Research Presentations:

Automatic IMRT and VMAT Treatment Planning for Head and Neck Cancer
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Purpose:
Advanced radiotherapy treatment planning such as IMRT and VMAT is time-consuming and planner-dependent. Automatic planning tools have the potential to reduce planning time and to improve plan quality and consistency. This study compares automatically generated IMRT and VMAT plans with the clinical plans for head and neck cancer.

Methods:
Seventeen HN patients treated with step-and-shoot IMRT were selected. The treatment goal was to simultaneously deliver 70 Gy to ≥95% of the high dose PTV and 56 Gy to ≥ 95% of the low dose PTV. In a commercial treatment planning system, the first ten HN cases were used to create and fine-tune automatic planning techniques. Using these auto-planning techniques, nine-field step-and-shoot IMRT plans (AP_IMRT) and two-arc VMAT plans (AP_VMAT) were automatically generated for the other seven HN patients. The clinical and automatic plans were compared using dosimetric endpoints, homogeneity index (HI), and conformity index (CI). Paired t-tests were performed and the results were considered significant if the p-values were ≤ 0.05.

Results:
The population averaged dosimetric endpoints, HI, and CI were summarized. All auto-planning IMRT and VMAT plans met the clinical dose limit requirements. The coverage of low dose PTV was significantly improved by use of the auto-plans. The doses to normal tissues, such as brainstem, right paratid, larynx, trachea, and esophagus, were significantly reduced in the auto-plans. Compared with the clinical plans, the AP_IMRT plans had similar HI and CI, and the AP_VMAT plans had comparable HI and improved CI.

Conclusion:
Auto-plans generated using both IMRT and VMAT techniques can be directly accepted for patient treatments. This commercially available auto-planning tool can improve plan quality and consistency while increasing planning efficiency.
Calculating Delivered Dose to Assess the Validity of 2.5 mm Margins in Head and Neck SBRT
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Purpose:
To determine the delivered dose for head and neck SBRT patients using pre-treatment images. This delivered dose will then be used to assess the viability of the 2.5 mm margins used in planning.

Methods:
Daily cone beam CTs (CBCTs) and their shifts, (from the rigid image registration with six degrees of freedom including three rotational and three translational variables,) were collected for 20 patients along with a planning CT, planned dose, and critical structures. The day 1 CBCT was aligned to the planning CT using the treatment shifts and then the dose and contours were transferred to the CBCT. The day 1 CBCT becomes the reference image for day 2-5. The day 2-5 CBCTs were aligned to the planning CT using the treatment shifts given and the dose and contours transferred. The day 2-5 CBCTs were then deformably registered to the day 1 CBCT. The dose delivered on days 2-5 were then deformed to the day 1 CBCT where they could be accumulated. These analyses accomplished with MIM 6.5.1. The accumulated doses for the 20 patients were evaluated against the planned doses using the initial planning criteria as points of comparison.

Results:
For CTV or GTV the delivered dose closely conformed to the planned (98% coverage), with an average decrease of 2.2% between planned and delivered coverage. This implies the 2.5 mm margin was sufficient. Larger CTVs appear to be correlated to smaller differences between planned and delivered coverage. Delivered dose for critical structures including the spinal cord, mandible, brain, brainstem, and larynx was acceptable, with differences between planned and delivered max dose less than 5% on average, although there were four outliers. Similarly for the parotid glands, globe, cochlear, optic nerve, lens, and submandibular glands, differences between planned and delivered doses were generally less than 5%.

Conclusion:
CTV coverage was acceptable, therefore a margin of 2.5 mm was sufficient to adequately treat tumors. The organs at risk (OAR) sparing capability of SBRT with a 2.5 mm margin was adequate. A small volume tumor may require a larger margin to treat effectively.
Real-Time In Vivo Dosimetry for SBRT Prostate Treatment
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Purpose:
The objective of the present study is to assess the performance of a new in-vivo dosimetry system in a high gradient dose region during stereotactic body radiation therapy (SBRT).

Methods:
The OARtrac system (RadiaDyne LLC, Houston, TX, USA) is a single-use prostate immobilization and real-time dose verification system for external beam irradiation of prostatic cancer. The system consists of two plastic scintillating detectors (PSD) located on the anterior surface and along the length of an endorectal balloon (labeled as proximal and distal respectively). The OARtrac system was used in a prostate SBRT treatment with 6 MV VMAT on an Elekta Infinity accelerator with an Agility treatment head for five fractions at 7Gy/fx to a total dose of 35 Gy. The patient was scanned with an endorectal balloon inserted. For each treatment, an endorectal balloon was inserted inside the patient to reproduce the simulation setup as close as possible. Cone-beam CT (CBCT) was taken in the image-guidance setup phase of the SBRT treatment to reduce the setup uncertainty. The measured dose was then compared to the computed dose from the treatment planning system. In addition, fraction specific computed dose was found to compare with the measured dose. The CBCT was exported to MIM (MIM Software, Cleveland, OH, USA) to be fused to the original treatment planning CT. This information was used to determine a more appropriate dose for the PSDs for each individual fraction.

Results:
The measured doses show a wide range of agreement with the expected doses, and the main reason is believed to be positioning uncertainty. For SBRT treatments, the dose gradient is high and a difference of a few millimeters can mean large changes in dose. Using the MIM software, it was possible to find the distance to agreement (DTA), which is the shortest distance from the estimated location of the PSD to the location that had the exact same calculated dose as the dose measured by the PSD. In most cases, the DTA was within a few millimeters.

Conclusion:
The major source of uncertainty is the localization of the PSDs in the CT scans since the detectors are water equivalent. The discrepancies between the measured and the calculated doses is most likely due to positioning uncertainties, as the DTA was typically within a few millimeters. Both measured and calculated doses agree that dose to the rectum is within reasonable limits. Future studies will need to find a way to better localize the PSDs in CT scans, most likely using a modified sensor with more radio opaque markers.

Disclosure:
This work was sponsored by RadiaDyne LLC.
Characterization of Interplay Errors in Step-And-Shoot IMRT of the Lung
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Purpose:
To quantify interplay errors in step-and-shoot IMRT (SS-IMRT) lung treatments due to interference between target motion frequencies and intensity modulation frequencies, and to provide recommendations on the use of motion management accordingly.

Methods:
A radiochromic film stack dosimeter (FSD) was developed to verify Monte Carlo simulations of interplay errors in SS-IMRT. The energy dependence, orientation dependence, and water equivalence of the FSD were characterized. The accuracy of the FSD was verified by comparison with TLD measurements and treatment planning software dose A Monte Carlo model of a linear accelerator was developed using the EGSnrc transport code for the simulation of interplay errors. The model was verified with the comparison of measured and simulated dose profiles. Conventionally fractionated and hypofractionated SS-IMRT treatment plans were prepared for the investigation of interplay errors. The delivery of each plan was measured with the FSD undergoing modeled respiratory motion. These measurements were reconstructed using the Monte Carlo accelerator model to verify the methodology for the simulation of interplay errors. For each treatment plan, deliveries were simulated for target motion periods from 1 s to 180 s to identify characteristic modulation frequencies for which interplay errors were greatest. The impact of respiratory motion irregularity on interplay errors was investigated, and cumulative interplay errors over conventional and hypofractionated treatment courses were quantified.

Results:
The FSD is energy independent, orientation independent, and water equivalent within 2%. Measurements with the FSD and TLD agree within respective measurement uncertainties (k=2) of 6.0% and 5.8%. Using gamma criteria of 3% dose difference and 2 mm distance to agreement, FSD measurements have 96% agreement with calculated dose distributions. Comparisons of measured interplay errors using the FSD and Monte Carlo simulations had 97%-99% agreement using gamma criteria of 3% and 3 mm. Simulations of the interplay effect found negligible errors for target motion periods of 3 s to 5 s. Errors in the CTV D₉₈ of 2% to 5% were found for target motion periods that coincided with the timescales of intrafield and interfield modulation. Over complete treatment courses of four and 35 fractions, there was no change in the CTV V₁₀₀.

Conclusion:
It was demonstrated that interplay errors are greatest for longer motion periods, representative of drifts in the baseline target position, corresponding with the low-frequency intensity modulations of the treatment. For motion amplitudes of 5 mm, for which the use of motion management is currently recommended, interplay errors were minimal. Based on the results of this work, amplitude-based motion management criteria are sufficient to mitigate interplay errors in SS-IMRT.
Online Adaptation to Internal and External Anatomical Changes In Stereotactic Radiosurgery (SRS) of L-Spine Tumors Using Cone Beam CT and TMR Ratios
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¹Cleveland State University; ²Cleveland Clinic.

Purpose:
To investigate the feasibility of an online adaptive radiotherapy strategy to minimize the dosimetric variations due to internal and external anatomical changes in stereotactic radiosurgery (SRS) of L-spine tumors using Cone Beam CT and TMR ratio correction factors.

Methods:
11 L-spine SRS patients were selected for this study. Three coplanar treatment plans were made to deliver 16Gy to 90% of GTV in one fraction. 1) IMRT with 9 beams equally distributed around the patient, 2) IMRT with 9 posterior beams every 20 degree, 3) VMAT with 360 degrees full arcs. Dose was calculated with heterogeneity correction and collapsed cone convolution algorithm. Pre-treatment CBCT was registered to the planning CT with the vertebral body as the alignment focus. For each patient, the external body and bowel gas were contoured on the planning CT and CBCT. The contours on CBCT were transferred to CT after image registration. To estimate actual delivered dose while considering patient’s anatomy of the treatment day, the following density overrides were performed on the planning CT. To consider external anatomy change, the CBCT external that was outside of the planning CT external were assigned to density one and the CT external outside the CBCT external were assigned to density zero. To consider the internal anatomy change, bowel gas contour in the planning CT was assigned one and the bowel gas contour transferred from the CBCT was assigned to zero. Correction factors (CF) were calculated using the effective depth information obtained from the planning system: CF = TMR (delivery)/TMR (planning). The adaptive plan was generated by multiplying the planned Monitor Units with the CFs. The mean absolute differences (MAD) between planning and estimated delivery without adaptation (P-D) and with adaptation (P-A) for V16Gy of the target (percentage of target volume covered by 16Gy); for Dmax and V12Gy of Cauda were evaluated.

Results:
The MAD of V16Gy cauda-equina Dmax and V12Gy were reduced using adaptation for all three plans (the difference was not significant for IMRT with posterior beams except for the Dmax of Cauda) as shown in the table.

Conclusion:
The online adaptive strategy using correction factors based on TMR ratios calculated using pre-treatment CBCT information was feasible for the patient plans in this study. IMRT with all posterior beams benefited less from the adaptation compared to IMRT with uniform beam arrangement and VMAT plans.

<table>
<thead>
<tr>
<th>TUMOR (V16Gy)</th>
<th>Cauda (Dmax)</th>
<th>Cauda (V12Gy)</th>
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<tr>
<td>P-D (%)</td>
<td>P-A (%)</td>
<td>p</td>
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<tr>
<td>Posterior</td>
<td>1.8±1.4</td>
<td>0.9±1.1</td>
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<tr>
<td>Uniform</td>
<td>2.4±1.3</td>
<td>0.8±0.7</td>
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<td>VMAT</td>
<td>2.6±1.3</td>
<td>1.0±0.9</td>
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Dosimetric Comparison of Ruthenium 106 vs. Iodine 125 in the Treatment of Uveal Melanoma
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Purpose:
Previous studies have suggested a dosimetric advantage for Ruthenium 106 (Ru-106) versus COMS Iodine 125 (I-125) in patients with small to medium sized uveal melanoma (UM). The goal of this study was to assess and compare doses to critical structures (optic disc, macula, lens and sclera) within the eye in patients treated with Ru-106 versus I-125 eye plaques.

Methods:
Doses to the optic disc, macula, lens and sclera were calculated with both I-125 and Ru-106 in forty patients with primary UM. Patients selected for the study had tumors with median apex height of 2.6mm (R: 1.5-5.2mm) and median basal size of 10.3mm (R: 4.5-17.0mm). Plaque Simulator 6 was used to calculate doses to these critical structures throughout the eye. Ru-106 treatments plans were simulated using the BEBIG CCA, CCB, and CCD plaques, while I-125 plaques were simulated using varying COMS plaques. Comparisons of the doses to critical structures were then made between Ru-106 and I-125.

Results:
Dosimetric comparisons of Ru-106 vs I-125 showed that median dose was less to the optic disc, lens, macula, and sclera. Median dose to the optic disc was 5.02 Gy for Ru-106, compared to 20.54 Gy for I-125. The median doses to the lens were 0.02 Gy and 7.10 Gy for Ru-106 and I-125, respectively. The macula and sclera received a median dose of 6.58 Gy and 172.05 Gy, respectively, in Ru-106 treatment plans, and 21.65 Gy and 189.15 Gy, respectively, from I-125 treatment plans. In all cases dose to the tumor apexes were identical for I-125 and Ru-106.

Conclusion:
In patients with small to medium sized primary UM brachytherapy treatments using Ru-106 were found to be dosimetrically superior to the standard I-125 treatments. Due to Ru-106’s beta decay and relatively short range, Ru-106 is able to reduce dose to critical structures in the eye while maintaining the prescribed dose to a tumor’s apex. The results suggest Ru-106 is a practical option when treating select UM.
The Effect of CBCT Volume Cutoff on the Dose Calculation for Adaptive Planning
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**Purpose:**
To determine the effect of patient volume cutoff in CBCT images on dose calculations for adaptive treatment planning.

**Methods:**
Thirty consecutive prostate patients treated on an Elekta Synergy were included for this study, seven of these patients had external volume cutoff in their CBCTs. These patients were prescribed 70 Gy over 28 fractions via Volumetric Modulated Arc Therapy (VMAT). For two of the patients external contours were added to the original CTs. The external contours included the true external volume and some cutoff volumes, which were created to mimic the cutoff seen in the CBCTs. The CTs and contours were then loaded into Pinnacle, and a density override was used so that everything outside the given external contour would be air. The original treatment plans were re-calculated using these new contours. The following DVH parameters are compared to evaluate the change in dose due to the external cutoff: PTV D95; prostate minimum dose; bladder V63; rectum V63; left and right femur V30; and penile bulb mean dose (D95 is the dose covering 95% of the target, V63 is the volume of the organ receiving at least 63 Gy).

**Results:**
Seven out of thirty patients were affected by a volume cutoff in their CBCTs. These seven patients all had a 40 slice CT volume over 10,000 cc, where the other 23 patients that were not affected had a 40 slice CT volume under 10,000 cc. Of the seven patients affected by volume cutoff, in 75% of their CBCTs the volume cutoff was less than 700 cc, or 6% of the total volume. At this 6% change in volume the PTV D95 was 1.8% greater than that at the true external volume; the prostate minimum dose was 1.1% greater; the bladder V63 was 2.9% greater; the rectum V63 was 11.3%; left and right femur V30 were 9.9% greater and 3.3% greater, respectively; and the penile bulb mean dose was 1.4% greater. A smaller change in volume of 1.5%, or 170 cc, can be seen in 25% of those CBCTs and results in a dose that was 0.5% greater for the PTV D95; 0.3% prostate minimum does; 0.9% bladder V63; 3.5% rectum V63; 2.7% and 0.8% left and right femur V30, respectively; and 0.2% penile bulb mean dose.

**Conclusion:**
Initial results indicate that a volume above 10,000 cc for a 40 slice CT will create a cutoff in the CBCT of that patient, and that this cutoff will have <2% increase in target dose and up to 11% change in organ at risk dose.
Purpose:
The purpose of this study was to investigate the impact of scanning parameters and breathing patterns on the image quality and the accuracy of computed tumor trajectory for a commercial 4D-CBCT system (Elekta Symmetry, XVI R4.5; Elekta Oncology System Ltd, Crawley, UK), in preparation for its clinical implementation.

Methods:
We simulated a series of periodic and aperiodic sinusoidal breathing patterns with a respiratory motion phantom. The aperiodic pattern was created by varying the period or amplitude of individual sinusoidal breathing cycles. 4D-CBCT scans of the phantom were acquired with a manufacturer-supplied scanning sequence (4D-S-slow) and two in-house modified scanning sequences (4D-M-slow and 4D-M-fast). While 4D-S-slow used small field-of-view (FOV), partial rotation (200°) and no imaging filter, 4D-M-slow and 4D-M-fast used medium FOV, full rotation and the F1 filter. The scanning speed was doubled in 4D-M-fast (100°/min gantry rotation). The image quality of the 4D-CBCT scans was evaluated using contrast-to-noise ratio (CNR), signal-to-noise ratio (SNR) and motion blurring ratio (MBR). The trajectory of the moving target was reconstructed by registering each phase of the 4D-CBCT with a reference CT. The root-mean-squared-error (RMSE) analysis was used to quantify its accuracy.

Results:
Significant decrease in CNR and SNR from 3D-CBCT to 4D-CBCT was observed. The 4D-S-slow and 4D-M-fast scans had comparable image quality while the 4D-M-slow scans had better performance due to doubled projections. Both CNR and SNR decreased slightly as the breathing period increased while no dependence on the amplitude was observed. The difference of both CNR and SNR between periodic and aperiodic breathing patterns was insignificant (p>0.48). At end-exhale phases, the motion blurring was negligible for both periodic and aperiodic breathing patterns; at mid-inhale phase, the motion blurring increased as the period, the amplitude or the amount of cycle-to-cycle variation on amplitude increased. Overall, the accuracy of localizing the moving target in 4D-CBCT was within 2 mm under all studied cases. No difference in the RMSEs was noticed among the three scanning sequences.

Conclusion:
Discussion and Conclusion: The 4D-M-fast scans, free of volume truncation artifacts, exhibited comparable image quality and accuracy in tumor motion reconstruction as the 4D-S-slow scans with reduced imaging dose (0.60 cGy vs. 0.99 cGy) due to the use of faster gantry rotation and the F1 filter, suggesting its suitability for clinical use.
Validation of a Method for Characterizing Scanner-Specific Bowtie Filters in CT
Chris L. Liptak, Ashraf G. Morgan, Frank F. Dong, Andrew N. Primak, Xiang Li;
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Purpose:
In Monte Carlo simulations of patient dose from a CT scan, accurate knowledge of a CT system’s bowtie filtration is essential. This information, however, is often proprietary. Lately, a method was proposed for using a real-time dosimeter to quickly and efficiently characterize the shape and attenuation properties of a bowtie filter for use in Monte Carlo simulations. The purpose of this study was to perform the first validation of the proposed method in terms of the accuracy of the simulated phantom dose.

Methods:
A Monte Carlo program previously developed and validated for a clinical CT system (SOMATOM Definition Flash, Siemens Healthcare) was used. In this study, the program was extended to output dose as a function of time. A model of a CTDI\textsubscript{100} pencil ion chamber, capable of collecting real-time signals at a 1-kHz framerate, was created and placed at the periphery of the scanner’s field-of-view. Axial scans, which included several rotations, were simulated at five different tube voltages (70, 80, 100, 120, 140 kVp). The resulting real-time dose waveforms were recorded. The method proposed by Boone and termed, “characterization of bowtie relative attenuation (COBRA)”, was used to extract relative bowtie attenuation profiles from the dose waveforms. A basis decomposition technique was then used to reconstruct an equivalent model of the bowtie filter, assuming that it is made of a single material. This single-material equivalent bowtie was validated against the known two-material actual bowtie (information provided by the manufacturer) in terms of simulated in-phantom dose. A standard 32-cm CTDI phantom and a custom-designed elliptical phantom were used.

Results:
For 70 kVp, there was good to excellent agreement between the two bowtie models. The largest disagreement (-10.3%) occurred for the lateral hole locations of the elliptical phantom. For 120 kVp, there was excellent agreement between the two models. The largest disagreement (3.4%) occurred for the periphery hole locations of the CTDI phantom.

Conclusion:
This simulation study provided an independent validation that the equivalent bowtie model obtained using the COBRA method compares well with the actual bowtie filter in terms of simulated radiation dose in acrylic phantoms.
Relative Importance of the Various Factors Influencing the Accuracy of Monte Carlo Simulated CT Dose Index
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¹Cleveland State University, ²Cleveland Clinic, ³Siemens Medical Solutions USA, Inc.

Purpose:
Monte Carlo simulation is the most frequently used technique for assessing individual patient dose in CT. The accuracy of a Monte Carlo program is often validated using the standard CT dose index (CTDI) phantoms by comparing simulated and measured CTDI₁₀₀. To achieve good agreement, many input parameters in the simulation (e.g., effective beam width and bowtie filtration) need to be accurately determined. However, not all the parameters have equal importance. Our aim was to assess the relative importance of the various factors that influence the accuracy of simulated CTDI₁₀₀.

Methods:
A Monte Carlo program previously validated for a clinical CT system was used to simulate CTDI₁₀₀. For the standard CTDI phantoms (32 cm and 16 cm in diameter), CTDI₁₀₀ values from central and four peripheral locations at 70 and 120 kVp were first simulated using a set of reference input parameter values (treated as the truth). To emulate the situation in which the input parameter values used by the researcher may deviate from the truth, additional simulations were performed in which intentional errors were introduced into the input parameters, the effects of which on simulated CTDI₁₀₀ were analyzed.

Results:
Errors in effective beam width up to 5.0 mm showed negligible effects on simulated CTDI₁₀₀ (<1.0%). Likewise, errors in acrylic density of up to 0.01 g/cm³ resulted in small CTDI₁₀₀ errors (<2.5%). In contrast, errors in spectral HVL produced more significant effects: slight deviations (+/- 0.2 mm Al) resulted in errors up to 4.4%, whereas more extreme deviations (+/- 1.4 mm Al) produced errors as high as 25.9%. Lastly, ignoring the presence of the CT table introduced errors up to 13.9%.

Conclusion:
Monte Carlo simulated CTDI₁₀₀ is insensitive to errors in effective beam width and acrylic density. However, they are sensitive to errors in spectral HVL. To obtain accurate results, the presence of the CT table should not be ignored.
Educating Institutions on the Value of the Medical Physicist

Educational Objectives:
1. Discuss areas where the Medical Physicist can be recognized as adding value to the institution.
2. Review behaviors that enhance the recognition of the Medical Physicist by peers and senior leadership.

Brief Outline:

Where can/should the Medical Physicist be recognized?
- Risk Management
- Technology Decisions
- Quality Improvement
- Improving Safety
- Education and Cont Ed for team members
- Developing relations in the C-suite

How can/should the Medical Physicist improve their recognition?
- Professionalism
- Administrative Recognition
  - Budgeting
  - Supervision
- Attendance at Chart Rounds, New Patient Rounds, Tumor Boards
- Non-traditional venues
- Being more than a Medical Physics Assistant

Night-In with the President-Elect:
AAPM: Perspectives from the National Level

Outline and Objectives:
1. Review the current state of the AAPM
2. Discuss major AAPM initiatives for 2015/2016:
   - Public Communications, Governance Assessment, Strategic Plan Updating
3. Open discussion on how to recover from Position Elimination
Invited Speakers

Jeremy D. Donaghue, M.S.
Chief Medical Physicist
Akron General Medical Center
Akron, OH

The VALUE of Medical Physicists at a Community Medical Center

Objectives:
- Understand the importance of medical physicists
- Identify duties of physicists outside of those normally expected
- Introduce automation to relieve some pressures
- Exploit added time (from automation) to implement more in-depth checks in other areas

Outline:
- Physical presence: prostate implants, HDR, Gamma Knife, stereotactic
- General Knowledge
- Planning checks
- Automated monitoring
- Information systems support
- Technology management

D. Allan Wilkinson, Ph.D., FAAPM
Medical Physicist
Cleveland Clinic Foundation
Cleveland, OH

Launching and Sustaining Medical Physics Residency at the Cleveland Clinic

Outline and Objectives:
- History of medical physics residency at the Cleveland Clinic
- Details and statistics of current program
- Current efforts to establish joint Doctor of Medical Physics (DMP) degree program with Cleveland State University
Evolution and Current Status of Medical Physics Residency Training

Outline and Objectives:
- Review brief history of the changes in the entry to medical physics
- Understand current requirements for ABR certification
- Discuss current CAMPEP requirements
- Evaluate funding options to support residency programs
- Overview of University of Michigan experience with medical physics residency training

MR-Guided Brachytherapy

Outline and Objectives:
- Review traditional 2D technique for brachytherapy treatment planning
- Discuss transition to image-guided brachytherapy
- Review of GEC ESTRO recommendations
- Discuss clinical commissioning of MR-guided brachytherapy

The Value of MRI in Radiation Therapy

Objectives:
1. Imaging technique and protocol for staging cancers
2. Image interpretation and pitfalls
3. Role of imaging in treatment planning and assessment of treatment response
**Abstract:**
The AAPM Professional Liability Insurance program provides a unique ability for medical physicists to obtain liability coverage for risks arising from the practice of medical physics. In the near future, the program is expected to introduce a new occurrence-form coverage option which has important implications and differences from the existing claims-made coverage. Since both forms will be offered to new and renewing policy holders, the intricacies of these two options will be explained. A brief history of the program will be given to review the collaboration between AAPM and its insurance partners that established and maintain the program that is available today.

**Objectives:**
4. Gain understanding of the role of AAPM in operating the professional liability insurance program
5. Gain understanding of the professional liability insurance programs offered to AAPM members
6. Gain understanding of the difference between claims-made form and occurrence form of coverage

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**Lung Cancer Screening**

**Objectives:**
1. Become familiar with NLST and other lung cancer screening trials leading to the USPSTF’s recommendation
2. Become familiar with CMS guidelines for CT lung cancer screening
3. Understand the importance of smoking cessation as an integral part of the screening program
4. Become familiar with ACR requirements for a designated lung screening center
5. Set up a CT low dose lung screening protocol and track the dose
Objective:
1. To establish a feasible, MR-based approach for pseudo-CT generation

Outline:
- Acquiring informative MR data with a clinically acceptable scanning workflow
- Data correction for MR UTE imaging
- Data processing and analysis for pseudo-CT generation

Abstract:
Previous work has demonstrated the technical feasibility of dose calculation using MRI by manual contouring and assigning bulk densities or from various pseudo-CT generation schemes. These prior techniques, although technically feasible, are clinically impractical due to long MR acquisition times and lack of automated workflow. Herein, we used an undersampled single acquisition UTE-mDixon pulse sequence and unsupervised clustering methods to generate a clinically robust workflow for pseudo-CT generation. Dose calculations were then evaluated using a commercial treatment planning system. Seven patients were included under a prospective protocol approved by the University Hospitals Case Medical Center Institutional Review Board. All patients had a reference CT for attenuation correction and four data sets were generated for each patient and used for dose calculation: 1) the reference CT; 2) the pseudo-CT created from UTE-mDixon and unsupervised clustering; 3) a T2 image for manual contouring and bulk density assignment; and 4) the same reference CT image but with a homogenous density assignment. Both 3D and volumetric modulated arc therapy plans were generated for each image set using a Pinnacle Planning System with the Collapsed Cone Convolution algorithm. A treatment plan was created using the reference CT (i.e., reference approach). This plan was then transferred onto the three other methods and the dose was recalculated by keeping the same field parameters and monitor units. Dose point calculation and gamma index with criteria of 3%/3mm were used to evaluate the dose accuracy.