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PATIENT DOSES FROM TYPICAL RADIOGRAPHY EXAMINATIONS IN THE LENINGRAD REGION

7 - 9 November 2019, Kaunas

Diagnostic reference levels in the Russian Federation

- **Introduced in the National Radiation Protection legislation:**
- "**Basic sanitary rules on the provision of the radiation safety** (OSPORB 99/2010)**"** - 2010
- MR 2.6.1.0066-12 "**The use of diagnostic reference levels to optimize the radiation protection of the patient in general X-ray examinations**" - 2012
- **2009-2016:** Data collection in different Russian regions
- **2016:** Proposals for DRLs for radiographic examinations for adult and pediatric patients
  - effective dose as a major dose quantity
  - national level
  - same DRLs for analogue and digital X-ray units
  - effective doses were calculated by IRH staff

Current issues with diagnostic reference levels

- The use of **DRLs is not mandatory yet**
- Biased dose data collection on a hospital level:
  a) Main dose quantity – **effective dose**
  b) Annual collection within the framework of national dose data collection (ESKID)
  c) Calculation of effective doses is based on the conversion coefficients from DAP/radiation output
  d) Calculation is performed by medical staff/external radiation control laboratories
- A strong requirement to:
  a) To verify **the existing dose data**
  b) To verify **the proposed approach** for the establishment of DRLs

Aims and objectives of the study

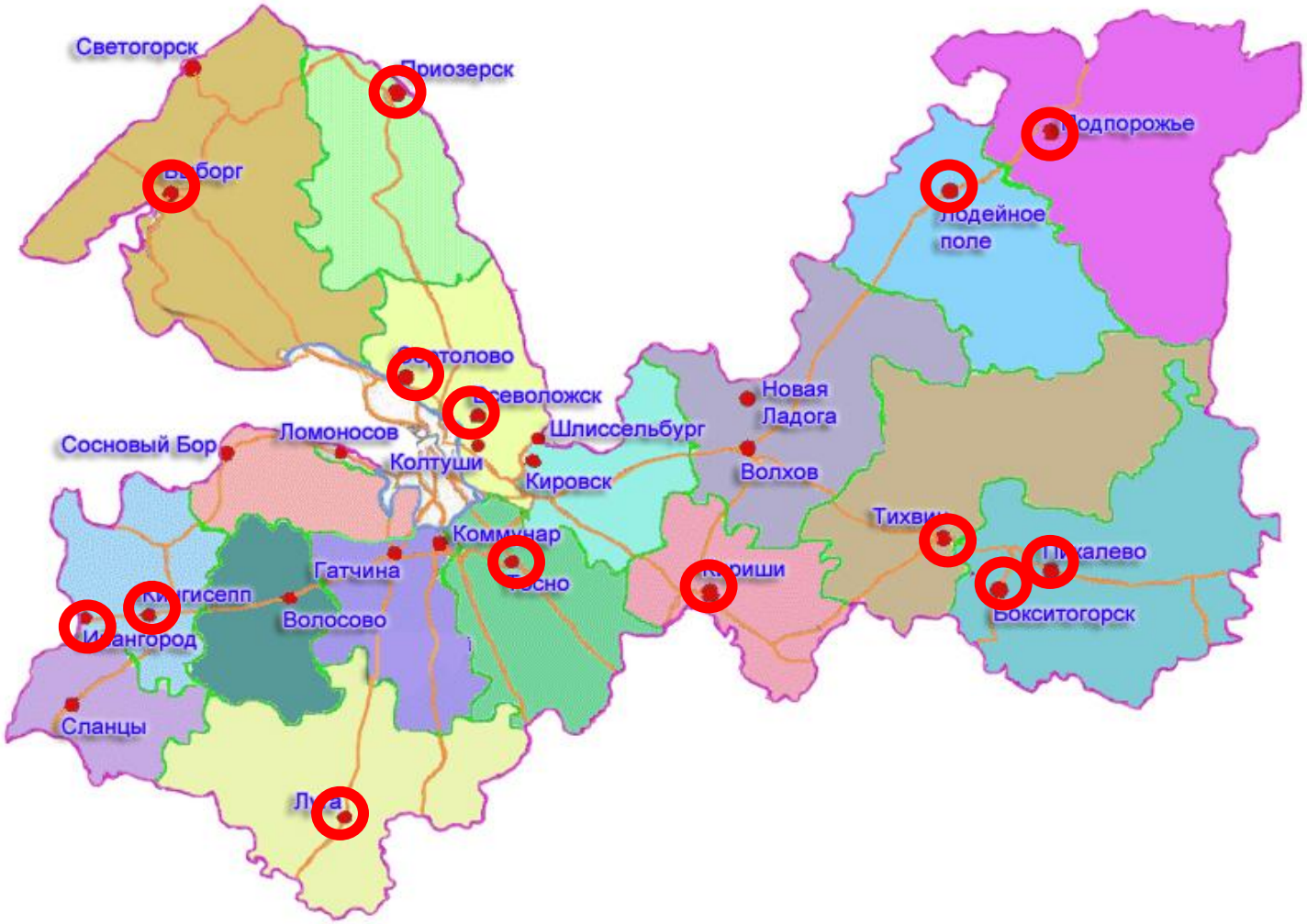
The aim of this study: to evaluate the previously proposed approach to the establishment of DRLs based on a regional dose survey.

The objectives of the study:

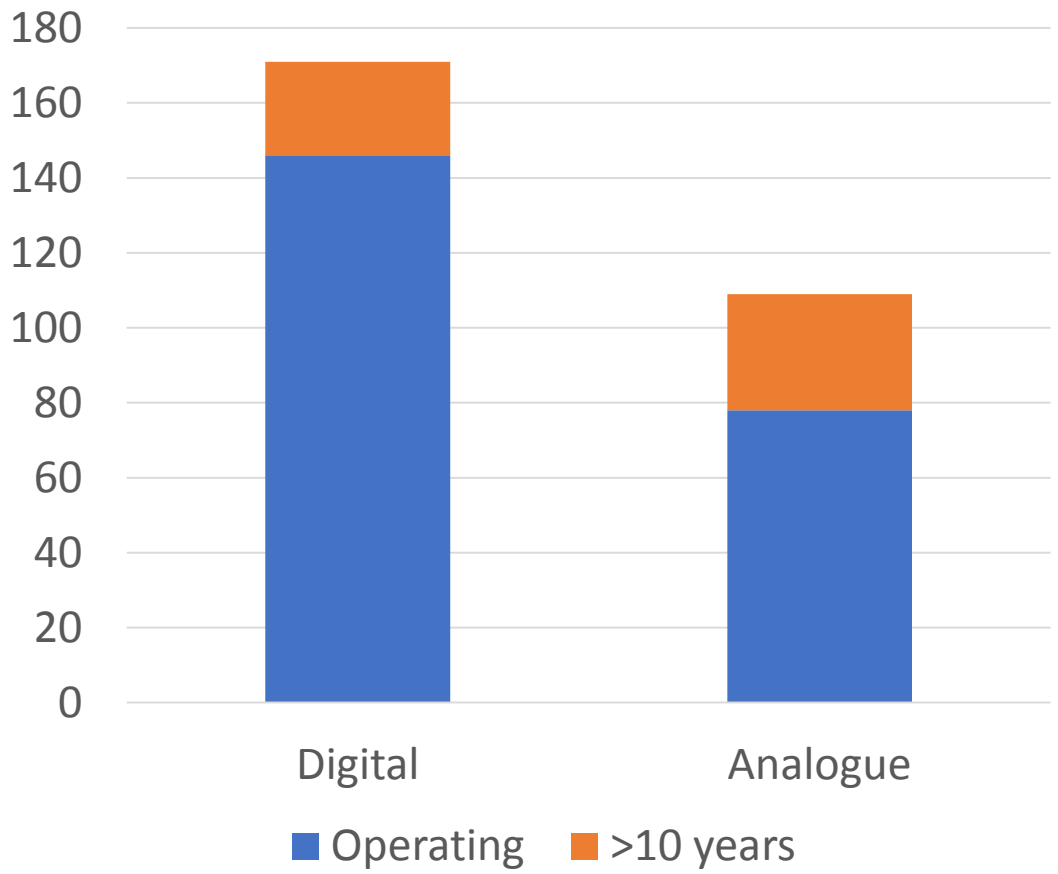
- To assess the existing regional dose data
- To perform a survey on typical doses from radiography examinations
- To perform a comparison between existing and collected dose data
- To propose preliminary regional DRLs for the most common radiography examinations

Data collection

14 central district hospitals with **224 X-ray units** have been selected for the survey



X-ray equipment



- 23 vendors
- ¼ of X-ray units - older than 10 years
- 65% - digital X-ray units, 35% - analogue
- The lack of clinical dosimeters even for the fluoroscopy units
- Digital information systems –

PACS – 4

RIS – 0

HIS – 1

Materials and methods

- **19** standard radiographic examinations were selected for the dose survey

Parameters:

✓type of examination
✓projection
✓age, weight, height of patients
✓ tube voltage (kV),
✓tube current (mA)
✓exposure time (s)
✓ focal-image distance (cm)
✓image field size (cm^2)
✓Dose – Area Product, DAP ($mGy \cdot cm^2$) (if available)

Examination	Projections
Skull	AP, LAT
Chest	AP, PA, LAT
Ribs	AP
Cervical spine	AP, PA, LAT
Thoracic spine	AP, LAT
Lumbar spine	AP, LAT
Abdomen	AP, LAT
Pelvis	AP, LAT
Hip	AP, LAT

**AP – anterior-posterior; PA-posterior-anterior, LAT-lateral*

Dose units – ESD and effective dose

Data collection

Evaluation of existing data

- X-ray examination protocols – source is unknown
- Radiation output measured by radiation control laboratories
- Effective doses were calculated based on conversion coefficients from rad. output

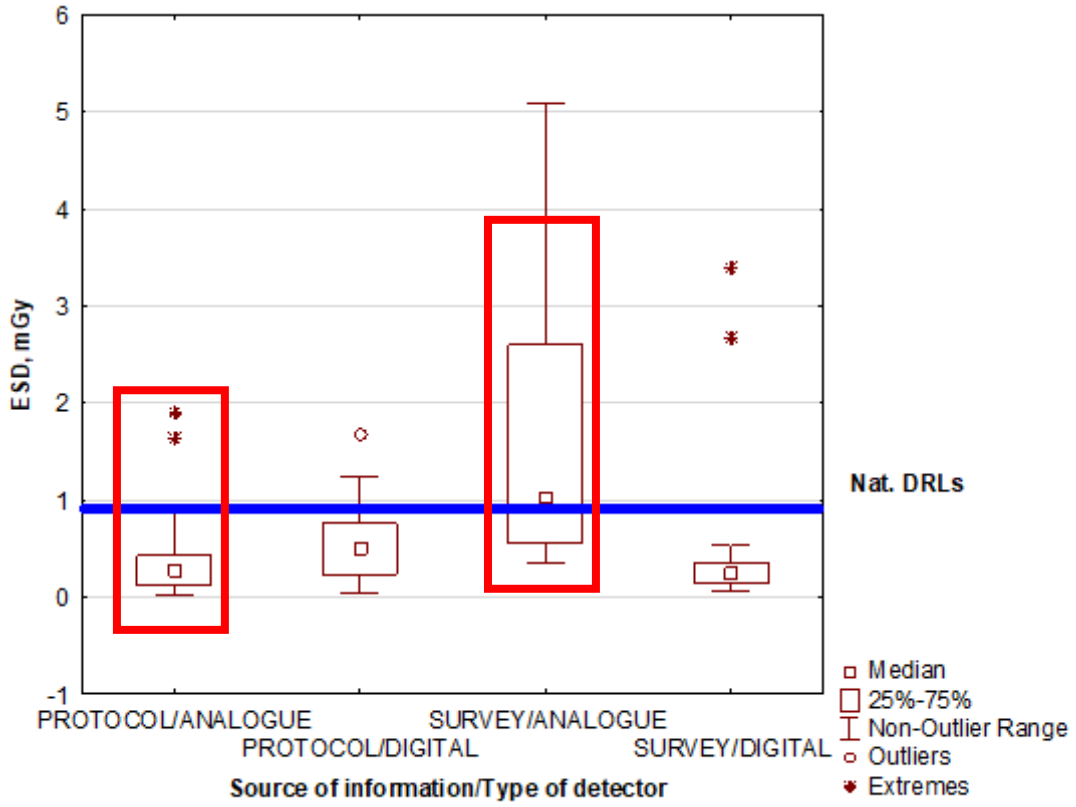
Dose survey

- Parameters of X-ray examinations from the spreadsheets
- Assessment of the individual patient doses (ED, ESD)
- Estimation of the typical effective doses using PCXMC 2.0 software

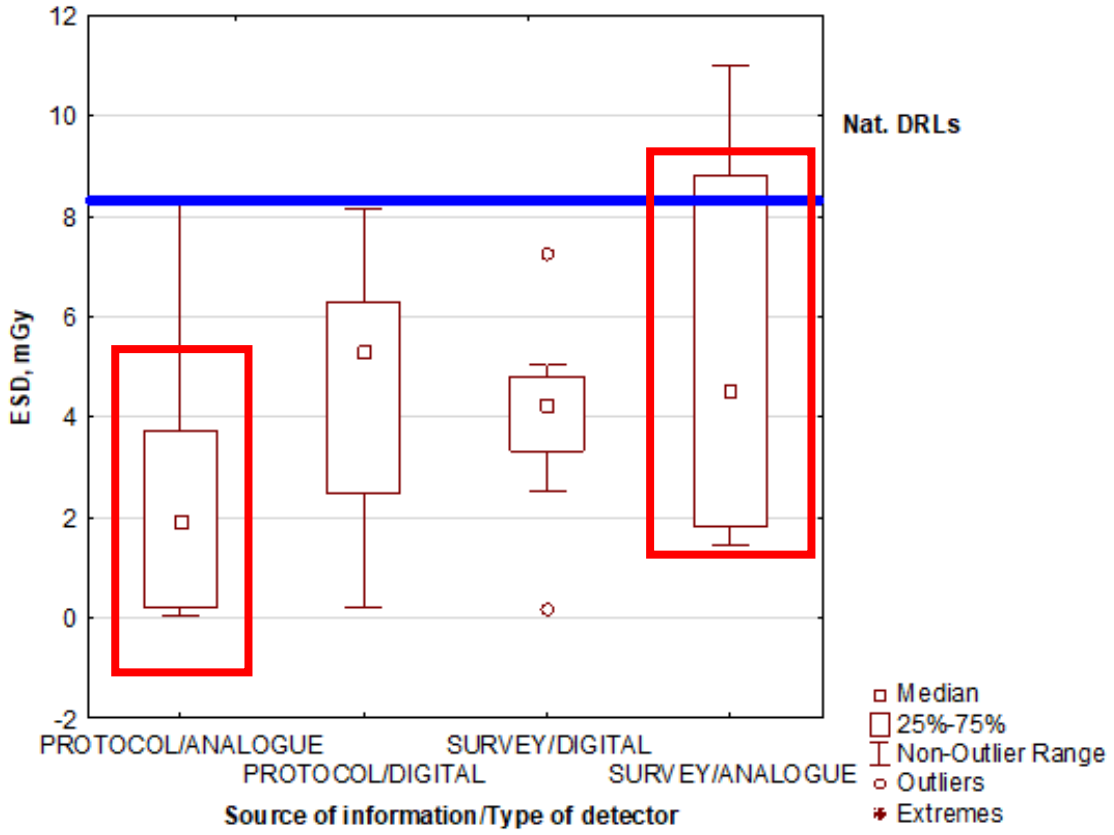
Assessment of typical doses as the median of the patient dose distribution (sample of 20-40 patients)

Results

ESD distribution



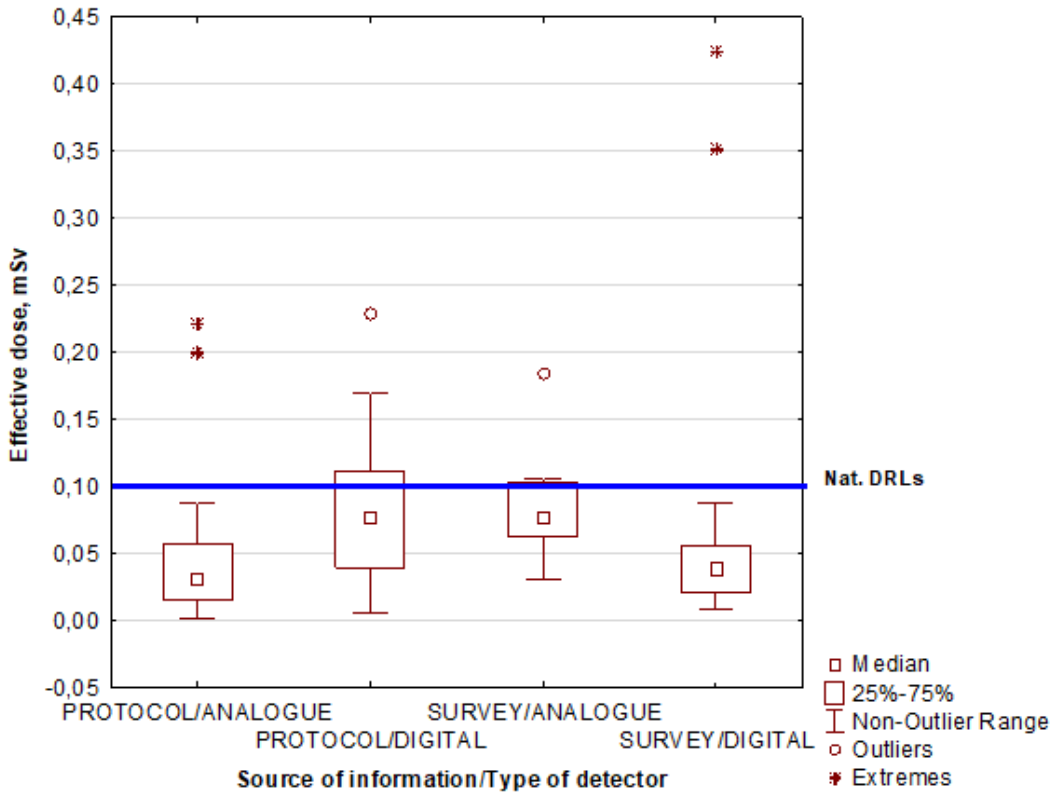
CHEST PA



LUMBAR SPINE AP

Results

Effective doses distribution



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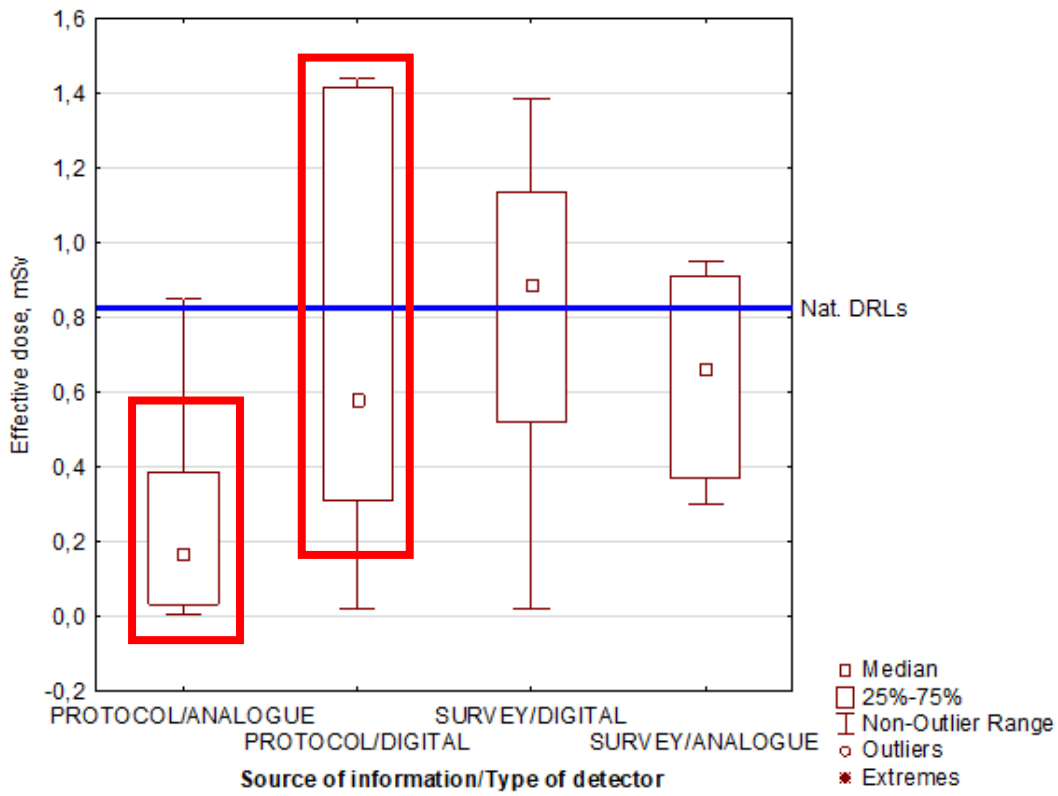

LUMBAR SPINE AP

Results

significant differences between the existing (protocols) and collected (surveys) typical patient doses, for all selected radiography X-ray examinations (Kruskall-Wallis test, with the subsequent Mann-Whitney test, $p<0,05$)

Factors:

- Biased data collection by the hospital staff and representatives of the external radiation control laboratories;
- Incorrect measurement of the radiation output by the representatives of the external radiation control laboratories;
- Procedural errors in typical dose estimation (failure to fulfill the requirements on the patient samples);
- For the X-ray units operating with automated exposure control (AEC) – the use of pre-examination tube current-time product (mAs) instead of the post-examination mAs for the calculation of ESD.

Preliminary DRLs

Examination	75%-percentiles of ESD distributions			
	protocols		survey	
	A*	D*	A	D
Skull AP	1,9	2,4	3,6	3,6
Skull LAT	2,0	2,4	8,9	4,4
Chest LAT	1,0	2,2	9,9	1,3
Chest PA	0,4	0,8	2,6	0,4
TS AP	2,8	6,2	1,8	5,0
TS LAT	5,7	7,2	6,9	12,2
CS AP	1,8	1,5	1,3	1,8
CS LAT	3,6	3,6	8,9	2,7
Abdomen AP	2,4	3,9	0,9	4,9
Pelvis AP	3,1	5,4	2,6	5,2
Pelvis LAT	-**	24,5	-	-
LS AP	3,7	6,3	8,8	4,8
LS LAT	12,2	23,2	29,8	12,4
Ribs AP	1,1	1,7	-	0,4

digital

Examination	75%-percentiles of ED distributions			
	protocols		survey	
	A*	D*	A	D
Skull AP	0,03	0,04	0,03	0,06
Skull LAT	0,02	0,04	0,07	0,07
Chest LAT	0,04	0,11	0,29	0,05
Chest PA	0,06	0,11	0,10	0,06
TS AP	0,29	0,61	0,20	0,57
TS LAT	0,09	0,22	0,18	0,26
CS AP	0,12	0,10	0,09	0,12
CS LAT	0,11	0,13	0,20	0,09
Abdomen AP	0,42	0,83	0,17	0,55
Pelvis AP	0,53	0,79	0,53	1,29
Pelvis LAT	-**	0,40	-	-
LS AP	0,38	1,42	0,91	1,14
LS LAT	0,23	0,68	0,84	0,66
Ribs AP	0,19	0,29	-	0,09

ital

75%-percentiles of ED distributions

Results

the preliminary DRLs for the Leningrad region are significantly lower (up to a factor of 3) for most X-ray examinations than previously proposed national DRLs

Factors:

- differences in the local radiological practice
- and/or relatively small X-ray unit sample

Results

the typical patient doses for the digital X-ray units were significantly higher compared to the analogue X-ray units for almost all types of examinations, except CS (AP)

Factors:

- All digital X-ray units were used for film-based imaging
- All digital X-ray units were equipped with the CCD-matrix or CR types of detectors (low sensitivity),
- dose ‘creep’

Conclusions

- Dose data collection will be continued in 2020-2021
- Ambitions – to cover, at least, 80% of all X-ray equipment of all hospitals
- Existing dose data is biased and can`t be used for establishment of DRLs and optimization (to implement of methodology of typical dose assessment as mandatory)
- The typical patient dose on digital X-ray unites are higher compare to analogue (to establish DRLs on analogue and on digital X-ray units, to perform the investigation)
- Regional DRLs are significantly lower than national DRLs(to promote the establishment of regional DRLs in the Russian Federation)

Thank you for your attention!