

IPEM Institute of Physics and
Engineering in Medicine

Dose to patients from X-ray imaging in Radiotherapy

Launch of another IPEM
working party
Dr Tim Wood



Overview

- Introduction
 - The aims of the working party
 - Who are we?
- The 'grand plan'
- Planning CT data collection
- CBCT data collection
- What about image quality?
- Summary



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Introduction

The aims of the working party,
and who we are



The aims of the working party

- To undertake an audit of typical imaging doses for the full range of X-ray imaging procedures undertaken in Radiotherapy departments
 - This includes planning CT scans, on treatment CBCT imaging, and also may consider other modalities such as planar X-ray and fluoroscopy
- To publish a range of typical ‘doses’ for common procedures
 - Like PHE do with national reference doses in diagnostic imaging
 - If data is good enough, this should allow adoption as national ‘DRLs’ for RT imaging
- Make data available to the UK Radiotherapy community that will enable better optimisation of imaging
 - This may also identify best practice that will ultimately benefit patients

Who are we?

- The core members of the working party are;
 - **Tim Wood** (Chair) – DR Physicist, Hull and East Yorkshire Hospitals NHS Trust
 - **Matthew Williams** (Secretary) – DR/RT Physicist, Velindre Cancer Centre
 - **Mark Cowen** – RT Physicist, Peterborough and Stamford Hospitals NHS Foundation Trust
 - **Anne Davis** – DR Physicist, Portsmouth Hospitals NHS Trust
 - **Becky Lindsay** – RT Physicist, Leeds Teaching Hospitals NHS Trust
 - **Rosy Plaistow** – RT Physicist, Cambridge University Hospitals NHS Foundation Trust
- Working party members cover and experience of all of the major equipment vendors
- Co-ordinating with and feeding back to IPEM DR and RT Special Interest Groups



Who else is involved?

- We are consulting with Radiotherapy Board throughout the lifetime of the project
 - A collaboration between The Royal College of Radiologists, the Society and College of Radiographers, and IPEM
- Also observers from Public Health England on the working party
 - Sue Edyvean as Head of the Medical Dosimetry Group, who perform the national surveys of diagnostic x-ray practice
 - Una Findlay as Senior Clinical Radiotherapy Officer in the Medical Exposures Group (also a member of RT Board)
- You!
 - Or at least those with some involvement in RT imaging...

Communication

- A lot of communication will go through the usual routes, such as mail-bases, etc
- Have used, and may continue to target IPEM Head of Physics service list
- Also look to promote in newsletters from IPEM, website, etc
- We will look to present updates as often as possible at relevant scientific meetings
 - See you next year?...
- We also have our group email account, or you can contact me directly
 - IPEMRTimaging@gmail.com
 - tim.wood@hey.nhs.uk



Potential barriers...

- We are a relatively small group with a very limited number of face-to-face meetings!
 - Had to limit the size of the group to keep costs down
 - Apologies for those who asked to be a part of the group and have not heard from me...
- We all have a day job!
 - We will endeavour to get this work completed ASAP and have a clear plan to get this done efficiently, but there may be bumps along the way
- You all have day jobs!
 - This work relies on the active participation and goodwill of Physics services and RT centres. We appreciate everyone's efforts in providing data and understand it can take time to get all the information we ask for



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The 'grand plan'

How are we going about this?



The 'grand plan'

- First meeting of the working party at IPEM HQ in June 2016
- Formulated a plan for the next 18-24 months to collect and analyse the data
- The ultimate aim is for at least two peer-reviewed publications in a relevant journal
 - Planning CT doses
 - CBCT doses
- We will look at other imaging modalities if there is time (and money) once CT and CBCT have been dealt with
- We may also extend to paediatrics, but this will need to be a more targeted exercise
 - Relatively few centres will be doing this – aim to collect some basic information on this at the outset of the project

The 'grand plan'

Pragmatism is key!

We are looking at using data collection techniques that work for the many, rather than the few

We are (probably) going to use parameters that are useful in the field, rather than the most 'scientifically rigorous'

Pre-data collection questionnaire

- We want to engage as many departments as possible – both NHS and private sector
 - Have sent out a letter via IPEM to all heads of RT Physics Services
- ***We are about to launch a questionnaire to get some information about the kinds of imaging being done in centres across the UK***
 - Introduce the project and what we hope to achieve
 - Get some contact information for the RT centres taking part
 - Get information CT/CBCT systems (make and model), number and the ***common types of protocol*** being used
 - Check what test equipment centres have access to
 - Find out if paediatrics are undertaken in the centre
 - Find out if 2D kV and fluoro are in routine use, and what protocols
 - Check whether centres are willing to actively participate in an image quality assessment follow-up exercise?

Pre-data collection questionnaire

- The purpose of this questionnaire is to help us tweak the data collection forms before we go live to minimise any problems
 - Check protocols in use agree with the list drawn up by the working party
 - Also gauge interest to see how active participation will be in this work – can then come up with a new more targeted approach if needs be!
 - Find out additional information for more targeted follow-up work if there is time in this project e.g. paediatrics, 2D, etc
- We aim to launch this via the mail-base and possibly target IPEM HoD list in the next couple of weeks
 - Waiting for IPEM to produce the final version and test
- Will be live for 2-3 weeks





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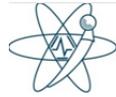
CT planning scans



CT planning scans

- Survey of CT planning scans will be the first audit
- Adapted the hybrid dose working party data collection sheets (subsequently modified for the PHE C-spine survey)
 - Excel data collection spreadsheets
 - Will use MATLAB database GUI to analyse the data
- Ask for protocol info and up to 30 patients for each scan
 - We acknowledge more is better, but we didn't feel all centres would be in a position to send us 'big data' in a timely fashion
 - It could take time to get systems set up to grab the data, or more likely people wouldn't take part!
 - Felt a little data from lots of centres is better than a lot of data from just a few
 - If people want to send us 'big data' we will use it (assuming we get all the info we need, preferably in same format as spreadsheet)

CT planning scans



IPeM

Radiotherapy Planning CT dose survey

Dear Colleagues,

Thank you for supporting this first UK dose audit of CT scans acquired for radiotherapy treatment planning.

The intention is to publish diagnostic reference levels (DRLs) for radiotherapy CT examinations in support of optimization.

Published data will be anonymised but each centre will be allocated, prior to publication, a unique reference number which will enable that centre to benchmark its own doses against the national data set.

If you have any queries about what data to collect, please review the Guidelines page in the first instance and then get in touch at the e-mail below.

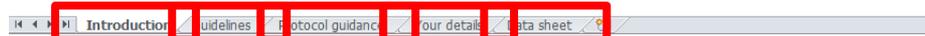
Please send the data to IPeMRTimaging@gmail.com

The deadline for submission is: DATEXXX

Many thanks for your participation,

The IPeM 'Dose to patients from X-ray imaging in Radiotherapy' Working Party

Tim Wood (Chair)
Matthew Williams (Secretary)
Mark Cowen
Anne Davis
Rebecca Lindsay
Rosy Plaistow



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CT planning scans



Radiotherapy Planning CT dose survey

Protocol: Please select from drop down list

Scanner Information	
Hospital Name*:	<input type="text"/>
Local system ID*:	<input type="text"/>
System manufacturer*:	<input type="text"/>
System model*:	<input type="text"/>
Year of manufacture of scanner:	<input type="text"/>

Standard Protocol Settings	
Local protocol name*:	<input type="text"/>
CTDI phantom size (cm) (i.e. 16 cm head or 32 cm body)*:	<input type="text"/>
Is Automatic Exposure Control (AEC) used?	<input type="text"/>
AEC name (e.g. AutoMA, ZDOM, CARE Dose 4D, Sure Expose):	<input type="text"/>
AEC setting type (e.g. ref noise index, reference mAs, etc):	<input type="text"/>
AEC setting value (e.g. SD 7.5, ref mAs 200):	<input type="text"/>
minimum to maximum mA range for AEC (where applicable):	<input type="text"/>
mA where AEC is not used	<input type="text"/>
Is iterative reconstruction used?	<input type="text"/>
Iterative recon type (e.g. ASIR, SAFIRE, iDose):	<input type="text"/>
Iterative recon value (e.g. ASIR 40%, SAFIRE 3, iDose level 4):	<input type="text"/>
Radiation beam collimation:- Beam width (mm):	<input type="text"/>
- Number of slices:	<input type="text"/>
- Detector size (mm) (e.g. 0.625,0.6):	<input type="text"/>

- Breast (no nodes)
- Prostate (no nodes)
- Gynae (no PA nodes)
- Lung 3D
- Lung 4D
- Neuro
- Head and Neck



CT planning scans

Tube voltage (kV):		[l]
Tube rotation time (s):		[m]
Primary <u>image</u> slice thickness (mm):		[n]
Scan field of view (SFOV) (mm):		[o]
Reconstruction field of view (DFOV) (mm):		[p]
Axial or helical?		[q]
Pitch (where applicable):		[r]
Reconstruction algorithm or kernel (e.g. B30; FC17; Std)		[s]
Is IV contrast used?		
How many scan phases? e.g. contrast & non-contrast scans = 2 phases		
Which other imaging modes are also used? (e.g. PET; MRI)		

Calibration Data

Error of indicated CT DIvol when last checked (+/- %)

* Denotes a mandatory field

** See notes on scanner specific help sheet

Notes:

Please include any other details and descriptions of your scan protocols e.g. non-contrast scan followed by contrast scan, 4D CT scan performed in two phases with 4D over tumour volume and 3D of whole lung, etc. Also include details of how other imaging modalities are used.

CT planning scans

Local system ID*:

Protocol:

Patient No	Age at time of scan (yrs)	Body Mass (kg)	Scan length (mm)	Average effective mAs per rotation	CTDI _{vol} (mGy)*	DLP (mGy.cm)*	Total mAs (whole scan not including scouts)	Comments
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
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25								
26								
27								
28								
29								
30								

Please complete for as many patients as possible up to a maximum of 30

* Denotes a mandatory field





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CBCT scans



CBCT scans

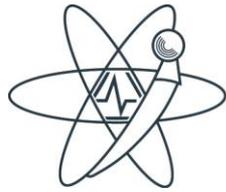
- This will be the second phase of data collection
- Need to consider;
 - Use of manufacturer defaults?
 - Size specific exposure protocols?
 - Do we need to collect patient dose info, or just protocol data?
 - Lack of ‘dose display’ on some systems
 - Accuracy of ‘dose display’ on those that have it
 - What kind of dose metric is most useful?
 - What parameters can we collect on the different systems i.e. Varian vs Elekta?

CBCT scans

- The WP feel just reporting kVp, mA, etc is not enough information as different models use different beam spectra
- The **provisional** plan is to give typical doses as **standard** $CTDI_w$ values (i.e. not wide beam dosimetry)
- **Rationale;**
 - The $CTDI_w$ will give an indication of how the dose is distributed in a phantom (take into account the spectrum), and will provide a link between the kVp/mA on different models
 - Wide beam dosimetry more ‘correct’, but additional complication for producing a number that can be used for comparison – prone to errors depending on exact measurement technique
 - Standard $CTDI_w$ (16/32 cm phantom at isocentre, 100 mm pencil chamber inside at relevant positions) should be **easy** for centres to measure (with readily available equipment) so that they can compare their doses to the reference values we produce

CBCT scans

- **Limitations;**
 - The numbers we produce will not be appropriate for estimating patient doses with (should you trust it in the first place for such purposes!)
- We want the audit to be practical and timely, so we may not ask all centres to actually measure the CTDI for their protocols
 - The working party aim to measure CTDI on all systems we cover and compare – check for consistency between models
 - If we find models are consistent ($\pm X\%$), we could use our CTDI values to calculate values from centres just providing kVp, mA, etc
 - Otherwise, we will have to ask centres to measure the CTDI for each protocol they submit data for (linac time?)
- We will thoroughly trial the data collection for CBCT before opening up!



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What about image quality?



What about image quality?

- The information that tends to be missing from all patient dose audits is a measure of image quality
- We may (time allowing) try to include this in our audit
- **BUT**, again we need to be pragmatic and find a simple technique that everyone can do/reproduce with readily available kit
- Options include;
 - CATPHAN – but is this appropriate for body protocols?
 - Simple image noise measurement in CTDI phantoms? Centres could either analyse themselves, or send the WP the images
 - May limit this to a narrower number of centres
 - May (assuming models are similar) perform measurements on the WP systems for selected protocols in the audit (e.g. low dose, average dose, high dose?)



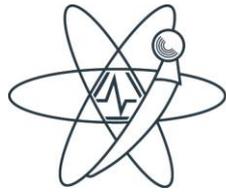
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Summary



Summary

- The IPEM 'Dose to patients from X-ray imaging in Radiotherapy' Working Party is up and running!
- We will be launching a simple **questionnaire** very soon to get a feel for practice across the UK (**next few weeks**)
- Will then launch the **CT Planning scan audit** (aiming for **mid-to-end of November**)
- Will work on practical solution for CBCT audit over winter 2016/17
- Launch **CBCT audit** in **spring/summer 2017**
- Will aim to include simple image quality measurements in the audits (if possible and practical)
- Peer-reviewed publications (hopefully CT one by the end of 2017, CBCT likely 2018)
- May then look at other issues if time e.g. paediatrics, etc



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Thanks for listening

Any questions, comments or
concerns?

