around the target (whole bladder) and the relative proportion of the bladder on the serial scans breaching these margins were compared.
Results: 61 scans were available for comparison. The mean post void residual volume from the planning scan was 112 cm^3 (SD 42 cm^3) representing on average 60% of full bladder capacity. There was considerable inter-fractional variation with a mean relative increase in bladder volume of 12% (SD 35%), with no observable trends over time. No differences were seen in the proportion of bladder breaching the 1.5 and 1 cm margin ($P = 0.18$).
Regression analysis demonstrated that it is possible to ensure complete coverage of the bladder with a 1 cm margin providing the volume was limited to less than 50% of the planning scan volume.
Conclusion: Using an empty bladder protocol it is feasible to reduce the PTV margin from 1.5 to 1 cm with complete coverage achievable if the volumes are limited to within 50% of the planning scan volume.

P60 Electronic Portal Imaging (EPI): Optimisation of Image Quality

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Introduction: It is important in radiotherapy that the treatment beam is adequately aligned to the tumour. By comparing bony anatomy on the EPI to that on the reference images taken at CT or simulator the accuracy of the treatment field can be determined. The imaging acquisition setting on the amorphous silicon (aSi) PortalVision™ imager had been preset as 2 reset frames to account for beam stabilising and 4 frames averaged to create the image.
Method: The PIPSPro QV3 phantom was mainly used to quantify image quality in terms of contrast, spatial resolution and noise. Images were acquired using various reset frames and frames averaged settings. More focused investigations were then made using other phantoms.
Results: The spatial resolution did not change when the number of frames (or dose) was increased. The number of reset frames did not affect contrast but the number of frames did. Optimal settings in terms of image quality per dose were found to be 1 reset frame and 3 frames averaged.
Conclusion: All patients at the NI Cancer Centre are now imaged using 1 reset frame and 3 frame averages. The dose from electronic portal imaging has been reduced by one third.

P61 Use of Simple Biological Markers to Monitor Gastrointestinal Toxicity during Pelvic Radiotherapy

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Background: Various physiological changes, including bile-acid malabsorption, reduced disaccharidase secretion and small bowel bacterial overgrowth, have been proposed to underlie the spectrum of gastrointestinal symptoms which occur during pelvic radiotherapy. How physiological changes correlate with symptoms is not known. Inexpensive biological markers may sensitively identify such changes and also reflect direct damage to the intestinal mucosa induced by pelvic radiotherapy. If so, these non-invasive markers could be used to monitor patients, enabling early identification of those at risk of developing severe acute (and perhaps consequential late) toxicity.
Methods: This prospective observational study examined biological markers of physiological change and gut damage and their relationship to gastrointestinal toxicity. Patients with pelvic malignancy were assessed before, during and after treatment with pelvic radiotherapy. Fasting glucose hydrogen breath tests, citrulline and lathosterol plasma levels and faecal calprotectin were measured. Gastrointestinal toxicity was evaluated using RTOG, IBDQ and Vaizey questionnaires.
Results: 59 patients were recruited (30 female), median age 61 years (41–82). Sites of disease included 19 prostate, 14 endometrial, 10 cervical, 6 rectal, 4 bladder, 3 ovarian, 2 other and 1 vaginal carcinoma. 83% developed an adverse change in their bowels during treatment, 50% developed significant gastrointestinal toxicity by week 5. In those with severe toxicity, a significant increase in faecal calprotectin (gut inflammation) (Wilcoxon rank; $P = 0.05$) and lathosterol (bile-acid malabsorption) (Wilcoxon rank $P = 0.01$) occurred. Plasma citrulline (mucosal cell mass) decreased but did not reach significance ($P = 0.1$). Bacterial overgrowth was more prevalent in patients with severe toxicity.
Conclusions: Simple, non-invasive markers may accurately describe the mechanisms underlying clinical toxicity during radiotherapy. A larger prospective evaluation of these markers alongside histological assessment is warranted in order to understand the relationship further. Early changes in these markers may indicate patients at risk of severe gastrointestinal toxicity.

P62 Active Breathing Control (ABC) in Radical Radiotherapy of Non-small Cell Lung Cancer (NSCLC)

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Purpose: Tumour movement in patients receiving radiotherapy (RT) for NSCLC can be restricted with an ABC device. We assessed tolerability and reproducibility of this device during a 6 week course of RT and the effect on lung parameters and report our early experience.
Method: Patients considered for radical RT underwent a training session to set the breath hold level (~70% of maximum inspiratory volume) and breath hold time. Planning CT scans were performed with and without the ABC and 3 field coplanar plans for each scan produced. Differences in lung V_{20}, planning target volume (PTV) coverage and maximum spinal cord dose were compared. The treatment time (time on the bed) and number of breath holds required were recorded. To assess reproducibility of the ABC, 2 further CT scans were acquired, in the middle and the end of the treatment course. The tumour was outlined and the centre of mass (COM) recorded. The tolerability of the device was assessed by weekly questionnaire.
Results: 3 patients [mean age 75 years (range 65–85)] completed radical RT to a dose of 64 Gy in 32 fractions using the ABC device. The mean training time was 15 min and the mean maximum breath hold time was 19 s (range 17–20 s). 5–7 breath holds were used for treatment. The ABC plan resulted in a mean reduction of V_{20} of 4.2% (range 3.1–5.9%) with no compromise of PTV coverage. The average standard deviation displacement of COM movement was 0.6 cm right to left, 0.3 cm anterior to posterior and 0.9 cm superior to inferior. Patients tolerated the device throughout treatment.
Conclusion: ABC is tolerated by patients undergoing radical radiotherapy for NSCLC. The restriction of tumour motion potentially allows a reduction in PTV margins and dose escalation. However, the tumour position throughout the course of treatment must be regularly monitored and corrections made using 'adaptive radiotherapy'.

P63 Combined Phase Conformal Radiotherapy of the Prostate

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Abstract not published

P64 Targeted Screening in Men with a Genetic Predisposition to Prostate Cancer. The IMPACT Study

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Aims: The relative risk of prostate cancer is 1.07 in BRCA1 carriers (1.8 in men under the age of 65 years) and 4.65 in BRCA2 carriers.

The results of 2 general population screening studies from Europe and the US are awaited, but no reduction in mortality has been achieved so far. It is likely that only a subset of high risk men will benefit from screening. IMPACT aims to establish a prostate cancer screening programme in men with BRCA1 and BRCA2 mutations to determine the incidence and pathology of prostate cancer and the sensitivity and specificity of PSA testing in this group.
Methods: Five hundred BRCA1 mutation carriers and 350 BRCA2 mutation carriers aged 40—69 years will be recruited over 5 years in 39 international centres. Eight hundred and fifty controls will be recruited from men who are predictive test negative for a known familial mutation in BRCA1 or BRCA2. Annual PSA will be taken. If the PSA is above 3.0, prostate biopsy will be offered. This will be the largest prostate cancer screening study in men with a known genetic mutation.
Results: 40 men have been recruited to date, comprising 18 BRCA2 carriers, 13 BRCA1 carriers and 9 controls. Three men have PSA levels above our threshold, a BRCA1 mutation carrier, a BRCA2 mutation carrier and a control. Their PSA levels are 3.8, 6.7 and 7.2, respectively. The BRCA1 mutation carrier has been found to have adenocarcinoma of the prostate gland, Gleason pattern 3 + 4. He is 48 years of age and asymptomatic. The other 2 men await prostate biopsy.
Conclusions: Our numbers are currently too small to make statistically relevant conclusions regarding incidence. We have recruited 40 men and detected prostate cancer in a BRCA1 mutation carrier at a young age of onset. Two further men with PSA levels above 3.0 await prostate biopsy. We would like to present our preliminary results.

P65 Analysis of the Sweeping Gap Test for Routine QC with a Varian 120 Leaf MLC

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Introduction: At present no national or international guidelines exist for routine quality control (QC) of multi-leaf collimators (MLC) for delivery of dynamic IMRT. Tests described by Chui et al. have been widely adopted by the Varian community. However, there is a lack of information in the literature on the sensitivity of these tests to detect MLC positional errors and therefore on the selection of appropriate tolerance levels. This work describes a systematic evaluation of the sweeping gap test's sensitivity in detecting errors in bank calibration for the 120 leaf MLC. This analysis will be referenced to clinical IMRT treatments, in the context of average leaf separation (ALS).
Method: Measurements were carried out on a Varian 6EX with a Millennium MLC. Leaf motion files were designed in Eclipse to deliver a uniform intensity fluence with 0.5 and 1.0 cm sweeping gaps. Leaf motions were systematically adjusted in a text editor to introduce intentional gap width errors of up to 1.0 mm (0.2 mm intervals). The delivered dose was measured with a Farmer ionisation chamber in WT1 material.
Results: MLC accuracy is directly proportional to dose error with a 0.5 mm leaf calibration error resulting in measured dose errors of 6 and 3% ($\pm$0.2%) for the 0.5 and 1 cm sweeping gaps. The sweeping gap field dose delivery was found to be very stable: dosimetric reproducibility of 0.2%.
Discussion: These results demonstrated a lower dose versus position error than work previously published for the 52 leaf MLC. Sweeping gap dose delivery errors as low as 0.5% can be resolved (0.1 mm MLC error). For complex IMRT fields (ALS of 1 cm), we aim to limit the dose error due to MLC calibration to $<$1%. We therefore use a tolerance of 2% on a 0.5 cm sweeping gap test for routine QC.

P66 Commissioning a Superposition Dose Calculation Model for 6 MV Photon Beams on a Radiotherapy Treatment Planning System

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Introduction: The Xio treatment planning system (CMS, St Louis) provides four different models for calculating photon dose distributions, these being Clarkson, convolution, superposition and fast superposition models.
Initial commissioning concentrated on the convolution dose model. Dosimetric verification in homogenous media demonstrated a generally highly acceptable degree of agreement between measured and calculated doses. Modelling of highly asymmetric beams with a motorised 60° wedge resulted in dose discrepancies of approximately 7% in the centre of a half blocked beam. When applied to inhomogenous media, dose differences of up to 15% were observed for relatively simple treatment set ups, prompting investigation of the superposition dose model.
Method: A series of four experiments was performed to compare the performances of the convolution and superposition dose models with respect to:

(i) modelling of dose adjacent to lung type heterogeneity (secondary build up);
(ii) modelling of dose beyond lung type heterogeneity;
(iii) modelling of penumbra broadening within lung type heterogeneity;
(iv) modelling of lateral scatter in tissue bilaterally adjacent to lung type heterogeneities.

Five lung cancer cases, previously planned on another system, were replanned on Xio using both convolution and superposition dose models to enable a clinical assessment of both algorithms.
Results: In all cases above, the superposition model performed considerably better than the convolution model, although again the modelling of a 60° motorised wedge appears to be problematical with dose discrepancies of around 6% noted in symmetric wedge fields after passing through lung. Paradoxically, the errors incurred in basic asymmetric wedge modelling in homogenous media and those incurred through heterogeneity correction act appear to act in opposite directions in certain circumstances.
Conclusion: Use of the superposition model on Xio considerably improves dose accuracy. Assessment of clinical cases demonstrated the difficulty of meeting previously accepted target dose homogeneity when the superposition model was used.

P67 Dose—Volume Evaluation of Whole-ventricular Radiotherapy for Localised Intracranial Germinomas

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Introduction: Management of localised primary intracranial germinomas has been controversial. Whole-ventricular radiotherapy (WVRT) plus a focal boost is now becoming recognized as the standard of care for this disease. Given the high survival rate and the young age of the patients, normal-tissue dose and late sequelae are highly relevant. The aim of this work is to quantify the normal-tissue dose sparing achievable by replacing whole-brain radiotherapy (WBRT) (in craniospinal irradiation) with WVRT and to evaluate WVRT techniques of different complexity.
Methods: Co-registered CT-MRI images of 5 patients were studied. Planning target volumes for whole ventricles (phase 1, PTV1) and boost to primary tumour (phase 2, PTV2) included a 1 cm margin and were prescribed to 24 Gy and 16 Gy, respectively. For phase 1, conformal parallel-opposed pair (PP), non-coplanar three- and four-field (3F and 4F) and four- and seven-field IMRT (4FIMRT and 7FIMRT) plans were compared. A conformal non-coplanar six-field technique was used in phase 2. All beams were 6 MV.