**Purpose/Objective:** This study aimed to investigate the magnitude of interfraction prostate bed motion and delineate reasonable CTV-PTV margins in situations where image-guided localization is performed using an analysis of bony anatomy landmarks or gold seed fiducial markers and in situation where image-guidance is applied more sparsely and patient set-up is done according to patient’s skin marks.

**Materials and Methods:** Thirteen prostate cancer patients, who had been implanted four gold seed fiducials into their prostate bed, were imaged daily by cone beam CT (CBCT) before radiotherapy. In total, 466 CBCT images were analyzed and total position error, set-up error and prostate bed motion were measured by analyzing the position of gold seed fiducials and localizations of bony anatomy landmarks.

**Results:** CTV-PTV margins were 4.9 mm in the left-right (LR) axes, 8.0 mm in the superior-inferior (SI) axes and 7.4 mm in the anterior-posterior (AP) axes when the localization was done aligning to skin marks (i.e. without the IGRT). If imaging was performed on the first three treatment fractions and the rest of the fractions were treated according to patient’s offset skin marks, the margins were 2.4 mm, 6.5 mm and 6.6 mm in the LR, SI and AP axes, respectively. If daily IGRT was performed and localization was done by bony anatomy landmarks, margins were 1.4 mm, 5.9 mm and 5.9 mm in the LR, SI and AP axes, respectively.

**Conclusions:** Daily pre-treatment CBCT can reduce CTV-PTV margins for 16%, 26% and 4% in the LR, SI and AP axes, respectively. Prostate bed motion seems to have a relatively more significant impact to the SI and AP margins when compared to set-up error, which has more important role in the LR margin. The alignment of bony anatomy landmarks or daily basis does not reduce margins significantly hence it is reasonable to use imaging more sparsely in that case. In daily IGRT either the use of CBCT or the gold seed fiducial localization seems profitable.

**EP-1273**

Impact of motion in advanced paediatric abdominal radiotherapy.

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**Purpose/Objective:** To investigate the magnitude of motion in advanced paediatric abdominal radiotherapy. EP-1273

**Materials and Methods:** The re-delineated volumes were compared for changes in ‘apparent’ volume and distribution. Anatomical positional variations and bowel gas changes led to changes in delivered dose to Organs at Risk. Conclusions: Highly conformal plans based on abdominal compression may be considered. Interventions such as those used in the adult practice to reduce the impact of bowel gas should be evaluated for suitability in this population. Reduction in bowel gas will improve CBCT image quality. Linac-based CBCT verification strategies must also be investigated to reduce potential dosimetric variation.

**EP-1274**

Calculation of the dose of the day using an in-house validated deformable registration algorithm

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**Purpose/Objective:** Validate an in-house deformable registration algorithm in order to calculate the ‘dose of the day’ and assess the need to replan head and neck (HN) patients, by deforming a planning CT (pCT) with CBCT data.

**Materials and Methods:** Data from 3 HN patients treated in our clinic was used in this study. These patients considerably changed shape throughout their treatment and therefore required replan midway. Therefore, in addition to the pCT and weekly CBCTs, a rescan CT (rCT) was also available. We register the pCT to a CBCT using an open-source deformable registration algorithm developed at our institution (NiFTK). Two tests were performed to assess the quality of our registrations: (i) structures delineated in the pCT were warped and compared with contours manually drawn by the same physician on the CBCT and (ii) dose calculations for the same IMRT plan on the deformed CT and rescan CT were compared. The structure set used on the first test was a mixture of bone and soft tissue structures, such as vertebrae and neck muscles, which can be seen unequivocally from the pCT and CBCT. Since the rCT and following CBCT are acquired 5-7 days apart, they do not represent the same geometry. To minimize errors in the dose calculation due to inaccuracy in representing the real geometry, we actually registered the pCT to a simulated CBCT, obtained from deforming the real CBCT to match the rCT. This simulated CBCT is a better representation of an ideal dataset, in which the rCT and CBCT would have been acquired at the same time. The dose distributions were compared using dose-difference (DD), gamma analysis (γ), target coverage (using isodose surfaces) and DVHs.

**Results:** The warped structures showed a good agreement with the manually drawn ones, with more than 90% of the warped structure pixels having distance less than 2mm from the manually drawn ones. The dose distributions were compared within a region of interest that contained the rCT body that received dose plus a 5mm margin. The dose to critical structures, such as parotids, brainstem and spinal canal, was also assessed. The mean DD value was less than 1% of the prescribed dose and 92.6% of the voxels have a DD less than 2% of the prescribed dose. The gamma analysis of the dose distributions passed 96.98% of the voxels agreeing within ±2% DD and 2mm distance-to-agreement (DTA). The 95% isodose surfaces were shown to have a maximum dose difference index (DDI) and overlap index (OI) of 0.959 and 0.971 respectively. DVHs were found to be in good agreement for the brainstem, spinal cord and parotids curves. The relative error estimating the absolute dose to the brainstem and spinal canal is 4.20% and 0.35% on the deformed dataset.

**Conclusions:** Our preliminary results indicate that pCT to CBCT deformable registration can be used to estimate the ‘dose of the day’. The structures of interest warped from the pCT can be used to compute daily DVHs. This strategy has potential clinical use to evaluate the need for a replan without significant increased workload to the clinic.

**EP-1275**

Gold seed markers in prostate bed image-guided radiotherapy

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**Purpose/Objective:** This study aimed to investigate the magnitude of interfraction prostate bed motion and delineate reasonable CTV-PTV margins in situations where image-guided localization is performed using an analysis of bony anatomy landmarks or gold seed fiducial markers and in situation where image-guidance is applied more sparsely and patient set-up is done according to patient’s skin marks.

**Materials and Methods:** Thirteen prostate cancer patients, who had been implanted four gold seed fiducials into their prostate bed, were imaged daily by cone beam CT (CBCT) before radiotherapy. In total, 466 CBCT images were analyzed and total position error, set-up error and prostate bed motion were measured by analyzing the position of gold seed fiducials and localizations of bony anatomy landmarks.

**Results:** CTV-PTV margins were 4.9 mm in the left-right (LR) axes, 8.0 mm in the superior-inferior (SI) axes and 7.4 mm in the anterior-posterior (AP) axes when the localization was done aligning to skin marks (i.e. without the IGRT). If imaging was performed on the first three treatment fractions and the rest of the fractions were treated according to patient’s offset skin marks, the margins were 2.4 mm, 6.5 mm and 6.6 mm in the LR, SI and AP axes, respectively. If daily IGRT was performed and localization was done by bony anatomy landmarks, margins were 1.4 mm, 5.9 mm and 5.9 mm in the LR, SI and AP axes, respectively.

**Conclusions:** Daily pre-treatment CBCT can reduce CTV-PTV margins for 16%, 26% and 4% in the LR, SI and AP axes, respectively. Prostate bed motion seems to have a relatively more significant impact to the SI and AP margins when compared to set-up error, which has more important role in the LR margin. The alignment of bony anatomy landmarks on daily basis does not reduce margins significantly hence it is reasonable to use imaging more sparsely in that case. In daily IGRT either the use of CBCT or the gold seed fiducial localization seems profitable.

**EP-1274**

Calculation of the dose of the day using an in-house validated deformable registration algorithm

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**Purpose/Objective:** Validate an in-house deformable registration algorithm in order to calculate the ‘dose of the day’ and assess the need to replan head and neck (HN) patients, by deforming a planning CT (pCT) with CBCT data.

**Materials and Methods:** Data from 3 HN patients treated in our clinic was used in this study. These patients considerably changed shape throughout their treatment and therefore required replan midway. Therefore, in addition to the pCT and weekly CBCTs, a rescan CT (rCT) was also available. We register the pCT to a CBCT using an open-source deformable registration algorithm developed at our institution (NiFTK). Two tests were performed to assess the quality of our registrations: (i) structures delineated in the pCT were warped and compared with contours manually drawn by the same physician on the CBCT and (ii) dose calculations for the same IMRT plan on the deformed CT and rescan CT (rCT) were compared. The structure set used on the first test was a mixture of bone and soft tissue structures, such as vertebrae and neck muscles, which can be seen unequivocally from the pCT and CBCT. Since the rCT and following CBCT are acquired 5-7 days apart, they do not represent the same geometry. To minimize errors in the dose calculation due to inaccuracy in representing the real geometry, we actually registered the pCT to a simulated CBCT, obtained from deforming the real CBCT to match the rCT. This simulated CBCT is a better representation of an ideal dataset, in which the rCT and CBCT would have been acquired at the same time. The dose distributions were compared using dose-difference (DD), gamma analysis (γ), target coverage (using isodose surfaces) and DVHs.

**Results:** The warped structures showed a good agreement with the manually drawn ones, with more than 90% of the warped structure pixels having distance less than 2mm from the manually drawn ones. The dose distributions were compared within a region of interest that contained the rCT body that received dose plus a 5mm margin. The dose to critical structures, such as parotids, brainstem and spinal canal, was also assessed. The mean DD value was less than 1% of the prescribed dose and 92.6% of the voxels have a DD less than 2% of the prescribed dose. The gamma analysis of the dose distributions passed 96.98% of the voxels agreeing within ±2% DD and 2mm distance-to-agreement (DTA). The 95% isodose surfaces were shown to have a maximum dose difference index (DDI) and overlap index (OI) of 0.959 and 0.971 respectively. DVHs were found to be in good agreement for the brainstem, spinal cord and parotids curves. The relative error estimating the absolute dose to the brainstem and spinal canal is 4.20% and 0.35% on the deformed dataset.

**Conclusions:** Our preliminary results indicate that pCT to CBCT deformable registration can be used to estimate the ‘dose of the day’. The structures of interest warped from the pCT can be used to compute daily DVHs. This strategy has potential clinical use to evaluate the need for a replan without significant increased workload to the clinic.
Optimized IGRT correction vector determined from a displacement vector field: Decision-making aid for re-planning

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Purpose/Objective: To present a new method that determines an optimized IGRT couch correction vector from a displacement vector field (DVF). The DVFs are computed by a deformable image registration (DIR) method. These DVFs describe setup variations and deformations of the patient anatomy in control-CTs in respect to planning-CTs. The proposed method can improve the quality of the volume-of-interest (VOI) alignment in IGRT, and can serve as a decision-making aid for re-planning.

Materials and Methods: The method is demonstrated using the CT data sets of 11 head-and-neck cancer patients with daily kilo-voltage control-CTs. A DVF is computed for each control-CT using an automatic DIR algorithm based on a template matching technique. The DVF is used for voxel tracking and re-contouring of the VOIs in the control-CTs. Then a rigid body transformation, which can be used as couch correction vector, is optimized. Aim of the optimization process is to find a vector and rotations that map the deformed VOIs into a specified territory. This territory is defined by a margin extension of the VOIs at the time of the planning process. Within this extension, VOI motion and deformation is tolerated. The optimization process considers pre-defined geometrical constraints of all VOIs considered relevant for patient alignment. The objective function in the optimization process is the sum of all volume fractions outside the defined territories. The optimization method used to define the minimum of the objective function is a widely used simplex algorithm. The method can also serve as a decision-making aid for re-planning: In this study, we chose the 'action level' for re-planning to be 2 volume percent of each VOI. If this criterion is exceeded by any VOI, re-planning is assumed to be necessary.

Results: Using the proposed method results in smaller fractions of the VOIs lying outside the defined territory after the IGRT correction. In comparison to the standard IGRT correction, which is a rigid registration method, the method is able to find more frequently a correction vector that fulfills the optimization goal. Also comparison of the standard IGRT correction with a version of the optimized IGRT strategy that does not consider rotations in the optimization process shows that in more fractions an acceptable alignment of the VOIs is achieved.

Conclusions: The knowledge of the deformation of the anatomy allows the determination of an optimized rigid correction vector, using our method. The method ensures controlled mapping of the VOIs despite small deformations. The manual choice of a region for registration when using IGRT will be superseded. The proposed method can also serve as a decision-making aid for re-planning: In this study, we chose the 'action level' for re-planning to be 2 volume percent of each VOI. If this criterion is exceeded by any VOI, re-planning is assumed to be necessary.

EP-1276
The use of adaptive planning using VMAT in head and neck squamous cell carcinoma
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Purpose/Objective: Recent evidence supports the use of adaptive planning in IMRT for H&N SCC. The use of adaptive planning with VMAT delivery is unknown. We performed a retrospective planning study to identify whether adaptive planning should be applied with delivery using VMAT.

Materials and Methods: A retrospective analysis was performed on 27 consecutive patients. A repeat planning CT at fraction 16 was delineated. For delineation on the repeat scan, the original GTVs and CTVs were copied and pasted from the original scan onto the repeat scan and volumes were adjusted for changes in anatomy position, but were not reduced in size. A non-adaptive plan was created by recalculating only and an adaptive plan was created by re-optimization and re-normalization.

Results: 87% of patients received neo-adjuvant chemotherapy. The mean absolute improvement reduction in conformity number and the D99 of the dose in PTV_HR was 0.06 (S.D. = 0.06) and 5.2% (S.D. = 6.67) respectively. The mean absolute improvement in conformity number of PTV_LR is 0.03 (S.D. = 0.03). In terms of organs at risk, the mean maximum dose to spinal cord and mean contra-lateral parotid was 0.3Gy (S.D. = 1.5), 0.2Gy (S.D. = 0.9) and -0.5Gy (S.D. = 2) where positive improvement is. These were a heterogeneous group of patients with median weight loss of 4.5kg (range -0.2kg to 11.3kg), median separation change at C1 and thyroid notch 0.5 cm (range 0 to 2.7cm) and 0.4cm (range -0.1 to 2.2cm).

Conclusions: Although we present a clinically feasible method of adaptive planning, in contrary to similar series there was very limited benefit to adaptive planning. This may be due to the use of VMAT, the high use of neo-adjuvant chemotherapy or patient selection. The small proportion of patients likely to benefit are likely to be in the group with changes in separation or weight, however robust data to confirm this awaits.

EP-1277
The effect of image window level adjustments on auto-contouring for NSCLC patients
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Purpose/Objective: To evaluate the total lung volume and Normal Tissue Complication Possibility (NTCP), V20, V10, and V5 values for non-small-cell cancer (NSCLC) patients by using two different image window level adjustment on auto-contouring options while keeping the same tumor coverage and dose distribution.

Materials and Methods: Treatment planning were performed for 15 patients with non-small-cell cancer using IMRT at our clinic. All patients underwent CT scan; 5 mm slice thickness (Siemens Emotion Duo) in supine position with the standard wing board. A dosimetric planning studies were performed except total lung. The treatment plans were generated with Prowess Panther 5.01 for delivery with 6 MV on a Siemens Artiste linear accelerator with a 80 pair MLC. All the plans were subsequently generated using consistent planning parameters such as optimization parameters and total dose. After finishing IMRT optimization for all patients by using contours obtained from Mediastinal window-level (W:635, L:2), the total lung’s contour was regenerated by using Lung window-level (W:1200; L:-400). For creating two different total lung volume, the auto-contouring option were used on treatment planning system (TPS). The total lung DVH parameters were compared with NTCP, V20, V10, V5 values and volume changes.

Results: According to the data obtained in this study when doing auto-contouring, by using appropriate of image window level is significantly important. This settings affects the NTCP, V10, V20 values and volume changes for the total lung. The differences of NTCP, V10, V20 values and volume changes were respectively 10.41%, 3.61%, 13.2%, 16% and 15.96%.

Conclusions: The auto-contouring options are commonly used at work faster clinical intensive operation. This study showed that both image window level differed significantly, care should be taken when auto contouring options as the importance of selection image window level value influence the risk of complication possibility reduced.

EP-1278
US imaging to reduce uterine perforation in a French cancer centre
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Purpose/Objective: Since dosimetry of brachytherapy is no more planned on orthogonal radiographs but on CT-scan, we noticed uterine perforations. This observation involves the removal of brachytherapy disposal and a second brachytherapy procedure. This implies risks of a general anaesthesia, delay of brachytherapy and organizational difficulties. Ultrasoundography is capable of determining limits of uterus. This retrospective study assesses the benefit of using US for image-guided cervical cancer brachytherapy to reduce uterine perforation in our clinical practice.

Materials and Methods: From November 2011 to April 2012, 21 patients with cervical cancer underwent brachytherapy after pelvic radiotherapy with/without concomitant cisplatin chemotherapy. We used Thin Trans-abdominal US for Trans-vaginal US in operation room. Uterine perforation was defined as penetration of uterine serosa by uterine tandem applicator on pelvic MRI or pelvic CT-scan.

Results: 20 applications were assessable (one patient had no pelvic CT-scan or MRI). Median age was 57 years old. There were 15 squamous cell carcinomas, four adenocarcinomas and one mucinous carcinoma. When US was not done, there were four uterine perforations (31%) and nine proper applications (71%). When