Some aspects of patient radioprotection in radiodiagnostic in Cluj area

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INTRODUCTION

- Radiation protection of patient represents a basic requirement for any radiological procedure involving population.
- Since 2000, the legislation in Romania in nuclear field concerning radiological security and radiological protection of patients as part of medical exposure, was elaborated by National Authority of Nuclear Activities Control (CNCAN) and MS.
- These regulations control the highest source of population artificial exposure (diagnostic radiology). Its contribution to the annual collective dose represents 90% from the total medical exposures.

PURPOSE

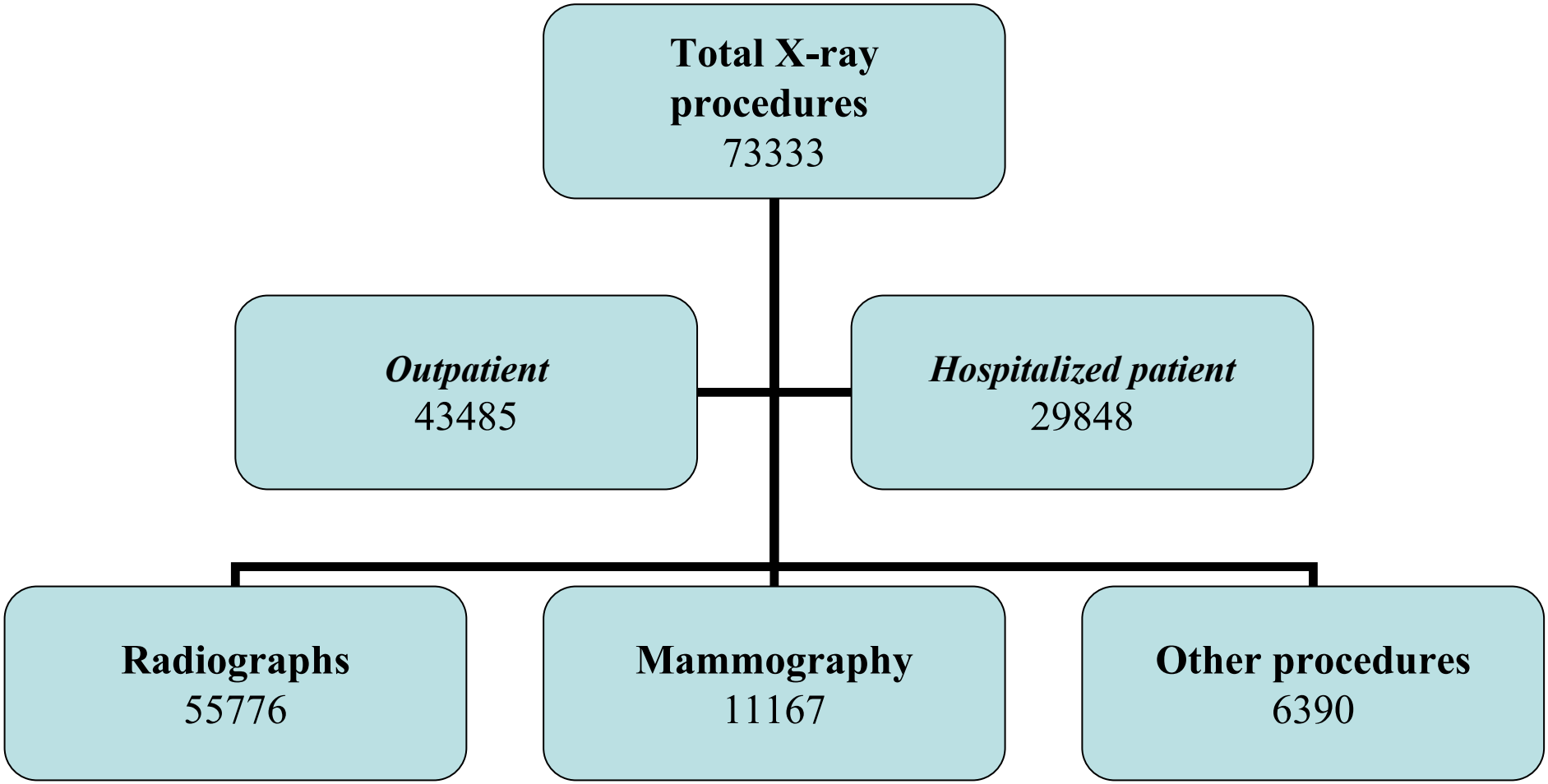
• Our department was involved in a study, during 2006-2008, and its objective is to estimate and reduce the patient medical irradiation risks, optimizing the quality of the radiological procedure.

MATERIALS AND METHODS

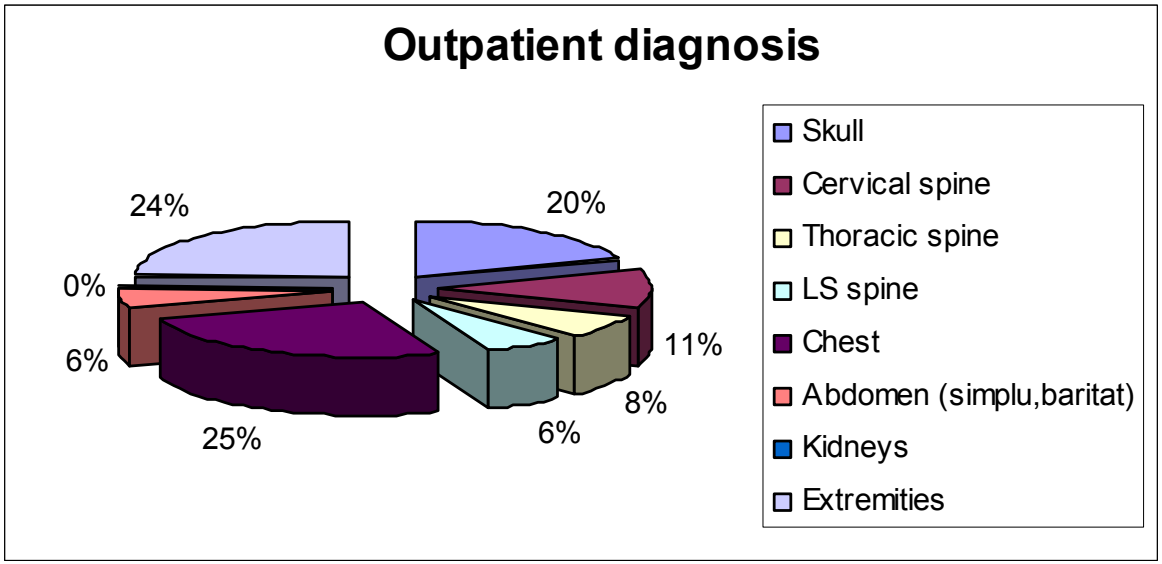
- We studied the most commonly used radiological equipments used in Cluj County Emergency Hospital, radiological unit representative regardind the addressability to Cluj county population and annual radiological consumption
- We also initiated a study regarding the radiological consumption of population in Cluj county
  - This study comprised investigations on the following aspects:
    - the number of radiological procedures,
    - the distributions regarding anatomical part,
    - age groups of patients.
- Several quality control tests of the new radiological equipment were performed in 2006 - 2008.
  - These tests evaluated the quality performance of physical parameters (e.g. kV, mAs, HVL, mGy/mAs) representing the most important factors affecting image quality and patient dose.
- Patient doses were estimated by Monte Carlo simulations using a PC program, named IradMed, developed in our department.

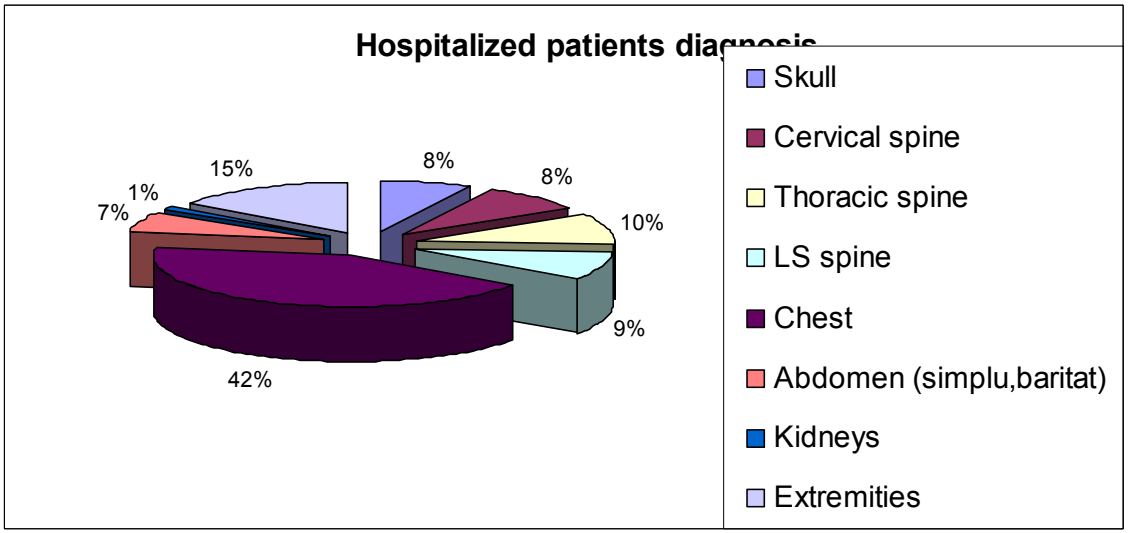
RESULTS

The average annual number of radiology procedures performed in a population of 702,755 inhabitants of Cluj County (Census 2002), 2006-2008

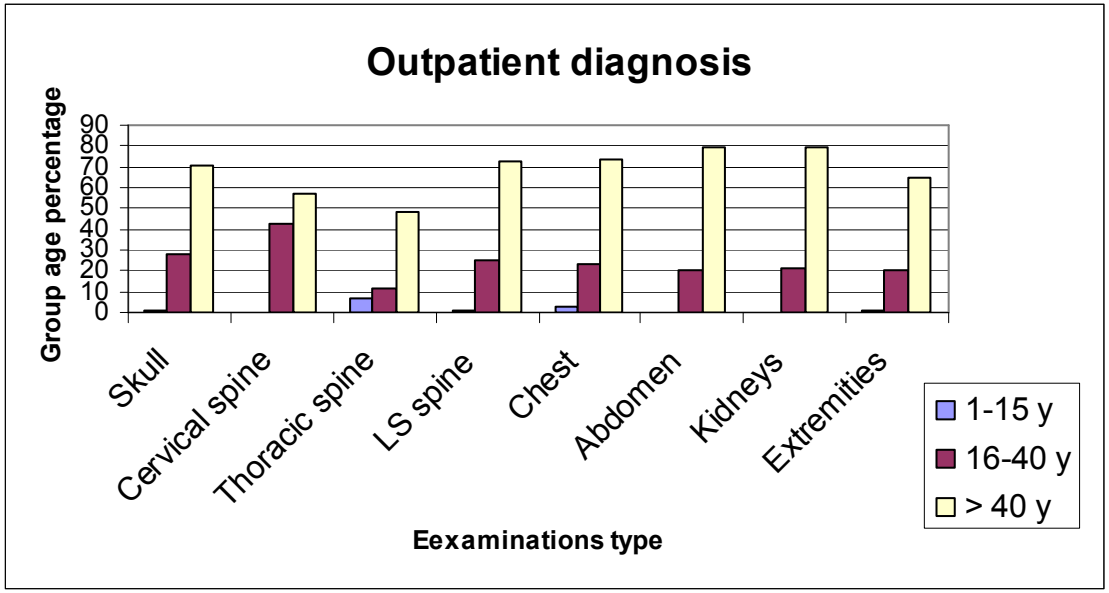


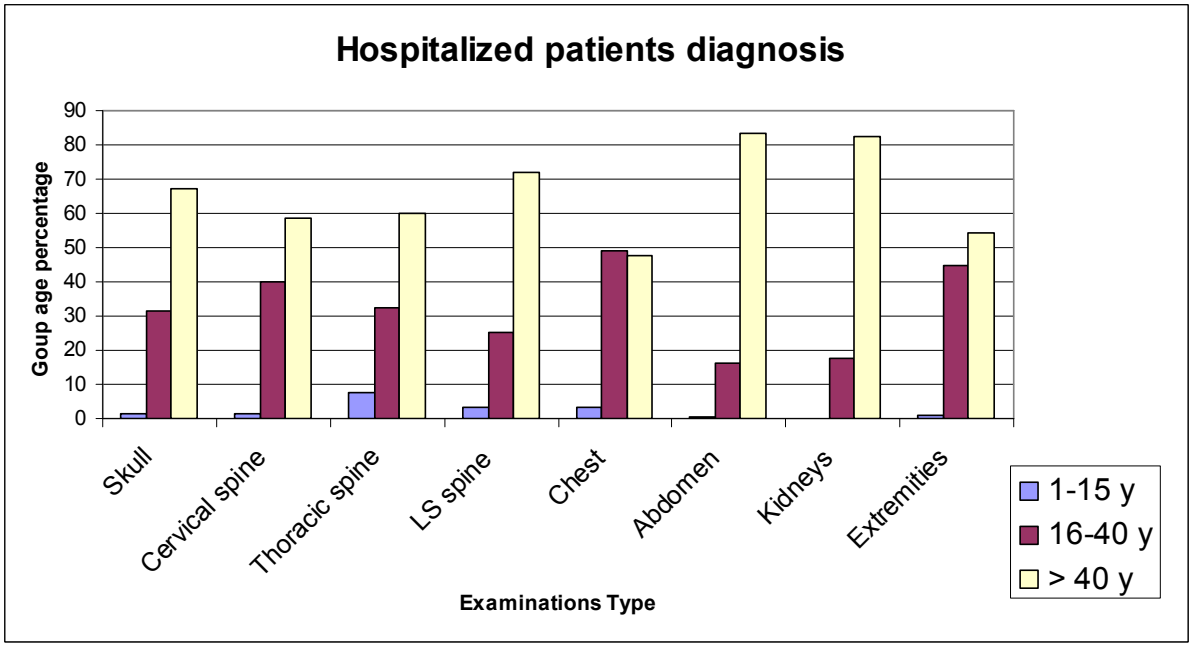
Percentage distribution of radiological examinations:





Distribution by age group of radiographs:





Tab. 1. Inspecting the physical parameters of radiological equipments

ID No	Physical parameter X-ray Equipment	kVp Accuracy Dif. (%)	kVp Reproduct. CV (%)	t_{exp} Accuracy Dif. (%)	t_{exp} Reproduct. CV (%)	Output Linearity CL (%)	Beam Quality HVL_1 (mmAl)
1	TELEDIAGNOST	0.72-2.04	0.38	0.00-2.15	0.05	0.014	3.21 +/- 0.16
2	PHILIPS SUPER 70	1.83-**18.68**	**5.02**	**6.84-20.77**	0.14	0.07	3.12 +/- 0.16
3	MULTIX COMPACT K	1.89-2.92	0.08	2.07-**12.05**	0.05	0.003	3.20 +/- 0.16
4	DUODIAGNOST	0.14-3.22	0.22	0.65-2.89	0.62	0.005	3.48 +/- 0.17
5	COLIMAT M	1.35-3.09	0.07	0.75-1.31	0.76	0.04	3.19 +/- 0.16
6	DUODIAGNOST	0.17-3.31	0.08	**5.12-5.81**	0.17	0.01	3.10 +/-0.16
7	DUODIAGNOST	0.84-3.39	0.08	1.05-3.29	0.01	0.001	3.81 +/- 0.19
8	COLIMAT M	**9.01-12.02**	0.07	0.7-**5.71**	0.11	0.044	3.14 +/- 0.16
	Quality control limits (%)	**5-10**	**5-10**	**5-10**	**5-10**	**0.1**	**> 2.5**

Tab.2. Patient doses estimated by Monte Carlo simulation (I)

X-ray Equipment	Examination type	kV	Doza supr. intr. [mGy]	Reference level [mGy]	Effective Dose [mSv]	Reference level [mSv]
TELEDIAGNOST Filt. Tot. Echiv. 4.023 mmAl	**ChestPA**	85	**2.696**	0.3	**0.412 +/- 0.219%**	0.02
	Lombar Spine AP	80	1.376	10	0.195 +/- 0.240%	1.3
	Lombar Spine LL	85	2.191	30	0.047 +/- 0.251%	-
	Cervical Spine AP	70	3.007	7	0.098 +/- 0.087%	0.7
	Abdomen AP	100	2.150	10	0.318 +/- 0.871%	1
PHILIPS SUPER 70 Filt. Tot. Echiv. 4.151 mmAl	**Chest PA**	75	**1.097**	0.3	**0.138 +/- 0.196%**	0.02
	Skull AP	65	3.917	5	0.029 +/- 0.487%	0.07
	Dorsal Spine AP	75	8.336	10	0.381 +/- 0.234%	1.3
	Abdomen AP	70	5.164	10	0.424 +/- 1.176%	1
	Kidneys AP	85	3.622	10	0.400 +/- 1.113%	1
MULTIX COMPACT K Filt. Tot. Echiv. 3.722 mmAl	**Skull AP**	71	1.275	5	0.014 +/- 0.901%	0.07
	Skull LL	64	1.227	3	0.013 +/- 0.697%	-
	Chest PA	70	0.226	0.4	0.011 +/- 0.147%	0.02
	Lombar Spine AP	81	5.228	10	0.231 +/- 0.147%	1.3
	Abdomen AP	81	5.228	10	0.503 +/- 1.220%	1
	Cervical Spine AP	64	0.890	10	0.023 +/- 0.123%	1.3
	Lombosacrat Spine	102	22.424	40	0.438 +/- 0.563%	

Tab.2. Patient doses estimated by Monte Carlo simulation (II)

X-Ray Equipment	Examination type	kV	Doza supr. intr. [mGy]	Reference level [mGy]	Effective Dose [mSv]	Reference level [mSv]
TELEDIAGNOST Filt. Tot. Echiv. 4.023 mmAl	**Chest PA**	85	**2.696**	0.3	**0.412 +/- 0.219%**	0.02
	Lombar Spine AP	80	1.376	10	0.195 +/- 0.240%	1.3
	Lombar Spine LL	85	2.191	30	0.047 +/- 0.251%	-
	Cervical Spine AP	70	3.007	7	0.098 +/- 0.087%	0.7
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	Skull LL	64	1.227	3	0.013 +/- 0.697%	-
	Chest PA	70	0.226	0.4	0.011 +/- 0.147%	0.02
	Lombar Spine AP	81	5.228	10	0.231 +/- 0.147%	1.3
	Abdomen AP	81	5.228	10	0.503 +/- 1.220%	1
	Cervical Spine AP	64	0.890	10	0.023 +/- 0.123%	1.3
	Lombosacrat Spine LL	102	22.424	40	0.438 +/- 0.563%	-

RESULTS:

Highlighted problems after applying the quality control tests are the following, in order of appearance:

- **inaccuracy of exposure time**, its real value is greater than the value shown theoretically => higher dose;

- inaccuracy of the tube high voltage applied (kV), for certain values (the highest) or the entire field of clinical use;

- high voltage values are reproducible only one of plants tested;

For all X-ray equipment we found :

- linearity of tube output,

- quality suitable for X-ray beam

Note that such problems occur in new generation facilities (installed after 2001). After conducting these tests, the units were informed on the issues highlighted and demanded the company to remedy these failures.

CONCLUSION

- Our results show that even on new radiological X-ray devices, the quality control program is required for diagnostic optimization