

# Patient dosimetry in paediatric diagnostic radiology

R. Borisova, Ch. Ingilizova, J. Vassileva  
National Centre of Radiobiology and Radiation Protection  
Sofia, Bulgaria



Workshop on Safety and Efficacy for New Techniques and Imaging using New equipment to support European Legislation  
Delft, the Netherlands, April 18-20, 2007

## Methods: dosimetry techniques

- Direct measurement with thermoluminescent dosimeters (TLDs)

LiF:Mg,Ti chips type TLD 100 (Harshaw)  
Annealing oven type T1321/U100 (PTW-Freiburg)  
PCL3 reader (Fimel)



SENTINEL Workshop - Delft, The Netherlands, April 18-20, 2007

## Methods: dosimetry techniques

- Calculation from the Dose-Area Product (DAP):  
parallel-plate ionization chamber  
DIAMENTOR E2 (PTW Freiburg)

$$ESD = BSF \cdot \frac{DAP}{A}$$

- Calculation from the tube output (Y)  
30 cm<sup>3</sup> ionization chamber  
with UNIDOS E (PTW Freiburg)

$$ESD = BSF \cdot \frac{Y \cdot (t - t_0)}{(FSD)^2}$$

- Calibration of DAP-meter on each unit individually
- BSF = 1.3 (1.2 ÷ 1.4 for a 5-year-old standard patient)

SENTINEL Workshop - Delft, The Netherlands, April 18-20, 2007

## Methods: diagnostic procedures

3 conventional X-ray units

- Chest radiography (CR) – AP and PA projections
- Pelvis radiography – AP projection
- Skull radiography – Lat projection
- Intravenous urography (IU) – AP projection
- Micturating cystourethrography (MCU) – AP projection

SENTINEL Workshop - Delft, The Netherlands, April 18-20, 2007

## Methods: data recorded

- Weight
- Height
- Sex
- Age
- Thickness
- Tube voltage
- Current-time product
- Focus-skin distance
- Focus-table distance
- Field size in the film plane
- Use of anti-scatter grid
- Speed class of screen film system
- Selection of exposure parameters
- Dose-Area Product
- Entrance Surface Dose (TLDs)

SENTINEL Workshop - Delft, The Netherlands, April 18-20, 2007

## Results: method comparison – uncertainty sources

- Direct measurement (≥ 0.5 mGy):** ± 10% to ± 25% (average: ± 18%)
- random uncertainty
  - uncertainty from calibration, energy dependence, non-linearity
- Calculation from DAP:** ± 16%
- DAP measurement
  - calibration uncertainty
  - measurement of FSD and field area
  - BSF
- Calculation from Y:** ± 17%
- assessment of Y
  - measurement of FSD
  - BSF

SENTINEL Workshop - Delft, The Netherlands, April 18-20, 2007

## Results: method comparison

454 patients

All three methods: 150

Two methods: 241

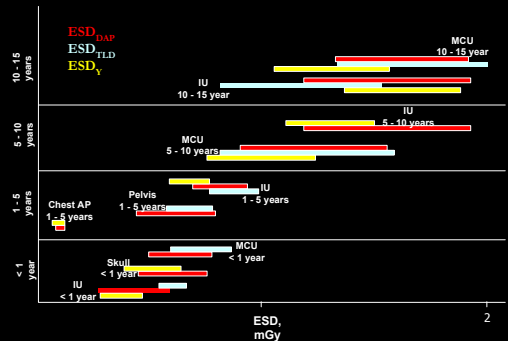
One method: 63

Relative percentage difference:

	ESD <sub>DAP</sub> v/s ESK <sub>TLD</sub>	ESD <sub>Y</sub> v/s ESK <sub>TLD</sub>	ESD <sub>DAP</sub> v/s ESK <sub>Y</sub>
median	14 %	18 %	17 %
mean	18 %	19 %	19 %

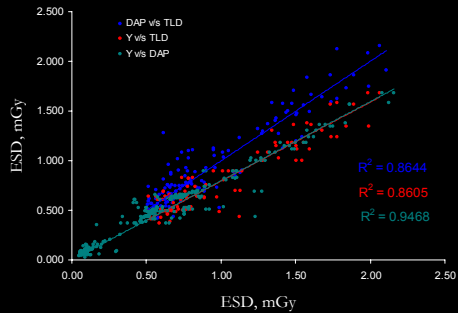
SENTINEL Workshop - Delft, The Netherlands, April 18-20, 2007

## Results: method comparison



SENTINEL Workshop - Delft, The Netherlands, April 18-20, 2007

## Results: method comparison



SENTINEL Workshop - Delft, The Netherlands, April 18-20, 2007

## Results: patient losses - sample size

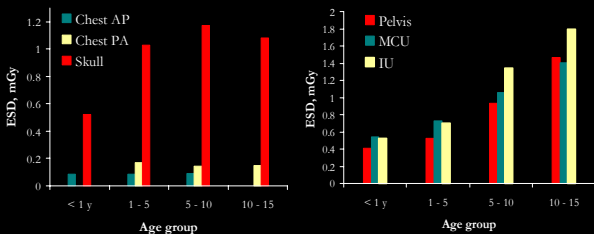
412 radiographs in 4 age bands

Number of patients in each age band:

	< 1 y	1 - 5	5 - 10	10 - 15
Chest AP	32	50	6	
Chest PA		11	21	15
IU	14	12	6	9
MCU	40	69	16	12
Pelvis AP	9	20	6	9
Skull Lat	5	6	13	31

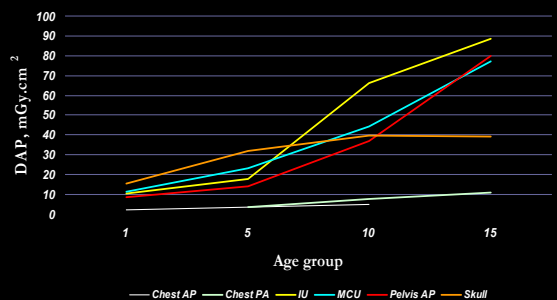
SENTINEL Workshop - Delft, The Netherlands, April 18-20, 2007

## Results: patient losses - age dependence of ESD



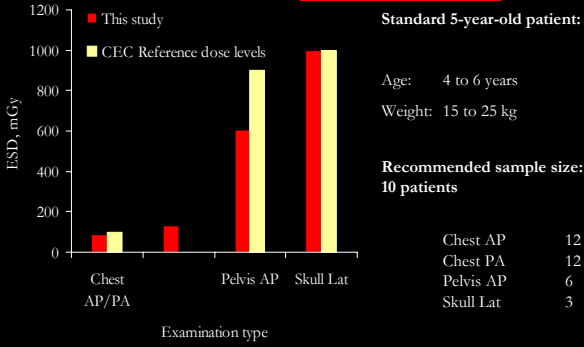
SENTINEL Workshop - Delft, The Netherlands, April 18-20, 2007

## Results: patient losses - age dependence of DAP



SENTINEL Workshop - Delft, The Netherlands, April 18-20, 2007

## Results: patient doses – comparison with CEC reference dose levels



SENTINEL Workshop - Delft, The Netherlands, April 18-20, 2007

## Results: patient doses – exposure parameters

**Selection of exposure settings:**  
predominantly by the radiographer

**Use of anti-scatter grid:**

used in all radiographs except in chest AP and 20% of chest PA

**Speed class of SFS:**

400

200 (75% of pelvic examinations)

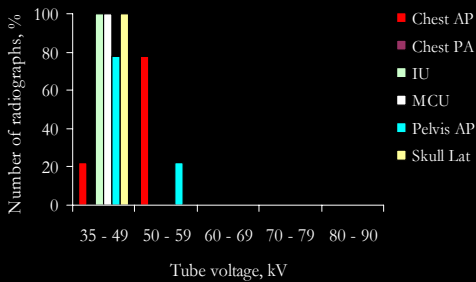
**Tube voltage settings:**

generally lower than the recommended by the CEC Guidelines

SENTINEL Workshop - Delft, The Netherlands, April 18-20, 2007

## Results: patient doses – exposure parameters

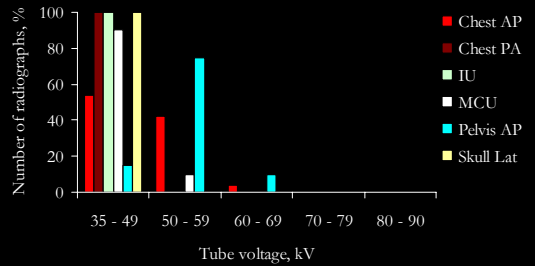
< 1 year



SENTINEL Workshop - Delft, The Netherlands, April 18-20, 2007

## Results: patient doses – exposure parameters

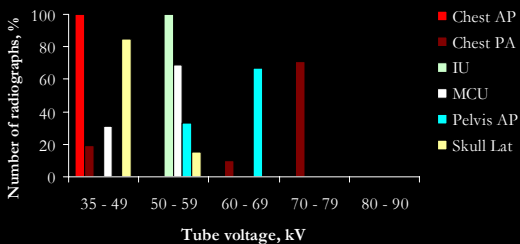
1 - 5 years



SENTINEL Workshop - Delft, The Netherlands, April 18-20, 2007

## Results: patient doses – exposure parameters

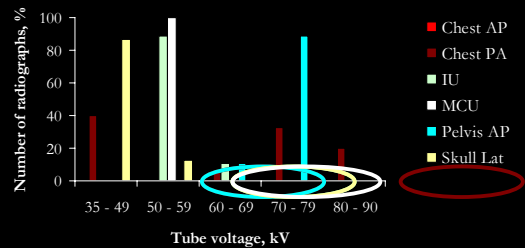
5 - 10 years



SENTINEL Workshop - Delft, The Netherlands, April 18-20, 2007

## Results: patient doses – exposure parameters

10 - 15 years



SENTINEL Workshop - Delft, The Netherlands, April 18-20, 2007

## Conclusions:

Preliminary results from the pilot study of paediatric doses in Bulgaria demonstrated great variation in patient doses and radiographic techniques used and the need for unification of the clinical practice and constant application of dose-reduction techniques.

Measurements of paediatric doses can be done using any of the three investigated methods; TLD materials for direct measurements should be selected with care; sources of uncertainty should be controlled as much as possible.