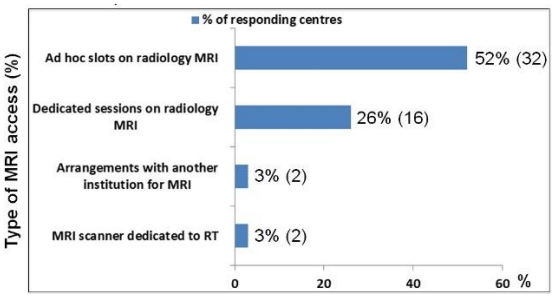
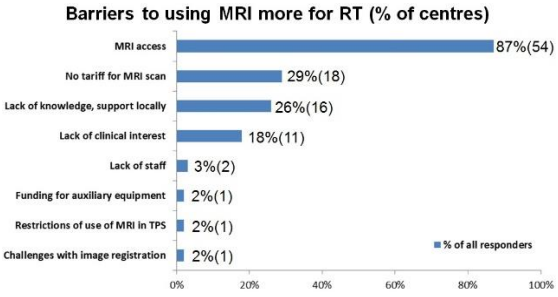


All centres using MRI in EBRT use rigid MRI to CT registration and two centres are currently using deformable image registration in addition. Commissioning and QA of image registration and MRI for EBRT showed large inter-centre heterogeneity caused by a lack of guidance.
Physics support for setting up a new MRI for EBRT service is varied across the UK with links with radiology being very important and 23% of centres reporting no support from physics staff with specialist MRI knowledge.
The largest reported barrier to utilising MRI further is a lack of MRI access (87% of centres) but a large proportion of all concerns are financially driven with a lack of tariff meaning centres do not get reimbursed for an MRI scan, see figure.



Looking forward, within the next five years, 37% of centres intend to use functional MRI, 38% of centres are planning for an MRI-simulator, 16% of centres are planning to utilise MRI-only radiotherapy and 10% are planning for an MRI-linac (on top of the 3% that currently have access).

Conclusion

The current use of MRI for EBRT in the UK was audited. More than 2 in 3 of centres have some form of MRI access, but there are only 2 MRI-simulators at present. Collaboration with radiology departments is vital for both MRI access and staff support. The main barriers to fully integrate MRI are financially driven and a lack of tariff resulting in limited access. Knowledge gaps have been identified such as the lack of standardised QA guidance that will be addressed in the IPEM guidelines.

OC-0604 The first UK survey of dose indices from radiotherapy treatment planning CT scans for adult patients

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Purpose or Objective

CT scans are an integral component of modern radiotherapy treatments, enabling the accurate localisation of the treatment target and organs-at-risk, and providing the tissue density information required for the calculation of dose in the treatment planning system. For these reasons, it is important to ensure exposures are optimised to give the required clinical image quality with doses that are as low as reasonably achievable. However, there is little guidance in the literature on dose levels in radiotherapy CT imaging either within the UK or internationally. The first UK wide dose survey for radiotherapy CT planning scans has been completed. The survey was initiated by a working party of the Institute of Physics and Engineering in Medicine (IPEM).

Material and Methods

Patient dose metrics were collected for prostate, gynaecological, breast, 3D-lung, 4D-lung, brain and head & neck scans. Median values per scanner and examination type were calculated and national dose reference levels and 'achievable levels' of CT dose index ($CTDI_{vol}$), dose-length-product (DLP) and scan length are proposed based on the third quartile and median values of these distributions, respectively.

Results

A total of 68 radiotherapy CT scanners were included in this audit. The proposed national dose reference levels and achievable levels are shown in the table below. Significant variations in dose indices were noted, with head & neck and lung 4D yielding a factor of eighteen difference between the lowest and highest dose scanners. There was also evidence of some clustering in the data by scanner manufacturer, which may be indicative of a lack of local optimisation of individual systems to the clinical task.

		Proposed reference level			Achievable level		
Examination	PD (cm)	$CTDI_{vol}$ (mGy)	DLP (mGy · cm)	Scan length (mm)	$CTDI_{vol}$ (mGy)	DLP (mGy · cm)	Scan length (mm)
Breast	32	10	390	360	8	280	330
Gynaecological	32	16	610	400	12	510	380
Lung 3D	32	14	550	390	10	410	370
Lung 4D	32	63	1750	340	36	1170	330
Prostate	32	16	570	340	13	420	310
Brain	16	50	1500	290	42	1110	250
Head and neck	16	49	2150	420	26	1080	400

Conclusion

The first UK wide audit of dose indices for adult patients undergoing CT scans for radiotherapy planning has been completed, and the results published (Tim J Wood et al 2018 Phys. Med. Biol. 63 185008). Reference values and achievable levels for $CTDI_{vol}$, DLP and scan length have been proposed for seven common types of CT scan. It is anticipated that providing this data to the UK and wider radiotherapy community will aid the optimisation of treatment planning CT scan protocols.

OC-0605 Is DIBH more robust than FB in VMAT left breast irradiation? Multicenter and multivendor analysis

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Purpose or Objective
VMAT usually increases the dose conformity to the target but enhance the mean dose to organs at risk, mainly for the heart. Deep Inspiration Breath Hold (DIBH) was demonstrated to help in reducing the mean heart dose (MHD) and might be required in some cases. This study systematically investigates the possible advantages of DIBH in comparison to standard Free Breathing (FB) for left breast VMAT.

Material and Methods
DIBH and FB VMAT plans for ten left side breast patients were optimized by two different TPSs (Monaco5.1 and Eclipse11) and Linac devices (Elekta Synergy and Varian TrueBeam). Dose prescriptions were 40.5Gy to the PTV_{breast} and 48Gy to the PTV_{boost} in 15 fractions. *PTV_{breast}98%>38.5Gy, PTV_{boost}98%>45.7Gy, and maximum dose to PTV_{boost}<107% were asked.* OARs constraints were MHD<*4Gy*, V_{18Gy}<5% for heart; D_{mean}<*10Gy*, V_{20Gy}<10% *for left lung;* D_{mean}<*3Gy for right lung and breast*. Several dynamic plan parameters and complexity indices were computed from the DICOM RTPlan files by using an homemade program. The overall modulation index MI_{tot} was scored to take into account in a single parameter the leaf speed and acceleration and the gantry speed (GS). A global quality parameter accounting for both dosimetric scoring and plan complexity was defined as GP=(MI_{tot}xMHD /*PTV_{breast}98%)*. Pre-treatment QA verifications were carried out in both centers using the EPID-based Epiqa5.0 software (EPIDOSsro, Bratislava). Gamma index (γ) analysis was performed with 3%G-3 mm, 2%G-2 mm and 3%L/3 mm criteria. Statistical significance was examined using a Wilcoxon signed rank-test for related samples and set at p≤0.05.

Results
A significant better PTV coverage was found for DIBH plans in both centers compared to FB plans. *DIBH plans were associated with a lower value in all the OARs dose parameters with significant reduction in MHD and $V_{hearth18Gy}$ (p<0.005).* For FB plans MHD>4Gy was observed in 30% of the cases. The plan complexity was generally slightly lower for DIBH plans than for FB ones, but differences were statistically significant only in few cases. The GP resulted significant lower in DIBH plans (Fig.1).

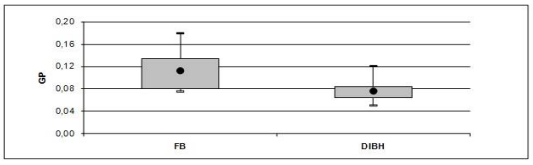

Fig.1 : Box plot for GP evaluated for DIBH and FB plans.

Regarding the plan delivery parameters, Eclipse used smaller and more complex MLC apertures, while Monaco further modulated the DoseRate and the GS than Eclipse, providing higher MI_{tot} values. Both DIBH and FB optimizations yielded good results for QA verification with γ(3%G-3mm)>95% in all cases (Fig.2); no significant difference was found. Higher γ(2%G-2mm) values for DIBH plans than for FB were found for the Elekta institution with significant differences (p<0.02).

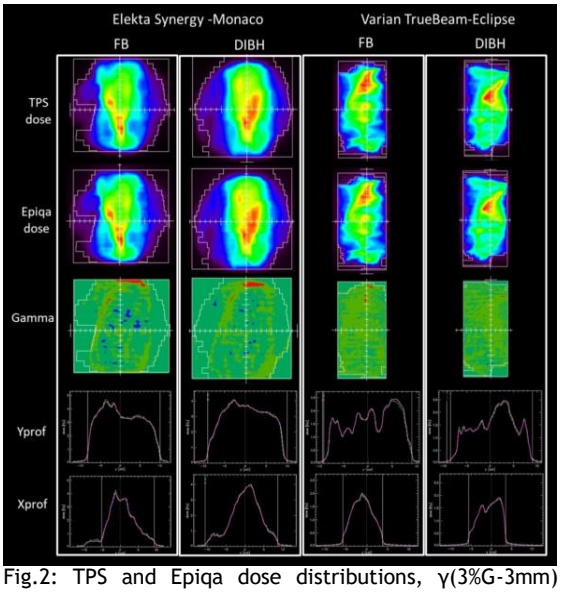

Fig.2: TPS and Epiqa dose distributions, γ(3%G-3mm) results and isocenter dose profiles for FB and DIBH plans of same patient.

Conclusion
VMAT DIBH technique is more robust than FB when the heart needs further sparing, because it allows an overall reduction of the OAR doses with a slightly lower level of plan complexity and without compromising plan deliverability.

OC-0606 IMRT QA: comparing independent recalculation against measurement based methods

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Purpose or Objective
To directly compare independent recalculation of the treatment plan against measurement-based IMRT QA to see which performed better at detecting unacceptable plans.

Material and Methods
Acceptability of IMRT delivery was assessed with 337 IROC head and neck phantoms previously irradiated as part of clinical trial credentialing, 18 of which failed to meet IROC's 7%/4mm acceptability criteria. For each of the 337 cases, the institution's IMRT QA result, based on the method employed by the institution, was abstracted to determine how well their clinical QA (conducted on the phantom plan at the time of phantom irradiation) predicted the phantom irradiation result (i.e., did the phantom pass or fail). Each case was also independently recalculated by IROC using the institution's DICOM data and Mobius 3D (with linac class-specific beam models) to determine how well the recalculation predicted the phantom irradiation results (i.e., pass or fail). Comparisons between measurement-based IMRT QA and independent recalculation were made using truth tables to determine sensitivity and specificity of each, including subdivision by IMRT QA device (EPID, ArcCheck, ion chamber, or MapCheck). ROC analysis was also performed to evaluate the accuracy of measurement-based IMRT QA and independent recalculation as the strictness of the criteria for flagging failures varied.

Results
For the 18 failing phantoms in the total cohort, measurement-based IMRT QA had a sensitivity of 6% (i.e., only 1 unacceptable plan was flagged based on clinical measurement-based IMRT QA methods). In contrast, the independent recalculation approach had a sensitivity of 72% (flagging 13 unacceptable plans). Overall, and when