Patient Dosimetry Audit for Establishing Local Diagnostic Reference Levels for Nuclear Medicine CT

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Ngonidzashe Michael Katsidzira

Matthew Gardner

RRPPS

University Hospitals Birmingham

NHS Foundation Trust

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NB: This work will be submitted for publication imminently

Background

- Diagnostic Reference Levels (DRLs) provide a useful tool for monitoring patient doses
- It is a legislative requirement to establish Local DRLs (LDRLs) (UK[1] and Europe[2])
- DRLs (Local and National) are well established in diagnostic radiology but not a common practice in Nuclear Medicine (NM) CT
- NDRLs are available for NM in terms of administered activity[3] (no information on CT component)
- Previous work has been carried out to establish DRL for PET/CT[4,5]

Background (cont…)

Table 1: IPEM Working Party Proposed NDRLs[6] for common NMCT examinations

Examination Type	CT Purpose	Proposed NDRLs	
		CTDIvol (mGy)	DLP (mGycm)
PET half body	Localisation	4.3	400
Parathyroid	Localisation	5.6	170
Bone	Localisation	5.6	180
Octreotide/MIBG	Localisation	5.4	240
Thyroid post ablation	Localisation	5.9	210
SPECT/PET cardiac	Attenuation Correction	2.0	34

Background (cont…)

- The aim of this work was to establish a system for NMCT in terms of
  - ✓ patient dosimetry audit
  - ✓ setting up LDRLs
- Patient dosimetry for NMCT presented a number of difficulties which may not be encountered for diagnostic radiology CT

Background (cont…)

- For diagnostic radiology CT, data are divided according to body region only (e.g. Lumbar Spine)
- For NMCT, data were divided according to ;
  - ✓ examination type (e.g. Bone)
  - ✓ body region
  - ✓ dose modes
- Obtaining sufficient patient numbers proved challenging for NMCT due to the above data division

Background (cont…)

Table 2: CT dose modes developed for Nuclear Medicine at the Queen Elizabeth Hospital Birmingham

Dose Mode	CT Purpose	kV	Quality Reference mAs*
Low	Attenuation Correction	130	10-16
Moderate	Localisation	130	40
Standard	Diagnostic CT	130	150
Metal	Patients with Orthopaedic Implants	130	330

*values are approximate as actual value depends on body region

Methods

- Data have been collected from examinations performed on
  - ✓ Two SPECT/CT scanners (Siemens Symbia T16 and T)
  - ✓ PET/CT scanner (Siemens Biograph mCT Flow)
- Data collection periods
  - ✓ SPECT/CT (November 2014 to July 2016)
  - ✓ PET/CT (April to August 2016)
- Examination data capture
  - ✓ Computed Radiological Information System (CRIS)
  - ✓ Paper records (manually recorded by NM Technologists)

Methods (cont…)

- CRIS downloads provided information on the
  - ✓ examination type
  - ✓ date of birth
  - ✓ date of examination
  - ✓ Dose Length Product (DLP)
- CRIS provided sufficient information to perform dose analysis for
  - ✓ PET/CT examinations
  - ✓ Cardiac SPECT/CT examinations

  (as these are not associated with different dose modes and body regions)

Methods (cont..)

- The mean and standard deviation of DLPs for common NMCT examinations were then calculated
- Data were subjectively assessed and any obvious outliers removed before analysis
- Paediatric data were also identified and removed before analysis
- Only examinations with 10, or more, patients were analysed
- LDRLs will be set based on the mean DLP

Methods (cont…)

- Paper records provided additional information for SPECT/CT (excluding Cardiac) examinations
  - ✓ body region
  - ✓ dose mode
  - ✓ scanner
- The CRIS data and paper records were matched using the patient identification number and examination date found on both records
- For common SPECT/CT examinations, data were divided in terms of the *examination type, body region, scanner and dose mode*

Results

Table 3 : Comparison between mean DLP and IPEM WP proposed NDRLs[6] for Bone SPECT/CT examinations for different body regions and dose modes

Examination Type	Body Region	Scanner	No. of Patients	Dose Mode	DLP (mGy cm)		
					Mean DLP	Standard Deviation	Proposed NDRLs
Bone	Pelvis	T	15	Moderate	105	40	180
	T-Spine	T	13	Moderate	133	40	180
	T-Spine/L-Spine	T	15	Moderate	124	26	180
	L-Spine	T	47	Moderate	107	33	180
	L-Spine	T16	24	Moderate	170	70	180
	L-Spine	T16	33	Standard	634	226	
	L-Spine	T16	11	Metal	1045	426	
	Feet/Ankles	T	10	Standard	153	44	
	Feet/Ankles	T16	32	Standard	221	39	
	Pelvis	T16	11	Standard	558	111	
	Pelvis	T16	34	Metal	1359	322	
	Knees	T16	10	Standard	230	130	
	Knees	T16	111	Metal	913	285	
	T-Spine/L-Spine	T16	24	Standard	704	306	

Moderate - Localisation, **Standard** - Diagnostic CT, **Metal** - Patient with orthopaedic implants

Results (cont..)

Table 4 : Comparison between mean DLP and proposed NDRLs[6] for different examination types body region and dose modes

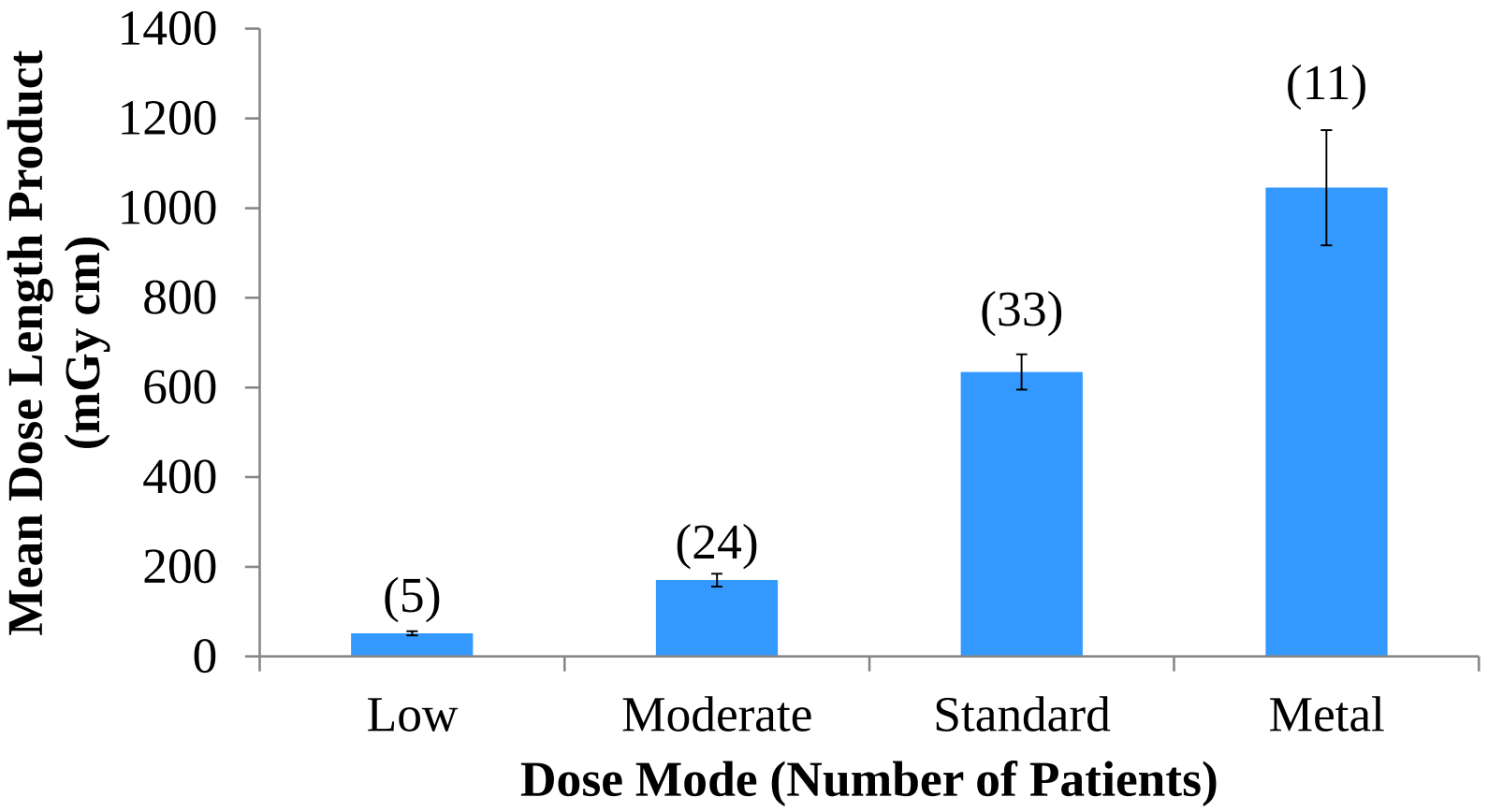
Examination Type	Body Region	Scanner	No. of Patients	Dose Mode	DLP (mGy cm)		
					Mean DLP	Standard Deviation	Proposed NDRLs
Parathyroid	Neck	T	19	Moderate	66	20	170
	Neck	T16	42	Moderate	120	36	170
Octreotide	Abdomen	T16	15	Moderate	280	97	240
	Abdo/Pelvis	T16	14	Moderate	204	109	240
	Chest/Abdo/Pelvis	T16	32	Moderate	377	164	240
	Head/Chest/Abdo/Pelvis	T16	10	Moderate	373	151	240
Cardiac	Heart	T16	2889	Low	34	1	34
PET/CT	Whole/half body	PET	1192	Moderate	346	164	400*

**Based on half body scan*

Low - Attenuation Correction, **Moderate** - Localisation

Results (cont..)

Figure 1: Mean Dose Length Product (DLP) data for Bone SPECT/CT Lumbar Spine examinations in the four dose modes.



Discussion

- The proposed NDRLs[6] specify the examination type and the scan purpose, but the details of the body region are not given
- Only Octreotide scans have mean DLP greater than the proposed NDRL
  - ✓ low numbers, patient height/weight
- T16 scanner tends to give higher DLPs than the T scanner
  - ✓ further optimisation of doses required
  - ✓ technology difference (relative tube capabilities and detector sizes)
- **Figure 1** clearly shows the importance of dividing the data according to dose mode
- Mean DLP PET/CT (half and whole body) was less than proposed NDRLs[6] (based on the half body only)

Conclusion

- Patient dosimetry for NMCT presents a number of difficulties which may not be encountered for Diagnostic Radiology CT
  - ✓ Dependence on paper records (CRIS does not provide all information)
  - ✓ Limited number of examinations available due to frequency of examinations and division of data
- Further improvements are planned to capture more data electronically through the CRIS system
- This system provides a useful basis for setting up LDRLs and hence a baseline for attempts at optimisation of NMCT doses

References

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Thank you for your attention
Any Questions?

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Contact Information

Ngonidzashe Michael Katsidzira
NgonidzasheMichael.Katsidzira@uhb.nhs.uk

Matthew Gardner
Matthew.Gardner@uhb.nhs.uk