

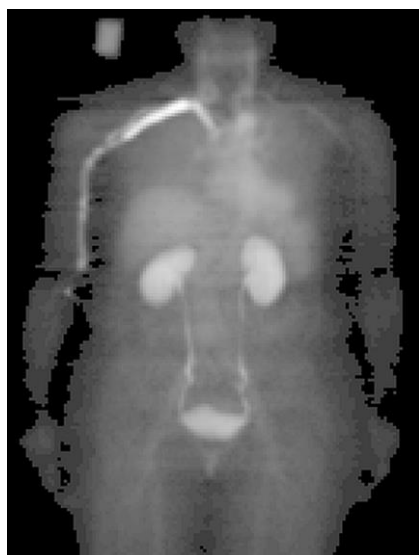
Effect of blood activity on dosimetric calculations for radiopharmaceuticals

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Note: the image is from the first imaging time

Supplemental table 1. Reference blood contents of considered regions of interest (in % of total blood) from ICRP Publication 89 (ICRP, 2002)

Regions of interest in CPK models for ^{18}F -FSPG	Adult female	Adult male
Kidneys	2.000%	2.000%
Heart ^a	8.950%	9.078%
Bladder content	0.000%	0.000%
Spleen	1.400%	1.400%
Pancreas	0.600%	0.600%
Liver	10.000%	10.000%
Stomach wall	1.000%	1.000%
Thyroid	0.060%	0.060%
Salivary glands ^b	0.244%	0.257%
Rest of body	75.746%	75.605%
Total body	100.000%	100.000%
Blood	100.000%	100.000%

^aMainly heart content. Includes the inner part of the heart wall, though.

^bICRP Publication 89 does not provide the blood contents for salivary glands. Mass fractions of blood in salivary glands were evaluated as average of the mass fractions of blood in some other tissues (namely: fat, brain, stomach/oesophagus, small intestine, large intestine, kidneys, liver, skeletal muscle, pancreas, red marrow, skin, thyroid, lymph nodes, gonads, adrenals, and urinary bladder). Blood contents for salivary glands were evaluated from the mass of salivary glands, mass fractions of blood in salivary glands and the total mass of blood.

Supplemental table 2. Estimated model parameters [min^{-1}]

Parameter/variable ^a	Compartmental pharmacokinetic model parameters, [min^{-1}]					
	1101/94 f	1102/94 f	1103/94 m	1104/94 f	1105/94 m	Mean $\pm$ SD
k(1,2) Other Kidney Tissue->Blood	4.2E-02	1.7E-02	4.0E-02	5.8E-02	4.5E-02	4.0E-02 $\pm$ 1.3E-02
k(1,5) Heart ^a ->Blood	4.3E-02	1.4E-02	3.6E-02	8.4E-02	1.3E-02	3.8E-02 $\pm$ 2.6E-02
k(1,6) Liver_1->Blood	3.3E-02	5.4E-03	3.9E-02	8.5E-02	6.7E-03	3.4E-02 $\pm$ 2.9E-02
k(1,7) Rest of Body->Blood	2.5E-02	0.0E+00	2.2E-02	2.1E-02	1.1E-02	1.6E-02 $\pm$ 9.1E-03
k(1,8) Pancreas->Blood	1.5E-02	1.1E-02	2.0E-02	1.7E-02	1.5E-02	1.5E-02 $\pm$ 3.1E-03
k(1,9) Spleen_1->Blood	8.3E-02	2.0E-02	8.4E-02	1.7E-01	0.0E+00	7.2E-02 $\pm$ 6.1E-02
k(1,13) Stomach w all->Blood	2.0E-02	4.3E-02	5.1E-02	1.8E-01	1.2E-02	6.1E-02 $\pm$ 6.1E-02
k(1,33) Salivary glands->Blood	4.4E-02	1.5E-02	4.4E-02	3.9E-02	1.4E-02	3.1E-02 $\pm$ 1.4E-02
k(1,34) Thyroid->Blood	8.9E-02	3.1E-02	4.8E-01	1.0E-01	2.4E-01	1.9E-01 $\pm$ 1.6E-01
k(2,1) Blood->Other Kidney Tissue	3.7E-02	2.8E-02	3.4E-02	4.4E-02	2.5E-02	3.3E-02 $\pm$ 6.8E-03
k(3,1) Blood->Urinary Path	5.3E-02	7.6E-02	5.6E-02	5.7E-02	4.6E-02	5.8E-02 $\pm$ 1.0E-02
k(4,3) Urinary Path->Ureter	9.3E-01	9.4E-01	1.0E+00	1.0E+00	4.4E-01	8.7E-01 $\pm$ 2.2E-01
k(5,1) Blood->Heart ^a	3.7E-03	2.2E-03	4.9E-03	2.4E-03	2.5E-04	2.7E-03 $\pm$ 1.6E-03
k(6,1) Blood->Liver_1	1.1E-02	8.2E-03	1.0E-02	1.6E-02	2.0E-03	9.4E-03 $\pm$ 4.6E-03
k(7,1) Blood->Rest of Body	7.0E-02	6.4E-03	8.1E-02	6.5E-02	1.7E-02	4.8E-02 $\pm$ 3.0E-02
k(8,1) Blood->Pancreas	4.5E-03	4.2E-03	2.7E-03	5.6E-03	3.1E-03	4.0E-03 $\pm$ 1.0E-03
k(9,1) Blood->Spleen_1	2.4E-03	1.2E-03	2.0E-03	4.0E-03	1.2E-05	1.9E-03 $\pm$ 1.3E-03
k(10,4) Ureter->Bladder content	8.8E-02	2.9E-02	6.8E-02	1.5E-01	1.2E-01	9.1E-02 $\pm$ 4.2E-02
k(13,1) Blood->Stomach w all	2.1E-03	1.9E-03	1.9E-03	1.3E-02	4.6E-04	4.0E-03 $\pm$ 4.8E-03
k(33,1) Blood->Salivary glands	5.4E-04	1.9E-04	5.3E-04	3.7E-04	1.0E-04	3.5E-04 $\pm$ 1.8E-04
k(34,1) Blood->Thyroid	8.0E-04	2.3E-04	3.5E-03	7.3E-04	7.6E-04	1.2E-03 $\pm$ 1.2E-03
k(62,6) Liver_1->Liver_2	2.9E-03	0.0E+00	1.8E-03	5.7E-03	9.3E-04	2.3E-03 $\pm$ 2.0E-03
k(92,9) Spleen_1->Spleen_2	1.4E-03	1.2E-03	0.0E+00	3.4E-03	0.0E+00	1.2E-03 $\pm$ 1.2E-03

SD is standard deviation

^aThe source region Heart comprised the heart content and only the inner part of the heart wall

^bParameter k(9,92) Spleen_2->Spleen_1 is not shown in the Supplemental table 2 because the estimated value of it was equal to zero for all five volunteers. This can be explained by too long retention of the radiopharmaceutical ¹⁸F-FSPG in the compartment Spleen_2 compared to the time of the measurements ($\approx$ 4 hours)

^cBlood volumes were not estimated, but fixed to the reference values, reported in ICRP Publication 89 – 3900 ml and 5300 ml for reference female and male, respectively

Supplemental table 3. Estimated^a voiding fractions

Serial number of voiding fraction	1101/94 f	1102/94 f	1103/94 m	1104/94 f	1105/94 m
1	1.0	1.0	1.0	1.0	1.0
2	1.0	0.9	0.8	1.0	1.0
3	1.0	1.0	0.6	0.1	0.8
4	0.9	1.0	1.0	1.0	0.8
5	-----	1.0	-----	0.1	-----
6	-----	-----	-----	1.0	-----

^aWhere it was not possible to estimate the voiding fractions, they were fixed to the value one – complete voiding

Supplemental table 4. Time-integrated activity coefficients derived from compartmental pharmacokinetic models for the volunteers 1101/94–1105/94 (^{18}F -FSPG)

Source organ/tissue	Time Integrated Activity Coefficients, [s]									
	1101/94 f		1102/94 f		1103/94 m		1104/94 f		1105/94 m	
	Value	SD	Value	SD	Value	SD	Value	SD	Value	SD
Kidneys	5.90E+02	2.74E+01	7.33E+02	2.29E+01	5.30E+02	1.01E+01	5.13E+02	2.51E+01	5.51E+02	1.52E+01
Kidneys w ith blood	6.05E+02	2.74E+01	7.45E+02	2.30E+01	5.43E+02	1.00E+01	5.27E+02	2.52E+01	5.70E+02	1.52E+01
Heart	5.40E+01	3.07E+00	6.09E+01	6.07E+00	7.68E+01	4.01E+00	1.81E+01	4.75E+00	1.18E+01	3.95E+00
Heart w ith blood	1.19E+02	1.50E+00	1.13E+02	4.83E+00	1.38E+02	3.84E+00	8.01E+01	3.55E+00	9.69E+01	4.06E+00
Bladder content	1.17E+03	5.54E+00	9.75E+02	1.68E+01	1.35E+03	2.64E+01	1.15E+03	1.53E+01	1.24E+03	1.96E+00
Spleen	2.36E+01	1.11E+00	2.97E+01	1.53E+00	1.45E+01	2.12E+00	2.29E+01	9.86E-01	1.71E+00	1.97E+00
Spleen w ith blood	3.37E+01	1.02E+00	3.78E+01	1.42E+00	2.39E+01	2.10E+00	3.25E+01	8.29E-01	1.48E+01	4.95E+00
Pancreas	1.51E+02	4.15E+00	1.46E+02	3.53E+00	6.88E+01	2.05E+00	1.64E+02	2.50E+00	1.42E+02	4.95E+00
Pancreas w ith blood	1.56E+02	4.16E+00	1.49E+02	3.57E+00	7.29E+01	2.04E+00	1.68E+02	2.52E+00	1.47E+02	4.95E+00
Liver	2.66E+02	1.04E+01	4.05E+02	1.14E+01	1.87E+02	1.18E+01	2.18E+02	1.21E+01	1.51E+02	2.55E+00
Liver w ith blood	3.39E+02	9.93E+00	4.63E+02	1.04E+01	2.54E+02	1.18E+01	2.87E+02	1.15E+01	2.45E+02	1.91E+00
Stomach w all	5.71E+01	1.95E+00	2.26E+01	2.11E+00	2.21E+01	4.31E+00	4.98E+01	4.90E+00	2.39E+01	3.47E+00
Stomach w all w ith blood	6.44E+01	1.93E+00	2.84E+01	2.45E+00	2.88E+01	4.30E+00	5.67E+01	4.88E+00	3.33E+01	3.46E+00
Thyroid	6.11E+00	3.91E-01	3.55E+00	4.59E-01	4.85E+00	5.37E-01	4.58E+00	2.35E-01	2.91E+00	4.22E-01
Thyroid w ith blood	6.55E+00	3.90E-01	3.90E+00	4.58E-01	5.25E+00	5.36E-01	4.99E+00	2.34E-01	3.47E+00	4.22E-01
Salivary glands	7.83E+00	2.11E-01	5.11E+00	4.15E-01	7.20E+00	3.15E-01	5.59E+00	6.21E-01	4.65E+00	5.53E-01
Salivary glands w ith blood	9.61E+00	1.94E-01	6.53E+00	5.17E-01	8.93E+00	3.11E-01	7.28E+00	6.57E-01	7.06E+00	5.51E-01
Rest of body	2.02E+03	4.38E+01	1.81E+03	4.59E+01	2.46E+03	5.86E+01	1.89E+03	5.26E+01	1.24E+03	3.75E+01
Rest of body w ith blood	2.58E+03	3.61E+01	2.25E+03	2.72E+01	2.97E+03	5.67E+01	2.41E+03	5.02E+01	1.95E+03	3.39E+01
^a Blood_ml	1.86E-01	8.52E-03	1.49E-01	1.14E-02	1.27E-01	3.10E-03	1.77E-01	9.69E-03	1.77E-01	2.43E-03
^a Blood_total	7.27E+02	3.32E+01	5.79E+02	4.43E+01	6.73E+02	1.65E+01	6.92E+02	3.78E+01	9.38E+02	1.29E+01
Total body	5.07E+03	2.18E+01	4.77E+03	1.71E+01	5.39E+03	2.98E+01	4.72E+03	3.57E+01	4.31E+03	1.82E+01

SD is standard deviation

^aBlood samples of the volunteer 1102/94 were not taken because of technical issues, however the total body activities and the activities in the considered source regions were sufficient to determine all parameters of the pharmacokinetic model, which – in turn – enabled us to estimate the blood activity for this volunteer.

The activity in the ureter compartment is not given because the ureter was not considered an explicit source region, but was a part of the source region Rest of body instead

Supplemental table 5. Time-integrated activity coefficients used in the dosimetry according to the concept-1 for the volunteers 1101/94–1105/94 (^{18}F -FSPG)

Source organ/tissue	Time Integrated Activity Coefficients, [s]				
	1101/94 f	1102/94 f	1103/94 m	1104/94 f	1105/94 m
Kidneys	5.90E+02	7.33E+02	5.30E+02	5.13E+02	5.51E+02
Heart w all ^a	5.40E+01	6.09E+01	7.68E+01	1.81E+01	1.18E+01
Bladder content	1.17E+03	9.75E+02	1.35E+03	1.15E+03	1.24E+03
Spleen	2.36E+01	2.97E+01	1.45E+01	2.29E+01	1.71E+00
Pancreas	1.51E+02	1.46E+02	6.88E+01	1.64E+02	1.42E+02
Liver	2.66E+02	4.05E+02	1.87E+02	2.18E+02	1.51E+02
Stomach w all	5.71E+01	2.26E+01	2.21E+01	4.98E+01	2.39E+01
Thyroid	6.11E+00	3.55E+00	4.85E+00	4.58E+00	2.91E+00
Salivary glands	7.83E+00	5.11E+00	7.20E+00	5.59E+00	4.65E+00
Rest of Body	2.02E+03	1.81E+03	2.46E+03	1.89E+03	1.24E+03
Blood_total	7.27E+02	5.79E+02	6.73E+02	6.92E+02	9.38E+02

Concept-1: source organs parenchyma without their blood contents, blood is a separated source

Supplemental table 6. Time-integrated activity coefficients used in the dosimetry according to the concept-2 for the volunteers 1101/94–1105/94 (^{18}F -FSPG)

Source organ/tissue	Time Integrated Activity Coefficients, [s]				
	1101/94 f	1102/94 f	1103/94 m	1104/94 f	1105/94 m
Kidneys	6.05E+02	7.45E+02	5.43E+02	5.27E+02	5.70E+02
Heart content ^a	6.50E+01	5.18E+01	6.11E+01	6.19E+01	8.51E+01
Heart wall ^a	5.41E+01	6.09E+01	7.69E+01	1.81E+01	1.18E+01
Bladder content	1.17E+03	9.75E+02	1.35E+03	1.15E+03	1.24E+03
Spleen	3.37E+01	3.78E+01	2.39E+01	3.25E+01	1.48E+01
Pancreas	1.56E+02	1.49E+02	7.29E+01	1.68E+02	1.47E+02
Liver	3.39E+02	4.63E+02	2.54E+02	2.87E+02	2.45E+02
Stomach wall	6.44E+01	2.84E+01	2.88E+01	5.67E+01	3.33E+01
Thyroid	6.55E+00	3.90E+00	5.25E+00	4.99E+00	3.47E+00
Salivary glands	9.61E+00	6.53E+00	8.93E+00	7.28E+00	7.06E+00
Rest of Body	2.58E+03	2.25E+03	2.97E+03	2.41E+03	1.95E+03

Concept-2: perfused source organs, i.e. with their blood contents, circulating blood is included into RoB

^aThe source region in this case comprised the heart contents and only the inner part of the heart wall. When considering a distinct blood source (concept-1), the heart contents (being pure blood) are part of this source and should not be considered separately in addition. Therefore the heart source in this case is only the heart wall (i.e., the SAFs for the heart wall are to be used). When considering perfused organs (concept-2), the heart source should consist of both the heart wall source and the heart contents source (i.e., two different sets of SAFs are to be used – for the heart wall and for the heart contents). The heart contents comprise 481 ml and 349 ml of blood for reference male and female, respectively. Therefore the activity of the heart contents can be calculated by multiplying the known activity-per-ml of blood by 481 ml (for male volunteers) or 349 ml (for female volunteers). The heart wall activity is then calculated by subtracting the heart contents activities from the time-integrated activity coefficients for the entire heart.

Supplemental table 7. Organ absorbed-dose coefficients, [mGy/MBq] (continuation of Table 2)

Target organ	1101/94-female			1102/94-female			1103/94-male			1104/94-female			1105/94-male		
	Concept-1	Concept-2	%Diff	Concept-1	Concept-2	%Diff	Concept-1	Concept-2	%Diff	Concept-1	Concept-2	%Diff	Concept-1	Concept-2	%Diff
Endosteum	5.73E-03	6.00E-03	-4.5%	5.21E-03	5.44E-03	-4.4%	5.34E-03	5.60E-03	-4.6%	5.37E-03	5.61E-03	-4.2%	4.08E-03	4.19E-03	-2.6%
Ovaries/Testes	1.70E-02	1.70E-02	0.0%	1.44E-02	1.44E-02	-0.2%	5.31E-03	5.63E-03	-5.6%	1.64E-02	1.64E-02	0.2%	3.90E-03	4.10E-03	-4.8%
Breast	5.12E-03	4.91E-03	4.3%	4.79E-03	4.64E-03	3.0%	4.40E-03	4.41E-03	-0.2%	4.64E-03	4.41E-03	5.2%	3.55E-03	3.26E-03	9.1%
Brain	3.54E-03	3.89E-03	-9.0%	3.11E-03	3.40E-03	-9.3%	3.45E-03	3.76E-03	-8.3%	3.31E-03	3.62E-03	-8.6%	2.25E-03	2.48E-03	-9.3%
Skin	3.88E-03	4.08E-03	-4.7%	3.52E-03	3.69E-03	-4.6%	3.53E-03	3.77E-03	-6.4%	3.63E-03	3.80E-03	-4.3%	2.55E-03	2.71E-03	-5.8%
Gall bladder	1.84E-02	1.74E-02	5.8%	2.04E-02	1.96E-02	3.8%	1.15E-02	1.10E-02	4.9%	1.69E-02	1.58E-02	6.4%	1.28E-02	1.14E-02	12.1%
Lymphatic nodes	1.01E-02	1.02E-02	-0.5%	9.58E-03	9.63E-03	-0.6%	9.55E-03	9.66E-03	-1.1%	9.48E-03	9.49E-03	-0.1%	8.37E-03	8.17E-03	2.4%
Muscle	5.57E-03	6.00E-03	-7.1%	5.11E-03	5.46E-03	-6.9%	5.06E-03	5.46E-03	-7.2%	5.22E-03	5.61E-03	-6.8%	3.70E-03	4.06E-03	-8.8%
Oral mucosa	3.96E-03	4.41E-03	-10.1%	3.48E-03	3.85E-03	-10.5%	3.65E-03	4.08E-03	-10.7%	3.66E-03	4.06E-03	-9.9%	2.29E-03	2.72E-03	-15.9%
Prostate	---	---	---	---	---	---	2.82E-02	2.81E-02	0.3%	---	---	---	2.52E-02	2.46E-02	2.3%
Uterus	2.83E-02	2.78E-02	1.8%	2.38E-02	2.34E-02	1.5%	---	---	---	2.76E-02	2.71E-02	1.9%	---	---	---

Supplemental table 8. Mean organ absorbed-dose coefficients, [mGy/MBq] (continuation of Table 3)

Target organ	Concept-1		Concept-2	
	Mean	SD	Mean	SD
Endosteum	5.15E-03	5.62E-04	5.37E-03	6.19E-04
Ovaries/Testes	1.14E-02	5.63E-03	1.15E-02	5.51E-03
Breast	4.50E-03	5.28E-04	4.32E-03	5.65E-04
Brain	3.13E-03	4.64E-04	3.43E-03	5.01E-04
Skin	3.42E-03	4.56E-04	3.61E-03	4.68E-04
Gall bladder	1.60E-02	3.35E-03	1.50E-02	3.37E-03
Lymphatic nodes	9.42E-03	5.79E-04	9.43E-03	6.73E-04
Muscle	4.93E-03	6.41E-04	5.32E-03	6.60E-04
Oral mucosa	3.41E-03	5.82E-04	3.82E-03	5.81E-04
Prostate	2.67E-02	1.52E-03	2.63E-02	1.77E-03
Uterus	2.66E-02	1.97E-03	2.61E-02	1.90E-03

SD is standard deviation

Supplemental table 9. Absorbed-dose coefficients for lungs of volunteer 1101/94 and contributions to it from all sources

Source region	Concept-1			Concept-2			Difference in Total dose, mGy/MBq	Difference in absolute contributions from Blood (1) and RoB (2)
	Relative contribution, %	Absolute contribution, mGy/MBq	Total dose, mGy/MBq	Relative contribution, %	Absolute contribution, mGy/MBq	Total dose, mGy/MBq		
Blood	61.3	5.87E-03	9.57E-03	---	---	6.36E-03	3.21E-03	1.95E-03
Heart content	---	---		6.0	3.81E-04			
Rest of body	19.6	1.87E-03		61.6	3.92E-03			
Liver	6.7	6.43E-04		12.9	8.20E-04			
Kidneys	4.9	4.71E-04		7.6	4.83E-04			
Heart wall	4.0	3.82E-04		6.0	3.83E-04			
Pancreas	1.2	1.16E-04		1.9	1.20E-04			
Stomach wall	1.0	9.33E-05		1.7	1.05E-04			
Spleen	0.7	6.60E-05		1.5	9.43E-05			
Bladder content	0.4	3.68E-05		0.6	3.68E-05			
Thyroid	0.2	1.55E-05		0.3	1.66E-05			
Salivary glands	0.0	4.48E-06		0.1	5.49E-06			

Supplemental table 9 shows the total lungs dose coefficients along with the contributions to them from all sources. The main contributions are from blood (concept-1) and RoB (concept-2). From the rightmost columns it can be inferred that already 61% of the difference between the two concepts originates in the different contribution from blood (concept-1) and RoB (concept-2). This demonstrates the higher impact of blood being present within the lungs to the lungs dose than if the blood activity is uniformly distributed in the RoB.