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ELECTRONIC RECORDING OF RADIATION EFFECTIVE DOSES IN MEDICAL IMAGING INVESTIGATIONS

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- The continuously increasing number of medical investigations using radiological methods imposes the necessity of recording the radiation effective doses for the patients.
- In Romania, an applied national research project develops a pilot study that analyses and record such types of data using a patient database, electronic cards for patients and doctors and a secured infrastructure based on Public Keys.
- The effective doses received by patients in many types of medical investigations are calculated, transformed, stored and cumulated.

Radiological Investigations

The Sievert (Sv) is the central unit of radiation dose implemented in the project. The International Commission on Radiological Protection (ICRP) recommends the use of the linear no-threshold (LNT) model [3].
For classic radiological investigation radiation dose is expressed in Dose Area Product (DAP), measured in (Gy*cm^2). DAP meters are shown in Figure 2. A DAP calculus example is shown in Table II.
For CT scans, The Computed Tomography Dose Index (CTDI), Dose Length Product (DLP) and Effective Dose (ED) are used. The DLP is measured in (mGy*cm). Conversion factors for normalized effective dose per DLP depend only on the scanned region. Conversion problems were detected for multiple CT scans in one single examination, implying a long procedure. More refinements can be used in future as shown in table III.

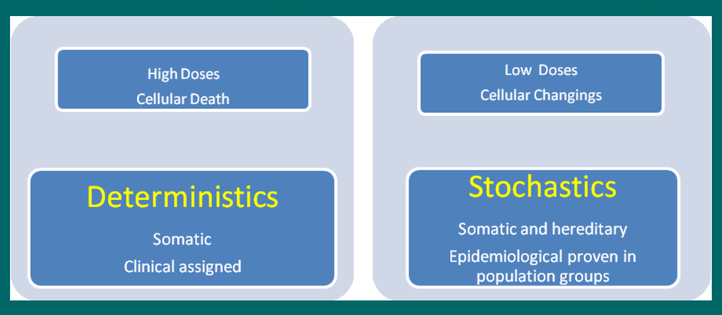

Fig. 1. Radiation biological effects

Table I. Human Cells Sensitivity to Radiation [1].

Radio sensitive	*Radio resistant*
Breast tissue	Heart tissue
Bone marrow cells	Large arteries
Mucosa lining of small intestines	Large veins
Sebaceous (fat) glands of skin	Mature blood cells
Immune response cells	Neurons
All stem cell populations	Muscle cells
Lymphocytes	

Fig. 2. DAP meters

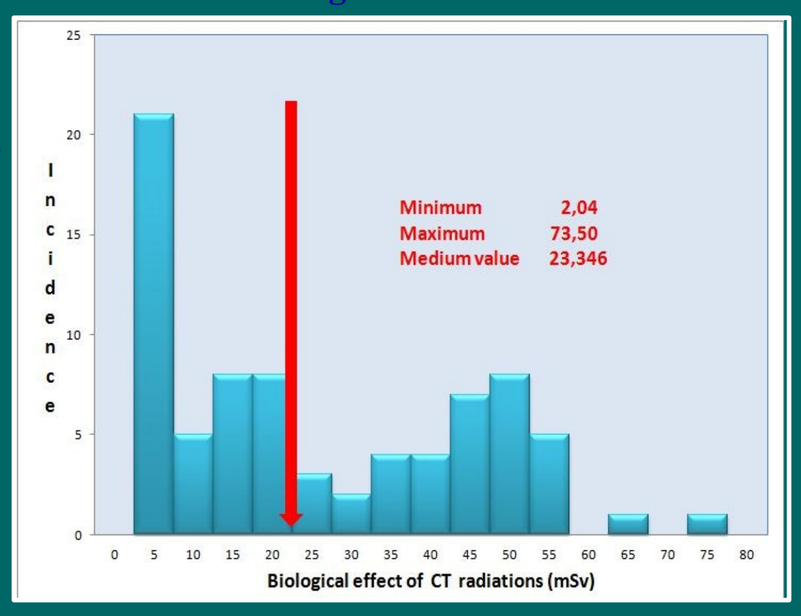

Fig. 3. Cumulative radiation doses received by patients in the study

Tabel II. Effective dose calculus.

Measured DAP	197 mGycm^2
Film Area	1.225 cm2
Skin dose	0.16 mGy
Lung factor	0.12
Effective dose	0.0192 mSv
197 : 1.225 = 0.16 * 0.12 = 0.0192	

Tabel III. Risk factor versus age.

Age Group (years)	*Multiplication factor for risk*
<10	x 3
10-20	x 2
20-30	x 1.5
30-50	x 0.5
50-80	x 0.3
80+	Negligible risk

Tabel IV. Radation Doses.

CT examinations	*Effective dose (mSv)*	*Equivalent number of PA chest radiographies*
Chest	15	750
Pelvis	10	500
Virtual colonoscopy	10	500
Abdomen	10	500
Coronary angiography	8.7	435
Spine	6	300
Pulmonary angiography	5.2	260
Calcium scoring	3	150
Neck	3	150
Head	2	100

The maximum cumulative dose has been over passed during a one month study in the hospital, at the beginning of the project [8]. The CT exams are the most concerning prescribed imaging investigations that can lead to high cumulative doses. Fig. 3 reveals aspects from the initial study .
The initial proposed threshold radiation dose of 20 mSv was frequently over passed and maybe a dose of 50 mSv may be accepted for medical investigations in the future [9].

Conclusions

- Radiation effects can be deterministic or stochastic, prompt or delayed, somatic or genetic. Compared to classical radiography, CT is a high-dose imaging method, although doses are still below the threshold dose for deterministic effects. ED/DLP coefficients have been used for converting DLP values in effective doses in mSv. The tissues factors are currently provided by the manufacturer of the CT scanner.
- ED/DLP values were common across similar-generation scanners from different vendors.
- Cumulating the total effective dose for each patient provides a more accurate method to generate reports.
- The actual used method for reporting establishes the total numbers of investigations by their type and uses an average effective dose for every type.
- This new recording system uses Public Key Infrastructure, digital signature and smart cards for storing and manipulating data.

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