Introduction to RP154 methology for population dose estimates

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Study on European Population Doses from Medical Exposure (Dose Datamed 2)
http://ddmed.eu/

Directive 84/466/Euratom:

Article 12
Estimates of population doses

Member States shall ensure that the distribution of individual dose estimates from medical exposure referred to in Article 1 (2) is determined for the population and for relevant reference groups of the population as may be deemed necessary by the Member State.

United Nations Scientific Committee on the Effects of Atomic Radiation, UNSCEAR since 1955

- Evaluate all published literature on the sources and effects of ionizing radiation
- Summarized in comprehensive reports about every 5th year

Are the reported differences in X-ray examination frequency and collective effective dose real? Give advice in how to do it!

Dosedatamed (2004 –07)

TREN/04/NUCL/S07.39241

Barry Wall (chair), David Hart	UK
Abbas Aroua, Philipp Trueb	Switzerland
Bernard Aubert, Pascale Scanff, Phillippe Pirard, Hélène Beauvais	France
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EC RP Nº 154 Annex 1 – DD Report 1
REVIEW OF RECENT NATIONAL SURVEYS OF POPULATION EXPOSURE FROM MEDICAL X-RAYS IN EUROPE

1. Introduction
2. History of population dose assessments from medical x-rays in Europe
3. National arrangements and responsibilities
4. National regulatory frameworks
5. National healthcare systems in 10 European countries
6. National strategies for assessing population dose from medical x-rays
7. Methods for assessing the frequency of x-ray examinations
8. Methods for assessing patient doses
9. Results
10. Discussion
11. Conclusions
12. References

Look back – explain differences!

Appendix 1: Recent national surveys of population dose from medical x-rays

Appendix 2: Accuracy of population dose estimates

EC RADIATION PTOTECTION No 154: EUROPEAN GUIDANCE ON ESTIMATING POPULATION DOSES FROM MEDICAL X-RAY PROCEEDURES

1. Introduction
2. Purposes for making population dose estimates for medical x-rays and the dose quantities used
3. Guidance on assessing frequency of x-ray examinations
   - 3.1 How to categorise examinations
   - 3.2 X-ray examination frequency survey methods
   - 3.3 Sources of uncertainty in frequency estimates and how to reduce them
4. Guidance on assessing patient doses
   - 4.1 Patient dose survey methods
   - 4.2 How to convert measured doses into organ and effective doses
   - 4.3 Sources of uncertainty in patient doses and how to reduce them
5. Guidance on assessing age/sex distributions of x-ray patients
6. Guidance on presenting the results of population dose estimates
7. Use of electronic information stored in modern medical imaging equipment and RIS

Tell us how to do it in the future!

The x-ray examination definition

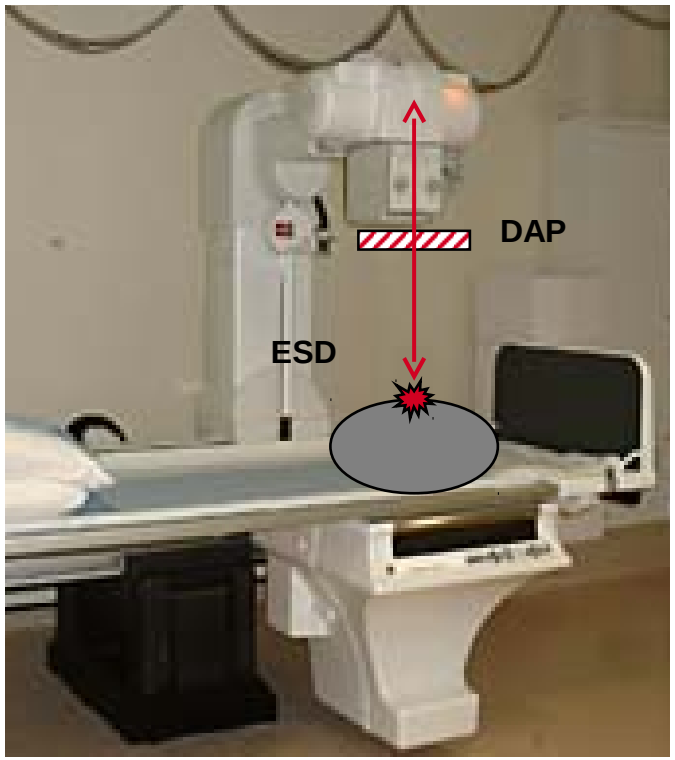
‘An x-ray examination or interventional procedure is defined as one or a series of x-ray exposures of one anatomical region/organ/organ system, using a single imaging modality (i.e. radiography/ fluoroscopy or CT), needed to answer a specific diagnostic problem or clinical question, during one visit to the radiology department, hospital or clinic’.

Frequency survey methods

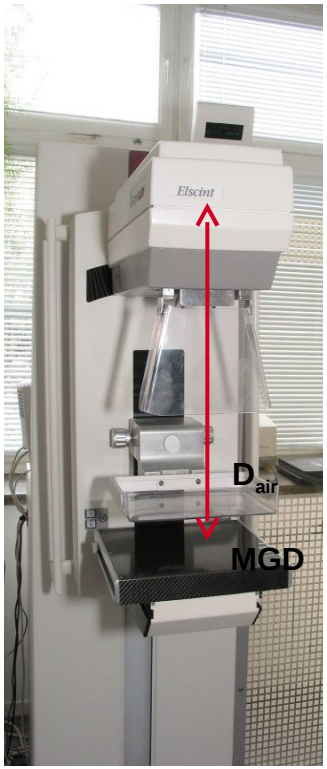
- How to categorize examinations
  - Plain film radiography, Radiography/fluoroscopy, CT, Interventional
  - 225 specific exams – 70 broader categories – ”top 20”
- How to estimate the number of examinations
  - from a sample of hospitals, clinics or practices
  - from central statistics held by government departments or insurance companies
  - sample scaled up to cover the whole country
- Identifying uncertainties in frequency estimates
  - Relating codes into actual numbers
  - Insufficiently differentiated codes
  - Bias in the sample and invalid assumptions
  - Lack of frequency data from some important providers of radiolog
  - Mistakes in the data recorded or collected

Dose survey methods

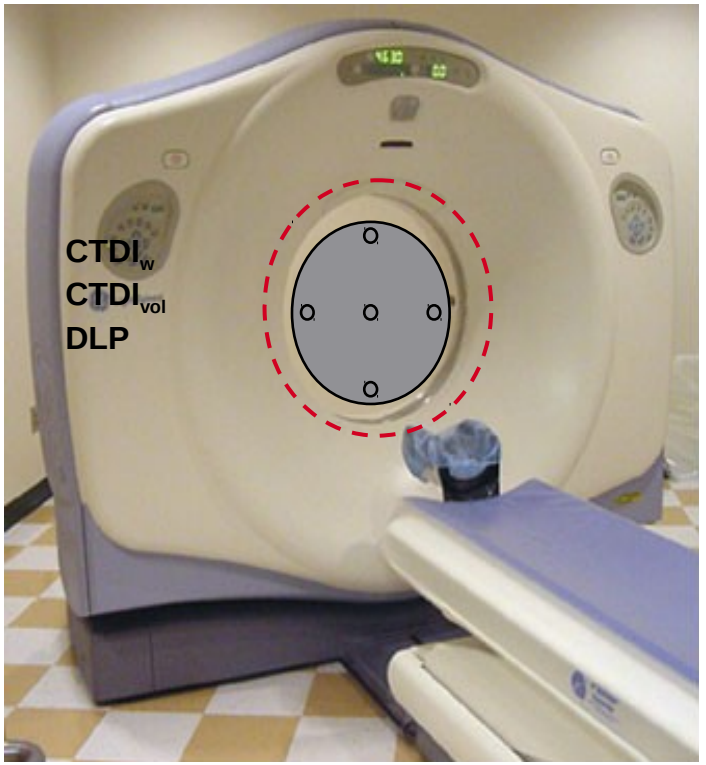
Radiography and fluoroscopy



Mammography



CT



- These practical dose quantities are a source for establishing national average dose figures, and for revising the Diagnostic Reference Levels for selected examination types
- These practical dose quantities are according to IEC standards stored in the DICOM header, and may be transferred to the RIS/PACS – dose collection will be easier in the future
- Conversion coefficients E/ESD, E/DAP, E/DLP are published for estimates of the effective dose

The "Top 20" Exams

2002

Exam type or category	% of total frequency*	% of total S*
Plain film radiography		
1. Chest/thorax	12 - 29	0.7 – 5.2
2. Cervical spine	2.0 – 5.4	0.05 – 2.3
3. Thoracic spine	1.0 – 3.1	0.5 – 3.7
4. Lumbar spine (inc. LSJ)	2.8 – 9.6	2.0 - 17
5. Mammography	0.3 – 15	0.6 – 4.7
6. Abdomen	1.1 – 4.3	1.1 – 4.7
7. Pelvis & hip	6.3 – 10	2.8 – 9.4
Radiography/ Fluoroscopy		
8. Ba meal	0.3 – 0.9	0.8 – 5.9
9. Ba enema	0.1 – 2.0	0.5 - 13
10. Ba follow	0.05 – 0.3	0.2 – 1.6
11. IVU	0.3 – 2.0	1.2 – 8.7
12. Cardiac angiography	0.2 – 1.3	1.0 – 9.9
All angiography	*1.1 – 2.4*	*6.4 - 16*
CT		
13. CT head	1.8 – 5.4	3.0 – 7.9
14. CT neck	0.06 – 0.9	0.1 – 1.1
15. CT chest	0.5 – 1.5	6.1 - 12
16. CT spine	0.3 – 2.8	1.5 - 13
17. CT abdomen	0.01 – 3.0	1.9 - 26
18. CT pelvis	0.03 – 1.5	0.3 – 9.7
19. CT trunk	0.1 – 5.6	1.1 - 27
All CT	*4.5 – 15*	*28 - 59*
Interventional		
20. PTCA	0.1 – 0.3	0.5 – 3.6
All interventional	*0.2 – 1.3*	*3.5 - 14*
TOTAL 1-20	**50-70**	**70-90**

Exam type	Mean E per examination (mSv)		
	Highst	**Middle**	**Lowest**
	DE CH	***ALL 10***	***NL UK***
1. Chest/thorax	0.25	**0.10**	0.03
2. Cervical spine	0.70	**0.27**	0.04
3. Thoracic spine	2.00	**1.00**	0.40
4. Lumbar spine	2.80	**1.90**	0.50
5. Mammography	0.40	**0.33**	0.25
6. Abdomen	1.80	**1.50**	0.50
7. Pelvis & hip	1.35	**0.90**	0.45
8. Ba meal	15.00	**7.70**	2.60
9. Ba enema	12.50	**8.60**	6.40
10. Ba follow	24.50	**10.00**	4.40
11. IVU	3.50	**4.00**	2.60
12. Cardiac angio.	11.25	**9.10**	5.30
All Angiography	***8.60***	***9.20***	***7.30***
13. CT head	2.40	**2.00**	1.60
14. CT neck	2.80	**2.50**	2.40
15. CT chest	8.20	**8.00**	6.60
16. CT spine	6.00	**5.30**	3.60
17. CT abdomen	13.50	**12.00**	10.20
18. CT pelvis	8.80	**8.70**	8.70
19. CT trunk	24.40	**14.00**	10.40
All CT	***7.05***	***6.10***	***5.35***
20. PTCA	17.00	**14.00**	13.15
All Interventional	***15.35***	***10.70***	***6.50***

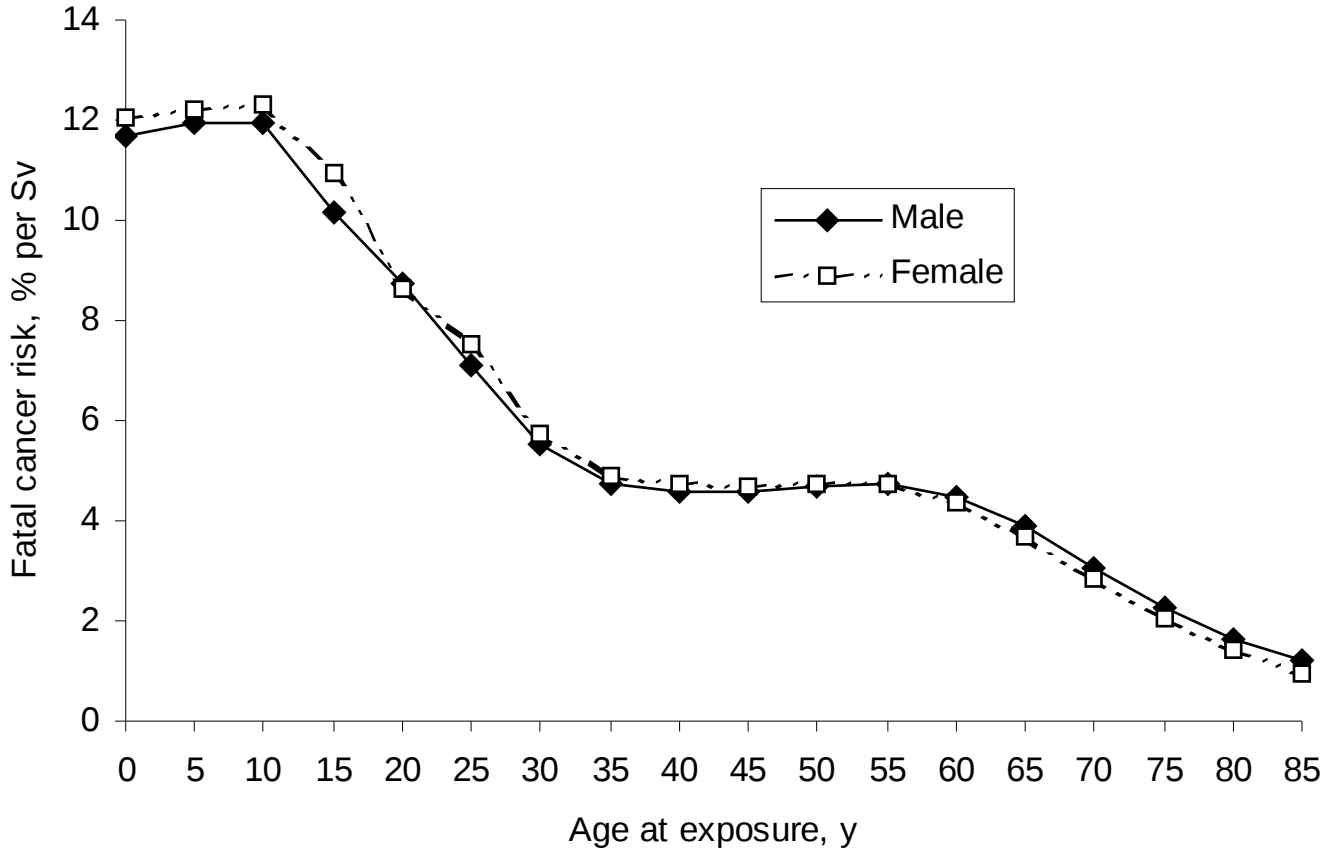
Typical dose values provided

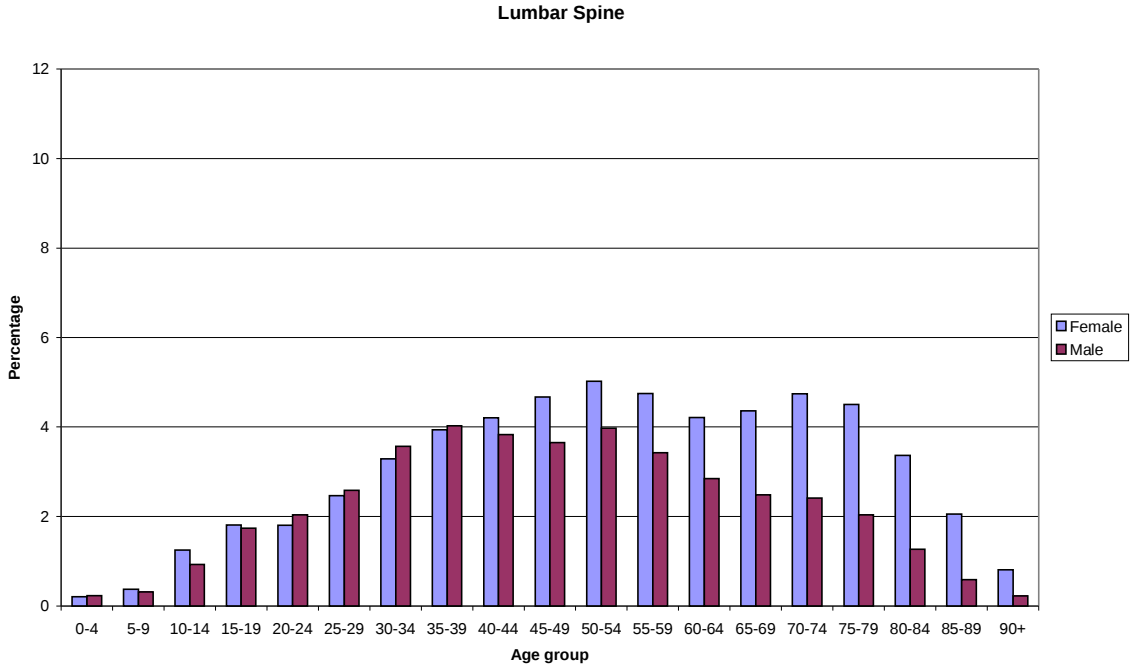
2002

A simple approach to assess the S based on “TOP 20”

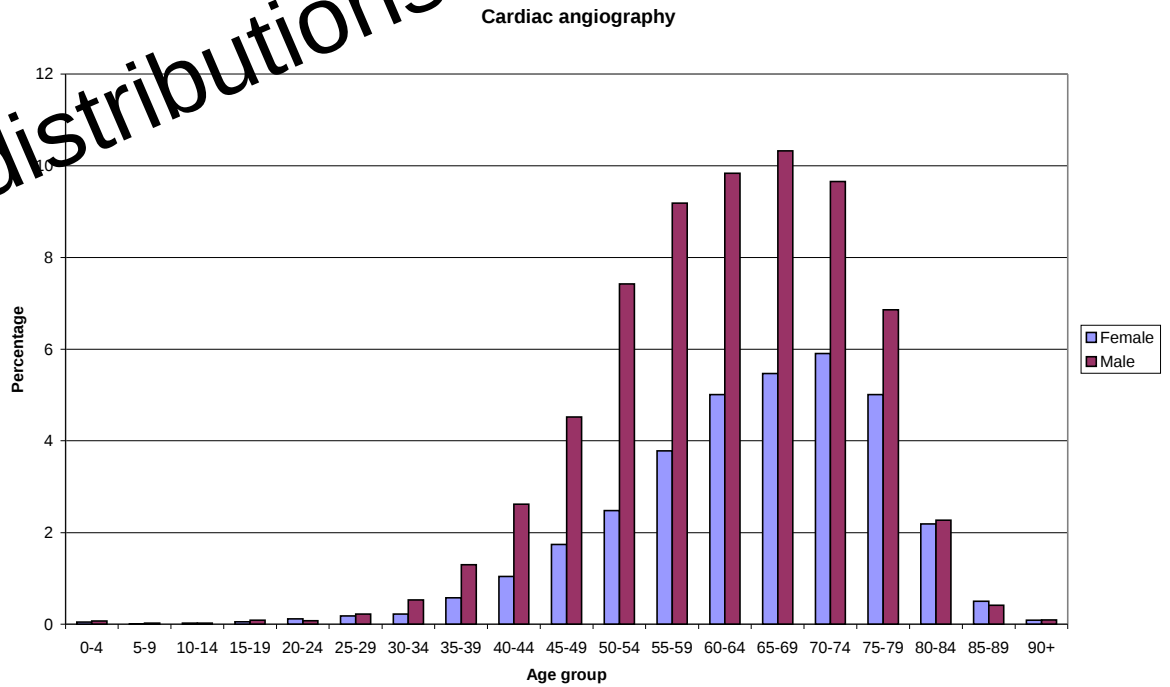
- There are big differences between countries in examination frequency, thus every country must do their own survey at least for those 20 exams
- Dose values are provided in the report based on comprehensive national dose surveys
  - Nevertheless; the equipment, exposure/scan technique and clinical applications will vary from one country to another
- For the 20 examination types; do some pilot studies to find whether you belong to a “high”, “middle” or “low” dose country, and select values from the report
- The CED for the “top 20” may be compared with others and scaled up to a total rough estimate

Total excess fatal cancer risk for uniform whole body exposure as a function of age at exposure and sex





Age- and sex distributions are provided



Summary of recommendations

1. **Collective effective dose surveys are a tool for observation:**
   - Secure the legal base for collecting the necessary information
2. **Information on Health system may explain national differences:**
   - Number of doctors, reimbursement systems, etc
3. **Frequency data: Definition of examinations, code systems**
   - Radiology associations, public authorities, insurance companies
4. **Dosimetry data : What are we measuring?**
   - Medical physics associations, manufactures, standardisation
5. **Regular evaluations of both examination frequency and patient doses are needed**
   - the examination frequency is considered to change most rapidly

TOP 20 exams (70% of frequency and 90% of doses) give good orientation

European Commission RADIATION PROTECTION No 154

- DD Report 2 "*European Guidance on Estimating Population Doses from Medical X-ray procedures*" have been published as an EC Report in the 'RADIATION PROTECTION' series. The document is available as a pdf files on the EC DGTREN Radiation Protection website
  - http://ec.europa.eu/energy/nuclear/radioprotection/p
- Annex 1 – DD Report 1 *"Review of recent national surveys of population exposure from medical X-rays in Europe"*
- Annex 2 – DD Report 1 (a) *Review of national surveys of population exposure from nuclear medicine examinations in eight European countries*

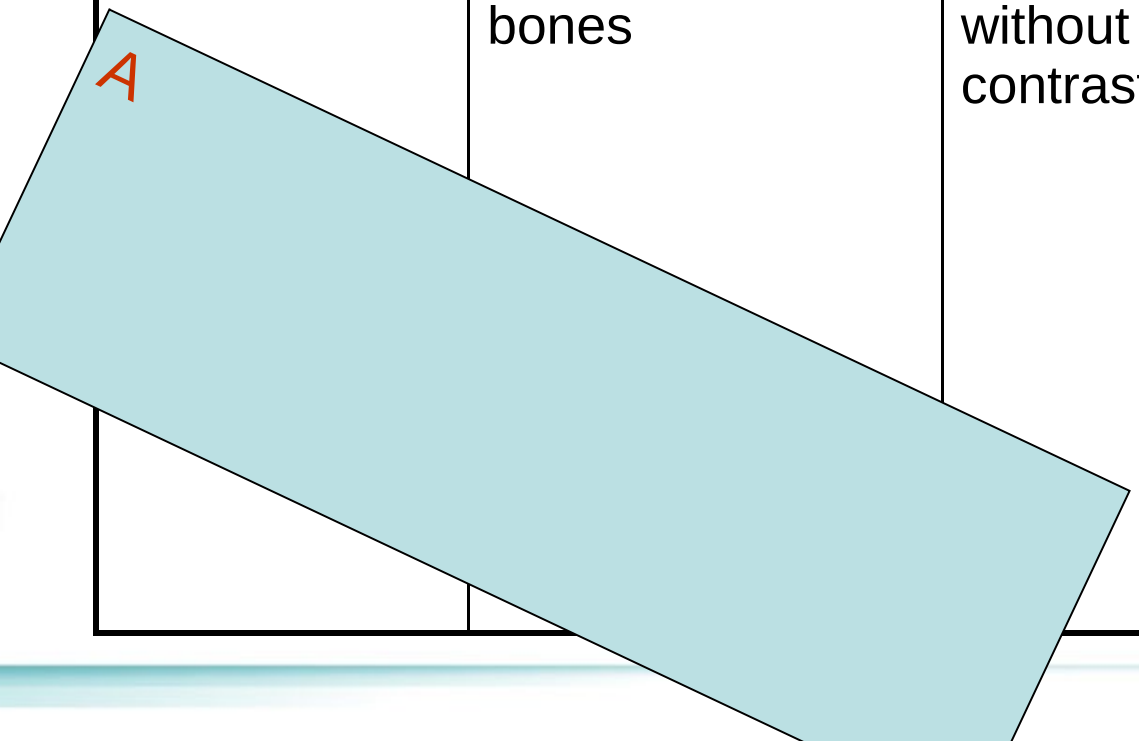
RP154 Useful References

- HOW TO CATEGORIZE X_RAY EXAMINATIONS
  - RP154 Chap 3/Table 2-5 PLAIN FILM RADIOGRAPHY – RADIOGRAPHY/ FLUOROSCOPY – COMPUTED TOMOGRAPHY – INTERVENTIONAL PROCEDURES Detailed Examination Descriptions for 'Top 20 Exams' (Appendix 1 to RP154)
- GUIDANCE ON ASSESSING PATIENT DOSES
  - Practical dose quantities – survey design – Conversion factors; Typical levels of dose for the TOP20 exams (Chap 4;Table 14, RP154)
- Accuracy of population dose estimates; Annex 1 to RP154, DD Report 1, APPENDIX 2;
  - A2.1 Accuracy of frequency estimates A2.2 Accuracy of patient dose estimates A2.3 Accuracy of collective effective dose estimates
- Typical European age/sex data for x-ray patients (Appendix 3 to RP154)
- Nuclear medicine examinations
  - There is no advise in RP154 in how to do a survey in NM. However, there is a review of national surveys of population exposure from nuclear medicine examinations in eight European countries in Annex 2 to RP154, DD Report 1(a)

On behalf of the DDM2 team!

How to identify a ”TOP 20 exam” – example CT head Norway

Exam Type	Specific exams included in ‘Exam type’	Common Technique	Examples for indications
13. CT head	Head, brain, facial bones	With or without contrast	Brain lesion Acute stroke Chronic rhinosinusitis Nasal obstruction Nasosinusitis polyposis anosmia Facial trauma. Chronic inflammation of middle ear Petrosal bone trauma Congenital malformations



How to establish a national dose figure – example CT head

- CT head in Norway are coded as
  - CT KC (brain), CT KV (sinus), CT AU (temple), CT FA (facial)

Radiological Code	CT KC	CT KV	CT AU	CT FA
Frequency #	**132691**	**24797**	**2188**	**11802**
DLP mGycm (# CT rooms)	**868.1 (77)**	**127.1 (33)**	**625.2 (4)**	**466.0 (9)**

$DLP_{CT\ head}$=((KC*868.1)+(KV*127.1)+(AU*625.2)+(FA*466))/(KC+KV+AU+FA)

$DLP_{CT\ head}$= 730.2 mGycm * 0.0021 mSv/mGycm= 1.5 mSv