

# THE EVALUATION OF DIAGNOSTIC MEDICAL EXPOSURES IN THE CZECH REPUBLIC



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## 1. Introduction

Since 1994 there is an effort to find the best way for statistical evaluation of medical exposures to ionizing radiation in the Czech Republic. There are three main sources of data - Institute of Health Statis-  
Tab. 1

Examination	Radiopharmaceutical	Nun. of pro- cedures	Average of ad- ministered ac- tivity [MBq]	Conversion fac- tor [mSv/MBq]	Collective ef- fective dose [mSv]
bone marrow imaging	<sup>99m</sup> Tc nanokoloid album	87	773.5	1.37E-02	921.9
bone imaging	<sup>99m</sup> Tc methylenfiosf.	30 143	746.1	5.47E-03	123018.6
bone imaging 3f	<sup>99m</sup> Tc methylenfiosf.	2 766	678.8	5.47E-03	10270.3
brain imaging dyn.	<sup>99m</sup> Tc pertechnetat	2 837	752.8	1.27E-02	27123.3
brain imaging static	<sup>99m</sup> Tc pertechnetat	3 521	702.8	1.27E-02	31426.9
brain imaging (SPECT)	<sup>99m</sup> Tc HM PAO	3 111	756.3	1.19E-02	27998.9
myocardial imaging stress	<sup>99m</sup> Tc MIBI	1 178	646.5	1.48E-02	11271.3
myocardial imaging stress	<sup>201</sup> Tl chloride	1 480	98.8	2.19E-01	32023.1
myocardial imaging	<sup>201</sup> Tl chloride	1 431	97.3	2.19E-01	30492.7
rn ventriculography	<sup>99m</sup> Tc RBC	1 470	689.0	6.97E-03	7059.4
rn ventriculography stress	<sup>99m</sup> Tc RBC	139	728.3	6.97E-03	705.6
rn angiography	<sup>99m</sup> Tc DTPA	346	441.5	8.37E-03	1278.6
rn phlebography	<sup>99m</sup> Tc MAA	6 094	340.8	1.37E-02	28452.6
chromexcretion function	<sup>131</sup> I rose beng.	1 251	1.3	1.27	2125.0
liver and spleen imaging	<sup>99m</sup> Tc colloid	2 412	188.8	9.07E-03	4130.3
funct.biliary system imaging	<sup>99m</sup> Tc trimethyl HIDA	1 152	239.3	1.96E-02	5403.2
lung perfusion imaging	<sup>99m</sup> Tc MAA	20 147	236.3	1.37E-02	65222.1
lung perfusion imaging	<sup>81</sup> Kr <sup>m</sup>	2 148	1.0	0.05	107.4
lung ventilation imaging	<sup>99m</sup> Tc MAA	1 225	199.8	1.37E-02	3353.1
lung ventilation imaging	<sup>99m</sup> Tc DTPA	1 224	737.3	8.37E-03	7553.6
lung ventilation imaging	<sup>99m</sup> Tc MAA	1 744	233.8	1.37E-02	5586.1
lung ventilation imaging	<sup>81</sup> Kr <sup>m</sup>	1 778	1.0	0.05	88.9
scintigraphy <sup>67</sup> Ga	<sup>67</sup> Ga citrate	824	185.3	1.10E-01	16795.6
rn nephrography	<sup>99m</sup> Tc DMSA	1 530	139.5	9.91E-03	2115.1
rn nephrography	<sup>99m</sup> Tc DTPA	2 349	339.3	8.37E-03	6671.0
rn nephrography	<sup>131</sup> I hippuran	18 613	1.0	1.00E-01	1861.3
rn residuum in urin.bladder	<sup>131</sup> I hippuran	1 729	1.5	1.00E-01	259.4
renal imaging	<sup>99m</sup> Tc DMSA	4 023	136.0	9.91E-03	5422.0
renal imaging	<sup>123</sup> I hippuran	1 552	1.0	2.45E-02	38.0
renal imaging dyn.	<sup>99m</sup> Tc DTPA	3 826	303.0	6.63E-03	7686.0
renal imaging dyn.	<sup>99m</sup> Tc MAG3	5 121	174.5	9.91E-03	8855.7
renal imaging dyn.	<sup>123</sup> I hippuran	1 389	1.6	2.45E-02	54.4
renal imaging dyn.(+GR)	<sup>99m</sup> Tc DTPA	2 269	266.3	8.37E-03	5057.4
thyroid imaging	<sup>99m</sup> Tc pertechnetat	11 352	136.0	1.27E-02	19607.2
tomograph.imaging (SPECT)	<sup>99m</sup> Tc MIBI	2 348	755.3	1.48E-02	26247.0
tomograph.imaging (SPECT)	<sup>201</sup> Tl chloride	3 192	106.8	2.19E-01	74658.3
<b>TOTAL</b>		<b>147 801</b>			<b>600941.6</b>

tical Systems of Ministry of Health, Hospitals and Health Insurance Comp. Recently there is very good co-operation between radiation protection bodies and General Health Insurance Comp. (GHIC) and databases of GHIC seem to be the best source of data for purpose of radiation protection. Data obtained from GHIC databases enable us to sort patients undergoing radiological or nuclear medicine or radio-therapeutical procedures by age and sex what is the first and essential step for correct evaluation of medical exposures from the point of view of patient's detriment.

## 2. Data and results

The first evaluation of obtained data allows calculating population irradiation factors for population of patients in Prague, which are 0.68 for X-ray and 0.72 for nuclear medicine procedures. Concerning the numbers of examination we can observe increasing trends generally. First results show that CT and mammography procedures are growing very fast. This is mainly due to new equipment in medical facilities and also due to new system of health insurance in our country, when physicians depend on the

**Tab. 2. Results of national survey in nuclear medicine departments in the Czech Republic in 1996 y./number of departments using individual procedures and average administered activity**

Type of examination	Type of radiopharmaceuticals	No. of department	A [MBq]
Circulation of cerebrospinal fluid imaging	<sup>111</sup> In DTPA	11	27
Thyroid uptake	<sup>131</sup> I	5	0.62
Thyroid scan	<sup>131</sup> I	8	7
Nephrography	<sup>131</sup> I OIH	28	0.8
Chromexcretion function	<sup>131</sup> I bengal rose	8	1.1
Myocardial imaging – stress	<sup>201</sup> Tl	17	91
Myocardial imaging	<sup>201</sup> Tl	17	83
Myocardial imaging - SPECT	<sup>201</sup> Tl	10	92
Ferrokinesics	<sup>59</sup> Fe	4	2.5
Scintigraphy <sup>67</sup> Ga	<sup>67</sup> Ga	16	165
Renal imaging - dynamic	<sup>99m</sup> Tc DTPA	32	250
Brain imaging – dynamic	<sup>99m</sup> Tc DTPA	9	754
Brain imaging – static	<sup>99m</sup> Tc DTPA	7	643
RN ventriculography	<sup>99m</sup> Tc ery in vitro	5	700
RN angiography	<sup>99m</sup> Tc ery in vitro	3	767
RN phlebography	<sup>99m</sup> Tc MAA	27	236
Myocardial imaging	<sup>99m</sup> Tc PYP	8	625
Liver imaging	<sup>99m</sup> Tc diethyl IDA	8	199
Renal imaging	<sup>99m</sup> Tc DMSA	28	188
Renal imaging with determ. func. ratio	<sup>99m</sup> Tc DMSA	28	171
Bone imaging	<sup>99m</sup> Tc HDP	9	706
Brain imaging – perf.	<sup>99m</sup> Tc HMPAO	17	741
Imaging with labelled white cells	<sup>99m</sup> Tc HMPAO WBC	10	424
Determ. of gastroesofag. reflux	<sup>99m</sup> Tc koloid	17	59
Liver and spleen imaging	<sup>99m</sup> Tc koloid	35	148
Lung imaging {perf.	<sup>99m</sup> Tc MAA	38	188
Lung imaging / SPECT	<sup>99m</sup> Tc MAA	5	260
Renal imaging / dynam.	<sup>99m</sup> Tc MAG 3	26	197
Bone imaging	<sup>99m</sup> Tc MDP	34	730
Lung perf. imaging	<sup>99m</sup> Tc microsferiy alb.	2	218
Bone marrow imaging	<sup>99m</sup> Tc nanokoloid	13	530
RN lymfography	<sup>99m</sup> Tc nanokoloid	12	187
Thyroid imaging	<sup>99m</sup> TcO <sub>4</sub>	39	128
Meckel's div.	<sup>99m</sup> TcO <sub>4</sub>	25	247
RN cystography with reflux examination	<sup>99m</sup> TcO <sub>4</sub>	3	53
Brain imaging – static	<sup>99m</sup> TcO <sub>4</sub>	30	625
Brain imaging – SPECT	<sup>99m</sup> TcO <sub>4</sub>	3	437
Cardio- angiography first pass	<sup>99m</sup> TcO <sub>4</sub>	10	584
RN angiography	<sup>99m</sup> TcO <sub>4</sub>	11	608

numbers of procedures performed.

During 1997 data from whole country concerned to nuclear medicine procedures were evaluated. Frequencies of procedures, average of administered activity and collective effective dose from the most frequent and important examination in the period VII. – XII.1995 and I. – VI. 1996 are presented in Tab.1. After first evaluation of obtained data we assess effective dose 0.7-0.8 mSv/per inhabitant and 3.8 mSv/per patient. We have to take into account also that GHIC cover not all people in the Czech Republic (in accordance with the annual report of GHIC – 75 %) and some procedures we have not still estimated by effective dose (about 15 % of all procedures).

During 1997 we obtained also the results from national survey on the type and amount of administered radiopharmaceuticals (see Tab.2). The questionnaires of survey were distributed to all from 50 nuclear medicine department in the country and 48 department answered. Based on the survey results, the reference levels (dose constraints) for nuclear medicine procedures were defined and implemented into new Czech legislation (Regulation No.184/1997) – Tab.3.

Concerning the X-ray examination the same way for their evaluation is followed, but number of proce-

**Tab. 3. Reference levels of administered activity for some diagnostic procedures in nuclear medicine related to adult patient (70 kg)**

Examination		Radionuclide	Chemical form	Administered activity [MBq]
BONE	Bone imaging	<sup>99m</sup> Tc	Phosphonate and phosphate compounds	800
BRAIN	Brain imaging static	<sup>99m</sup> Tc	TcO <sub>4</sub> <sup>-</sup> , DTPA	600
	Brain imaging (SPECT)	<sup>99m</sup> Tc	TcO <sub>4</sub> <sup>-</sup> , DTPA, HM - PAO	800
	Cisternography	<sup>111</sup> In	DTPA	40
THYROID	Thyroid imaging	<sup>99m</sup> Tc	TcO <sub>4</sub> <sup>-</sup>	150
		<sup>123</sup> I	I <sup>-</sup>	7
	Thyroid metastases(after abl.)	<sup>131</sup> I	I <sup>-</sup>	400
	Parathyroid imaging	<sup>201</sup> Tl	Tl chloride	80
LUNG	Lung ventilation imaging	<sup>81</sup> Kr <sup>m</sup>	gas	6000
		<sup>99m</sup> Tc	DTPA aerosol	150
	Lung perfusion imaging	<sup>99m</sup> Tc	Human albumin	200
	Lung imaging (SPECT)	<sup>99m</sup> Tc	MAA	300
LIVER & SPLEEN	Liver, spleen imaging	<sup>99m</sup> Tc	Labeled colloid	150
	Functional biliary system im.	<sup>99m</sup> Tc	IDA derivate	250
	Liver imaging (SPECT)	<sup>99m</sup> Tc	Labeled colloid	300
CARDIO-VASCULAR	First pass blood flow studies	<sup>99m</sup> Tc	TcO <sub>4</sub> <sup>-</sup>	900
	Myocardial imaging	<sup>99m</sup> Tc	Phosphonate and phosphate compounds	600
	Myocardial imaging (SPECT)	<sup>99m</sup> Tc	isonitriles	800
		<sup>201</sup> Tl	Tl chloride	110
		<sup>99m</sup> Tc	Phosphonate and phosphate compounds	800
STOMACH G.I. TRACT	Stomach/salivary gland im.	<sup>99m</sup> Tc	TcO <sub>4</sub> <sup>-</sup>	100
	Meckels diverticul. imaging	<sup>99m</sup> Tc	TcO <sub>4</sub> <sup>-</sup>	400
		<sup>99m</sup> Tc	Labeled normal red blood cells	600
	Oesophag. transit and reflux	<sup>99m</sup> Tc	Labeled colloid	60
	Gastric emptying	<sup>99m</sup> Tc	Labeled colloid	60
KIDNEY, URINARY SYSTEM, ADRENALS	Renal imaging static	<sup>99m</sup> Tc	DMSA, gluconate and glucoheptonate	200
	Renal imaging dynamic	<sup>99m</sup> Tc	DTPA, MAG3	250
	Renal imaging (SPECT)	<sup>99m</sup> Tc	DMSA, gluconate and glucoheptonate	300
	Nephrography	<sup>131</sup> I	Hippuran	1
MISCELLANEOUS	Tumor or abscess imaging	<sup>67</sup> Ga	citrate	150
		<sup>201</sup> Tl	Tl chloride	100
	Neuroectodermal tumor imaging	<sup>123</sup> I	MIBG	200
		<sup>131</sup> I	MIBG	20
	Abscess imaging	<sup>99m</sup> Tc	HM - PAO labeled white cells	600

dures is much higher of course and the evaluation of data will be terminated on the end of this year. Data obtained from GHIC databases were however partially used for filling of UNSCEAR questionnaires and results are presented in Tab.4.

**Tab. 4. Form 2: Diagnostic X-ray examinations**

Examination	Num. of procedures performed annually	Effective dose (mSv)		Age distribution (%)			Sex distribution (%)	
		Mean	Variation	0-15	15-40	>40	M	F

**MEDICAL EXAMINATIONS**

Chest radiography	1 498 000	0.05		10.2	17.6	72.1	49.5	50.5
Chest photofluorography	255 417	0.70						
Chest fluoroscopy	51 442							
Limbs and joints	2 374 579			18.1	31.1	50.8	47.5	52.5
Spine	Lumbar	565 376	2.00	6.3	28.2	65.6	42.8	57.2
	Thoracic	395 763	1.76	9.7	35.0	55.2	43.7	56.3
	Cervical	560 245	0.28	5.4	30.3	64.3	37.4	62.6
	Whole	28 268		28.1	32.4	39.5	44.3	55.7
Pelvis/hip	678 451	1.26		20.5	15.9	65.5	35.2	64.8
Head	904 601	0.28		24.4	36.0	39.6	47.6	52.4
Abdomen	209 230	3.00		4.4	20.3	75.3	48.9	51.1
Upper gastrointestinal	123 988	3.00		2.9	25.3	71.7	43.0	57.0
Lower gastrointestinal	54 245	8.50		2.6	15.6	81.8	40.6	59.4
Cholecystography	37 932	1.26		0.1	10.4	89.4	36.3	63.7
Urography	124 134	2.04		10.8	17.7	71.5	55.2	44.8
Mammography screening	0							
clinical dg.	122 321	0.50 <sup>+) )</sup>		0	37.2	62.8	0.9	99.1
CT	head	232 000	1.10	8.4	22.4	69.2	47.2	52.8
	body	116 000	9.20	4.6	15.3	80.1	49.0	51.0
Angiography	Cerebral	4 634	2.80	4.1	22.4	73.4	55.7	44.3
	Cardiac	11 583	3.60	0	4.7	95.3	76.3	23.7
	Other	41 698	8.90	6.4	9.0	84.6	66.2	33.8
Interventional procedures	PTCA			0	4.3	95.7	77.4	22.6
	Other	316 246		9.0	16.1	74.9	58.9	41.1
Pelvimetry(indicate etal dose)				2.6	87.2	10.3	15.4	84.6
Other	447 749			13.1	14.8	72.1	56.3	43.7
<b>TOTAL</b>	<b>9 153 902</b>			<b>12.9</b>	<b>25.3</b>	<b>62.0</b>	<b>45.4</b>	<b>54.6</b>

**DENTAL EXAMINATIONS**

Intraoral	2 000 000 <sup>++)</sup>	0,10						
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<sup>+) )</sup> average effective dose calculate for whole examination of breasts ( 4 projections ) with risk coef. 0,05

<sup>++)</sup> qualified estimation based on the numbers of dental X-rays machines in the country, the high increase of number of dental examination in comparison with the previous period is attributed to the high increase of the numbers of private dentists in our country after 1989 y.

<b>POPULATION BASE</b>	For numbers of exam : whole country For age and sex distribution : capital city ( about 10% of population ), the same distribution is assumed for whole country
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