



Evaluation of the radiation load of children in neonatal departments of Slovak hospitals

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Exposure of human with sources used in medicine is an **important contribution to the total dose** of ionizing radiation to which man is exposed.

Current legislation in Slovak Republic introduces the methods of quality assurance and quality control of radiological examinations.

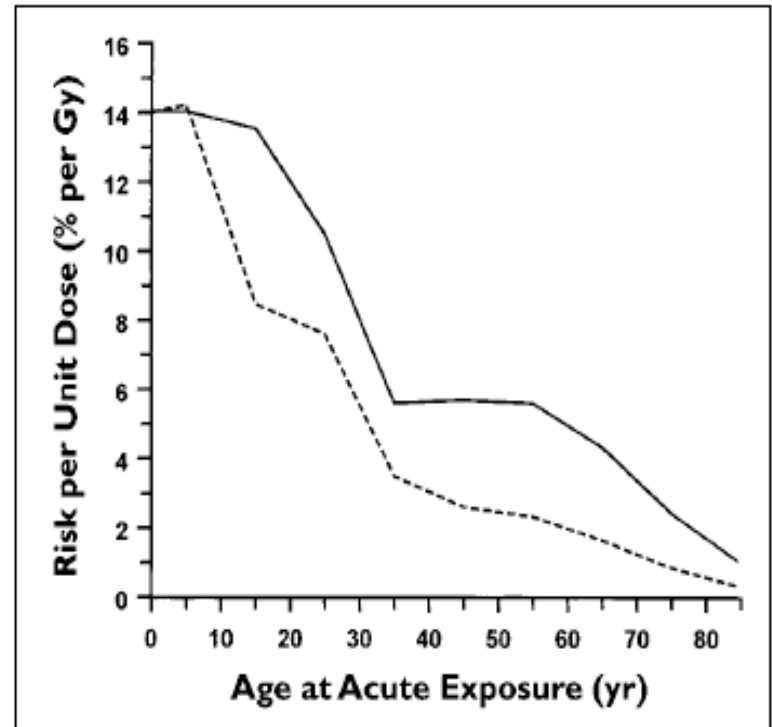
Diagnostic radiology plays an important role in the assessment and treatment of premature newborns requiring intensive care.

It is often necessary to perform a large number of examinations

Any radiological examination of children must be very carefully considered and realized with all available safeguards.

Children are far more sensitive than adults to the chromosome-damaging effects of radiation, because of the highly mitotic state of their cells;

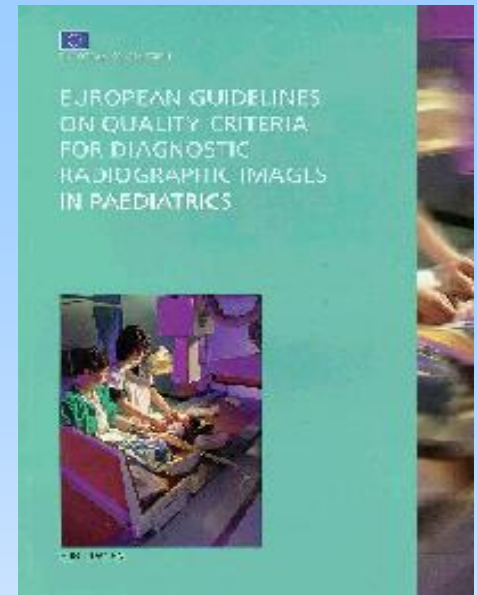
the sensitivity of a tissue to radiation is directly proportional to its rate of proliferation.



The recommendation "*European Guidelines on Quality Criteria for Diagnostic Radiographic Images in Paediatrics*", from the year 1996, determined the best techniques for radiological examination of infants and children.



The best radiological technique is a technique with **acceptable level of image** for the correct diagnosis and at the same time with the **lowest radiation exposure** of children to minimize the risks associated with ionizing radiation.



In the special care baby unit, premature newborn with a gestational age as low as 24 weeks and a birthweight as low as 600g, often suffer from a variety of serious to life-threatening complications, which usually result from diseases in the respiratory and cardiovascular system.

Children born prematurely have often **underdeveloped lungs**, leading to respiratory distress syndrome.

The radiological examination of the chest is the only method to assess the position of endotracheal tubes, catheters and cannulas.

It is indicated for monitoring the course of treatment, the effect of ventilation and circulation changes as a result of heart defects.

Intestinal infection (necrotizing enterocolitis), slow passages are indications of radiological examination of abdomen.



Pic. 1 – X-RAY images of the abdomen and chest, 2 x chest of newborn with birth weight 1500 g

The aim of our study was to review radiological procedures used in neonatological departments in Slovak Republik.

12 hospitals received the questionnaire concerning X ray examinations of newborns.

We mapped the existing equipments for radiological examinations for newborn in neonatal departments at the hospitals in central region of Slovakia, types of radiological examinations and the parameters of the most frequent examinations (the voltage of the x-ray tube, the product of the current, the total filtration, exposure time, the size of the field, the film-skin distance).

We performed own measurements of the impact doses and determined the entrance surface doses ESD.

The findings were compared with recommendations of the European Commission.

RTG vyšetrenia na novorodeneckých oddeleniach	
Názov zdravotníckeho zariadenia	
Počet narodených detí v roku 2009	
Počet detí narodených v 2009 podstupujúcich rtg vyšetrenia	
Celkový počet rtg vyšetrení	
z toho vyšetrenia pľúc	
brucha	
vyšetrenia vo vše	
počet rtg vyšetrení v inkubátore	
počet detí podstupujúcich rtg vyšetrenia s pôrodnou hmotnosťou pod 1000g	
počet detí podstupujúcich rtg vyšetrenia s pôrodnou hmotnosťou 1000-1500g	
počet detí podstupujúcich rtg vyšetrenia s pôrodnou hmotnosťou od 1500g-2000g	
počet detí podstupujúcich rtg vyšetrenia s pôrodnou hmotnosťou od 2000g-2500g	
počet detí podstupujúcich rtg vyšetrenia s pôrodnou hmotnosťou nad 2500g	
počet detí podstupujúcich rtg vyšetrenia viac ako raz	
maximálny počet rtg vyšetrení u jedného dieťaťa	
typ používaného rtg zariadenia*	
rok výroby	
generátor	
použité expozičné parametre**	
napätie na rtg lampe (kV)	
prúd (mA) alebo množstvo žiarenia (mAs)	
expozičný čas (s)	
filtrácia	
vzdialenosť ohnisko-koža	
vzdialenosť ohnisko-film	
vstupná povrchová dávka alebo kerma vo vduchu	
vyclonenie poľa	
aké ochranné tienenie bolo použité	
fixácia, sedatíva	
použité zosilňovacie fólie	

Exposure parameters and parameters of the examination of the chest in Directive „European Guidelines on Quality Criteria for Diagnostic Radiographic Images in Paediatrics" .

Exposure parameters and parameters of the examination.

Focal spot size	0,6 mm ($\leq 1,3$ mm)
Additional filtration	1 mmAl + 0,1 v 0,2mm Cu
Screen film system	200-400
FFD	80-100 (150) cm
The voltage of the x-ray tube	60-65 kV
Automatic exposure	no
Exposure time	< 4 ms
Protective shielding	protective lead shielding
ESD	80 μ Gy

Results

Table 1 and Table 2 are shown the X-ray equipments used in various workplaces in hospitals, number of tests performed in year 2010 and exposure parameters, the measured impact dose and exposure time values.

The most frequently performed examination is the radiological examination of the chest in an incubator or on a bed in the sagittal projection, less frequently were performed radiological examinations of abdomen and babygrams.

The neonatal radiological examination does not repeat because low level of diagnostic images.

By all neonatal examinations was consistently used lead rubber shielding.

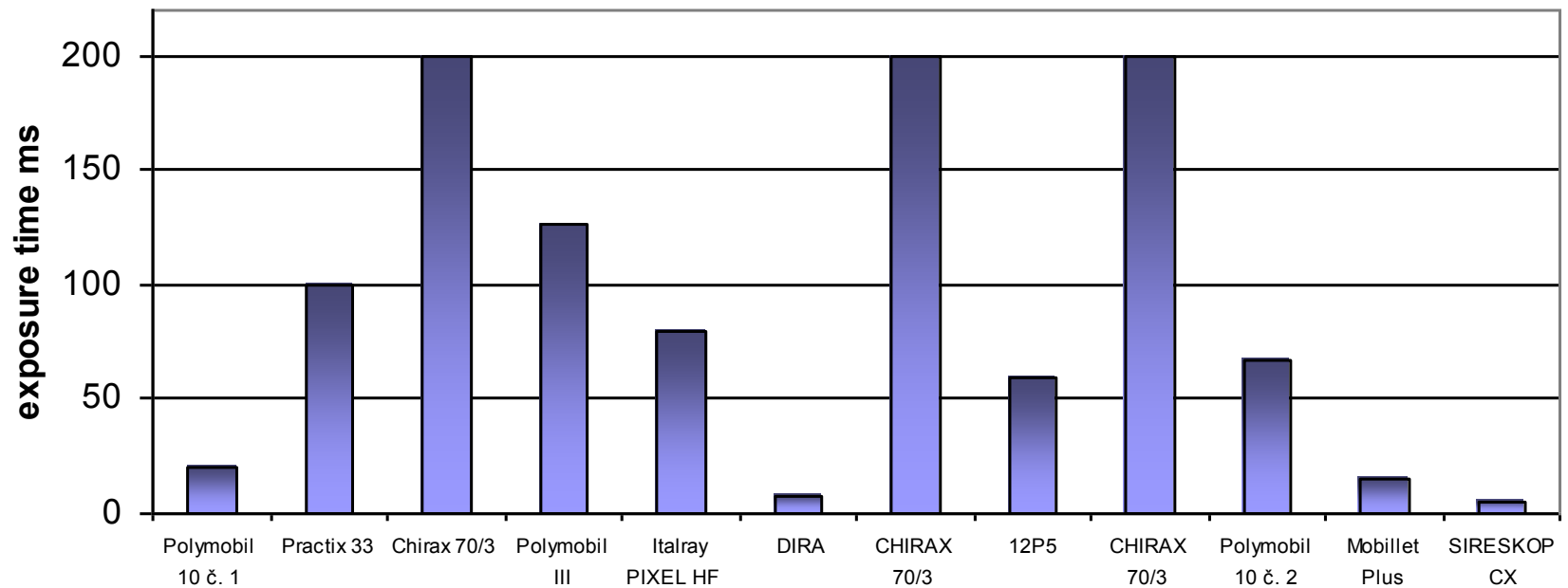
The comparison of values of exposure time a ESD between the workplaces in hospitals are performed in pic. 2 and pic. 3.

Hospital	Radiological equipments	Number of radiological examinations	Maximum radiological examination per neonate
1	Polymobil 10	368	15
2	Practix 33	28	3
3	Chirax 70/3	10	1
4	Polymobil III	25	1
5	Italray PIXEL HF	14	1
6	DR Digital X-Ray system DIRA	7	1
7	CHIRAX 70/3	806	
8	12P5	110	3
9	CHIRAX 70/3	15	1
10	Polymobil 10	10	1
11	Mobillet Plus	10	1
12	SIRESKOP CX	33	1

Table 1 – Radiological equipments and number of examinations of newborn

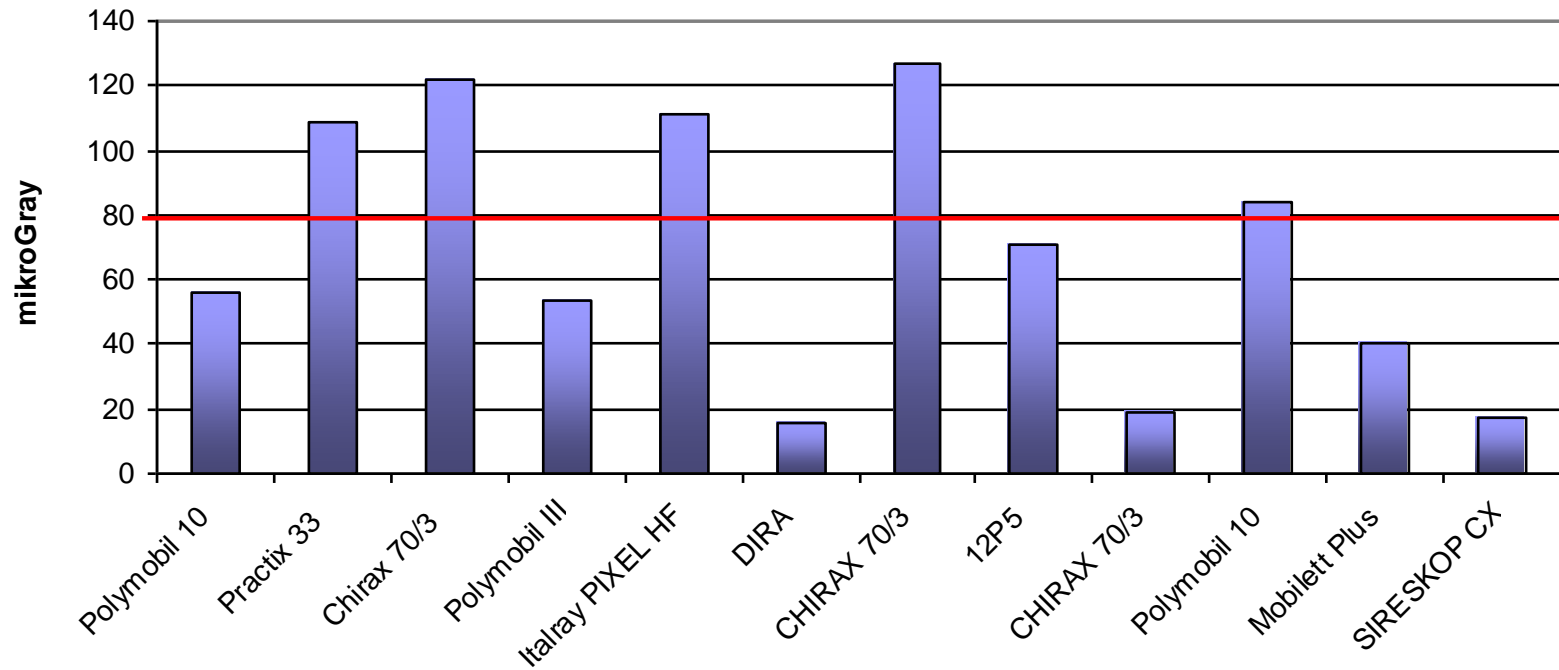
	Radiological equipments	Voltage of tube kV	Product of the Current mAs	Impact dose uGy	Exposure time ms	FFD cm	Filtration mm Al
1	Polymobil 10	44-46	2-3,2	21-44	17,5 -21,2	100	2,8
2	Practix 33	44-47	5-6,3	61-87	82-106	100	2,7
3	Chirax 70/3	60		95	150	80	2,0
4	Polymobil III	42	5	43	126	100	3,2
5	Italray PIXEL HF	49-55		53-67	80	110	2,7
6	Digital X-Ray system DIRA	57	4	12	8	180	3,14
7	CHIRAX 70/3	60		109	200	80	2
8	12P5	50-57		38-57	60	110	2
9	CHIRAX 70/3	60		10-15	150-200	85	3
10	Polymobil 10	40	10	68	66,6	100	2,7
11	Mobilett Plus	44	5	32,4	15	100	3,8
12	SIRESKOP CX	49	2,5	14,14	4,5	115	4,5

Comparison of exposure time



Short exposure time (<4 ms) is recommended to eliminate motion blur due to increased heart rate of newborns

Comparison of ESD



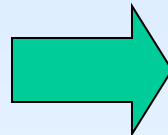
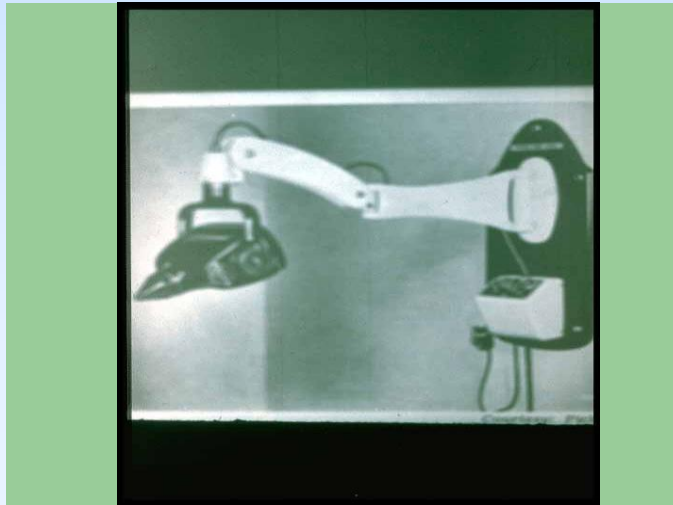
Conclusion

Comparison of exposure parameters and parameters of neonatal radiological examination shows a discrepancy with the recommendations of the EC „European Guidelines on Quality Criteria for Diagnostic Radiographic Images in Paediatrics" (voltage of x-ray tube, exposure time, additional filtration).

The entrance surface doses of neonatal radiological examinations of the chest is comparable in many workplaces with EC recommendations, but the examination of newborn is not completely optimized.

The use of mobile x-ray machines to neonatal wards is a frequent phenomenon, although they are not designed for use in the paediatric.

In particular, it is not possible to set a higher voltage and at the same time the additional filtration, as recommended by the EC directive. These x-ray machines operate with a current of 100-160 mA and setting a short exposure time cannot be achieved.



In view of the low doses at a distance of 1 and 2m from the x-ray apparatus, it can be assumed that there is no significant exposure to other babies in incubators.



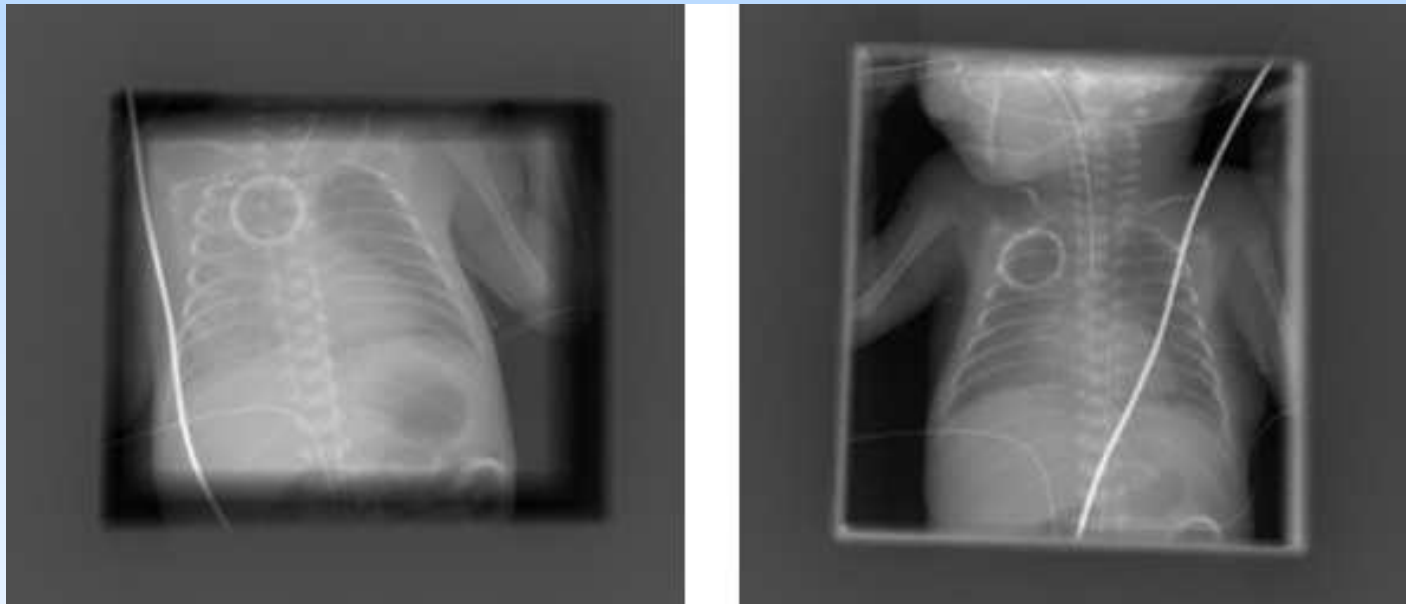
The study has shown a necessity to deal with this topic to optimize the X-ray procedures and radiation protection of newborn.

Optimizing of equipments and radiological procedures, together with the application of criteria issued by the European Commission could greatly reduce the dose. It is, however, a difficult process that requires the cooperation of radiological physicists, radiological assistants and physician-pediatrician.

Despite the fact that the risk from radiological examination is low compared with other risks arising from the health status of children born prematurely, it is necessary to try to minimize the radiograph exposure, by limiting of field of imaging and by using the appropriate protective shielding.

Elimination of useless doses

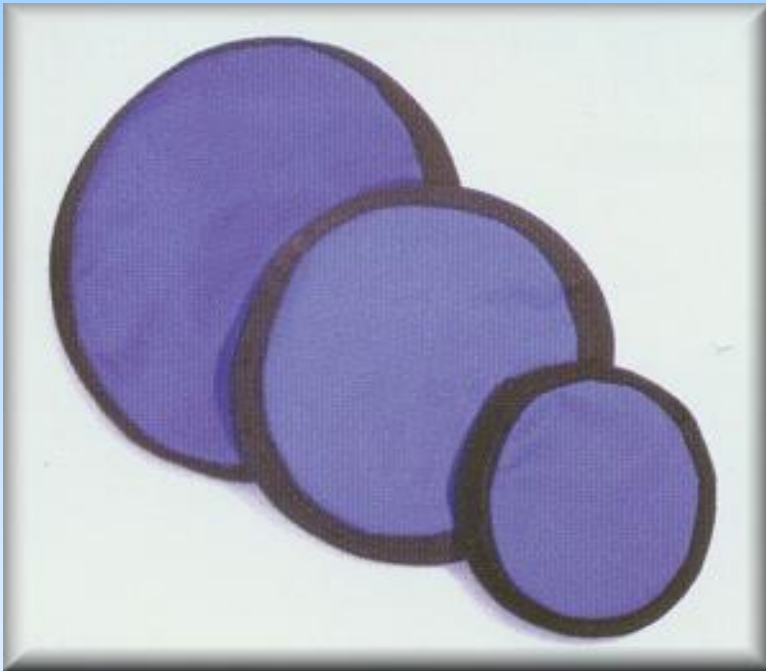
- To reduce the absorbed dose in tissue investigated the minimum of which is still required to obtain diagnostic information



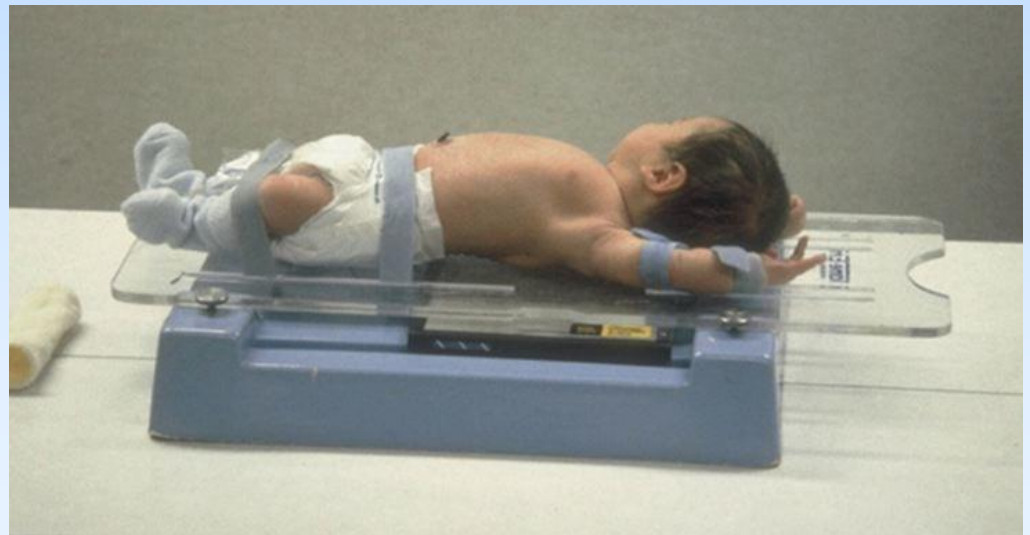
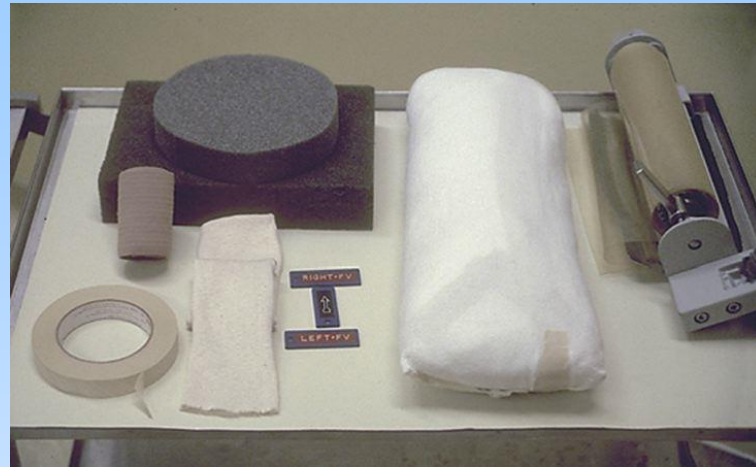
An example of correct and incorrect collimation

K. Smans: The development of doses optimisation strategies for x-ray examinations of newborns, Leuven, 2009

- To limit the exposure of other parts of the body



- to limit the frequency of unnecessary repeat examinations



We expect that our results allow the unification of radiological procedures, issued by the European Commission, but will mainly contribute to the dose reduction of infants hospitalized for various reasons in the neonatal clinics.

The obtained results will also create the proposal of **diagnostic reference levels** for this group of patients, which fail in the slovak legislation.



Thank you!