



Staff Doses & Practical Radiation Protection in DEXA


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Patient X-ray Doses

- Examination Types**
 - General X-ray
 - Fluoroscopy / screening
 - CT
 - Mammography
 - Dental
 - DEXA
 - Special Procedures (Angiography/Vascular)
- Equipment, techniques, patient and part of anatomy being examined result in a range of doses for different examinations.



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Typical Doses from common examinations

Examination	Patient Dose (mSv)	Examination	Patient Dose (mSv)
Dental	0.01	CT Head	2.0
Skull AP / PA	0.03	CT Chest	8.0
Chest PA	0.02	CT abdomen	10.0
Chest LAT	0.04	CT Pelvis	10.0
Lumbar Spine AP	0.7	Coronary Angiography	3.1 – 7
Lumbar Spine LAT	0.3	PTCA / Stent	9 - 29 (50)
Abdomen AP	0.7	RF Ablation	17
Pelvis AP	0.7	PTA (Vascular)	7 – 9
Urography (IVU)	2.5	Nephrostomy	3.9 – 8
Barium Meal / Follow	3.0	Cerebral Angiography	7
Barium Enema	7.0	TIPS	55.5

Source: NRPB (UK)

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Dose from DEXA scans

- Use of Radiology equipment to determine the Bone Mineral Density of a patient.
- Typically low doses
 - Patient effective dose between 0.001mSv – 0.01mSv
- But
 - Doses increasing with newer technology
 - Fan-beam is comparable to Dental X-ray and approaching that of Chest X-ray.
 - As with other ionising radiation modalities, same principles apply whereby all examinations must be justified & As Low As Reasonably Achievable (ALARA).
 - Increasing patient doses, higher workloads & faster throughput means more scattered radiation to staff.

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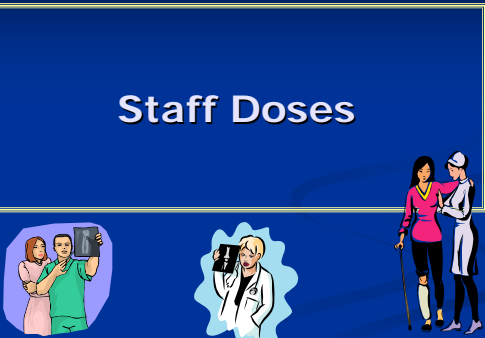
DEXA for Health Screening?

- MED 97/43 & SI 478 (2002)
- Areas of special concern:
 - Interventional Radiology
 - CT
 - Paediatrics
 - Health screening (Population screening)
- Special attention to be given to QA and dose assessment for these practices.
- Ensure that appropriate techniques are used (training, proper protocols.)



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Staff Doses



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Staff Doses – Radiology (UK)

Group (mSv/y)	0–1	1–5	5–10	10–15	15–20	>20	Average
Radiographers	99%	0.09%	0.01%*	-	-	-	0.05
Radiologists	95%	5%	-	-	-	-	0.18
Cardiologists	87.5%	11%	1%	-	0.5%*	-	0.44
Other Clinicians	98%	2%	-	-	-	-	0.09
Departmental Nurses	97.5%	2.44%	-	0.06%*	-	-	0.08
Scientific / Technical staff	97.5%	2.41%	0.09%*	-	-	-	0.08
Other staff	99.3%	0.5%	0.2%	-	-	-	0.06
Total	98.25%	1.7%	0.04%	0.07%*	0.07%*	-	0.1mSv/y

* 1 person only

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Staff Doses - Radiology

- This table shows that on average, Radiology workers in the UK receive an annual dose of 0.1mSv per year.
- The annual dose limit for radiation workers is 20mSv per year.
- Good radiation protection practice and shielding design of X-ray facilities means that the dose is significantly lower than the annual limit.

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Staff Doses by Occupation (UK)

Group	Average Annual Dose (mSv/y)
All Medical Workers	
Diagnostic	0.1
Radiotherapy	0.15
Nuclear Medicine	0.19
Total (17,000)	0.12
Coal Mines	0.6
Non-coal Mines	4.5
Aircrew	2.0
Dental	0.1
Veterinary	0.1
General Industry	0.4
Research / Education	0.1

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Staff Doses - Ireland

Group (mSv/y)	0-1	1-5	>5	Average
Medical (Total 4,700)				
Diagnostic	99.1%	0.9%	-	0.1
Radiotherapy	99.2%	0.8%	-	0.1
Nuclear Medicine	100%	-	-	0.13
Dentistry	100%	-	-	0.05
Veterinary	100%	-	-	0.05
Other Medical (Labs etc.)	100%	-	-	0.09
Industrial (Total 700)	97.8%	2.2%	-	0.13
Education (Total 450)	100%	-	-	0.06

Background Radiation of ~3mSv/yr varies substantially across the country

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Irish Occupational Doses

- This table shows that Irish staff doses are comparable to UK Radiology staff and on average, we receive an annual dose of 0.1mSv per year.
- Remember! The annual dose limit for radiation workers is 20mSv per year.
- As in the UK, Ireland has a well developed structure of radiation protection and this facilitates the low recorded doses for radiation workers.

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DEXA Staff Doses

- Staff doses from DEXA scanners are typically low.
- For pencil beam systems, often no additional shielding required.
- For fan beam systems, may need to position operator at >2m from scanner and / or mobile lead screen.
- Cone beam systems and C-arm configurations for lateral morphometry may have higher scatter levels.
- Annual scatter dose for typical workload has been measured at 1m from the scanner between 0.1mSv – 1.0mSv (Sheahan et al., 2006)

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What is main cause of dose to staff?

- Recall: Interaction of Radiation with matter
 - Absorbed
 - Transmitted
 - Scattered
- Scattered Radiation
 - Necessitates protection of staff and public
 - Scatter is highest closest to the source* of scatter (patient)

* Note there is a small amount of leakage radiation from tube housing

What about risk to members of public?

- There is a risk to members of the public from scattered radiation.
- Members of the public (i.e. not radiation workers, and not patients undergoing an examination) have an annual dose limit of 1mSv per year.
- All X-ray facilities should be designed to reduce the scattered radiation outside the X-ray room to acceptable limits.
- Shielding design of rooms is optimised, by using a design constraint of 0.3mSv per year. If levels exceed this, shielding will be required.

Protection of Public / Staff

- Shielding of DEXA X-ray rooms
 - Will depend on existing structure, i.e. concrete or partition walls?
 - Also depends on clinic workload, size of room and type of scanner
 - Seek advice from Radiation Protection Advisor (RPA)
 - Need to assess doors, floors, walls, ceilings, windows
 - RPA will take this into consideration and calculate the shielding requirements.
 - May need additional shielding in form of lead, barium plaster, solid concrete etc.
 - Best to do this at design stage / planning of room.
 - Shielding guidelines available from Radiological Protection Institute of Ireland (RPII) Design Code, British Institute of Radiology (BIR), National Council on Radiation Protection (NCRP, USA) and others.

Practical Radiation Protection Techniques

Dose Reduction - Patients

- Every exposure must be justified & optimised.
- ALARA - As Low As Reasonably Achievable.
- Reducing patient dose reduces staff dose.
- Establish standard operating protocols and optimise where possible in terms of Radiation Protection.

Dose Reduction - Patients

- Equipment factors:
 - Appropriate selection of equipment
 - System operating satisfactorily (Good QA programme)
- Technique:
 - Use scan mode suitable for patient (e.g. thin, standard)
 - Careful positioning to avoid repeats
 - Be aware of the radiation dose for each mode of operation
- Training
 - Specific to equipment type and procedures.
 - Systems training - supplier applications specialist
 - Clinical training
 - Radiation Protection training
 - Continuing Professional Development – maintain & improve knowledge

Dose Reduction - Patients

- **Proper collimation**
 - Reducing beam size reduces scatter & unnecessary exposure.
 - Select appropriate field size for area to be scanned.
- **Proper selection of scan mode**
 - Select the most appropriate mode

Protection of Staff

- **Training**
 - Staff should be trained in system operation
 - And trained in radiation protection (SI 478)
- **Radiation Safety Procedures / Local Rules**
 - Read and understand. Review regularly
 - Local rules for Pregnant staff
 - System must be switched off after use, locked and keys kept securely to avoid inadvertent exposures.
- **Equipment layout**
 - Position staff desk / computer at maximum distance from DEXA scanner

Protection of Staff

- **Protective Equipment**
 - Lead aprons not usually practical for DEXA, a mobile lead screen is more suitable if additional shielding required.
- **Classification of areas**
 - Only staff who have a necessity to be in the 'controlled' area may be there during X-ray exposure.
- **Dose monitoring**
 - Staff to wear personnel dosimeters and doses to be monitored
 - High results should be investigated.

Mobile Lead Screens



- Not ideal for sitting at DEXA workstation – limited view

- **Better design for DEXA**

Dosimeters



Pregnant Staff

- **Dose Limits**
 - Unborn child protected as member of public
 - Limit of 1mSv applies for term of pregnancy after declaration.
- **Declaration**
 - Notify employer / line manager as soon as possible.
- **Working Conditions**
 - Employer should perform risk assessment of working conditions.
 - Should ensure that dose to foetus will be <1mSv for remainder of pregnancy (following declaration).
 - May involve change in working conditions
 - Pregnant staff member to review local rules and adhere to good practice as normal.

Staff Protection

- 3 Principles of Protection
 - Time
 - Distance
 - Radiation will fall off with distance (inverse square law).
 - Always stay out of primary radiation beam
 - Double the distance - reduces dose by factor of 4
 - Shielding
 - Use mobile lead screen if advised.

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- ✓ Use a mobile lead screen for additional shielding

- ✓ Increase the distance



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Summary

- Staff doses in DEXA generally low, but increasing with new technology and with increased workload.
- Additional shielding may be required in some cases.
- Always adhere to good radiation protection practice to reduce both patient and staff doses.

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