7E-01	6.7E-01
Liver	6.6E-02	8.3E-02	8.7E-02	9.6E-02	1.5E-01	1.5E-01	2.5E-01	2.5E-01	5.0E-01	5.0E-01	6.7E-01	6.7E-01
Lung	1.3E-01	1.6E-01	1.2E+00	1.0E+00	1.0E+00	1.0E+00	1.6E+00	1.6E+00	4.0E+00	4.0E+00	2.5E+00	2.5E+00
Lymphatic nodes	1.0E+00	1.2E+00	3.3E-01	3.6E-01	3.2E-01	3.2E-01	5.6E-01	5.6E-01	6.4E-01	6.4E-01	6.1E-01	6.1E-01
Muscle	5.3E-02	8.4E-02	3.9E-02	3.6E-02	6.2E-02	6.2E-02	1.3E-01	1.3E-01	2.1E-01	2.1E-01	3.0E-01	3.0E-01
Oesophagus	2.9E+00	3.5E+00	1.0E+00	1.2E+00	1.2E+00	1.1E+00	2.1E+00	2.2E+00	3.9E+00	3.9E+00	2.8E+00	2.8E+00
Oral mucosa	4.0E-02	1.8E-01	2.9E-01	4.5E-01	1.4E-01	1.4E-01	1.6E-01	1.6E-01	1.5E-01	1.5E-01	9.6E-01	9.6E-01
Ovaries	-	2.7E-02	-	4.2E-02	-	6.6E-02	-	1.1E-01	-	1.9E-01	-	2.0E-01
Pancreas	2.6E-02	3.2E-02	2.7E-02	2.9E-02	4.6E-02	4.6E-02	8.1E-02	8.1E-02	1.6E-01	1.6E-01	2.2E-01	2.1E-01
Prostate	2.3E-02	-	2.9E-02	-	5.8E-02	-	9.4E-02	-	2.0E-01	-	1.7E-01	-
Red marrow	6.6E-02	8.4E-02	4.0E-02	4.4E-02	5.6E-02	5.7E-02	8.5E-02	8.5E-02	2.1E-01	2.1E-01	3.1E-01	3.1E-01
Salivary glands	1.1E-01	2.6E-01	1.9E-01	2.4E-01	7.9E-01	7.9E-01	6.3E-01	6.3E-01	7.5E-01	7.4E-01	1.7E+00	1.7E+00
Skin	3.0E-02	4.3E-02	3.9E-02	5.3E-02	6.6E-02	6.6E-02	9.2E-02	9.2E-02	9.7E-02	9.7E-02	1.4E-01	1.4E-01
Small intestine wall	1.9E-02	2.6E-02	2.1E-02	2.3E-02	3.4E-02	3.4E-02	6.8E-02	7.1E-02	1.5E-01	1.5E-01	2.0E-01	2.0E-01
Spleen	2.2E-02	3.0E-02	2.2E-02	2.6E-02	4.1E-02	4.1E-02	8.2E-02	8.2E-02	1.9E-01	1.9E-01	2.4E-01	2.4E-01
Stomach wall	5.7E-02	6.4E-02	5.9E-02	6.8E-02	1.1E-01	1.1E-01	1.7E-01	1.7E-01	3.9E-01	3.9E-01	5.1E-01	5.1E-01
Testes	7.9E-03	-	1.5E-02	-	2.3E-02	-	4.5E-02	-	7.2E-02	-	8.5E-02	-
Thymus	2.7E+00	2.5E+00	2.1E+00	3.6E+00	1.4E+00	1.4E+00	1.7E+00	1.7E+00	4.1E+00	4.1E+00	2.8E+00	2.8E+00
Thyroid	1.7E+02	2.1E+02	2.5E+02	2.6E+02	3.3E+02	3.3E+02	5.4E+02	5.4E+02	6.3E+02	6.3E+02	5.1E+02	5.1E+02
Urinary bladder wall	7.3E-02	9.8E-02	9.8E-02	1.0E-01	1.7E-01	1.7E-01	2.2E-01	2.2E-01	3.0E-01	2.9E-01	3.1E-01	3.0E-01
Uterus/ cervix	-	3.2E-02	-	9.4E-02	-	1.6E-01	-	1.3E-01	-	5.9E-01	-	5.4E-01
Effective dose (mSv/MBq)	7.9E+00		1.0E+01		1.3E+01		2.2E+01		2.6E+01		2.1E+01	

^{125}I

(b) oral administration, medium uptake.

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	4.7E-02	5.2E-02	3.6E-02	3.7E-02	6.4E-02	6.4E-02	1.2E-01	1.2E-01	3.1E-01	3.1E-01	3.6E-01	3.6E-01
Brain	1.0E-02	1.3E-02	1.7E-02	1.9E-02	3.8E-02	3.9E-02	6.1E-02	6.2E-02	1.2E-01	1.2E-01	1.9E-01	1.9E-01
Breast	1.0E-02	3.6E-02	1.2E-02	1.6E-02	2.4E-02	2.4E-02	4.8E-02	4.7E-02	1.0E-01	1.0E-01	1.7E-01	1.7E-01
Colon wall	3.3E-02	4.1E-02	4.2E-02	4.1E-02	7.3E-02	7.2E-02	1.3E-01	1.3E-01	2.8E-01	2.8E-01	4.0E-01	4.0E-01
Endosteum (bone surface)	5.5E-02	7.1E-02	5.3E-02	6.0E-02	8.7E-02	8.7E-02	1.6E-01	1.6E-01	3.5E-01	3.5E-01	5.3E-01	5.3E-01
ET region	7.2E-01	1.0E+00	1.6E-01	2.4E-01	3.5E-01	3.5E-01	3.7E-01	3.7E-01	2.9E-01	2.9E-01	9.6E-01	9.6E-01
Gall bladder wall	5.1E-02	5.5E-02	5.5E-02	6.1E-02	9.0E-02	9.0E-02	1.5E-01	1.5E-01	3.1E-01	3.1E-01	4.2E-01	4.2E-01
Heart wall	1.0E-01	1.1E-01	8.6E-02	1.1E-01	1.1E-01	1.1E-01	2.3E-01	2.3E-01	5.5E-01	5.5E-01	5.9E-01	5.9E-01
Kidneys	1.0E-01	1.2E-01	1.2E-01	1.3E-01	1.9E-01	1.9E-01	3.5E-01	3.5E-01	6.8E-01	6.8E-01	9.9E-01	9.9E-01
Liver	1.0E-01	1.3E-01	1.4E-01	1.5E-01	2.3E-01	2.3E-01	3.9E-01	3.9E-01	8.0E-01	8.0E-01	1.1E+00	1.1E+00
Lung	2.1E-01	2.6E-01	1.9E+00	1.6E+00	1.6E+00	1.6E+00	2.6E+00	2.6E+00	6.6E+00	6.6E+00	4.2E+00	4.2E+00
Lymphatic nodes	1.6E+00	1.9E+00	5.3E-01	5.7E-01	5.1E-01	5.1E-01	9.1E-01	9.1E-01	1.1E+00	1.1E+00	9.9E-01	9.9E-01
Muscle	8.3E-02	1.3E-01	6.0E-02	5.5E-02	9.6E-02	9.6E-02	2.0E-01	2.0E-01	3.4E-01	3.4E-01	4.8E-01	4.8E-01
Oesophagus	4.6E+00	5.5E+00	1.7E+00	1.9E+00	1.9E+00	1.8E+00	3.5E+00	3.5E+00	6.5E+00	6.5E+00	4.7E+00	4.7E+00
Oral mucosa	6.3E-02	2.9E-01	4.6E-01	7.1E-01	2.2E-01	2.2E-01	2.5E-01	2.5E-01	2.3E-01	2.3E-01	1.6E+00	1.6E+00
Ovaries	-	3.2E-02	-	4.2E-02	-	6.8E-02	-	1.2E-01	-	2.3E-01	-	2.7E-01
Pancreas	3.5E-02	4.2E-02	3.4E-02	3.8E-02	6.1E-02	6.1E-02	1.1E-01	1.1E-01	2.2E-01	2.2E-01	3.1E-01	3.1E-01
Prostate	2.3E-02	-	2.9E-02	-	5.8E-02	-	9.7E-02	-	2.1E-01	-	2.1E-01	-
Red marrow	1.0E-01	1.3E-01	6.2E-02	6.8E-02	8.6E-02	8.7E-02	1.3E-01	1.3E-01	3.3E-01	3.3E-01	4.8E-01	4.8E-01
Salivary glands	1.5E-01	3.8E-01	2.8E-01	3.6E-01	1.2E+00	1.2E+00	9.7E-01	9.7E-01	1.2E+00	1.2E+00	2.8E+00	2.7E+00
Skin	4.6E-02	6.6E-02	6.1E-02	8.3E-02	1.0E-01	1.0E-01	1.4E-01	1.4E-01	1.5E-01	1.5E-01	2.1E-01	2.1E-01
Small intestine wall	2.4E-02	3.3E-02	2.8E-02	3.0E-02	4.5E-02	4.6E-02	9.2E-02	9.5E-02	2.1E-01	2.1E-01	2.9E-01	2.9E-01
Spleen	2.9E-02	3.7E-02	2.9E-02	3.5E-02	5.6E-02	5.6E-02	1.1E-01	1.1E-01	2.7E-01	2.7E-01	3.5E-01	3.5E-01
Stomach wall	6.1E-02	6.9E-02	6.3E-02	7.2E-02	1.2E-01	1.2E-01	1.9E-01	1.9E-01	4.6E-01	4.6E-01	6.0E-01	6.0E-01
Testes	1.1E-02	-	1.7E-02	-	3.0E-02	-	5.5E-02	-	9.6E-02	-	1.2E-01	-
Thymus	4.2E+00	4.0E+00	3.4E+00	5.7E+00	2.2E+00	2.2E+00	2.9E+00	2.8E+00	6.8E+00	6.8E+00	4.7E+00	4.7E+00
Thyroid	2.8E+02	3.3E+02	3.9E+02	4.1E+02	5.3E+02	5.3E+02	8.9E+02	8.9E+02	1.1E+03	1.1E+03	8.5E+02	8.5E+02
Urinary bladder wall	6.7E-02	9.0E-02	9.0E-02	9.1E-02	1.5E-01	1.5E-01	2.1E-01	2.0E-01	3.2E-01	3.1E-01	3.4E-01	3.2E-01
Uterus/ cervix	-	3.3E-02	-	1.1E-01	-	2.0E-01	-	1.4E-01	-	7.1E-01	-	7.3E-01
Effective dose (mSv/MBq)	1.3E+01		1.7E+01		2.2E+01		3.6E+01		4.4E+01		3.5E+01	

3121 ^{125}I

3122 (c) i.v. administration, high uptake.

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	6.1E-02	6.8E-02	4.6E-02	4.8E-02	8.4E-02	8.4E-02	1.7E-01	1.7E-01	4.3E-01	4.3E-01	5.0E-01	5.0E-01
Brain	1.3E-02	1.7E-02	2.2E-02	2.4E-02	5.0E-02	5.1E-02	8.2E-02	8.3E-02	1.6E-01	1.6E-01	2.7E-01	2.7E-01
Breast	1.3E-02	4.9E-02	1.6E-02	2.0E-02	3.3E-02	3.2E-02	6.5E-02	6.4E-02	1.4E-01	1.4E-01	2.4E-01	2.4E-01
Colon wall	4.1E-02	4.9E-02	5.2E-02	5.2E-02	9.1E-02	9.1E-02	1.6E-01	1.6E-01	3.7E-01	3.7E-01	5.4E-01	5.4E-01
Endosteum (bone surface)	7.6E-02	9.7E-02	7.2E-02	8.2E-02	1.2E-01	1.2E-01	2.3E-01	2.3E-01	4.9E-01	4.9E-01	7.5E-01	7.5E-01
ET region	1.0E+00	1.4E+00	2.2E-01	3.4E-01	4.8E-01	4.8E-01	5.3E-01	5.2E-01	4.2E-01	4.2E-01	1.4E+00	1.4E+00
Gall bladder wall	6.8E-02	7.4E-02	7.3E-02	8.2E-02	1.2E-01	1.2E-01	2.1E-01	2.1E-01	4.4E-01	4.4E-01	5.9E-01	5.9E-01
Heart wall	1.4E-01	1.6E-01	1.2E-01	1.6E-01	1.6E-01	1.6E-01	3.2E-01	3.2E-01	7.8E-01	7.8E-01	8.5E-01	8.5E-01
Kidneys	1.3E-01	1.5E-01	1.5E-01	1.7E-01	2.5E-01	2.5E-01	4.6E-01	4.6E-01	9.3E-01	9.3E-01	1.4E+00	1.4E+00
Liver	1.4E-01	1.7E-01	1.9E-01	2.0E-01	3.1E-01	3.1E-01	5.5E-01	5.5E-01	1.1E+00	1.1E+00	1.6E+00	1.6E+00
Lung	2.9E-01	3.6E-01	2.7E+00	2.3E+00	2.3E+00	2.3E+00	3.8E+00	3.8E+00	9.6E+00	9.6E+00	6.1E+00	6.1E+00
Lymphatic nodes	2.3E+00	2.7E+00	7.4E-01	8.0E-01	7.2E-01	7.2E-01	1.3E+00	1.3E+00	1.5E+00	1.5E+00	1.4E+00	1.4E+00
Muscle	1.1E-01	1.8E-01	8.3E-02	7.5E-02	1.3E-01	1.3E-01	2.8E-01	2.8E-01	4.8E-01	4.8E-01	6.9E-01	6.9E-01
Oesophagus	6.4E+00	7.7E+00	2.3E+00	2.7E+00	2.6E+00	2.6E+00	5.0E+00	5.0E+00	9.4E+00	9.5E+00	6.9E+00	6.9E+00
Oral mucosa	8.6E-02	4.0E-01	6.5E-01	9.9E-01	3.1E-01	3.1E-01	3.5E-01	3.5E-01	3.3E-01	3.3E-01	2.3E+00	2.3E+00
Ovaries	-	3.7E-02	-	4.3E-02	-	7.1E-02	-	1.3E-01	-	2.7E-01	-	3.5E-01
Pancreas	4.4E-02	5.3E-02	4.2E-02	4.7E-02	7.6E-02	7.6E-02	1.4E-01	1.4E-01	3.0E-01	3.0E-01	4.2E-01	4.2E-01
Prostate	2.4E-02	-	3.0E-02	-	5.7E-02	-	1.0E-01	-	2.3E-01	-	2.6E-01	-
Red marrow	1.4E-01	1.8E-01	8.5E-02	9.3E-02	1.2E-01	1.2E-01	1.8E-01	1.8E-01	4.6E-01	4.6E-01	6.8E-01	6.8E-01
Salivary glands	2.0E-01	5.1E-01	3.7E-01	4.8E-01	1.7E+00	1.7E+00	1.4E+00	1.4E+00	1.6E+00	1.6E+00	3.9E+00	3.9E+00
Skin	6.3E-02	9.1E-02	8.4E-02	1.2E-01	1.4E-01	1.4E-01	2.0E-01	2.0E-01	2.1E-01	2.1E-01	3.0E-01	3.0E-01
Small intestine wall	2.9E-02	4.0E-02	3.5E-02	3.8E-02	5.8E-02	5.9E-02	1.2E-01	1.2E-01	2.7E-01	2.7E-01	3.9E-01	3.9E-01
Spleen	3.6E-02	4.6E-02	3.7E-02	4.5E-02	7.2E-02	7.2E-02	1.5E-01	1.5E-01	3.6E-01	3.6E-01	4.8E-01	4.8E-01
Stomach wall	6.5E-02	7.4E-02	6.8E-02	7.7E-02	1.3E-01	1.3E-01	2.2E-01	2.2E-01	5.4E-01	5.4E-01	7.1E-01	7.1E-01
Testes	1.3E-02	-	2.0E-02	-	3.7E-02	-	6.7E-02	-	1.2E-01	-	1.6E-01	-
Thymus	5.9E+00	5.6E+00	4.7E+00	8.0E+00	3.1E+00	3.1E+00	4.1E+00	4.1E+00	9.9E+00	9.9E+00	6.8E+00	6.8E+00
Thyroid	3.9E+02	4.6E+02	5.5E+02	5.8E+02	7.5E+02	7.5E+02	1.3E+03	1.3E+03	1.5E+03	1.5E+03	1.2E+03	1.2E+03
Urinary bladder wall	6.1E-02	8.1E-02	8.2E-02	8.3E-02	1.4E-01	1.4E-01	2.0E-01	1.9E-01	3.4E-01	3.3E-01	3.8E-01	3.6E-01
Uterus/ cervix	-	3.5E-02	-	1.4E-01	-	2.4E-01	-	1.4E-01	-	8.6E-01	-	9.6E-01
Effective dose (mSv/MBq)	1.7E+01		2.3E+01		3.0E+01		5.2E+01		6.3E+01		5.1E+01	

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^{125}I

(d) oral administration, saturated thyroid.

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	1.2E-02	1.2E-02	9.4E-03	8.8E-03	1.4E-02	1.4E-02	2.2E-02	2.2E-02	4.7E-02	4.7E-02	5.5E-02	5.5E-02
Brain	3.0E-03	3.6E-03	4.7E-03	4.9E-03	7.9E-03	8.0E-03	1.3E-02	1.3E-02	2.3E-02	2.3E-02	3.5E-02	3.5E-02
Breast	2.5E-03	3.0E-03	2.7E-03	3.3E-03	4.4E-03	4.2E-03	8.1E-03	8.0E-03	1.5E-02	1.4E-02	2.6E-02	2.6E-02
Colon wall	1.4E-02	1.8E-02	1.8E-02	1.6E-02	2.7E-02	2.6E-02	4.2E-02	3.9E-02	8.4E-02	8.2E-02	9.3E-02	9.0E-02
Endosteum (bone surface)	3.0E-03	4.0E-03	5.6E-03	5.7E-03	8.8E-03	8.7E-03	1.6E-02	1.6E-02	3.7E-02	3.7E-02	5.6E-02	5.6E-02
ET region	3.5E-03	5.2E-03	6.2E-03	7.1E-03	9.8E-03	9.8E-03	1.3E-02	1.3E-02	2.0E-02	2.0E-02	3.2E-02	3.2E-02
Gall bladder wall	5.9E-03	7.1E-03	1.1E-02	1.1E-02	9.7E-03	9.7E-03	1.9E-02	1.9E-02	3.9E-02	3.9E-02	5.6E-02	5.6E-02
Heart wall	8.9E-03	9.3E-03	4.6E-03	5.6E-03	8.4E-03	8.4E-03	1.6E-02	1.6E-02	3.2E-02	3.2E-02	4.2E-02	4.2E-02
Kidneys	3.0E-02	3.6E-02	3.4E-02	3.8E-02	5.0E-02	5.0E-02	8.1E-02	8.1E-02	1.4E-01	1.4E-01	2.1E-01	2.1E-01
Liver	8.3E-03	1.1E-02	8.8E-03	1.0E-02	1.6E-02	1.6E-02	2.5E-02	2.5E-02	4.9E-02	4.9E-02	6.4E-02	6.4E-02
Lung	6.0E-03	7.5E-03	7.8E-03	8.6E-03	1.2E-02	1.2E-02	2.0E-02	2.1E-02	5.3E-02	5.3E-02	6.6E-02	6.6E-02
Lymphatic nodes	1.0E-02	1.1E-02	6.8E-03	6.6E-03	9.6E-03	9.6E-03	1.9E-02	1.9E-02	3.5E-02	3.5E-02	4.5E-02	4.5E-02
Muscle	3.5E-03	4.6E-03	4.4E-03	4.5E-03	7.2E-03	7.2E-03	1.3E-02	1.2E-02	2.4E-02	2.4E-02	3.5E-02	3.5E-02
Oesophagus	1.1E-02	1.3E-02	9.2E-03	9.9E-03	1.5E-02	1.5E-02	2.8E-02	2.8E-02	5.5E-02	5.5E-02	7.0E-02	7.0E-02
Oral mucosa	3.0E-03	4.9E-03	9.7E-03	1.1E-02	1.2E-02	1.2E-02	1.3E-02	1.3E-02	2.1E-02	2.1E-02	4.3E-02	4.3E-02
Ovaries	-	1.8E-02	-	4.2E-02	-	6.2E-02	-	9.7E-02	-	1.4E-01	-	1.0E-01
Pancreas	1.0E-02	1.5E-02	1.5E-02	1.5E-02	2.3E-02	2.3E-02	3.6E-02	3.6E-02	6.7E-02	6.6E-02	7.7E-02	7.7E-02
Prostate	2.2E-02	-	2.9E-02	-	6.0E-02	-	9.1E-02	-	1.7E-01	-	1.2E-01	-
Red marrow	4.4E-03	6.3E-03	5.0E-03	5.7E-03	8.3E-03	8.2E-03	1.3E-02	1.3E-02	2.9E-02	2.9E-02	4.9E-02	4.9E-02
Salivary glands	3.8E-02	4.8E-02	5.2E-02	5.3E-02	7.7E-02	7.7E-02	9.6E-02	9.6E-02	1.4E-01	1.4E-01	2.6E-01	2.6E-01
Skin	2.5E-03	3.4E-03	3.3E-03	3.7E-03	5.8E-03	5.9E-03	1.0E-02	1.0E-02	1.9E-02	1.9E-02	2.8E-02	2.8E-02
Small intestine wall	1.0E-02	1.5E-02	1.0E-02	1.0E-02	1.5E-02	1.6E-02	3.0E-02	3.3E-02	6.0E-02	6.0E-02	7.2E-02	7.1E-02
Spleen	9.5E-03	1.6E-02	9.1E-03	1.1E-02	1.7E-02	1.7E-02	3.4E-02	3.4E-02	6.5E-02	6.5E-02	7.3E-02	7.3E-02
Stomach wall	5.1E-02	5.6E-02	5.3E-02	6.2E-02	9.1E-02	9.1E-02	1.4E-01	1.4E-01	2.9E-01	2.9E-01	3.7E-01	3.7E-01
Testes	3.4E-03	-	1.1E-02	-	1.3E-02	-	2.9E-02	-	3.6E-02	-	3.6E-02	-
Thymus	6.9E-03	7.4E-03	8.0E-03	1.1E-02	1.0E-02	1.0E-02	1.8E-02	1.8E-02	4.6E-02	4.6E-02	5.7E-02	5.8E-02
Thyroid	2.7E-01	3.3E-01	4.4E-01	4.5E-01	6.6E-01	6.6E-01	1.5E+00	1.5E+00	2.8E+00	2.8E+00	3.1E+00	3.1E+00
Urinary bladder wall	8.4E-02	1.1E-01	1.1E-01	1.2E-01	1.9E-01	1.9E-01	2.4E-01	2.4E-01	2.8E-01	2.8E-01	2.6E-01	2.6E-01
Uterus/ cervix	-	3.0E-02	-	6.0E-02	-	1.0E-01	-	1.2E-01	-	4.1E-01	-	2.6E-01
Effective dose (mSv/MBq)	3.0E-02		3.9E-02		5.9E-02		1.1E-01		2.0E-01		2.3E-01	

^{125}I

(e) oral administration, removed thyroid.

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	1.2E-02	1.2E-02	9.4E-03	8.8E-03	1.4E-02	1.4E-02	2.2E-02	2.2E-02	4.7E-02	4.7E-02	5.5E-02	5.5E-02
Brain	3.0E-03	3.6E-03	4.7E-03	4.9E-03	7.9E-03	8.0E-03	1.3E-02	1.3E-02	2.3E-02	2.3E-02	3.5E-02	3.5E-02
Breast	2.4E-03	3.0E-03	2.7E-03	3.3E-03	4.4E-03	4.2E-03	8.0E-03	8.0E-03	1.4E-02	1.4E-02	2.6E-02	2.6E-02
Colon wall	1.4E-02	1.8E-02	1.8E-02	1.6E-02	2.7E-02	2.6E-02	4.2E-02	3.9E-02	8.4E-02	8.2E-02	9.3E-02	9.1E-02
Endosteum (bone surface)	2.9E-03	3.9E-03	5.6E-03	5.7E-03	8.8E-03	8.6E-03	1.6E-02	1.6E-02	3.7E-02	3.6E-02	5.5E-02	5.5E-02
ET region	2.8E-03	4.3E-03	6.1E-03	6.8E-03	9.4E-03	9.4E-03	1.2E-02	1.2E-02	2.0E-02	2.0E-02	2.9E-02	2.9E-02
Gall bladder wall	5.9E-03	7.1E-03	1.1E-02	1.1E-02	9.7E-03	9.7E-03	1.9E-02	1.9E-02	3.9E-02	3.9E-02	5.6E-02	5.6E-02
Heart wall	8.8E-03	9.2E-03	4.5E-03	5.5E-03	8.3E-03	8.3E-03	1.6E-02	1.6E-02	3.1E-02	3.1E-02	4.1E-02	4.1E-02
Kidneys	3.0E-02	3.6E-02	3.4E-02	3.8E-02	5.0E-02	5.0E-02	8.1E-02	8.1E-02	1.4E-01	1.4E-01	2.1E-01	2.1E-01
Liver	8.3E-03	1.1E-02	8.8E-03	1.0E-02	1.6E-02	1.6E-02	2.5E-02	2.5E-02	4.9E-02	4.9E-02	6.4E-02	6.4E-02
Lung	5.8E-03	7.3E-03	5.6E-03	6.8E-03	9.8E-03	9.7E-03	1.6E-02	1.6E-02	3.6E-02	3.6E-02	5.2E-02	5.2E-02
Lymphatic nodes	8.6E-03	9.2E-03	6.2E-03	6.0E-03	9.0E-03	9.0E-03	1.8E-02	1.8E-02	3.3E-02	3.3E-02	4.2E-02	4.2E-02
Muscle	3.4E-03	4.5E-03	4.3E-03	4.4E-03	7.2E-03	7.1E-03	1.2E-02	1.2E-02	2.3E-02	2.3E-02	3.4E-02	3.4E-02
Oesophagus	6.5E-03	7.4E-03	7.4E-03	7.8E-03	1.3E-02	1.3E-02	2.2E-02	2.2E-02	3.9E-02	3.9E-02	5.4E-02	5.4E-02
Oral mucosa	3.0E-03	4.6E-03	9.2E-03	9.8E-03	1.1E-02	1.2E-02	1.2E-02	1.2E-02	2.1E-02	2.1E-02	3.8E-02	3.8E-02
Ovaries	-	1.8E-02	-	4.2E-02	-	6.2E-02	-	9.7E-02	-	1.4E-01	-	1.0E-01
Pancreas	1.0E-02	1.5E-02	1.5E-02	1.5E-02	2.3E-02	2.3E-02	3.6E-02	3.6E-02	6.6E-02	6.6E-02	7.7E-02	7.7E-02
Prostate	2.2E-02	-	2.9E-02	-	6.0E-02	-	9.2E-02	-	1.7E-01	-	1.2E-01	-
Red marrow	4.3E-03	6.2E-03	5.0E-03	5.6E-03	8.2E-03	8.1E-03	1.3E-02	1.3E-02	2.9E-02	2.9E-02	4.8E-02	4.8E-02
Salivary glands	3.8E-02	4.7E-02	5.2E-02	5.3E-02	7.6E-02	7.6E-02	9.4E-02	9.4E-02	1.3E-01	1.3E-01	2.5E-01	2.5E-01
Skin	2.5E-03	3.3E-03	3.2E-03	3.7E-03	5.7E-03	5.8E-03	9.9E-03	1.0E-02	1.9E-02	1.9E-02	2.8E-02	2.8E-02
Small intestine wall	1.0E-02	1.5E-02	1.0E-02	1.0E-02	1.5E-02	1.6E-02	3.0E-02	3.3E-02	6.0E-02	6.0E-02	7.2E-02	7.1E-02
Spleen	9.5E-03	1.6E-02	9.1E-03	1.1E-02	1.7E-02	1.7E-02	3.4E-02	3.4E-02	6.5E-02	6.5E-02	7.3E-02	7.3E-02
Stomach wall	5.1E-02	5.6E-02	5.3E-02	6.2E-02	9.1E-02	9.1E-02	1.4E-01	1.4E-01	2.9E-01	2.9E-01	3.7E-01	3.7E-01
Testes	3.4E-03	-	1.1E-02	-	1.3E-02	-	2.9E-02	-	3.6E-02	-	3.6E-02	-
Thymus	2.8E-03	3.5E-03	4.3E-03	4.8E-03	7.5E-03	7.6E-03	1.3E-02	1.3E-02	2.9E-02	2.9E-02	4.1E-02	4.2E-02
Thyroid	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Urinary bladder wall	8.4E-02	1.1E-01	1.1E-01	1.2E-01	1.9E-01	1.9E-01	2.4E-01	2.4E-01	2.8E-01	2.8E-01	2.6E-01	2.6E-01
Uterus/ cervix	-	3.0E-02	-	6.1E-02	-	1.0E-01	-	1.2E-01	-	4.1E-01	-	2.6E-01
$\sum_T w_T \left[\frac{H_T^F + H_T^M}{2}\right]^{\#}$ (mSv/MBq) *	1.7E-02		2.0E-02		3.2E-02		4.8E-02		8.6E-02		1.0E-01	

* Strictly speaking, patients with removed thyroid do not correspond to the ICRP reference individual. So this value, calculated analogously to the effective dose but without the thyroid as a target organ, is formally not the effective dose as defined by ICRP. (see also § 59).

Table A.27.9. Dose coefficients for ^{131}I-labelled iodide.
(a) oral administration, low uptake.

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	7.2E-02	8.2E-02	6.7E-02	7.2E-02	1.1E-01	1.1E-01	1.9E-01	1.9E-01	4.6E-01	4.6E-01	5.8E-01	5.7E-01
Brain	4.4E-02	6.5E-02	7.0E-02	7.7E-02	1.2E-01	1.3E-01	1.7E-01	1.7E-01	2.8E-01	2.8E-01	4.4E-01	4.4E-01
Breast	4.7E-02	9.7E-02	4.6E-02	5.6E-02	8.5E-02	8.3E-02	1.5E-01	1.4E-01	2.8E-01	2.7E-01	4.5E-01	4.5E-01
Colon wall	6.1E-02	7.1E-02	7.5E-02	7.1E-02	1.2E-01	1.2E-01	1.9E-01	1.9E-01	4.2E-01	4.2E-01	6.2E-01	6.1E-01
Endosteum (bone surface)	7.3E-02	9.2E-02	9.4E-02	1.0E-01	1.5E-01	1.5E-01	2.8E-01	2.8E-01	5.8E-01	5.8E-01	8.7E-01	8.7E-01
ET region	3.6E-01	5.3E-01	2.0E-01	2.4E-01	3.3E-01	3.3E-01	3.9E-01	3.9E-01	4.3E-01	4.3E-01	9.0E-01	9.0E-01
Gall bladder wall	5.9E-02	6.8E-02	6.8E-02	7.8E-02	9.3E-02	9.3E-02	1.6E-01	1.6E-01	3.4E-01	3.4E-01	5.0E-01	5.0E-01
Heart wall	1.6E-01	1.8E-01	1.5E-01	1.5E-01	1.9E-01	1.9E-01	3.0E-01	3.0E-01	6.2E-01	6.2E-01	7.8E-01	7.8E-01
Kidneys	1.9E-01	2.2E-01	2.2E-01	2.5E-01	3.4E-01	3.4E-01	6.2E-01	6.3E-01	1.3E+00	1.3E+00	2.2E+00	2.2E+00
Liver	1.0E-01	1.2E-01	1.2E-01	1.4E-01	2.2E-01	2.2E-01	3.9E-01	3.9E-01	9.6E-01	9.6E-01	1.5E+00	1.5E+00
Lung	2.0E-01	2.3E-01	6.5E-01	5.5E-01	6.6E-01	6.6E-01	1.1E+00	1.1E+00	2.9E+00	2.9E+00	2.5E+00	2.5E+00
Lymphatic nodes	6.0E-01	6.4E-01	2.1E-01	2.2E-01	2.3E-01	2.3E-01	4.3E-01	4.3E-01	6.4E-01	6.4E-01	7.9E-01	7.9E-01
Muscle	6.5E-02	9.2E-02	6.2E-02	6.0E-02	9.9E-02	9.9E-02	1.9E-01	1.9E-01	3.7E-01	3.7E-01	5.8E-01	5.8E-01
Oesophagus	1.5E+00	1.7E+00	6.9E-01	7.4E-01	8.2E-01	8.1E-01	1.6E+00	1.6E+00	3.1E+00	3.1E+00	2.9E+00	2.9E+00
Oral mucosa	1.5E-01	3.3E-01	3.8E-01	4.5E-01	3.5E-01	3.5E-01	4.3E-01	4.3E-01	4.7E-01	4.7E-01	1.3E+00	1.3E+00
Ovaries	-	7.2E-02	-	1.1E-01	-	1.6E-01	-	2.4E-01	-	4.1E-01	-	4.8E-01
Pancreas	6.8E-02	7.7E-02	7.4E-02	7.8E-02	1.2E-01	1.2E-01	1.9E-01	1.9E-01	3.8E-01	3.8E-01	5.5E-01	5.5E-01
Prostate	6.9E-02	-	8.4E-02	-	1.5E-01	-	2.3E-01	-	4.2E-01	-	4.3E-01	-
Red marrow	1.5E-01	1.8E-01	1.3E-01	1.4E-01	1.8E-01	1.8E-01	2.8E-01	2.8E-01	5.4E-01	5.4E-01	8.4E-01	8.4E-01
Salivary glands	3.8E-01	5.6E-01	5.2E-01	5.7E-01	1.0E+00	1.0E+00	1.2E+00	1.2E+00	1.6E+00	1.6E+00	3.2E+00	3.2E+00
Skin	4.3E-02	5.4E-02	5.1E-02	5.9E-02	8.4E-02	8.4E-02	1.4E-01	1.4E-01	2.4E-01	2.4E-01	3.7E-01	3.7E-01
Small intestine wall	5.2E-02	6.9E-02	5.7E-02	6.0E-02	8.7E-02	9.0E-02	1.6E-01	1.7E-01	3.5E-01	3.5E-01	5.1E-01	5.1E-01
Spleen	7.5E-02	8.8E-02	6.3E-02	7.6E-02	1.2E-01	1.2E-01	2.1E-01	2.1E-01	4.7E-01	4.7E-01	6.7E-01	6.7E-01
Stomach wall	3.6E-01	3.8E-01	4.6E-01	4.9E-01	7.2E-01	7.2E-01	1.1E+00	1.1E+00	2.1E+00	2.1E+00	2.3E+00	2.3E+00
Testes	2.2E-02	-	5.3E-02	-	7.4E-02	-	1.2E-01	-	2.0E-01	-	2.7E-01	-
Thymus	1.5E+00	1.4E+00	1.3E+00	2.0E+00	9.7E-01	9.7E-01	1.4E+00	1.4E+00	3.4E+00	3.4E+00	3.0E+00	3.0E+00
Thyroid	2.4E+02	2.8E+02	3.8E+02	3.9E+02	5.6E+02	5.6E+02	1.2E+03	1.2E+03	1.9E+03	1.9E+03	1.8E+03	1.8E+03
Urinary bladder wall	1.9E-01	2.5E-01	2.5E-01	2.6E-01	4.3E-01	4.3E-01	5.8E-01	5.8E-01	8.4E-01	8.4E-01	7.9E-01	7.8E-01
Uterus/ cervix	-	9.3E-02	-	2.7E-01	-	4.0E-01	-	2.8E-01	-	1.1E+00	-	1.1E+00
Effective dose (mSv/MBq)	1.1E+01		1.6E+01		2.3E+01		4.8E+01		7.7E+01		7.4E+01	

3136 ^{131}I

3137 (b) oral administration, medium uptake.

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	8.3E-02	9.4E-02	7.8E-02	8.5E-02	1.3E-01	1.3E-01	2.4E-01	2.4E-01	6.0E-01	6.0E-01	7.6E-01	7.6E-01
Brain	5.9E-02	8.9E-02	9.1E-02	1.0E-01	1.7E-01	1.7E-01	2.2E-01	2.2E-01	3.7E-01	3.7E-01	5.9E-01	5.9E-01
Breast	6.1E-02	1.4E-01	5.8E-02	7.2E-02	1.1E-01	1.1E-01	1.9E-01	1.9E-01	3.7E-01	3.7E-01	6.0E-01	6.0E-01
Colon wall	6.3E-02	7.1E-02	7.7E-02	7.4E-02	1.2E-01	1.2E-01	2.1E-01	2.1E-01	5.0E-01	5.0E-01	7.7E-01	7.6E-01
Endosteum (bone surface)	9.9E-02	1.3E-01	1.2E-01	1.3E-01	1.9E-01	1.9E-01	3.7E-01	3.7E-01	7.7E-01	7.7E-01	1.2E+00	1.2E+00
ET region	5.5E-01	8.2E-01	2.9E-01	3.6E-01	4.9E-01	4.9E-01	5.8E-01	5.8E-01	6.3E-01	6.3E-01	1.4E+00	1.4E+00
Gall bladder wall	7.2E-02	8.2E-02	7.9E-02	9.2E-02	1.1E-01	1.1E-01	2.0E-01	2.0E-01	4.4E-01	4.4E-01	6.5E-01	6.6E-01
Heart wall	2.3E-01	2.4E-01	2.1E-01	2.2E-01	2.6E-01	2.6E-01	4.2E-01	4.2E-01	8.8E-01	8.8E-01	1.1E+00	1.1E+00
Kidneys	1.9E-01	2.3E-01	2.3E-01	2.6E-01	3.7E-01	3.7E-01	7.0E-01	7.0E-01	1.6E+00	1.6E+00	2.7E+00	2.7E+00
Liver	1.3E-01	1.6E-01	1.6E-01	1.8E-01	2.9E-01	2.9E-01	5.4E-01	5.4E-01	1.4E+00	1.4E+00	2.2E+00	2.2E+00
Lung	2.9E-01	3.3E-01	9.9E-01	8.4E-01	9.9E-01	9.9E-01	1.7E+00	1.7E+00	4.4E+00	4.4E+00	3.8E+00	3.8E+00
Lymphatic nodes	9.1E-01	9.8E-01	3.0E-01	3.2E-01	3.3E-01	3.3E-01	6.1E-01	6.1E-01	9.3E-01	9.3E-01	1.1E+00	1.1E+00
Muscle	8.9E-02	1.3E-01	8.1E-02	7.9E-02	1.3E-01	1.3E-01	2.6E-01	2.6E-01	5.1E-01	5.1E-01	8.2E-01	8.2E-01
Oesophagus	2.2E+00	2.5E+00	1.0E+00	1.1E+00	1.2E+00	1.2E+00	2.4E+00	2.4E+00	4.6E+00	4.6E+00	4.3E+00	4.3E+00
Oral mucosa	2.2E-01	5.0E-01	5.7E-01	6.8E-01	5.1E-01	5.1E-01	6.2E-01	6.2E-01	6.7E-01	6.7E-01	1.9E+00	2.0E+00
Ovaries	-	6.8E-02	-	1.0E-01	-	1.5E-01	-	2.3E-01	-	4.4E-01	-	5.6E-01
Pancreas	7.6E-02	8.3E-02	7.9E-02	8.5E-02	1.3E-01	1.3E-01	2.2E-01	2.2E-01	4.6E-01	4.6E-01	6.9E-01	6.9E-01
Prostate	6.3E-02	-	7.7E-02	-	1.4E-01	-	2.2E-01	-	4.3E-01	-	4.9E-01	-
Red marrow	2.0E-01	2.4E-01	1.8E-01	1.9E-01	2.4E-01	2.4E-01	3.8E-01	3.8E-01	7.4E-01	7.4E-01	1.2E+00	1.2E+00
Salivary glands	4.4E-01	6.9E-01	6.3E-01	7.0E-01	1.3E+00	1.3E+00	1.5E+00	1.5E+00	2.0E+00	2.0E+00	4.1E+00	4.1E+00
Skin	5.7E-02	7.2E-02	6.7E-02	7.8E-02	1.1E-01	1.1E-01	1.8E-01	1.8E-01	3.1E-01	3.1E-01	4.9E-01	4.9E-01
Small intestine wall	5.4E-02	6.9E-02	5.9E-02	6.3E-02	9.4E-02	9.6E-02	1.8E-01	1.8E-01	4.1E-01	4.1E-01	6.3E-01	6.3E-01
Spleen	9.0E-02	9.9E-02	7.2E-02	8.8E-02	1.4E-01	1.4E-01	2.5E-01	2.5E-01	6.0E-01	6.0E-01	8.6E-01	8.6E-01
Stomach wall	3.5E-01	3.6E-01	4.4E-01	4.7E-01	6.9E-01	6.9E-01	1.0E+00	1.0E+00	2.1E+00	2.1E+00	2.3E+00	2.3E+00
Testes	2.1E-02	-	5.0E-02	-	7.3E-02	-	1.3E-01	-	2.2E-01	-	3.2E-01	-
Thymus	2.4E+00	2.1E+00	2.0E+00	3.1E+00	1.5E+00	1.5E+00	2.1E+00	2.1E+00	5.3E+00	5.3E+00	4.7E+00	4.7E+00
Thyroid	3.7E+02	4.4E+02	5.9E+02	6.1E+02	8.7E+02	8.7E+02	1.8E+03	1.8E+03	3.0E+03	3.0E+03	2.9E+03	2.9E+03
Urinary bladder wall	1.7E-01	2.2E-01	2.2E-01	2.3E-01	3.8E-01	3.8E-01	5.2E-01	5.2E-01	8.0E-01	7.9E-01	8.0E-01	7.8E-01
Uterus/ cervix	-	8.5E-02	-	2.7E-01	-	4.0E-01	-	2.7E-01	-	1.2E+00	-	1.3E+00
Effective dose (mSv/MBq)	1.6E+01		2.4E+01		3.5E+01		7.4E+01		1.2E+02		1.2E+02	

3138

3139 ^{131}I

3140 (c) oral administration, high uptake.

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	9.5E-02	1.1E-01	9.0E-02	9.8E-02	1.5E-01	1.5E-01	2.9E-01	2.9E-01	7.4E-01	7.4E-01	9.5E-01	9.5E-01
Brain	7.4E-02	1.1E-01	1.1E-01	1.3E-01	2.1E-01	2.1E-01	2.8E-01	2.8E-01	4.6E-01	4.6E-01	7.5E-01	7.5E-01
Breast	7.6E-02	1.8E-01	7.0E-02	8.8E-02	1.4E-01	1.3E-01	2.4E-01	2.3E-01	4.6E-01	4.6E-01	7.6E-01	7.6E-01
Colon wall	6.6E-02	7.1E-02	7.9E-02	7.6E-02	1.3E-01	1.3E-01	2.3E-01	2.3E-01	5.8E-01	5.7E-01	9.2E-01	9.2E-01
Endosteum (bone surface)	1.3E-01	1.6E-01	1.5E-01	1.7E-01	2.4E-01	2.4E-01	4.6E-01	4.6E-01	9.7E-01	9.7E-01	1.5E+00	1.5E+00
ET region	7.4E-01	1.1E+00	3.8E-01	4.7E-01	6.4E-01	6.4E-01	7.7E-01	7.7E-01	8.3E-01	8.3E-01	1.8E+00	1.8E+00
Gall bladder wall	8.5E-02	9.5E-02	9.0E-02	1.1E-01	1.4E-01	1.4E-01	2.3E-01	2.4E-01	5.5E-01	5.5E-01	8.2E-01	8.2E-01
Heart wall	2.9E-01	3.1E-01	2.7E-01	2.9E-01	3.4E-01	3.4E-01	5.4E-01	5.4E-01	1.2E+00	1.2E+00	1.5E+00	1.5E+00
Kidneys	2.0E-01	2.3E-01	2.4E-01	2.8E-01	4.0E-01	4.0E-01	7.8E-01	7.8E-01	1.9E+00	1.9E+00	3.2E+00	3.2E+00
Liver	1.6E-01	1.9E-01	2.0E-01	2.3E-01	3.6E-01	3.6E-01	7.0E-01	7.0E-01	1.8E+00	1.8E+00	3.0E+00	3.0E+00
Lung	3.8E-01	4.3E-01	1.3E+00	1.1E+00	1.3E+00	1.3E+00	2.3E+00	2.3E+00	6.0E+00	6.0E+00	5.1E+00	5.1E+00
Lymphatic nodes	1.2E+00	1.3E+00	3.9E-01	4.2E-01	4.4E-01	4.4E-01	8.1E-01	8.1E-01	1.2E+00	1.2E+00	1.5E+00	1.5E+00
Muscle	1.1E-01	1.6E-01	1.0E-01	9.7E-02	1.6E-01	1.6E-01	3.2E-01	3.2E-01	6.6E-01	6.6E-01	1.1E+00	1.1E+00
Oesophagus	3.0E+00	3.4E+00	1.4E+00	1.5E+00	1.6E+00	1.6E+00	3.1E+00	3.1E+00	6.3E+00	6.3E+00	5.8E+00	5.8E+00
Oral mucosa	2.9E-01	6.6E-01	7.5E-01	9.0E-01	6.7E-01	6.7E-01	8.2E-01	8.2E-01	8.7E-01	8.7E-01	2.6E+00	2.6E+00
Ovaries	-	6.4E-02	-	9.2E-02	-	1.3E-01	-	2.3E-01	-	4.6E-01	-	6.5E-01
Pancreas	8.4E-02	8.9E-02	8.4E-02	9.3E-02	1.5E-01	1.5E-01	2.5E-01	2.5E-01	5.4E-01	5.4E-01	8.4E-01	8.4E-01
Prostate	5.7E-02	-	6.9E-02	-	1.3E-01	-	2.1E-01	-	4.4E-01	-	5.4E-01	-
Red marrow	2.6E-01	3.1E-01	2.3E-01	2.4E-01	3.0E-01	3.0E-01	4.8E-01	4.8E-01	9.4E-01	9.4E-01	1.5E+00	1.5E+00
Salivary glands	5.0E-01	8.3E-01	7.3E-01	8.2E-01	1.6E+00	1.6E+00	1.9E+00	1.9E+00	2.4E+00	2.4E+00	5.0E+00	4.9E+00
Skin	7.1E-02	9.0E-02	8.3E-02	9.7E-02	1.3E-01	1.4E-01	2.3E-01	2.3E-01	3.9E-01	3.9E-01	6.1E-01	6.1E-01
Small intestine wall	5.5E-02	7.0E-02	6.1E-02	6.7E-02	1.0E-01	1.0E-01	2.0E-01	2.0E-01	4.8E-01	4.8E-01	7.5E-01	7.5E-01
Spleen	1.1E-01	1.1E-01	8.1E-02	9.9E-02	1.6E-01	1.6E-01	2.9E-01	2.9E-01	7.2E-01	7.2E-01	1.1E+00	1.1E+00
Stomach wall	3.3E-01	3.4E-01	4.2E-01	4.4E-01	6.6E-01	6.6E-01	1.0E+00	1.0E+00	2.0E+00	2.0E+00	2.2E+00	2.2E+00
Testes	2.1E-02	-	4.7E-02	-	7.2E-02	-	1.3E-01	-	2.5E-01	-	3.7E-01	-
Thymus	3.2E+00	2.9E+00	2.7E+00	4.1E+00	2.0E+00	2.0E+00	2.8E+00	2.8E+00	7.3E+00	7.3E+00	6.4E+00	6.4E+00
Thyroid	5.0E+02	5.9E+02	8.0E+02	8.3E+02	1.2E+03	1.2E+03	2.5E+03	2.5E+03	4.1E+03	4.1E+03	4.0E+03	4.0E+03
Urinary bladder wall	1.5E-01	1.9E-01	1.9E-01	2.0E-01	3.3E-01	3.3E-01	4.7E-01	4.6E-01	7.6E-01	7.5E-01	8.1E-01	7.9E-01
Uterus/ cervix	-	7.7E-02	-	2.7E-01	-	4.1E-01	-	2.6E-01	-	1.3E+00	-	1.5E+00
Effective dose (mSv/MBq)	2.2E+01		3.3E+01		4.8E+01		1.0E+02		1.7E+02		1.6E+02	

3141

3142 ^{131}I

3143 (d) oral administration, saturated thyroid.

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	5.2E-02	6.0E-02	4.6E-02	4.8E-02	7.2E-02	7.2E-02	1.1E-01	1.1E-01	2.2E-01	2.2E-01	2.6E-01	2.6E-01
Brain	1.8E-02	2.2E-02	3.1E-02	3.2E-02	4.8E-02	4.8E-02	7.3E-02	7.3E-02	1.2E-01	1.2E-01	1.9E-01	1.9E-01
Breast	2.2E-02	2.3E-02	2.4E-02	2.7E-02	3.9E-02	3.7E-02	6.6E-02	6.5E-02	1.2E-01	1.2E-01	2.0E-01	2.0E-01
Colon wall	5.6E-02	7.1E-02	7.2E-02	6.7E-02	1.0E-01	1.0E-01	1.6E-01	1.5E-01	2.9E-01	2.9E-01	3.6E-01	3.6E-01
Endosteum (bone surface)	2.7E-02	3.3E-02	4.1E-02	4.3E-02	6.6E-02	6.5E-02	1.2E-01	1.2E-01	2.6E-01	2.6E-01	3.4E-01	3.4E-01
ET region	1.6E-02	2.3E-02	3.9E-02	3.9E-02	5.0E-02	5.0E-02	6.4E-02	6.4E-02	9.7E-02	9.7E-02	1.4E-01	1.4E-01
Gall bladder wall	3.5E-02	4.4E-02	4.9E-02	5.2E-02	5.4E-02	5.5E-02	9.1E-02	9.2E-02	1.6E-01	1.6E-01	2.3E-01	2.3E-01
Heart wall	4.8E-02	5.4E-02	3.0E-02	3.5E-02	5.3E-02	5.3E-02	8.8E-02	8.9E-02	1.7E-01	1.7E-01	2.3E-01	2.3E-01
Kidneys	1.7E-01	2.1E-01	2.0E-01	2.3E-01	3.0E-01	3.0E-01	4.8E-01	4.8E-01	8.5E-01	8.4E-01	1.3E+00	1.3E+00
Liver	4.7E-02	5.8E-02	5.1E-02	5.9E-02	8.6E-02	8.6E-02	1.3E-01	1.3E-01	2.4E-01	2.4E-01	3.2E-01	3.2E-01
Lung	3.7E-02	4.3E-02	3.9E-02	4.5E-02	6.3E-02	6.3E-02	1.0E-01	1.0E-01	2.2E-01	2.2E-01	2.9E-01	2.9E-01
Lymphatic nodes	4.5E-02	4.9E-02	3.8E-02	3.7E-02	5.5E-02	5.5E-02	9.2E-02	9.2E-02	1.6E-01	1.6E-01	2.1E-01	2.1E-01
Muscle	2.2E-02	2.8E-02	2.7E-02	2.8E-02	4.3E-02	4.3E-02	7.0E-02	6.9E-02	1.3E-01	1.3E-01	1.9E-01	1.9E-01
Oesophagus	8.3E-02	9.2E-02	8.5E-02	8.8E-02	1.3E-01	1.3E-01	2.1E-01	2.1E-01	3.5E-01	3.5E-01	4.6E-01	4.6E-01
Oral mucosa	2.2E-02	2.9E-02	5.2E-02	5.3E-02	6.8E-02	6.8E-02	8.8E-02	8.8E-02	1.4E-01	1.4E-01	2.4E-01	2.4E-01
Ovaries	-	7.8E-02	-	1.3E-01	-	1.7E-01	-	2.5E-01	-	3.7E-01	-	3.4E-01
Pancreas	5.3E-02	6.6E-02	6.4E-02	6.5E-02	9.4E-02	9.4E-02	1.4E-01	1.4E-01	2.5E-01	2.5E-01	3.2E-01	3.1E-01
Prostate	8.0E-02	-	9.6E-02	-	1.7E-01	-	2.5E-01	-	4.1E-01	-	3.4E-01	-
Red marrow	4.2E-02	5.4E-02	5.1E-02	5.6E-02	7.4E-02	7.3E-02	1.1E-01	1.1E-01	2.1E-01	2.1E-01	3.1E-01	3.1E-01
Salivary glands	2.6E-01	3.3E-01	3.4E-01	3.5E-01	5.1E-01	5.1E-01	6.6E-01	6.5E-01	9.4E-01	9.4E-01	1.8E+00	1.8E+00
Skin	1.8E-02	2.2E-02	2.3E-02	2.5E-02	3.8E-02	3.9E-02	6.3E-02	6.4E-02	1.2E-01	1.2E-01	1.7E-01	1.7E-01
Small intestine wall	4.9E-02	6.8E-02	5.3E-02	5.4E-02	7.6E-02	7.8E-02	1.3E-01	1.4E-01	2.4E-01	2.4E-01	3.1E-01	3.1E-01
Spleen	4.8E-02	6.7E-02	4.6E-02	5.6E-02	8.0E-02	8.0E-02	1.4E-01	1.4E-01	2.6E-01	2.6E-01	3.4E-01	3.4E-01
Stomach wall	3.9E-01	4.1E-01	5.1E-01	5.4E-01	7.8E-01	7.8E-01	1.2E+00	1.2E+00	2.2E+00	2.2E+00	2.4E+00	2.4E+00
Testes	2.3E-02	-	5.9E-02	-	7.5E-02	-	1.2E-01	-	1.6E-01	-	1.8E-01	-
Thymus	3.2E-02	3.4E-02	3.7E-02	4.5E-02	5.3E-02	5.3E-02	8.7E-02	8.7E-02	1.8E-01	1.8E-01	2.5E-01	2.5E-01
Thyroid	1.9E+00	2.2E+00	3.1E+00	3.2E+00	4.7E+00	4.7E+00	1.1E+01	1.1E+01	2.1E+01	2.1E+01	2.3E+01	2.3E+01
Urinary bladder wall	2.3E-01	3.0E-01	3.0E-01	3.1E-01	5.1E-01	5.1E-01	6.8E-01	6.7E-01	9.1E-01	9.0E-01	7.8E-01	7.8E-01
Uterus/ cervix	-	1.1E-01	-	2.7E-01	-	3.8E-01	-	3.0E-01	-	9.8E-01	-	7.5E-01
Effective dose (mSv/MBq)	1.8E-01		2.5E-01		3.7E-01		7.0E-01		1.3E+00		1.5E+00	

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(e) oral administration, removed thyroid.

	Absorbed dose (mGy/MBq)											
	Adults		15 years		10 years		5 years		1 year		infant	
Organs	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Adrenals	5.2E-02	6.0E-02	4.6E-02	4.8E-02	7.2E-02	7.2E-02	1.1E-01	1.1E-01	2.1E-01	2.1E-01	2.6E-01	2.6E-01
Brain	1.8E-02	2.2E-02	3.1E-02	3.2E-02	4.7E-02	4.8E-02	7.2E-02	7.2E-02	1.2E-01	1.2E-01	1.9E-01	1.9E-01
Breast	2.1E-02	2.3E-02	2.4E-02	2.7E-02	3.9E-02	3.7E-02	6.6E-02	6.5E-02	1.2E-01	1.1E-01	2.0E-01	2.0E-01
Colon wall	5.6E-02	7.1E-02	7.2E-02	6.7E-02	1.0E-01	1.0E-01	1.6E-01	1.5E-01	2.9E-01	2.9E-01	3.6E-01	3.6E-01
Endosteum (bone surface)	2.6E-02	3.3E-02	4.0E-02	4.2E-02	6.5E-02	6.5E-02	1.2E-01	1.2E-01	2.6E-01	2.6E-01	3.3E-01	3.3E-01
ET region	1.4E-02	1.8E-02	3.8E-02	3.8E-02	4.8E-02	4.8E-02	6.1E-02	6.1E-02	9.4E-02	9.4E-02	1.3E-01	1.3E-01
Gall bladder wall	3.5E-02	4.4E-02	4.9E-02	5.2E-02	5.4E-02	5.4E-02	9.1E-02	9.2E-02	1.6E-01	1.6E-01	2.3E-01	2.3E-01
Heart wall	4.7E-02	5.3E-02	2.9E-02	3.5E-02	5.2E-02	5.2E-02	8.7E-02	8.7E-02	1.6E-01	1.6E-01	2.2E-01	2.2E-01
Kidneys	1.7E-01	2.1E-01	2.0E-01	2.3E-01	3.0E-01	3.0E-01	4.8E-01	4.8E-01	8.5E-01	8.5E-01	1.3E+00	1.3E+00
Liver	4.7E-02	5.8E-02	5.1E-02	5.9E-02	8.5E-02	8.6E-02	1.3E-01	1.3E-01	2.4E-01	2.4E-01	3.2E-01	3.2E-01
Lung	3.5E-02	4.2E-02	3.4E-02	4.1E-02	5.8E-02	5.8E-02	9.4E-02	9.5E-02	1.9E-01	1.9E-01	2.7E-01	2.7E-01
Lymphatic nodes	4.0E-02	4.4E-02	3.7E-02	3.6E-02	5.3E-02	5.3E-02	9.0E-02	9.0E-02	1.5E-01	1.5E-01	2.0E-01	2.0E-01
Muscle	2.2E-02	2.8E-02	2.7E-02	2.7E-02	4.3E-02	4.3E-02	6.9E-02	6.8E-02	1.2E-01	1.2E-01	1.8E-01	1.8E-01
Oesophagus	7.2E-02	7.9E-02	8.0E-02	8.3E-02	1.2E-01	1.2E-01	1.9E-01	1.9E-01	3.3E-01	3.3E-01	4.3E-01	4.3E-01
Oral mucosa	2.1E-02	2.7E-02	5.0E-02	5.0E-02	6.6E-02	6.6E-02	8.5E-02	8.6E-02	1.4E-01	1.4E-01	2.3E-01	2.3E-01
Ovaries	-	7.8E-02	-	1.3E-01	-	1.7E-01	-	2.5E-01	-	3.7E-01	-	3.4E-01
Pancreas	5.3E-02	6.6E-02	6.4E-02	6.5E-02	9.4E-02	9.4E-02	1.4E-01	1.4E-01	2.5E-01	2.5E-01	3.2E-01	3.1E-01
Prostate	8.0E-02	-	9.7E-02	-	1.7E-01	-	2.5E-01	-	4.1E-01	-	3.5E-01	-
Red marrow	4.1E-02	5.3E-02	5.1E-02	5.5E-02	7.3E-02	7.2E-02	1.1E-01	1.1E-01	2.1E-01	2.1E-01	3.1E-01	3.1E-01
Salivary glands	2.6E-01	3.2E-01	3.4E-01	3.5E-01	5.1E-01	5.1E-01	6.5E-01	6.5E-01	9.4E-01	9.4E-01	1.8E+00	1.8E+00
Skin	1.8E-02	2.2E-02	2.3E-02	2.5E-02	3.8E-02	3.8E-02	6.3E-02	6.3E-02	1.2E-01	1.2E-01	1.7E-01	1.7E-01
Small intestine wall	4.9E-02	6.8E-02	5.3E-02	5.4E-02	7.6E-02	7.8E-02	1.3E-01	1.4E-01	2.4E-01	2.4E-01	3.1E-01	3.1E-01
Spleen	4.8E-02	6.7E-02	4.6E-02	5.6E-02	8.0E-02	8.0E-02	1.4E-01	1.4E-01	2.6E-01	2.6E-01	3.4E-01	3.4E-01
Stomach wall	3.9E-01	4.1E-01	5.1E-01	5.4E-01	7.8E-01	7.8E-01	1.2E+00	1.2E+00	2.2E+00	2.2E+00	2.4E+00	2.4E+00
Testes	2.3E-02	-	5.9E-02	-	7.5E-02	-	1.2E-01	-	1.6E-01	-	1.8E-01	-
Thymus	2.0E-02	2.3E-02	2.7E-02	2.9E-02	4.6E-02	4.6E-02	7.6E-02	7.6E-02	1.5E-01	1.5E-01	2.1E-01	2.1E-01
Thyroid	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Urinary bladder wall	2.3E-01	3.0E-01	3.0E-01	3.1E-01	5.1E-01	5.1E-01	6.8E-01	6.8E-01	9.1E-01	9.1E-01	7.8E-01	7.8E-01
Uterus/cervix	-	1.1E-01	-	2.7E-01	-	3.8E-01	-	3.0E-01	-	9.8E-01	-	7.5E-01
$\sum_T w_T \left[\frac{H_T^F + H_T^M}{2}\right]^{\#}$ (mSv/MBq) *	9.8E-02		1.2E-01		1.8E-01		2.7E-01		4.9E-01		5.7E-01	

* Strictly speaking, patients with removed thyroid do not correspond to the ICRP reference individual. So this value, calculated analogously to the effective dose but without the thyroid as a target organ, is formally not the effective dose as defined by ICRP. (see also § 59).

A.28. ^{123}I-labelled brain receptor substances (generic model)

A.28.1. Biokinetic information

(A 165) The structure of the model for ^{123}I-labelled brain receptor substances (generic model) is similar to the one for ^{18}F-labelled brain receptor substances, with different values of the transfer coefficients. Refer to Section A.14 for more details on the underlying data sets.

A.28.2. Biokinetic model

(A 166) The model proposed here is a compartmental version of the descriptive one presented in (ICRP, 2015). It assumes that fractions of 0.06, 0.20, 0.20, 0.05, 0.03, and 0.003 of the administered activity are distributed to the brain, liver, lungs, stomach wall, kidneys, and thyroid, respectively. The remaining activity is assumed to be distributed uniformly throughout the rest of the body. The biological half-time in lungs and stomach wall amounts to 8 h, in brain and thyroid to 100 h. In all other organs and tissues, 50% of the activity is retained with a biological half-time of 8 h, and 50% with 100 h.

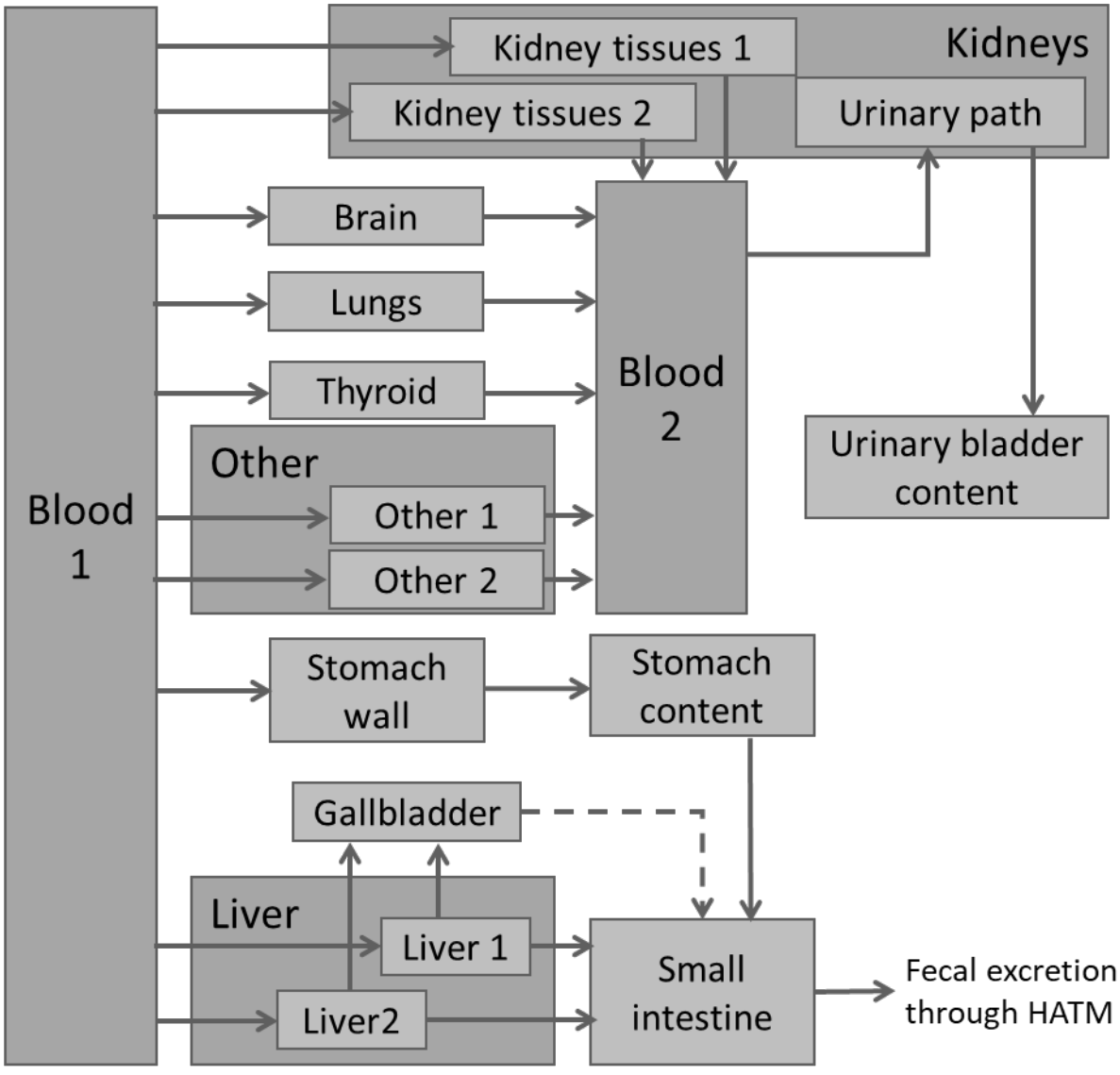

Fig. A.28.1. Biokinetic model for ^{123}I-labelled brain receptor substances (generic model).

Table A.28.1. Values of the transfer coefficients (h^{-1}).

From	To	All age groups
Blood 1	Brain	1.25E+00
Blood 1	Lungs	4.16E+00
Blood 1	Thyroid	6.24E-02
Blood 1	Liver_1	2.08E+00
Blood 1	Liver_2	2.08E+00
Blood 1	Stomach wall	1.04E+00
Blood 1	Kidney Tissues_1	3.12E-01
Blood 1	Kidney Tissues_2	3.12E-01
Blood 1	Other 1	4.75E+00
Blood 1	Other 2	4.75E+00
Brain	Blood 2	6.93E-03
Lungs	Blood 2	8.66E-02
Thyroid	Blood 2	6.93E-03
Kidney Tissues 1	Blood 2	8.66E-02
Kidney Tissues 2	Blood 2	6.93E-03
Other 1	Blood 2	8.66E-02
Other 2	Blood 2	6.93E-03
Stomach wall	Stomach contents	8.66E-02
Liver 1	Small intestine	6.07E-02
Liver 1	Gallbladder	2.60E-02
Liver 2	Small intestine	4.85E-03
Liver 2	Gallbladder	2.08E-03
Blood 2	Urinary Path	1.20E+02
Urinary Path	Urinary bladder content	1.20E+01

Radioactive half-life of ^{123}I: 13.27 h

A.28.3. Specific assumptions for the calculations

(A 167) Activity in liver is excreted according to the liver-biliary model (see A.6.3), with 30% of the activity being transferred to the gallbladder.

A.28.4. References for ^{123}I-labelled brain receptor substances

Berman, M., Hoff, E., Barandes, M., et al., 1968. Iodine kinetics in man – a model. J. Clin. Endocrinol. Metab. 28, 1–14.

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