Joint Symposium Room: Monarch
Breast Cancer Imaging and Treatment

SA-A-Monarch-01
Radiation Therapy in the Management of Early Stage Breast Cancer
J Peterson[1] *, (1) Mayo Clinic, Jacksonville, FL

Approximately 200,000 women were diagnosed with breast cancer in the past year, representing one fourth of all cancers diagnosed in women. Radiation therapy plays a vital role in the treatment of breast cancer, particularly early stage breast cancer. Treatment of breast cancer comprises about 25% of the caseload in a typical radiation oncology practice.

Treatment of early stage breast cancer has evolved over the years from mastectomy to breast conserving therapy with lumpectomy and whole breast radiation therapy, which results in similar outcomes with improved cosmesis and conservation of the breast. Continued research has focused on advances in the technical delivery of radiation therapy and the development of partial breast radiotherapy.

This talk will focus on the treatment of early stage breast cancer with an emphasis on advances in treatment planning and partial breast radiotherapy.

Educational Objectives:
1. To discuss surgical options for early stage breast cancer
2. To understand the role of radiation in the treatment of early stage breast cancer
3. To demonstrate the technical aspects of radiotherapy planning
4. To review the rationale and patient selection for partial breast radiotherapy

SA-A-Monarch-02
An Introduction to Breast Cancer: Biology, Pathology, and the Latest in Screening and Diagnostic Tools
K Tzou, Mayo Clinic Jacksonville, Jacksonville, FL

Breast cancer is a highly prevalent disease among women. With the increased utilization of screening mammography since the 1980's, we have seen an increase in detection rates of earlier stage breast cancers. Due to earlier detection, increased awareness, improvements in screening, and improvements in therapy, breast cancer mortality rates have declined since the 1990's.

This talk reviews the evolving biology, pathology, and screening and diagnostic tools being used to help formulate optimal treatment plans for breast cancer patients today.

Educational Objectives:
1. To understand the epidemiology of breast cancer
2. To understand the risk factors, natural history, and histopathology of breast cancer
3. To learn the current guidelines for breast cancer screening
4. To understand mammographic findings significant for breast cancer
5. To understand when a Breast MRI is indicated

Young Investigator Poster Displays
Exhibit Hall

PO-YI-EXH-01
Effects of Optical density instability of Gafchromic EBT film on IMRT dosimetry
F Mckenna[1] *, I Ali[1] , S Ahmad[1] , (1) Department of Radiation Oncology, The University of Oklahoma Health Sciences Center, Oklahoma City, OK

Purpose: To investigate effect of optical density growth with time when using Gafchromic EBT film for IMRT QA verification. **Methods and Materials:** Several phantom plans were generated from actual IMRT patient plans. For each phantom plan, dose was calculated onto a phantom (30x30x20 cm3). Several Gafchromic films were exposed. A film placed at 10 cm depth was exposed to IMRT beams; and a second to step doses from 30 to 300 cGy to convert optical density to dose. These films were digitized using a Vidar Dosimetry Pro16 scanner. Film dose distributions calculated using RIT software, were compared to those from Eclipse treatment planning system. Dose difference and Gamma parameters were calculated. To investigate effect of OD growth, IMRT and calibrated films were scanned three times: 10 minutes, 75 hours and 150 hours post irradiation and early calibration films were associated with late IMRT and vise versa for evaluation. **Results**: IMRT film with synchronized calibration provides the best match (0% peak dose difference; <5% FWHM) with 2D dose distribution from Eclipse. Peak dose differences of 10% were observed from IMRT film with non-synchronized calibration. The gamma passing rate (DTA 5 mm; dose difference 5%) was > 95%, when IMRT films were synchronized with calibration films. **Conclusion**: A time difference between radiation exposure and digitization of IMRT and calibration films can cause dose difference between measured and calculation. We recommend that a patient filmed scanned X hours after exposure be calibrated with a step wedge that was scanned X hours after exposure.

PO-YI-EXH-02
A Computational Study of Intensity Modulation Radiation Therapy (IMRT) Treatments of Head and Neck, and Prostate Cancers.
A PYAKURYAL[1] *, (1) Northwestern Memorial Hospital / University of Illinois at Chicago, Chicago, IL

Purpose: The outcome of IMRT treatments for cancer can be evaluated by assessing the dose volume histograms (DVHs) for various targets and critical organs (ORGANs) in treatment plans. In-house built software called *Histogram Analysis in Radiation Therapy* (**HART**, Jang et al, 2008, Med Phys 35, p 2812) was utilized for DVH assessments, plan based indices (PIs) evaluations, dose response polynomial modeling (POLYMODELs), and the radiation toxicity analysis for various ORGANs. **Method and Materials:** Three to four different IMRT plans at various prescription doses range were simulated in Pinnacle^3 for treatments of twenty HN patients, and eleven PS patients at Northwestern Memorial Hospital. HART extracted DVH statistics were examined for each planning target volumes (ptvs) and ORGANs for the radiation toxicity analysis. PIs were statistically analyzed. Optimal POLYMODEL simulations and Fano-Factor evaluations were performed. The impacts of composite PD on tolerance dose (TD50) limitations on ORGAN complications were also analyzed. **Discussion and Conclusions**: A better correlation of dose volume coverage in targets was achieved. ORGANS were spared below their TD50. Mean PIs for all plans were also found to be in good agreement. Polynomial techniques can also be efficiently and precisely used to determine the dose response models for various ORGANs. Analyzed results for PS patients also showed more reliable treatment outcomes. We have demonstrated the efficiency, consistency and accuracy of the automated software, HART, in evaluation of the quality of IMRT plans and the dose response modeling of ORGANs utilizing precise DVH statistics extracted for a large number of patients.

PO-YI-EXH-03
Effects of Tissue Density on Organ Dose in Accelerated Partial Breast Electronic Brachytherapy
C Cheng , A Walters*, S Ahmad , The University of Oklahoma Health Sciences Center, Oklahoma City, OK

Purpose: To establish a model for organ dose calculation with tissue density correction for Accelerated Partial Breast Electronic Brachytherapy. **Materials and Methods:** The radial dose function for X-ray point source (S700 Axxent^{TM}) in a water phantom (30 x 30x 30 cm^3) was calculated using GEANT4 Monte Carlo code. An in-house semi spherical breast phantom (radius = 7.5 cm) with ICRU-44 tissue density and composition was used. Bone (1 cm thick) was imbedded in muscles (2 cm thick) followed by 5 cm thick lung. A source was placed 1.7 cm anterior to chest wall. To quantify organ doses of breast, skin, rib and lung, 34 Gy was prescribed to PTV. The

PTV covers tissue all around the balloon up to 1 cm away from balloon surface. Doses were calculated from the nipple to lung at 1mm interval. **Results:** Our simulated radial dose function agrees well with the commissioning data with <3% deviation. The simulated bone dose with tissue heterogeneity was 5.7 times higher than that without heterogeneity. This agrees well with expected prediction of $(Z_{eff}/Z_{water})^3$. The lung dose behind the bone was found < 5 Gy. Detailed results will be presented. **Conclusions:** This study provides the importance of utilizing tissue density correction in dose calculation for breast cancer treatment plan with low energy X-ray source. The unit density dose calculation underestimates rib dose by a factor of 5. To avoid possible normal tissue complication, dose calculation with tissue heterogeneity is recommended.

PO-YI-EXH-04

Effect of hadronic process differences on fluence distributions of particles generated from proton interactions in tissues - A GEANT4 Monte Carlo simulation

Y Chen[1] *, S Ahmad[1] , (1) , Department of Radiation Oncology, The University of Oklahoma Health Sciences Center, Oklahoma City, OK

Purpose: To simulate interaction of 250 MeV protons in tissues using GEANT4 (version 4.8.3) Monte Carlo code that utilizes electromagnetic and hadronic interactions to determine yield and the angular distributions of generated proton, neutron and photon for different hadronic processes. **Materials and Methods:** A cylindrical phantom (length=42 cm, diameter= 42 cm, ICRU 4-element soft tissue) was placed in vacuum. A spherical detector surrounding the phantom with radius = 100 cm was implemented. The number of generated proton, neutron, and photon crossing this detector was counted in 18 theta bins (ten degree each). The three Hadronic inelastic processes for proton were (1) low-energy parameterized nuclear inelastic; (2) binary cascade; (3) pre-compound (below 170 MeV) with a Bertini cascade (above 150 MeV). Common to all three processes were standard electromagnetic for gamma, electron and positron; low-energy parameterized electromagnetic for proton and ions; low-energy parameterized nuclear elastic scattering (G4LElastic) for proton and ions; and low energy parameterized inelastic for ions. The elastic and inelastic processes for neutrons with energy greater than 4 eV (G4NeutronHPorLEModel) and lower than 4 eV (G4NeutronHPThermalScattering Data in library G4NDL3.1) were used for computation. **Results:** The total number of generated proton, neutron and photon per incident proton was 0.0059, 0.389, 0.39 for hadronic process (1); 0.0027, 0.208, 0.57 for process (2); and 0.0023, 0.158, 0.72 for process (3), respectively. The three normalized fluence angular distributions for proton, neutron and photon will be presented. **Conclusions:** Careful selection of hadronic process in simulations plays a vital role for secondary particle generation.

Therapy Symposium — Room: Monarch

Challenges for Advanced IGRT

SA-C-Monarch-01

CBCT technology for RT: Present and Future.

W Song[1] *, (1) University of California, San Diego, La Jolla, CA

The use of in-room cone-beam computed tomography (CBCT) for patient visualization and alignment has recently revolutionized the field of radiation therapy and has now become part of the treatment routine for many disease sites. The ability to visualize the three dimensional soft-tissue volume at treatment setup has allowed a wide range of image-guided adaptive radiotherapy (IGART) techniques to be feasible, the least of which is to reduce the set-up errors and allow subsequent increase in dose prescription for better tumor control.

There are many issues of interest for CBCT that needs discussion and can be categorized into three main classes: 1) optimal clinical use of CBCT, 2) technical characteristics of CBCT and its limitations, and 3) quality assurance. Each of the topics will be discussed in detail and an attempt will be made to connect and summarize the issues in a meaningful and sensible way.

This lecture will provide an overview of the current clinical applications of CBCT, its limitations and characteristics, research developments, and QA issues.

Educational Objectives:

1. Understand the current state-of-the-art and limitations of CBCT technology
2. Applications of CBCT for IGART
3. Understand the quality assurance issues of CBCT

SA-C-Monarch-02

External Surrogate Measurement and Internal Target Motion: Photogrammetry as a Tool in IGRT

T Waldron*, University of Iowa Hospital & Clinics, Iowa City, IA

Guidance by radiographic imagery provides highly accurate and reproducible localization in the management of patient setup and motion in Radiation Oncology, but continuous fluoroscopy results in undesirable radiation dose to healthy tissues. A growing number of specialized products have evolved whose function is to facilitate non-radiographic/noninvasive setup and motion management of the patient on the treatment table. Most of these systems utilize photogrammetry to monitor the position of some external feature or surrogate as an indicator of target or tumor position. Several basic technologies in use include infrared illumination, visible speckle projection, and laser line projection as a means of measurement. Users and potential users should be aware of their practical advantages and limitations in clinical use.

This lecture will provide an overview of fundamental concepts of stereo projection imaging and pattern projection photogrammetry. Some systems in clinical use will be briefly described.

Educational Objectives:

1. Gain understanding of the underlying fundamental principles of concepts of photogrammetry as applied to currently available clinical equipment.
2. Understand some of the practical aspects of utilizing photonic surrogate position and motion sensors in the Radiation Oncology clinic.
3. Acquire knowledge of basic operating principles of currently-available systems as relevant to the practicing physicist.

SA-C-Monarch-03

Feasibility of 4D IMRT Delivery for Hypofractionated High Dose Partial Prostate Treatments

R Price[1] *, J Li[2] , A Pollack[3] , L Jin[4] , E horwitz[5] , M Buyyounouski[6] , C Ma[7] , (1) Fox Chase Cancer Center, Philadelphia, PA, (2) Fox Chase Cancer Center, Philadelphia, PA, (3) University of Miami Miller School of Medicine, Miami, Florida, (4) Fox Chase Cancer Center, Philadelphia, Pennsylvania, (5) Fox Chase Cancer Center, Philadelphia, PA, (6) Fox Chase Cancer Center, Philadelphia, PA, (7) Fox Chase Cancer Center, Philadelphia, PA

While IMRT is proving to be effective in the treatment of prostate cancer there remains room for improvement. Specifically, dose escalation to areas of the prostate demonstrating high clonogenic cell density may improve treatment outcome. These partial prostate target areas may be found through MR spectroscopy or direct biopsy. However, the surrounding normal structures and the movement of the prostate during treatment limit the dose that can be delivered safely.

An in-house protocol is being developed in which 76 Gy in 38 fractions is delivered to the entire prostate PTV via IMRT. An IMRT boost to the high disease density region(s) is then delivered in a single 10 Gy fraction that brings the dose to a biological equivalent of 106 Gy. Isoeffective dose calculations (EQD_2) were employed to determine the boost dose. Composite plans were generated assuming 2 Gy fractions for the entire treatment. Additionally, EQD_2 calculations were performed and composite plans generated for cumulative rectal dose. DVH and isodose analysis is performed and comparisons made with our routine acceptance criteria. In order to meet these criteria it is necessary to reduce the PTV margins from our standard 8mm (5mm posteriorly) to uniform 3mm expansions. This is not possible using daily localization techniques and active tracking is employed throughout using implanted Calypso Beacons. This allows for a decrease in the PTV margins for the initial prostate and boost IMRT regimes and subsequent increased rectal sparing.

However, simple Cartesian intrafractional motion is not the only source of discrepancy involved when determining the appropriate PTV expansion. Other sources of error such as target rotation and deformation may play significant roles requiring correction if margins are to be reduced to 3mm.

This lecture will describe a method to limit the dose to critical structures, namely the rectum, during routine IMRT delivery to the prostate allowing for a dose escalated boost to be delivered to the areas in need. Additionally, sources of error encountered through our clinical use of the Calypso Beacons and the ramifications for PTV reduction by utilizing active tracking will be discussed.

Educational Objectives:
1. To be exposed to advanced IGRT methods (MRS) utilized in the planning process.
2. To understand issues related to combining hypofractionated "boost" plans to conventional IMRT plans.
3. To understand active organ tracking and the implications for target coverage and normal tissue sparing through PTV reductions.

Mammography Symposium Room: Sandler Center
Mammography Present Practices

SA-C-Sandler-01
Breast Imaging: Now and the Future
J Harvey[1] *, (1) University of Virginia

Breast cancer mortality is declining in the United States, largely due to mammographic screening. However, mammography is limited in sensitivity for women with dense breast tissue. Women that are at high risk for breast cancer due to genetic susceptibility may benefit from screening MRI. This modality is less well validated for other breast cancer risk factors, such as LCIS, personal history of breast cancer, and dense breast tissue. In addition, MRI may be less cost-effective for women that are not at very high risk for breast cancer due to lower pre-test probability of disease and increased false-positive studies. Emerging technologies, such as breast specific gamma imaging and positron emission mammography may be more cost-effective for ancillary screening of women at moderate risk for breast cancer. CT and tomosynthesis may result in improved specificity and possibly improvement in sensitivity over conventional mammography. In summary, recommendations for screening in the future will likely be driven by individual risk assessment, with high risk women receiving the most intensive screening, moderate risk women receiving moderate screening, and low risk women continuing with mammography or CT/tomosynthesis.

Educational Objectives:
1. Understand how to modify screening strategies based on lifetime breast cancer risk
2. Understand the role of MRI in breast cancer screening
3. Describe the emerging role of screening US, tomosynthesis, CT, scintigraphy, and PET in breast imaging

SA-C-Sandler-02
Mammography: Basic Physics
C Wilson, Medical College of Wisconsin, Milwaukee, WI

This presentation is a review of the physics underlying film screen mammography. While x-rays have been used for over a century tor produce diagnostic radiographic images mammography has been used clinically for less than forty years. Physical factors that influence image quality in mammography will be covered in this presentation. Topics to be covered are x-ray generation, the appropriate choices of target and filter materials, the function of screen-film mammographic receptors, dedicated x-ray mammography units, scatter reduction and breast compression, automatic exposure control, viewing conditions, dose and screen-film quality control.

Educational Objectives:
1. Understand the multiple factors that affect the acquisition and image quality of screen-film mammography images.
2. Understand the need for and methods of quality control for screen-film mammography.

SA-C-Sandler-03
Mammography: Dosimetry
L. Rothenberg*, Memorial Sloan-Kettering Cancer Center, New York, NY

Mammography dosimetry is performed for several reasons: (a) to evaluate the risk to the patient, an important consideration in benefit-risk analysis of screening of asymptomatic women; (b) to compare the risks of competing imaging techniques; (c) to assess the performance of mammographic equipment during acceptance and quality control testing; (d) to answer questions concerning dose from patients and staff; and (e) to comply with requirements and guidelines from regulatory and accrediting agencies. Several dose and exposure parameters will be reviewed with emphasis being placed on the mean glandular dose as the best estimator of patient risk. The many factors which can affect dose will be discussed and methods to obtain optimum images with minimum dose will be presented. Finally, results of nationwide surveys of mammography dose will be reviewed.

Therapy Symposium Room: Monarch
New Developments in SBRT

SA-D-Monarch-01
Patterns of failure seen in the SBRT treatment of paraspinal disease
D Lovelock[1] *, (1) Memorial Sloan-Kettering Cancer Center, New York, NY

The use of high-dose single-fraction and hypo-fractionated treatments for metastatic disease and re-treatment of tumors that have progressed after prior irradiation is an emerging treatment modality. Local control rates from 80% to 90% have been reported. Complications such as esophageal stricture and radiation myelitis of the spinal cord have had low incidence. Vertebral fracture is more prevalent but it readily managed using minimally invasive surgical procedures such a vertebroplasty or kyphoplasty. The prescription doses and fractionation schemes vary. Limiting factors on the dose that can be delivered are the normal tissue tolerances of structures such as the spinal cord and esophagus. One approach to examining the sufficiency of the dose prescription is to examine the patterns of failure. We have analyzed the dose distributions of 91 consecutive single-fraction treatments. Correlations between local failure and the minimum target dose and other measures of dose insufficiency will be presented. The volumes associated with tumor progression seen in post-treatment MR scans have been delineated identified by a radiologist. This was done for patients undergoing single fraction treatment to previously un-irradiated sites, and to patients undergoing 5 fraction treatments to sites of previous radiation treatment. The spatial characteristics of the failure volumes and their relationship with the target volumes will be presented.

SA-D-Monarch-02
Treatment Planning for CyberKnife Radiosurgery
M Witten*, Winthrop-University Hospital, Mineola, NY

The CyberKnife® (Accuray, Inc., Sunnyvale, CA, USA) allows the delivery of robotic stereotactic radiosurgical treatments with a total clinical accuracy of less than a millimeter for stationary targets, and less than three millimeters for targets undergoing intra-fraction excursion. The system consists of a six-jointed robot (KUKA Roboter, Augsburg, DE), a compact 6 MV 9.5 GHz X-band linear accelerator as an end effector, a treatment couch capable of motion in five degrees of freedom (three translational, roll, pitch, but manual yaw), two ceiling-mounted kV x-ray sources, two amorphous silicon detectors, and various subsystems. The introduction of the RoboCouch® (Accuray, Inc.) has provided a patient support assembly capable of motion in six degrees of freedom.

Treatment planning is performed using MultiPlan® (Accuray, Inc.), a proprietary treatment planning system that has undergone much revision in the past few years. Treatment plans typically involve the delivery of 100-200 beams, using 1-3 fixed circular collimators, which range in size from 5-60 millimeters; however, it should be noted that some CyberKnife centers have upgraded to an iris variable collimator, thus obviating the need to change the collimators during treatment. Beams are delivered from fixed points in space called nodes. Node sets are arranged in either spherical (for intracranial treatments) or ellipsoidal (for extracranial treatments) configurations. The nominal SAD is fixed at 800 mm for intracranial treatments, and ranges from 900 mm to 1000 mm for body treatments. Treatment planning consists of the generation of candidate beams via targeting of the planning target volume (PTV) using random point placement within the PTV contour set, beam reduction and beam weight optimization through inverse planning, and plan evaluation of the resulting isodose distribution and dose-volume histograms (DVHs).

Dose calculation was implemented in early versions of MultiPlan® with simple ray tracing without contour correction, but subsequent releases have added contour correction as well as a parallel Monte Carlo engine. A simplex

linear programming algorithm was the early preferred method of performing beam weight optimization, and an iterative algorithm introduced in later versions of the treatment planning software provided a second option, but it remains underdeveloped. The most current version of MultiPlan® features a completely redesigned inverse planning algorithm, which implements sequential multi-objective optimization. At no point in development has the ability to apply dose-volume constraints to critical organs been implemented. Instead, the user can only specify maximum doses to critical organs, or, in the latest version, the allowed mean doses to critical organs.

Treatment planning strategies usually involve the creation of tuning structures to shape the isodose distribution, with the addition of manual constraint points to address unwanted bleeding of the isodsoses. Typical CyberKnife® SBRT sites are prostate, lung, pancreas, and spine.

Educational Objectives:
1. Understand the CyberKnife® treatment delivery system.
2. Understand the MultiPlan® treatment planning system and its limitations.
3. Understand the basic approach to treatment planning for CyberKnife® cases.

SA-D-Monarch-03

Clinical experience and recent developments in the SBRT of lung cancer

P Balter[1] *, (1) University of Texas M.D. Anderson Cancer Center, Houston, TX

Image-guided hypofractionated external beam radiotherapy, often referred to as stereotactic body radiation therapy (SBRT) has become the standard of care for small inoperable lung lesions in the past few years. The excellent success of this technique has spawned trials comparing outcomes of SBRT to surgery. At MDACC we have been performing SBRT treatments for inoperable lung lesions for the past 5 years, first using an in-room CT-on-rails system and then using a Varian OBI unit with CBCT. Patients are planned using 4DCT or breath-hold CT and treated either free breathing or during a breath-hold. All patients are planned on Pinnacle using CT-based heterogeneity corrections. We do not use IMRT but do allow EDW. This presentation will discuss the imaging, planning, and treatment techniques for SBRT using both the CT-on-rails and CBCT-based setup as well as compare free breathing vs. breath hold treatment techniques.

Educational Objectives:
1. To understand how SBRT is different from conventionally fractionated radiation therapy.
2. To understand the challenges in treating thoracic tumors with SBRT.
3. To understand the strengths and weakness of different in-room setup techniques.
4. To understand the strengths and weakness of different respiratory management techniques.

The author of this presentation receives finical support through sponsored research agreements with Philips and Accuray. The author's institution receives financial support through a master research agreement from Varian. Equipment from all of these vendors will be mentioned in this presentation.

Mammography Symposium Room: Sandler Center

Digital Mammography

SA-D-Sandler-01

QC of Digital Systems

M Martin[1], Therapy Physics Inc., Gardena, CA

The requirements for Medical Physics testing of Full Field Digital Mammography (FFDM) Units is currently covered by the Mammography Quality Standards Act as administered by the FDA and recognized accrediting bodies. Some tests are uniform for all manufacturers while several of the units have specific tests for each particular manufacturer with limits specific to that model. These uniform and specific tests of the major manufacturers of FFDM units will be covered in detail in this presentation. Limits as established by each manufacturer and accepted by the FDA and the accrediting bodies will be discussed for each unit. The actual number of tests required for the medical physicists and the Quality Assurance Program that must be followed by the technologists are unique for each brand and type of equipment. Both Direct FFDM and CR FFDM units will be covered in this discussion.

The recommended frequency of testing and specific requirements as established by each vendor will be discussed with suggested methods to be used for each of the required tests. Sample reports for each unit will be shown along with the required summary pages that must be used to report the physicists test results. Expected results for image quality and mid-glandular dose will be given and discussed relative to each type of FFDM unit.

Educational Objectives:
1. Attendees will be aware of the image quality requirements for each of the FFDM units that are currently in use in the United States.
2. Attendees will be aware of the patient mid-glandular dose limits for FFDM units.
3. Attendees will be familiar with the required physicists tests and methods to perform these for each type of FFDM unit.

SA-D-Sandler-02

Artifacts in Digital Mammography

W Geiser[1] *, G Whitman[2] , T Haygood[3] , L Santiago[4] , T Stephens[5] , D Thames[6] , (1) M.D. Anderson Cancer Center, Houston, Texas, (2) M.D. Anderson Cancer Center, Houston, Texas, (3) M.D. Anderson Cancer Center, Houston, Texas, (4) M.D. Anderson Cancer Center, Houston, Texas, (5) M.D. Anderson Cancer Center, Houston, Texas, (6) M.D. Anderson Cancer Center, Houston, Texas

Screen film mammography is the gold standard for breast cancer screening. However, digital mammography is taking over as the modality of choice for performing mammography. Early detection of breast cancer is directly related to the mammographer's ability to detect abnormalities visible on mammograms. Artifacts on digital mammograms reduce image quality and may present clinical and technical difficulties for the mammographer, mammography technologist, medical physicist, and for equipment service personnel. Factors that create artifacts in digital mammography may be related to problems with the digital detector array, the mammographic unit assembly, the image storage system and processing or may be patient related. Being able to recognize these artifacts improves the quality of mammographic interpretation and prevents characterization of artifacts as real breast pathology.

All facilities that perform digital mammography are required to implement a quality control program based on manufacturers recommendations for their equipment that have been approved by the FDA in order to meet American College of Radiology criteria for accreditation.

The objective of this presentation is to recognize artifacts in digital mammography to avoid mistaking artifacts for real breast pathology and to improve the quality of mammographic interpretation.

Educational Objectives:
1. Recognize common artifacts in digital mammography.
2. Avoid mistaking artifacts for real breast pathology.
3. Know how to correct for the artifact and improve the quality of mammographic interpretation.

SA-D-Sandler-03

New X-ray tube Technology in Digital Mammography

M Flynn

No abstract provided.

Therapy Symposium Room: Monarch

Electronic Brachytherapy

SA-F-Monarch-01

Electronic Brachytherapy QA

J Hiatt[1] *, (1) Rhode Island Hospital, Providence, RI

Electronic Brachytherapy (EB) is internal radiation therapy that involves placing a miniature x-ray source inside the patient close to or in the tumor. Recently, one EB system (Axxent, Xoft Inc., Sunnyvale, CA) has been released for clinical use. Because of its novelty, EB has been relatively unstudied thus far in the clinical setting and is consequently unfamiliar to

many medical physicists. The EB modality offers several advantages over the Ir-192 standard of care HDR brachytherapy source. Because of the relatively low energy of the EB device (50 kV), treatments can be delivered in an unshielded room in contrast to the shielding required for HDR brachytherapy. The low external exposure rate also allows staff to remain near the treatment couch during dose delivery, offering the opportunity to provide comfort and encouragement in close proximity to the patient.

Although EB is not under jurisdiction of the NRC and currently does not have AAPM published quality assurance (QA) recommendations, upon acquiring an EB system, it is the responsibility of the physicist to ensure the system is and remains safe for the treatment of patients. Commissioning an EB system should include tests of well-chamber constancy, beam stability, source positional accuracy, output stability, timer linearity, dummy marker/source position coincidence, controller functionality and safety interlocks and treatment planning data verification following AAPM TG56 recommendations. An EB system should be treated as an HDR remote afterloader with robust and rigorous daily, monthly and annual QA procedures.

This lecture will provide an overview of EB, describe a commissioning procedure, and detail routine QA tests.

Educational Objectives:
1. Gain basic knowledge of EB as a potential HDR-alternative treatment modality
2. Learn a proposed commissioning protocol for an EB system
3. Gather an understanding of routine EB QA procedures

Conflict of Interest: Partial financial support was provided by Xoft, Inc.

SA-F-Monarch-02

Electronic Brachytherapy Sources

T Rusch[1] *, (1) Xoft Inc., Sunnyvale , CA

Electronic brachytherapy (eBx) is a treatment modality in which a miniature x-ray source is used to provide intracavitary or interstitial radiation therapy. The Xoft Axxent® source operating at 50 kVp and 0.3 mA beam current has a depth-dose characteristic which is essentially equivalent to ^{125}I with a dose rate equivalent to a 7 Ci ^{192}Ir source. Because the source emits relatively low energy x-rays and contains no radionuclides, shielding requirements are modest and it can be used in a wide variety of treatment facilities. To date eBx has been used for accelerated partial breast irradiation using a balloon applicator placed in a lumpectomy cavity, vaginal cuff irradiation using a rigid vaginal cylinder, and intraoperative radiation therapy following breast conserving surgery.

The Axxent electronic brachytherapy source is a miniature diode x-ray source attached to a flexible high voltage cable and enclosed in a catheter which contains recirculating cooling water. Prior to treatment delivery, the source air kerma strength is measured using a well ionization chamber calibrated with respect to the Attix free air chamber at the University of Wisconsin Medical Radiation Research Laboratory. The spatial distribution of dose from the source is characterized by the TG-43 parameters radial dose function and anisotropy function. These were determined by Monte Carlo simulation, radiochromic film dosimetry and miniature ion chamber measurements in a water phantom. Treatment planning for the eBx source is performed using either the Varian BrachyVision® or the Nucletron Plato® treatment planning system.

The final stages of the source manufacturing process include measurements of a) the spatial characteristics of azimuthal symmetry, polar anisotropy and depth-dose; and b) the x-ray output reproducibility and stability during repeated on-off cycling and an extended operating period. Automated software runs the tests, analyzes and evaluates the results, and produces printed reports that form part of the permanent history for each source. This manufacturing testing of every source ensures that those accepted for human use will be stable, and have spatial output characteristics consistent with the values used for treatment planning within error limits established to ensure accurate dose delivery.

Educational Objectives:
1. Understand key elements of electronic brachytherapy source construction and operation.
2. Understand the rationale and methodology of air kerma strength calibration.
3. Understand methods to characterize and confirm the source spatial dose distribution.

SA-F-Monarch-03

The Biology of 50KV EBT vs Ir-192 HDR for Vaginal Cylinder Gyn Brachytherapy

C Orton, Wayne State University, Detroit, MI

Due to the lower energy of 50kV electronic brachytherapy (EB) radiation compared with that of Ir-192, the biological effectiveness of EB is greater than that of conventional brachytherapy. This is because the average LET of the electrons released by the 50 kV x rays is higher, leading to an increase in the yield of DNA double strand breaks, which are lethal. In terms of the α and β parameters of the linear-quadratic (L-Q) model, this means an increase in the α (irreparable damage) component with EB. In contrast, the β (reparable damage) component is not affected by the LET and hence remains unchanged. The ratio of the α's for EB and Ir-192 radiations gives the relative biological effectiveness (RBE) of the EB radiation compared to that of Ir-192 *for very small doses*. This is known as the RBE_{max}. Values of RBE_{max} given in the literature are of the order of 1.4 – 1.5 but it will be shown that this grossly overemphasizes the biological effectiveness of EB radiation for doses used in clinical practice. For doses/fraction of 7 Gy, the L-Q model predicts that the RBE for cancers should be about 1.17, whereas, for late-reacting normal tissues it is only about 1.07. Hence, for a constant effect on late-reacting normal tissues, there is a potential 10% increase in biological effectiveness in terms of tumor damage. We ought to be able to exploit this "therapeutic advantage" of electronic brachytherapy. According to the L-Q model, it should be possible to reduce the dose when converting from Ir-192 based brachytherapy to EB by about 7%, yet increase the effect on tumors by about 10% without increasing the risk of late-reacting normal tissue damage. Should the dose be reduced by about 7% for these treatments, therefore? Not necessarily because, if late-reacting normal tissue tolerance is the limiting factor on the dose that can be safely delivered, the increase in *bioeffective* dose for late-reacting normal tissues if the prescribed dose were not reduced would be only about 7%, which is far less than the reduction in *physical* dose to surrounding normal tissues with the less penetrating EB radiation.

A second potential advantage of EB over Ir-192 relates to the O_2 effect. The higher the LET of the radiation the lower the protection offered by hypoxia. Since many cancers are known to contain hypoxic cells which decrease radiation sensitivity, the higher-LET EB radiation ought to exhibit an advantage for these cancers.

For the treatment of endometrial cancers using vaginal cylinders, however, both these advantages are just "theoretical" unless proven by clinical trials since the L-Q model is just an approximation, and the presence of hypoxic cells in these cancers has not yet been demonstrated or shown to effect outcome.

Educational Objectives:
1. Understand why EB radiation has a higher biological effectiveness than Ir-192 gamma rays.
2. Understand how the linear-quadratic model can be used to estimate the RBE of EB at doses/fraction used clinically.
3. Understand why EB might exhibit some biological advantages over conventional brachytherapy.

Mammography Symposium Room: Sandler Center

Advances in Breast Imaging

SA-F-Sandler-01

Breast Tomosynthesis

A Smith[1] *, T Wu[1], Hologic Inc., Bedford MA

The ACRIN/DMIST trial showed that digital mammography and screen-film mammography had similar clinical performance, with digital being superior in dense breasts and pre- and peri-menopausal women. Tomosynthesis offers the potential for a significant improvement over both digital and analog mammography in cancer detection and recall rates.

Tomosynthesis is not yet FDA approved, but is available clinically outside the US and is being investigated in the US in research settings. This lecture shall cover the clinical status and applications of tomosynthesis, and also review clinical trial results.

Educational Objectives:
1. Understand the motivations for the use of breast tomosynthesis
2. Understand how tomosynthesis will be used clinically.
3. Understand the clinical trial results of breast tomosynthesis

Disclosure: Andy Smith is an employee of Hologic, Inc.

SA-F-Sandler-02

CT Imaging of the Breast with a Novel New System

J Neugebauer[1] *, (1) Koning Corporation, West Henrietta, New York

Historically, the use of Computed Tomography for imaging breast tissue in the USA has been relegated to determining local/ regional breast cancer recurrence and extent of disease. The primary reasons for its' lack of use in the detection and diagnosis of breast cancer have been identified as inferior image quality, high radiation dose, inability to cover the entire breast and difficult patient positioning.

In 1975, a custom designed CT for Breast was developed by General Electric and underwent extensive clinical study at the Mayo Clinic and the University of Kansas Medical Center. While initial results were most promising, the product never came to market due to high dose, poor resolution and use of IV Contrast. As such, mammography has grown to be the gold standard in breast imaging.

In the mid 1990s', research in Cone beam CT for breast imaging was underway at UC Davis and University of Rochester Medical Center. Prototypes of dedicated Cone Beam CT Scanners for the breast have been developed at both institutions with more than favorable results compared to mammography in radiation dose, coverage of the breast tissue and image quality.

With multislice/ multiplaner and 3D capability, Cone Beam CT surpasses 2D projection imaging as a viable diagnostic tool and has the potential to become a commercial success.

This lecture will present the clinical results of an dedicated Cone Beam CT for breast imaging and it's comparison to digital mammography.

Educational Objectives:
1. Understand the current use of CT in Breast Imaging and its limitations
2. Understand the development history of CT imaging of the breast.
3. Understand the diagnostic value and capabilities of a modern dedicated Cone Beam CT for Breast Imaging.

Therapy Symposium — Room: Monarch
Advances in Arc Therapy

SU-A-Monarch-01
Advances in arc therapy
C Yu[2] *, (1) Univ Maryland School of Medicine, Baltimore, MD, (2) Univ Maryland School of Medicine, Baltimore, MD

Intensity modulated arc therapy (IMAT) was proposed in 1995 by Yu as an alternative to Tomotherapy. Due to the lack of an efficient planning algorithm, wide clinical adoption of IMAT as a major form of radiation treatment delivery did not happen until a 2007 when multiple new planning methods were developed and commercial interests in IMAT were intensified due to competition. Specifically, a commercial product, RapidArc, based on the Volumetric Modulated Art Therapy (VMAT) developed by Otto, was developed and marketed by Varian in 2007. VMAT is a single arc form of IMAT that delivers apertures of varying weightings with a single arc rotation. The intense commercial promotion and fast clinical adoption caused much confusion and controversy. There is a lack of a general understanding of how such arc treatments are planned, and what delivery limitations and compromises are made. It is therefore the purpose of this presentation to provide a summary of this technology and some guidelines on its clinical implementation.

A historical review of all the works leading to the wide clinical adoption will be provided. Different planning methods will be described by a companion presentation in the same session. Issues related to clinical implementations, including commissioning and quality assurance will also be described. We will also hope to provide some perspectives on its further development in the context of increased clinical use of image guidance. Because there has been vast experience in IMRT using multiple intensity modulated fields, comparisons between IMAT and IMRT will also be made in the review to illustrate its advantages and limitation in the areas of planning, delivery and quality assurance.

SU-A-Monarch-02
Planning Methods for Rotational IMRT on Linear Accelerators
M Earl[1] *, (1) Univ. of Maryland School of Medicine, Glen Burnie, MD

The process and concept for rotational IMRT (R-IMRT) planning are similar to that of fixed-field IMRT. However, the increased complexity of a R-IMRT plan makes it significantly more computationally difficult to plan. The main differences are the increased number of beams used in the optimization and the consideration of interconnectivity of beam apertures in leaf sequencing. These obstacles have slowed the clinical implementation of R-IMRT despite its clinical advantages.

Within the past few years, planning methods for R-IMRT have attracted great interest in the radiation oncology community in order to exploit its significant clinical advantages. The two fundamental methods for R-IMRT planning parallel that of fixed-field IMRT: a two-step approach (utilizing optimization and leaf sequencing) and an aperture based approach. With the two-step approach, the optimization does not differ much from fixed-field IMRT, where static beams are defined and fluences subsequently optimized for each beam angle. However, the leaf-sequencing aspect is significantly more complicated due to the interconnectedness of the apertures within an arc. The physical limits of the linear accelerator and dosimetric differences between discrete and continuous leaf movement limit the distance leaves can travel between adjacent beam angles within an arc. For aperture based approaches, these limits are typically included in the optimization itself.

The first conceptualization of R-IMRT, intensity modulated arc therapy (IMAT), was proposed by Yu as a series of overlapping arcs, whereby the linac gantry rotates multiple times about the patient. Overlapping arcs produce intensity modulation at any given beam angle. While multi-arc IMAT has considerable dosimetric advantages, delivering R-IMRT plans in a single gantry rotation has drawn much attention recently primarily due to the extremely fast delivery times. Commercial applications have been developed for the planning and delivery of single-arc R-IMRT plans, most notably RapidArc from Varian.

An overview of current planning techniques for both multiple-arc and single-arc R-IMRT will be given. Particular attention will be paid to the delivery limitations and the associated challenges in planning will be discussed. Both aperture based and leaf-sequencing techniques, along with their benefits and drawbacks will be examined.

Diagnostic Symposium — Room: Sandler Center
Vascular Imaging

SU-A-Sandler-01
Physics and applications for imaging vascular disease
D Hintenlang, University of Florida, Gainesville, FL

Vascular Imaging includes a wide variety of imaging modalities applied to an even wider variety of vascular diseases related diagnostic examinations and procedures. The most recent statistics indicate that 34.2% of deaths in the United States can be attributed to cardiovascular disease (CVD) and that in excess of 4 million in-patient CVD associated procedures utilizing x-ray imaging are performed in the US annually. Vascular imaging applications have evolved from some of the earliest x-ray experiments performed by Roentgen to sophisticated 4-dimensional modalities that are being introduced clinically. A review of the vascular anatomy and diseases related to the current clinical applications is presented along with an overview of vascular imaging procedures and objectives. The capabilities of major vascular imaging modalities including ultrasound, MR, CT, PET, SPECT and traditional x-ray angiography are presented along with general predictions of future capabilities and applications of these systems.

While many new technologies provide promising capabilities, technological developments in x-ray angiography permit this traditional “gold standard” to provide flexible and continued applications for a number of invasive procedures. Many of these improvements are the result of improved detector elements which can provide high resolution and potentially lower patient dose, but when integrated into large area flat panel detectors may result in net a increase in dose from scattered radiation to medical staff and patients. Recent trends in technology and performance of these systems is discussed along with the increased clinical capabilities associated with improved visualization of arterial walls and structure. Future benefits of vessel visualization and details of plaque detail and differentiation are presented in the context of the next generation of vascular imaging techniques.

Ultrasound provides a non-ionizing and low cost alternative for the vascular imaging of localized regions of the body. For arteries located relatively near the surface of the body, ultrasound can provide dynamic anatomical imaging and quantitative flow measurements based on spectral Doppler analysis. Technological advances in ultrasound provide additional prospects for minimizing operator-dependent variations in exam quality and the potential to further differentiate plaques for improved diagnosis.

Educational Objectives:
1. Understand the vascular anatomy and examples of diseases relevant to diagnosis through vascular imaging.
2. Understand the unique imaging requirements, and how they are achieved, for technologies applicable to diagnosing and treating cardiovascular disease.
3. Understand the physical principles and technological advances in ultrasound applications in vascular imaging.
4. Understand the physical principles and technological advances in fluoroscopic applications in vascular imaging.

SU-A-Sandler-02

Credentialing of cardiologists and other non-radiologists for Fluoroscopy and CT

M Martin[1] *, Therapy Physics Inc., Gardena, CA

Developing a fluoroscopy credentialing program for non-radiologists involves more than the content of the didactic component. Establishing a program requires formal support by facility management and acceptance by the medical staff. The medical physicist will need to address the process with administration and provide recommendations for didactic content, testing, and continuing education. Task Group Report 124 of the AAPM, "Guide for Establishing a Credentialing/Privileging Program for Users of Fluoroscopic Equipment in Healthcare Organizations" provides guidance for obtaining approval and support to establish such a program as well as recommendations for policy development and content. A review of currently existing programs is incorporated into this report to recommend educational standards of fluoroscopy training in the areas of radiation biology, radiation and imaging physics, and radiation safety for both patients and personnel.

Educational Objectives:

1. Attendees will be familiar with the guidance for obtaining approval and support for establishing a credentialing and privileging program for the use of fluoroscopy in medical institutions.
2. Attendees will be aware of the recommendations for policy development and content as outlined in the AAPM Task Group Report #124.
3. Attendees will be familiar with the recommended educational standards for fluoroscopic training in the areas of radiation biology, radiation and imaging physics, and radiation safety for the different levels of fluoroscopy usage in medical facilities.
4. Attendees will be aware of the recommended levels of education and training for users based on the complexity and risk of the procedures to be performed utilizing fluoroscopy.

Therapy Symposium — Room: Monarch

Alternative Therapy Techniques

SU-C-Monarch-01

Photodynamic Therapy of Prostate Cancer

T Zhu[1] *, (1) University of Pennsylvania, Philadelphia, PA

Purpose: This study analyzes the results of image-guided prostate photodynamic therapy (PDT) that integrates PDT dosimetry, light source optimization, computerized light power adjustment, and volumetric real-time light fluence calculation to deliver uniform photodynamic dose to the target volume (prostate) and spares the critical structures (rectum and bladder). **Methods and Materials:** All procedures are under the image guidance of transrectal ultrasound. The PDT dosimetry includes multi-channel real-time in-vivo light dosimetry, absorption and fluorescence spectroscopy for 3D optical properties, drug concentrations, and tissue oxygenation. Drug concentration is also determined using fluorescence from a single optical fiber. These measurements are made before and after motexafin lutetium (MLu)-mediated photodynamic therapy (PDT) using a computerized step motor. The light fluence rate distributions are also measured along the catheters during PDT and compared to the 3D volumetric light fluence calculations. Real-time light fluence calculation was performed on the 3D target volumes using ultrasound image guidance. An optimization algorithm determines the light source strength, lengths, location, and retraction for cylindrical diffusing fibers (CDF) based on the 3D heterogeneous optical properties. The resulting light source power is feedback into a 12-channel beamsplitter that is connected to a motorized attenuator system to control the light source intensity interactively during PDT. **Results:** Preliminary data have shown widespread heterogeneities of optical properties and photosensitizing drug distribution. As a result of these heterogeneities, methods to quantifying the three-dimensional (3D) distributions of these quantities in individual prostate are essential for the successful application of PDT. Comparison of light fluence rate between real-time measurements and calculation is performed in heterogeneous medium and the standard deviations are within 30% with a simplified model and better than 11% for an improved model. **Conclusions:** We have shown the rational and potential for an integrated system that is capable of obtaining critical parameters (light, drug, and oxygenation) and using the PDT dosimetry result as feedback to optimize treatment delivery. We concluded that a real-time dosimetry and feedback system for monitoring PDT dose during treatment is both achievable and required for clinical interstitial PDT applications.

Educational Objectives:

1. To explain the basic principle of PDT dosimetry.
2. To review explicit PDT dosimetry techniques to characterize tissue optical properties, drug concentration, tissue oxygen concentration, and PDT efficacy.
3. To discuss the rational and requirement for a feedback system incorporating PDT dosimetry, PDT dose optimization, and computerized light delivery.
4. Summarize the clinical results of Prostate PDT.

SU-C-Monarch-02

The Role of MRI-Guided High-Intensity Focused Ultrasound in Cancer Therapy

L Chen * Fox Chase Cancer Center, Philadelphia, PA

Ultrasound is best known for its imaging capability in diagnostic medicine. However, there have been considerable efforts to develop its therapeutic use. High-Intensity Focused Ultrasound (HIFU) has long been known to offer the potential of precise "Trackless lesioning" but has only recently with the current high quality methods of medical imaging, become a practical possibility for clinical treatment.

Focused ultrasound uses ultrasound energy for tissue ablation. When the sound waves are focused to a small volume in the body, the intensity is high and the temperature at the focal point rises to 70-95 ºC, high enough to ablate the tissue. Proper treatment design will ensure that the energy density will be high at the focal point but low at other locations, and thus avoiding damages to nearby normal tissues.

The volume of ablation (lesion) following a single HIFU exposure is small and will vary according to the transducer characteristics, but it is typically cigar shaped with dimensions in the order of 1-3 mm (transverse) x 8-15 mm (along the beam axis). To ablate clinically relevant volumes these lesions must be placed side by side properly to "paint" the desired target volume.

Simply calculating an optimal treatment plan is not enough to ensure optimal outcome. Patient anatomic variability and tissue inhomogeneities have been shown to produce vastly different responses to thermal energy deposition, especially deep in the body. High quality imaging techniques can provide precise visualization and localization of the tissue damage. MR images enable the physician to localize the tumor and plan the treatment in the full 3 dimensions. Real-time MR thermometry can provide an indication of tissue damage if critical temperatures are known.

In several centers worldwide, HIFU is now being used clinically to treatment solid tumors (both malignant and benign), including those of the brain, breast, liver, kidney, prostate, bone matastases, pancreas and soft-tissue sarcoma. MRI-guided high-intensity focused ultrasound (MRgFUS) is currently commercially available for clinical applications.

Recent advances in the area of therapeutic ultrasound also involve drug delivery. Enhancement of drug delivery to tumors with HIFU has been demonstrated in animal models *in vivo*. Ultrasound emitted in short, high-energy pulses, will result in focused regional shock waves, which alter vascular and/or cell membrane permeability without permanently damaging the tissue. MR imaging can be used to place the ultrasound beam in the target area and monitor the effect of the treatment and the increased vascular permeability will allow for efficient delivery of macromolecular pharmaceutical agents to the treatment target. The mechanisms for producing the observed enhancement are thought mainly due to a non-thermal effect – the stable cavitation.

This lecture will provide an overview of MRgFUS and introduce the equipment that is commercially available for clinical applications in cancer treatment.

Educational Objectives:

1. The principles of MRgFUS
2. Advantages and limitations of MRgFUS for tissue ablation
3. Potential clinical applications of MRgFUS for cancer treatment

SU-C-Monarch-03

Laser Thermal Therapy

G Shafirstein[1] *, (1) University of Arkansas for Medical Sciences, Little Rock, Arkansas

Selective absorption is the premise underlying non invasive laser thermal therapy. At select laser wavelengths and pulse durations, the laser energy is absorbed by chromophores and converted into heat (i.e. thermal). Adjacent tissue and overlaying skin are spared due to the selective absorption. Laser thermal therapy has no systemic side effects and the treatment is completed within minutes.

However, the clinical response to laser therapy is highly dependent on the lesion vascularity, location, size and laser type and settings. Thus, there are practically 100s combinations of laser types and settings that can be selected to treat a specific lesion. Hence, careful treatment planning must be employed to achieve acceptable clinical outcomes following laser therapy.

In this talk we will review the key parameters that dictate the response of benign lesions to laser therapy. We will discuss empirical and theoretical methods to select laser settings for best clinical response and how to use multiple lasers for the treatment of a single lesion. Results from clinical and pre-clinical studies will be presented to demonstrate the efficacy of these methods.

Educational Objectives:
1. Understand the principles of non invasive laser therapy.
2. Learn how to design an effective laser treatment planning.
3. Understand laser therapy of benign lesions.
4. Understand the benefits and limitation of laser thermal therapy.

Diagnostic Symposium — Room: Sandler Center

3-D Angiography Studies

SU-C-Sandler-01

Coronary Magnetic Resonance Imaging

M Stuber[1] *, (1) , Johns Hopkins University School of Medicine, Departments of Radiology, Medicine, Electrical and Computer Engineering

According to the statistics of the American Heart Association (AHA), coronary artery disease (CAD) remains the leading cause of death for men and women in the United States. The current gold standard for the diagnosis of hemodynamically significant CAD in vivo is selective X-ray coronary angiography. However, X-ray coronary angiography has a few disadvantages. X-ray coronary angiography only describes luminal vessel alterations. Relevant information about the coronary artery vessel wall cannot be obtained. Furthermore, a small but significant risk of complications exists: invasiveness, radiation exposure for both the patient and physician have to be considered, iodinated contrast agents are needed and the procedure is expensive. In addition, up to 40% of patients who undergo X-ray coronary angiography are found to have no significant coronary artery lumen stenosis. For these reasons, there is a strong need for alternative non-invasive techniques which are more cost effective, and which provide not only information about the vessel lumen but also about the vessel wall without the need for ionizing radiation. Coronary magnetic resonance imaging (coronary MRI) offers several advantages. It has a relatively high spatial resolution, high soft-tissue contrast and the ability to generate images in any three-dimensional plane without the need for ionizing radiation. Other advantages of coronary MRI are the possibility for repeated measurements and the ability to simultaneously assess the coronary lumen, the coronary vessel wall and even blood-flow in the coronary circulation.

Educational Objectives**:**
1. Understand the rationale why coronary MRI provides a valuable alternative.
2. Understand the challenges associated with MRI of the coronary arteries.
3. Learn about the current status of coronary MRI in comparison to the gold standard

SU-C-Sandler-02

SPECT and PET/CT for cardiac imaging

T Turkington, Duke University

Single photon emission computed tomography (SPECT) and positron emission tomography (PET) both provide means of cardiac health. SPECT is currently widely used for cardiac applications, whereas PET, whose oncologic use has grown rapidly over the last ten years, is not yet widely used for cardiac applications but is particularly well-suited for several measurements of interest. Measurements include blood perfusion, viability, ejection fraction, and wall motion defects. The addition of CT to both SPECT and PET systems enhances cardiac imaging for multiple reasons, including fast attenuation correction and the potential for providing additional information available from CT scans such as CT angiography. There are potential pitfalls related to CT-based attenuation correction.

We will review the basic physics of SPECT and PET imaging, including degrading factors and potential corrections. In addition, we will discuss the range of cardiac imaging techniques available for SPECT and PET. Finally, we will discuss nuclear medicine instrumentation specifically designed for cardiac applications.

Educational Objectives:
1. Understand the basic physics of SPECT and PET imaging.
2. Become familiar with SPECT and PET/CT cardiac applications.
3. Understand the benefits of dedicated cardiac imaging systems.

Research sponsored by GE Healthcare.

Therapy Symposium — Room: Monarch

Clinical Monte Carlo

SU-D-Monarch-01

Clinical Monte Carlo: Photon Beams

C-M Ma, Fox Chse Cancer Center, Philadelphia, PA

The Monte Carlo method has been proved to be the most accurate dose calculation technique for radiation therapy dosimetry. This presentation will facilitate participants with the clinical implementation and application of Monte Carlo dose calculation algorithms in photon radiotherapy treatment planning and dosimetry verification. Following a brief introduction to the Monte Carlo method, descriptions will be given of the clinical implementation and commissioning of the Monte Carlo dose calculation software. Detailed discussions will be given on the actual and potential impact of Monte Carlo dose calculation algorithms on conventional photon beam therapy and advanced radiotherapy treatments such as intensity modulated radiotherapy (IMRT), stereotactic radiosurgery and radiotherapy (SRS and SRT).

Comparisons of patient treatment plans generated using conventional dose calculation algorithms and Monte Carlo methods will be made with an emphasis on the causes of the dose discrepancies. Further discussions will be conducted on the use of Monte Carlo dose calculation as a radiotherapy treatment QA tool to validate individual patient plans and as an investigation tool to improve target dose conformity and normal tissue sparing using novel photon treatment techniques and other beam modalities.

Educational Objectives:
1. To describe clinical implement and commissioning of Monte Carlo dose calculation algorithms for photon radiotherapy treatment planning.
2. To describe the applications of Monte Carlo dose calculation in treatment planning and beam delivery QA for advanced radiotherapy treatments.
3. To discuss the impact of Monte Carlo dose calculation on the development of novel beam modalities and radiotherapy treatment techniques.

SU-D-Monarch-02

Clinical Monte Carlo: electron beams

J Cygler[1] *, (1) The Ottawa Hospital Cancer Centre, Ottawa, Ontario CA

This lecture describes commissioning and clinical implementation of commercial Monte Carlo based treatment-planning systems for electron beams. The rationale for Monte Carlo dose calculations for electron beams is presented. Effects of different type of inhomogeneities (geometry and density) on electron beam dose distribution are briefly discussed.

Two commercially available Monte Carlo based treatment planning systems are discussed. Commissioning tests of treatment planning systems with emphasis on Monte Carlo relevant ones are presented. Unlike when commissioning a conventional treatment planning, the purpose of commissioning tests is not only to evaluate the accuracy of the system, but also to define the optimum calculation parameters, such as number of histories, calculation voxel size, etc., for its clinical use. The clinical implementation issues, procedure and treatment planning protocol are described. Examples of dose calculation times for typical anatomies and Monte Carlo parameters are given. Finally, clinical impact of Monte Carlo based dose calculations is also discussed.

Educational Objectives:
1. Appreciate the need for MC based treatment planning systems
2. Understand the effect of different types of inhomogeneities (geometry and density) on dose distribution
3. Understand how to set user control parameters in the TPS to achieve optimum results (minimum statistical noise, minimum distortion of real dose distribution)
4. Learn and understand differences between water tank and real patient anatomy based monitor unit values

Acknowledgement: Research sponsored by Nucletron and Varian corporations.

Diagnostic Symposium — Room: Sandler Center

4-D Cardiac Imaging

SU-D-Sandler-01

Cardiac applications of dual energy CT, calcium scoring and perfusion studies

K Johnson[1] *, (1) University of Florida College of Medicine - Jacksonville, Jacksonville, FL

Cardiac computed tomography (CT) has experienced a dramatic increase in clinical use over the past decade. Facilitating that rise in use have been numerous advances in CT technology – especially multi-slice and helical CT and decreases in gantry rotation times. More recent advances have allowed for significant reductions in radiation dose to the patient and the rebirth of dual energy imaging.

Dual energy CT (the simultaneous acquisition of images at two X-ray tube voltages) has shown potential in its early usage to image myocardial perfusion much like a cardiac SPECT exam. This single scan pairs functional information with the anatomic imaging of CT coronary angiography at minimal cost of increased dose. Other promising dual energy cardiac CT applications include plaque characterization, iron imaging, and contrast enhanced calcium scoring.

This lecture will provide an overview of recent advances in cardiac CT including 4-D imaging, calcium scoring, dose reduction strategies, and with a focus on dual energy CT applications.

Educational Objectives:
1. Understand the history of cardiac CT
2. Understand the current and developing clinical uses of cardiac CT
3. Understand the different advantages conferred to cardiac CT by new advances in scanner technology

SU-D-Sandler-02

Use of 320-slice MDCT in Vascular, Cardiac and Brain Studies: Initial Clinical Experience and Radiation Dose Assessments

M Arreola, L Lavoie, M Ghita, Department of Radiology, University of Florida, Gainesville, FL

A 320-slice multi-detector computed tomography (MDCT) scanner has been in use at the University of Florida for six months. Implementation of this new technology required a multidisciplinary team to take into account many crucial factors. First, selection of an adequate site proved to be difficult because of weight and cooling specifications, which forced a modification of the initial plans, resulting in the scanner being installed about 50 yards away from the main CT hub, thus creating certain workflow issues and minor staffing problems. Second, the size of the computer hardware combined with the hospital's decision to install a dedicated thin-slice archive (TSA) of several Terabytes in capacity also resulted in additional space and cooling requirements. This TSA allows clinicians and researchers to access originally-acquired volumetric data for comparison and protocol-optimization purposes for months post-study. Third, use of the scanner poses extremely demanding network bandwidth requirements in the area where the scanner resides, as data acquired are immediately stored in the TSA, and other generated images are transferred to PACS main archives and workstations. Fourth, the need for workstations which can adequately display and allow manipulation of perfusion and 3D studies in several key areas of the medical campus, such as neurosurgery and cardiology did not become fully evident until the tremendous benefits of the scanner became apparent to the hospital's medical staff.

As the two main clinical applications of the scanner are cardiac and brain imaging, two clinical projects were initiated immediately in conjunction with the Emergency Department: chest pain patients and patients in the stroke alert protocol. These are long-term studies which are expected to yield clinical results later in the year. To date, the scanner is being used for all types of CT angiography (CTA) studies, but in particular, cardiac-gated studies. Cardiac perfusion studies will begin later in the summer as software becomes available, though brain perfusion studies are already being performed routinely. A critical part of this implementation and of the optimization of clinical protocols is that of radiation dose. The diagnostic physics group at UF has begun a dual effort in this aspect: first, in the determination of organ doses by direct measurement using a commercially-available optically-stimulated luminescent (OSL) dosimetry system which makes use of individual small OSL detectors placed on anthropomorphic phantoms and scanned using the clinically-approved protocols. Second, to perform MonteCarlo simulations of such organ doses as well as the corresponding equivalent doses for the purpose of comparing them with the scanner-generated computed tomography dose index (CTDI) and dose-length product (DLP) values displayed and stored in the study's DICOM header. Preliminary data on organ and equivalent doses will be presented for brain-perfusion, cardiac and brain CTA and AVM studies.

Educational Objectives:
1. Understand the issues on planning and installation of a 320-slcie MDCT scanner
2. Understand the use of the scanner in vascular, cardiac and brain studies
3. Understand the process of optimization of clinical protocols for these studies
4. Understand the impact on patient doses which result from these studies.

Joint Symposium — Room: Monarch

Imaging and Radiotherapy

SU-F-Monarch-01

The Role of In-Room kV X-Ray Imaging for Patient Setup and Target Localization

F Yin[1] *, (1) Duke University Medical Center, Durham, NC

In-room kilovoltage (kV) x-ray imaging has become widespread practice for radiotherapy patient setup and target localization. In-room kV imaging refers to radiographic imaging using kV x-ray sources in the radiation treatment room. Task Group 104 (TG 104) reports on the various in-room systems which are commercially available using one or more kV imaging modalities. In-room kV imaging systems are divided into three categories: rail-track-mounted systems, ceiling/floor-mounted systems, and gantry-mounted systems. Several distinct systems have been made commercially available,

each with unique capabilities, limitations and levels of operational complexity. A hybrid system is also introduced, which combines two different mounting systems. TG 104 reports on the configurations, specifications and operational principles of each of these in-room kV x-ray imaging systems. Methods by which these systems can be used to improve treatment accuracy and their limitations are discussed. The report also provides an overview of the issues related to effective implementation of these systems for routine clinical procedures. General guidance is made for appropriate acceptance testing and quality assurance of these systems for safety, image quality and data management. The report includes a review of image-guided processes in the clinical setting, and strategies for effective modification of these processes based on clinical data. Several noteworthy works in progress towards the development of kV based image guidance are briefly discussed in this report. It is the desire of this Task Group to provide useful information to the radiation therapy community to facilitate the implementation and operation of high quality kV x-ray image guidance for radiation therapy.

Educational Objectives:
1. Understand the current existing kV x-ray systems used in the radiation treatment room, including system configurations, specifications, operation principles, and functionality.
2. Understand the current clinical application methods about how these systems could be used to improve treatment accuracy and their limitations.
3. Understand issues related to effective implementation in the routine clinical procedures.
4. Understand issues related to acceptance testing and quality assurance.

SU-F-Monarch-02

Managing the Imaging Dose during Image-Guided Radiation Therapy

M J Murphy, Virginia Commonwealth University, Richmond, VA

Radiographic image guidance has emerged as the new paradigm for patient positioning, target localization, and external beam alignment in radiotherapy. Today, image-guided radiotherapy (IGRT) can involve 3DCT for treatment planning, fluoroscopy and 4DCT for pre-treatment motion assessment, daily in-room CT for setup and evaluation of anatomical changes, and intra-fraction x-ray imaging for target tracking. All of these image guidance techniques give a radiation dose to the patient. Consequently, the adoption of IGRT methods has led to a significant increase in the patient's concomitant radiation dose. Whereas the therapy dose has always been analyzed in detail, in the past only cursory attention has been paid to imaging dose. It is now important for clinical practitioners to pay close attention to the accumulation of imaging dose. The AAPM has recognized the importance of imaging dose management by supporting Task Group 75's report on the subject. This review is condensed from that report. Its purpose is to enable the clinical practitioner to approach imaging dose with the same quantitative rigor as the therapeutic dose.

Educational Objectives:
1. illustrate the varieties of transmission imaging in IGRT (emission imaging such as PET and SPECT will not be included);
2. review the methods and issues in imaging dose estimation;
3. summarize the characteristic doses associated with various imaging modalities and configurations;
4. present the methodology for summing dose from multiple modalities;
5. discuss the evaluation of risk;
6. review dose management strategies.

Special Session/Workshop Room: Monarch
Medical Response to Radiation Incidents

MO-A-Monarch-01
Opening Remarks
D Broga[1] *, (1) VCU Medical Center, Richmond, VA
Opening Remarks

MO-A-Monarch-02
The Terrorist Nuclear Threat and Incident Response Planning
J MacKinney[1] *, (1) US Department of Homeland Security, Washington, DC

The nuclear threat has changed since the end of the Cold War: while global nuclear warfare is certainly still possible, the more imminent concern is a nuclear device in the hands of terrorists. There are several possible paths by which terrorists could acquire a nuclear device. Further, changing geopolitical conditions could rapidly alter the terrorist nuclear threat, as evidenced by developments in North Korea, and the AQ Kahn proliferation network. No pathway for terrorist acquisition of a nuclear device is easy, and uncertainties abound, but the threat cannot be ignored. During the Cold War the United States carried out wide-ranging analyses of nuclear weapons effects focusing on strategic impacts, such as total casualties, infrastructure loss, and industry incapacitation. Cold War civil defense research and programs correspondingly centered on survivability of the nation as a whole, with emphasis on civilian fallout shelters and preparedness drills. The post-9/11 nuclear threat, regarded as a single, relatively small terrorist weapon detonated at ground-level in a city, poses new challenges in assessing impacts with the goal of effective response to the incident in the affected city. A foundation for response planning must be built on our best understanding of the threat, and potential impacts of a nuclear attack on a city. In order to begin nuclear attack response planning, more detailed assessments and descriptions of the post-nuclear urban impacts are needed to provide the basis upon which planning can proceed. In this presentation, a summary of the terrorist nuclear threat will be provided, and an assessment of the current state of knowledge of impacts from a terrorist nuclear attack on the urban environment is given from the perspective of early response activities at the incident scene.

Educational Objectives:
1. Understand the nature of the terrorist nuclear threat
2. Understand factors that affect early response to a nuclear attack
3. Understand the use of zones for planning response operations

MO-A-Monarch-03
Radiation Emergency Preparedness in the DOE (NNSA) with a General Overview of REAC/TS and It's Role in the NNSA –FRMAC Emergency Response
A Wiley[1] *

The general radiological emergency response in the USA is primarily managed by the US Dept. of Energy , National Nuclear Security Administration (NNSA) Office of Emergency Response through an interagency federal emergency response group called the Federal Radiological Monitoring and Assessment Center (FRMAC) ,headquartered at Nellis Air Force Base, Nevada.
A discussion of FRMAC, its interagency components, and how it coordinates with and provides assistance to the state and local radiological emergency response will be presented in the format of a brief NNSA-FRMAC video.

The Radiation Emergency Assistance Center/Training Site (REAC/TS) provides the US Department of Energy (DOE)- NNSA with medical and health physics advice/consultation on radiation accidents.
Since 1976 REAC/TS has responded to thousands of calls for medical advice/consultation on the medical management of internal and external radiological contamination, as well as to other types of whole body and partial body exposures to ionizing radiations.

REAC/TS also maintains 24/7 medical radiological emergency response teams capable of 4 hours (national) and 6 hours (international) response, as directed by NNSA.

These teams are routinely deployed as a part of FRMAC operations (but, may be deployed independent of FRMAC, to support any operation of interest by NNSA) and are deployed with the equipment and personnel necessary to provide "on site" radiation emergency medicine and health physics advice /consultation, as well as basic medical emergency response, including special radiation countermeasure drugs (such as Ca, Zn DTPA and Prussian Blue) for the treatment of a limited number of people.

REAC/TS has a Cytogenetic Bio-Dosimetry Laboratory whose capabilities have been tested in a national exercise.

REAC/TS is a WHO Collaborating Center with significant past participation in international radiation emergency response incidents, exercises and training, as well as support to the IAEA RANET and IAEA on documents development and accident investigations.

REAC/ TS provides many CME training courses per year in radiation emergency medicine and health physics with realistic drills on site at Oak Ridge ,as well as multiple briefer courses off site, to a wide variety of federal, state and local groups, including CDC, DOD, and NASA..

REAC/TS also began a Radiation Accident Registry in the 1970,s as a means of collecting data on radiological/nuclear accidents and incidents so that REAC/TS , DOE and interested scientists could analyze these events. Analysis of such accidents is important since we must learn, even from these rare, but often tragic events.

A few examples of various types of accidents from the REAC/TS Registry will be discussed.

Professional Symposium Room: Sandler Center
ABR Exam Update

MO-A-Sandler-01
ABR Initial Certification – 2009 Update
S Thomas[1] *

This presentation will provide a comprehensive overview of the requirements and processes involved for the American Board of Radiology (ABR) initial certification examination in Radiologic Physics. The home office of the ABR in Tucson, Arizona will be introduced with emphasis on the support staff involved in administering the certification examinations. The written (computerized) examination sequence consists of two parts: a.) Part 1 that has a general medical physics and a clinical component; and, b.) Part 2 that is specific to one of the 3 disciplines offered (Therapeutic Radiologic Physics, Diagnostic Radiologic Physics, or Medical Nuclear Physics). The requirements for eligibility to take each part will be reviewed (education and experience) as well as the format of the 2 examinations. Once the candidate has successfully passed Parts 1 and 2, the final step in the examination process prior to certification is an oral examination in the specific specialty given in June in Louisville, Kentucky. The content and format of the oral exam will be described. The 5-year statistics (2004 – 2008) for the examinations will be presented including: number of candidates per year; passing rates for the written exams; passing rates for the oral examination. Finally, there will be a discussion of the future educational requirements for eligibility to take the ABR Part 1 exam known as the 2012/2014 initiatives; namely, enrollment in or graduation from a CAMPEP accredited medical physics program by the specified dates: a.) 2012 - graduate program (MS or Ph.D.) or residency, and b.) 2014 - residency.

MO-A-Sandler-02
ABR Exam Update
M Earl

No abstract provided.

MO-A-Sandler-03

What should Prospective ABR Oral Board Examinees be prepared for ?

K. Wijesooriya*

Purpose: Experience of a medical physicist at the ABR oral boards will be presented. The material covered in preparation for taking the exam will be discussed. Courses out there that help one get started quickly for a thorough preparation for oral boards will be summarized. Finally the important talent one should acquire to best present your answers to the examiners will be addressed. Suggestions and recommendations to the ABR trustees, and oral examiners on how to improve the exam will be briefly touched.

Special Session/Workshop Room: Monarch

Medical Response to Radiation Incidents

MO-C-Monarch-01

Medical Physicists Volunteering for the Medical Reserve Corps

J Lanza[1] *, (1) Florida Department of Health, Pensacola, Florida

The Medical Reserve Corps (MRC) is a federal DHHS program whose mission is to improve the health and safety of communities across the country by organizing and using public health, medical, and other volunteers. Joining your local MRC would be a great opportunity for medical and health physicists to learn about disaster preparedness activities in their community and to be part of a response effort to mitigate the effects of natural and man-made (terrorism) disasters, but especially after a radiological/nuclear incident. MRC units are community-based, frequently sponsored by the local public health department, and provide the infrastructure to organize and use volunteers who want to develop the expertise to prepare for and respond to emergencies and promote healthy living throughout the year. MRC volunteers supplement existing emergency and public health resources, and are not first responders. Examples of how medical and health physicists could be used in an emergency situation include: (1) acting as consultants to public health and other responders regarding human health effects from radiation exposures; (2) providing contamination screening services at community and other types of reception centers; (3) assisting in collecting bioassays at alternative medical treatment sites; and, (4) being the liaison between hospital emergency personnel and local authorities in identifying and triaging radiation exposure victims. Each MRC will provide benefits to volunteers including: (1) the opportunity to serve their community during times of need; (2) education and training including the Incident Command System; (3) participation in table-top and field exercises; and, (4) first access to vaccinations and other medications during a biological incident or disease outbreak. This presentation will also include information on how medical and health physicists can find and join their local MRC.

MO-C-Monarch-02

Commonwealth of Virginia's Medical Reserve Corp.

J Freeland[1] *

Integral to the success of a Medical Reserve Corp is the process of identifying individuals in each state willing to serve as volunteers. The Emergency System for Advance Registration of Volunteer Health Professionals (ESAR-VHP) is the national network of State-based programs that effectively facilitate the use of health professional volunteers in local, State, and Federal emergency responses. All states have developed an approach for meeting the requirements of these initiatives. This talk will discuss the purpose and requirements of ESAR-VHP and discuss how the Commonwealth of Virginia has implemented the requirements.

Educational Objectives:

1. Understand what ESAR-VHP is.
2. Understand where to obtain information unique to your state program.
3. Understand the purpose of ESAR-VHP including the role of volunteers.

MO-C-Monarch-03

Radiation Reserve Volunteer Corps

D Gilley[1] *, W Passetti[2] , J Williamson[3] , (1) , (2) Florida Bureau of Radiation Control, Tallahassee, FL, (3) Florida Bureau of Radiation Control, Tallahassee, FL

In the event of a radiological emergency, population monitoring for large numbers of individuals must be available assist in identifying citizens who may be contaminated with radioactive material and to reassure those who are not contaminated. The National Response Framework assigns coordination of federal support for population monitoring to HHS through ESF 8, Public Health and Medical Services. This coordination of federal support does not necessarily include equipment and personnel resources for the actual monitoring; this is expected to be provided by the state and local government.

In an effort to satisfy this mission, the State of Florida Department of Health established a Radiation Response Volunteer Corps (RRVC) as a sub specialty of the Medical Reserve Corps (MRC). Members of the medical and health physics community were identified as potential volunteers. Training was provided to the volunteers by the Florida's Bureau of Radiation Control with assistance from the HPS, CDC and the MRC and they were encouraged to volunteer for this activity through the Florida Medical Reserve Corps. The sub-special "Radiation Response Volunteer Corps" was created by expanding the MRC registration to capture, professional license and national credentialing information.

At the conclusion of the presentations, attendees will have the tools to establish their own Radiation Response Volunteer Corps within the Medical Reserve Corps in their state or region.

MO-C-Monarch-04

Public Health Response to Radiation Emergencies and Potential Roles of Volunteer Radiation Professionals

A Ansari[1] *, (1) Centers for Disease Control and Prevention, Atlanta, GA

In case of a terrorist attack involving a radiological dispersal device or an improvised nuclear device, response agencies at all levels of government will face many challenging issues requiring radiation protection expertise. For example, local public health and emergency management agencies will need to monitor potentially impacted and concerned citizens for radioactive contamination, provide them with information and needed assistance, and support operations at evacuation centers or shelters to accommodate the displaced population. Communities hundreds of miles away are likely to be impacted as they host a displaced population. The need for radiation protection expertise in preparing for and effectively responding to a nuclear or radiological emergency is paramount, but local response agencies may not have this needed expertise available to them locally. In the United States, there are tens of thousands of radiation professionals including health physicists, medical physicists, radiological or nuclear medicine technologists, and others who can assist local agencies. These radiation professionals can provide a much-needed resource to their community by volunteering for already established health volunteer organizations in their own communities. The enlisting and appropriate training of such volunteers must be done before an emergency occurs not after. In this presentation, current efforts at federal, state, and local levels to outreach, enlist, and train volunteer radiation professionals will be described. The potential roles of these volunteers in assisting with population monitoring activities will also be described. For individual volunteer radiation professionals, the time commitment is minimal. Potential rewards are significant.

Educational Objectives:

1. Understand the need for radiation protection expertise in effectively responding to a radiation emergency at the local response level.
2. Understand how medical physicists can assist their local public health and emergency management agencies.
3. Learn what current efforts are underway and what local volunteer organizations exist today that can enlist and train medical physicists for response to a radiation emergency.

MO-C-Monarch-05

VCU Medical Center 3 Tier Response and HAZMAT HICS Team

Dean W. Broga[1] *, (1) VCU/VCU Medical Center, Richmond, VA

Each medical facility is required by the JCAHO to develop a chemical/biological/radiological (CBR) emergency response plan to deal with mass casualty incidents (MCI) involving these agents. Most hospitals are already involved in the routine monitoring of radiation either in nuclear medicine and/or radiation oncology. Controlling exposures, spill control and decontamination are familiar processes for these departments but not to the emergency room (ER) personnel. Managing an MCI is something that the ER may deal with especially at large facilities. The marriage of the two concepts requires both groups to understand each others process.

This lecture provides an overview of the 3-tiered process employed at VCU Medical Center to managed the occupational level event, a mid-range MCI/CBR and a large scale terrorist event. Also discussed will be the structure of a HICS Decon Team necessary to the deployment of a functional staff response.

Educational Objectives:
1. Understand the need for a tiered response.
2. Understand the issues related to patient treatment, decon and containment.
3. Understand the issues related to staffing needs in order to provide a effective process.

Professional Symposium Room: Sandler Center
Starting New Residency Program

MO-C-Sandler-01
2012/2014 Deadline and the Significance of Residency Programs to the Medical Physics Community
D Frey[1] *, (1) Medical Univ of South Carolina, Charleston, SC

The American Board of Radiology (ABR) has announced that, beginning in 2014, a CAMPEP approved residency will become a requirement of the ABR. This talk will discuss the background for this decision and also discuss the implications of the decision.

Educational Objectives:
1. The participants will understand the 2014 ABR requirement
2. The participants will be familiar with the background to the ABR decision

MO-C-Sandler-02
AAPM Position on Residency Training and Experience with an Academic CAMPEP Accredited Program
M Herman, Division of Medical Physics, Department of Radiation Oncology, Mayo Clinic, Rochester, MN

In the clinic, where there is currently pressure for consistency and public accountability, we review the accepted definition "A Qualified Medical Physicist is an individual who is competent to practice independently one or more of the subfields of medical physics…. With board certification in the appropriate medical physics subfield and continuing education…" (AAPM Professional Policy 1E). And from the ACMP-AAPM Medical Physics Scope of Practice: "The essential responsibility of the Qualified Medical Physicist's clinical practice is to assure the safe and effective delivery of radiation to achieve a diagnostic or therapeutic result as prescribed in patient care."
There is a converging expectation for consistency of training, experience and credentials to practice medical physics. The CARE act, Consistency, Accuracy, Responsibility, and Excellence in Medical Imaging and Radiation Therapy Act of 2007, will lay the foundation for federally mandated prerequisites to practice in medical imaging and radiation oncology. The law would require all states to recognize minimum qualifications to practice medical physics. The draft text for these requirements includes specific medical physics training and experience followed by board certification. Meanwhile, the ABR forecast in 2003 that by 2012, a CAMPEP accredited clinical residency could be required to sit for the board exam in medical physics. All but two certification examinations within the American Board of Medical Specialties (ABMS require accredited clinical training as board pre-requisites. The AAPM (PP-19A) and the ACMP both went on record supporting the requirement that accredited clinical residency precede board certification. Evidence suggests that graduates of CAMPEP accredited residency programs fully pass the ABR exam on the first attempt at a 95% rate, as compared to the overall ABR average pass of 53% over the same time period.

Consistency in medical physics training and experience is paramount to quality medical care. This does not in any way suggest exclusivity in terms of pathways to become a medical physicist. Medical physics is a strong profession due to the breadth of disciplines that ultimately culminate in a medical physics career. In any case and regardless of initial training, clear competencies and experience are defined that when followed produce high quality medical physicists.

In addition, specific experience will be reviewed for starting and maintaining an academic medical physics residency program. Caveats within an institution and changes over the years will be discussed.

Educational Objectives:
1. To recognize the importance of consistent, structured clinical training in medical physics.
2. To understand the position on medical physics residency training that the American Association of Physicists in Medicine
3. To understand issues associated with developing an academic medical physics residency program

MO-C-Sandler-03
CAMPEP's role in residency training
B Gerbi[1] *, University of Minnesota, Minneapolis, MN

The roll of the Commission on Accreditation of Medical Physics Education Programs, Inc. (CAMPEP) in medical physics education is first and foremost, to ensure quality in all aspects of medical physics education. This applies to the accreditation of graduate and residency programs in medical physics, and to continuing education in medical physics to maintain a level of quality and competency once the basic information has been acquired. The rationale for CAMPEP accreditation is to standardize the level of quality and content of material and to ensure that the basic information that is the foundation of medical physics has been conveyed to the students. An additional role beyond standardization is to establish minimum training standards and guideline for accredited programs. Accreditation ensures that the institutions participating in the program have adequate facilities, adequate faculty numbers and expertise, and adequate structure within their programs to provide a quality educational experience. The objectives of maintaining an accredited program are to advance academic quality, to demonstrate public accountability, and to encourage in purposeful change and needed improvement within the program and within the field. There are many benefits associated with program accreditation. These include increased visibility within and outside the program, improved structure and documentation within the program, and to improve the educational experience within the institution.

Many individuals find the process of accreditation to be a daunting task. This can indeed be the case but CAMPEP and the AAPM are making great efforts to help programs become accredited. Most recently a program writing workshop was held where 24 individuals representing 24 different institutions met for a day and a half concentrating specifically on producing a final Self-Study document. In addition, CAMPEP has provided much more detailed guidelines and self-study writing templates to assist in the development of programs. Review and reporting templates for reviewers, new reviewers, and lead reviewers have been developed to improve the quality and uniformity of reviews done by different individual and to streamline the review process. CAMPEP has much more detailed policies and procedures to define exactly the roles of various officers and individuals associated with the accreditation process. As CAMPEP accredited program to become more formalized, structured, and of uniformly higher quality, so to has CAMPEP become a much more streamlined and better organization.

The residency program at the University of Minnesota has changed and improved over the years. The residency program started out as an informal and loosely structured apprenticeship. As the accreditation progress became more rigorous, the program was continuously upgraded to meet the improved CAMPEP guidelines. It took real effort to formalize the program and make it what it is today. We have benefited continuously, as have our residents, from this improved structure and definition within the program.

Educational Objectives:
1. To explain the role of CAMPEP in residency training
2. To explain how CAMPEP assists potential programs to become accredited
3. To explain the residency review process
4. To describe how improvements in CAMPEP's guidelines have improved the program at the University of Minnesota

MO-C-Sandler-04

A Medical Physics Residency Program within a Clinical Medical Physics Practice

L Sweeney[1] *

Residency Programs in general are administered by Academic Institutions. Large portions of these programs are exclusively clinical. The implementation of national Medical Physics requirements places a large burden on these institutions. It is possible to fulfill the CAMPEP Accreditation in other practice settings. Our Physics Consulting group, Northwest Medical Physics Center (NMPC), instituted a Medical Physics Residency Program in 2005. NMPC is a clinically based Therapy Oncology Physics practice. Our Program is based on CAMPEP requirements and is currently in the accreditation process. The Program is capable of fulfilling any didactic needs as well as clinical requirements and is totally funded by NMPC. Specifics of the arrangements and obligations of both the Resident and NMPC will be discussed.

MO-C-Sandler-05

Developing a clinical radiation oncology physics residency in the community cancer center setting

B Wichman*, Kansas City Cancer Center, Overland Park, KS

The recent changes in qualifications for the ABR radiologic physics board examinations have caused great concern in the medical physics community. In community hospitals and radiation oncology centers, there is worry about the future availability of qualified physicists and the ability to recruit new professionals. A possible solution in the community setting is the establishment of medical physics residency positions.

The keys to successfully starting a residency program are adequate preparation and access to those who have experience directing accredited programs. AAPM TG 133 and CAMPEP have provided sufficient guidance such that many community hospitals and cancer centers should be able to replace junior physicist positions with residency positions. There are many aspects to this replacement, including funding, gaining administrative approval, the conversion timeline, and providing adequate facilities, faculty and instruction to the resident. The establishment of an affiliation with an existing CAMPEP accredited residency can assist greatly in residency program development and provide facilities and instruction not available in the community clinic.

The development of a medical physics residency in the community setting does take work and careful planning, but is readily achievable. There are many tools and resources available to make the process straightforward. Development of a residency will be paramount to retaining access to those entering the profession in the years to come.

This presentation will describe the process to start a new residency program in the community setting, from initial planning through application for CAMPEP accreditation.

Educational Objectives:

1. Understand the challenges the ABR 2012/2014 initiative poses to the community hospital or cancer center
2. Understand the reasoning behind development of a residency program
3. Understand the development process of an affiliated residency program

Special Session/Workshop Room: Monarch

Medical Response to Radiation Incidents

MO-D-Monarch-01

Diagnosis and Medical Management of Internal Contamination with Radionuclides

A Wiley[1] *

Due to the increasing use of radionuclides in medicine, research ,industry and with their associated presence in nuclear power generation , and from the current concern for their potential use by terrorists , we can expect a continued and increasing need to medically manage internal contamination with radioactive materials in workers and in the general public.

The challenge, therefore, for the medical clinician is to select and appropriately employ those medical drugs and procedures which will reduce the absolute amounts and the residence times of these materials in the body in order to successfully mitigate, minimize and in general manage the radiation dose delivered to the body and/or organ systems. Since there are a wide variety of possible radionuclide contaminations, associated with a variety of chemical and physical forms, there are accordingly a variety of preferred drug countermeasures and procedures which optimally must be specifically tailored to the specific exposure scenario.

These questions and challenges have been addressed in the past by some well known publications from NCRP, ICRP, IAEA, etc.

This presentation is a general review of this literature with a few medical management examples from clinical experience in some actual accidents.
NCRP-65 has been for about 30 years been one of the more widely used references for the medical management of internal contamination ;and for the past few years this publication has been under revision and updating by an NCRP committee in order to make it more useful --and for facilitating the management of possible mass casualty situations . Accordingly, comments will also be made on some of the expected changes/additions in the new edition.

MO-D-Monarch-02

Receiving a Patient Contaminated With Radioactive Material

R Beauchamp[1] *

In our modern world there are increasing concerns over local hospitals' abilities to handle the victims of a radiation related terrorist event. This is compounded by the general lack of understanding and fear associated with all things radioactive. However, with just a few common sense concepts and an emphasis on the fact that "medical care comes first", any Emergency Department should be able to deal with a patient that arrives contaminated with radioactive material.

Educational Objectives:
1. Identify medical treatment and decontamination priorities for the contaminated patient.
2. Identify the basic steps to protect caregivers from significant radiation exposure.
3. Identify basic procedures for controlling contamination while treating a patient contaminated with radioactive materials.

MO-D-Monarch-03

Real-time Detector Test

Dean W. Broga[1] *, (1) VCU/VCU Medical Center, Richmond, VA

Most hospitals are already involved in the routine monitoring of radiation either in nuclear medicine and/or radiation oncology. Radiation instruments are used to control exposures, monitor for spills and assess decontamination efforts. The range and variety of instruments on hand vary with the types and uses of materials at the facility.

This lecture will review some of these instruments emphasizing their uses and limitations. The lecture will include a real-time test in which participants will be asked to identify a number of unknown radionuclides based on the response of the instruments reviewed earlier. The lecture will conclude with a review of the correct answers and a reemphasis of the limitations of the different instruments.

Educational Objectives:
1. Understand the types of instruments that might be used in a radiological emergency.
2. Understand the limitation of these instruments.
3. Use this information to make a real-time evaluation of unknown sources.

Professional Symposium Room: Sandler Center
Ethics and Law for Medical Physicists

MO-D-Sandler-01
Differentiation of the Professional, Ethical and Legal Duties of Medical Physicists

F Bagne *

This lecture describes and distinguishes the professional, ethical and legal duties of a medical physicist. Issues arising in performing one's duty as a professional while maintaining employment and social responsibilities are discussed. With audience participation, examples are provided to differentiate the professional, ethical and legal conduct of a medical physicist in delivering healthcare services.

Particular emphasis is placed in understanding one's role and making the correct decision when facing certain difficult employment and service situations.

Young Investigator Room: Sandler Center
Symposium

MO-F-Sandler-01
Effects of breathing variation on internal target volume (ITV) in respiratory gated radiation therapy

J Cai *, R McLawhorn, K Sheng, P Read, J Larner, S Benedict, University of Virginia, Charlottesville, VA

Purpose: To investigate the effects of breathing variation on ITV in respiratory-gated radiation therapy. **Method and Materials:** 7 volunteers and 5 lung cancer patients underwent a 5-minute MRI scan in the sagittal plane to acquire dynamic MRI (dMRI) of lung motion, from which motion trajectories of the tumor (for patients) or a pulmonary vessel (for volunteers) were determined. A MATLAB program was written to simulate cine-mode 4DCT by segmenting/resorting dMRI. Image motion phantoms were created by moving a round-disk (mimicking tumor) with dMRI-determined trajectories for all subjects. Simulated 4DCT (sCT) were generated from phantom images, and also from dMRI for patients. Internal target area (ITA, 2D counterpart of ITV) in the gated window was determined from both sCT and dMRI in each of the phantom and patient studies, from which the area (ITA_{GW}), major axis ($L1$) and minor axis ($L2$) were determined and compared. Similarity between the two ITAs was also calculated. **Results:** In phantom study with a 3cm "tumor", measurements in dMRI are all significantly (p-value<0.001) greater than those in sCT (ITA_{GW}=992.9±121.7mm^2, $L1$=38.1±3.8mm, $L2$=33.1±1.0mm in dMRI; ITA_{GW}=836.7±66.6mm^2, $L1$=34.1±2.4mm, $L2$=31.2±0.7mm in sCT). These differences are even greater with a 1cm "tumor". Similar results were found in patients study (ITA_{GW}=1554.4±822.5mm^2, $L1$=49.9±11.3mm, $L2$=38.5±11.9mm in dMRI; ITA_{GW}=1319.0±852.7mm^2, $L1$=43.2±14.0mm, $L2$=36.8±12.0mm in sCT). Similarity between two ITAs is 0.79±0.10 and 0.83±0.09 in phantom study and patient study respectively. **Conclusion:** 4DCT may underestimate the gated window ITV. An addition margin to account for the breathing variation may be necessary in determining gated window PTV.

MO-F-Sandler-02
Investigation of the dosimetric consequences based on imaging used for conventional, gated and tracking radiotherapy of mobile tumors

TEBOH ROLAND[1] *, Y LIU[1] , N Papanikolaou[1] , (1) The University of Texas Health Science Center at San Antonio, San Antonio, TX

Purpose: Investigate the dosimetric consequences based on imaging used for conventional, gated and tracking radiotherapy of mobile tumors. **Method and Materials:** Data from two patients previously treated for lung cancer with approximately 1cm tumor extent of motion was used. Both 3D and 4D dose distributions were computed with 4D accounting for organ motion and based on a 4DCT image set while 3D dose was based on a static anatomy. The 4D dose was derived from multiple 3D plans corresponding to various phases of the respiratory cycle via a validated non-rigid deformable image registration algorithm. We compared the 3D versus 4D plan predicted lung volume irradiated by at least 20Gy (V_{20}), mean lung dose (MLD), isocenter point dose (IPD), and the target generalized equivalent uniform dose (GTV-gEUD and PTV-gEUD) for conformal radiotherapy (no margins to account for motion – 3DCRT; with 4DCT derived margins to account for motion – 4D Static), gated and tracking radiotherapy. **Results:** The discrepancies between the 3D and 4D plan predictions were: 17%, 4%, 1%, 1% for lung V_{20}; 8%, 7%, 2%, 2% for the PTV-gEUD; 1%, 4%, 0.6%, 2% for MLD; 0.6%, 2%, 0.8%, 0.4% for the GTV-gEUD and 0.2%, 0.7%, 0.3%, 0.7% for the IPD for the delivery techniques 3DCRT, tracking, 4D static and gating respectively. **Conclusion:** Although we observed some trend in the dosimetric parameters considered, for example, the discrepancies across all parameters for the 4D static and gating techniques were within 2%, further studies involving varied tumor characteristics are required for any concrete conclusions.

MO-F-Sandler-03
Intensity Modulated Proton Planning for Ocular Tumor using Human Anatomy Dose Algorithm and Preliminary Comparison with IMRT Planning

B Massingill[1] *, Y LIU[1] , A Diaz[1] , N Papanikolaou[1] , C Esquivel[1] , (1)Cancer Therapy Research Center, Radiation Oncology, University of Texas Health Science Center at San Antonio, San Antonio, Texas

Purpose: We aim to provide accurate dose calculations for ocular tumor and adjacent critical organs using intensity modulated proton therapy (IMPT) using a human anatomy-based Monte Carlo model. Dose is simulated using the Monte Carlo code MCNPX and compared to standard photon IMRT planning using Pinnacle3® TPS. **Method and Materials:** The human anatomy model was adapted from the Visible Human Project from the National Library in Medicine. Sectioned images were assigned physical properties. Two independent trials were developed using IMRT and IMPT, respectively. Isodose lines and dose profiles for each transverse, sagittal and coronal view of the VHP model were provided for planning evaluation. Dose volume histogram in eyes, optic nerves, brain, chiasm, lacrimal, pituitary, lens, and PTV were compared between IMRT and IMPT. **Results:** The ocular tumor was well covered by 95% in IMRT and 70% isodose in IMPT. Comparing the IMRT and IMPT, the mean dose was 4508 cGy and 3762 cGy-Eq for PTV, 2770 cGy and 1524 cGy-Eq for the eye, 3300 cGy and 1192 cGy-Eq for lens, 794 cGy and 162 cGy-Eq for optic nerve, 193 cGy and 20 cGy-Eq for lacrimal, 26 cGy and 0.0 cGy-Eq for brain, 120 cGy and 0.0 cGy-Eq for chiasm, 272 cGy and 0.00 cGy-Eq for pituitary and, respectively.
Conclusion: IMPT provided conformal dose to the ocular tumor and significantly spared dose to the surrounding critical organs compared to IMRT. Human-anatomy based Monte Carlo dose potentially provides more accurate dose calculations when accounting for the tissue component in the eyes.

MO-F-Sandler-04
Radiobiologic Evaluations of Stereotactic Body Radiation Therapy (SBRT) Treatment Plans in Patients with Non Small Cell Lung Cancer (NSCLC)

T De La Fuente Herman[1] *, T Herman[1] , K Hibbitts[1] , M Vlachaki[2] , J Stoner[1] , S Ahmad[1] , (1) The University of Oklahoma Health Sciences Center, Oklahoma City, OK, (2) Wayne State University, Detroit, Michigan

Purpose: To evaluate radiobiological effective doses from SBRT treatment plans. **Materials and Methods:** 20 patients with stage I NSCLC were scanned using 4D CT techniques. Treatment planning was performed with 6 MV non-opposing coplanar beams using Eclipse Treatment Planning system with tissue heterogeneity corrections. Prescription dose was 60 Gy in three fractions. Based on the universal survival curve (USC)*, the biologically effective dose (BED), standard effective dose (SED), and single fraction equivalent dose (SFED) values were calculated:

$$BED = \frac{1}{\alpha \cdot D_0}\left(D - n \cdot D_q\right) \qquad SFED = D - (n-1)\cdot D_q \quad ; SED = \frac{BED}{1 + \frac{2}{(\alpha/\beta)}} \quad ;$$

Dose volume histograms (DVH) were used to generate equivalent uniform doses (EUDs) calculated with clonogen cell density = 220 million, SF_2=0.4, and α/β = 10, or 8.605 (Park et al). EUDs replaced D in the equations above.

Results: The minimum, mean and maximum PTV doses were 53.07, 62.23 and 66.32 Gy respectively. The dose heterogeneity index ($D_{1\%}/D_{99\%}$) was 1.14%. Accounting for heterogeneities from tissue and dose distributions, the SFED was 4% less than Park's value. **Conclusions:** The SFED* with EUD, is suitable for describing and comparing SBRT prescription schemes as it incorporates the strengths of the linear quadratic model for doses near the shoulder region and the multi-target model for large doses that fall on the

exponential part of the cell survival curve, giving an accurate description of the equivalent potency of SBRT. Use of EUD is more biologically relevant than use of prescribed dose, since it falls between minimum and mean dose on the DVH.

*****Park et al., Int. J. Radiation Oncology Biol. Phys., 70 (2008) p847-852

MO-F-Sandler-05

Setup Margins Requirements for Stereotactic Lung Radiotherapy

T Niedermayr[1] *, M Herman[2] , (1) Mayo Clinic, Rochester, MN, (2) ,

Purpose: Optimum treatment efficacy requires that setup uncertainties be determined for each institution, treatment site and technique. This work investigates how the use of volumetric image guidance affects tumor targeting accuracy and tumor volume margin requirements in SBRT lung patients. These results are compared to the RTOG 0618 SBRT lung protocol requirements. **Method and Materials:** Setup uncertainties and margins were established for forty-five patients treated with stereotactic lung radiotherapy using the Varian OBI CBCT imager for daily target localization. At each treatment fraction at least three CBCTs were acquired to assess 1) the initial required shifts 2) to verify the patient position before treatment and 3) to assess the patient position after treatment. **Results:** The group margins were calculated according to the Van Herk formalism with the intent to give 95% of the prescribed dose to 90% of the patient population. With laser alignment an average margin of 20.6 mm in each direction is required. After CBCT localization, the average margin requirement in each direction is reduced to 3.3 mm. If the intrafraction tumor motion is taken into account, this margin is increased to 4.0 mm. **Conclusion:** The amplitude of the 95%-90% margin (3-5 mm depending on direction) is consistent with the RTOG requirements of 5-10 mm. Larger margins might be required if higher dose or population coverages are intended. **Conflict of Interest:** This research was funded in part by Varian Medical Systems.

Joint Symposium — Room: Monarch
TG 117 , TG 142 and TG 106

TU-A-Monarch-01
MR Data for Treatment Planning and Stereotactic Procedures: Sources of Distortion, Protocol Optimization, and Spatial Accuracy Assessment (Preview of TG117 Report)
D Brinkmann*, Mayo Clinic, Rochester, MN

Image-guided therapies, including stereotactic radiosurgery, biopsy procedures, IMRT and image-guided surgery are being used with increasing frequency. Although originally based primarily on CT data, image-guided therapies increasingly use magnetic resonance images in conjunction with or instead of CT data in the planning of or real-time guidance of interventional procedures. Unlike CT imaging, the spatial accuracy of MRI data depends on both an appropriate QC program and the choice of appropriate image acquisition techniques. TG-117 seeks to provide guidance regarding the optimization of imaging protocols and distortion assessment procedures when MR systems are to be used to obtain data for procedures in which high spatial accuracy is critical.

This lecture will provide a preview of TG-117, reviewing the physical bases for spatial distortions due to both system hardware and interaction of the system with the patient, describe methods for reducing or eliminating effects of distortion in MR imaging including protocol optimization and correction strategies, and discuss a general approach for evaluating distortions and developing QC procedures for MR systems used to obtain data for procedures requiring high spatial accuracy.

Educational Objectives:
1. Understand the physical bases for spatial distortions in MR imaging.
2. Understand the impact of protocol optimization and correction strategies on spatial distortions.
3. Understand issues related to assessing distortion and QC testing for clinical applications requiring high spatial accuracy.

TU-A-Monarch-02
Task Group 142: Quality Assurance of Medical Accelerators
J Hanley[1] *, (1) , Hackensack University Medical Center, Hackensack, NJ

The AAPM TG-40 report published in 1994 is a widely used and referenced document which includes recommendations for general quality assurance (QA) tests for medical linear accelerators. Since the publication of TG-40, several new technologies have been developed and are now commonly used in clinical practice. These technologies include: multi-leaf collimation (MLC), asymmetric jaws, dynamic and virtual wedges, and electronic portal imaging devices (EPID). Image guided devices such as cone-beam CT (CBCT), static kilovoltage (kV) imaging, and respiratory gating were rarely used in 1994. In addition, TG-40 did not consider the demands placed on an accelerator by procedures such as stereotactic radiosurgery (SRS), stereotactic body radiation therapy (SBRT), total-body photon irradiation (TBI) and intensity-modulated radiotherapy (IMRT) treatment. Also, the quality of linear accelerators in terms of accuracy and precision has improved in recent years, allowing for procedures such as SRS, SBRT and IMRT.

The purpose of this report is to build upon the recommendations of TG-40 for QA of medical linear accelerators including the before mentioned technologies and procedures such as SRS, SBRT, TBI and IMRT.

Educational Objectives:
1. Understand the underlying principles behind the development of a Quality Assurance program for a modern linear accelerator.
2. Understand the necessity for defining different tolerances for Quality Assurance tests based of the nature of the treatments delivered on the linear accelerator.
3. Understand all aspects of a Quality Assurance program for a modern linear accelerator.

TU-A-Monarch-03
Beam Data Commissioning: An overview of TG-106
I Das, Indiana University School of Medicine, Indianapolis, IN

Recently published AAPM Task Group-106 (Das et al. 2008) provided detailed information on the beam data collection for the commissioning of a linear accelerator. Based on the task group, discussion on procedures for acquiring specific photon and electron beam parameters and methods to reduce measurement errors will be discussed. Additionally following topics will be elaborated: need for commissioning data, issues with beam commissioning measurements, selection of phantom size and material, selection of cable, adopter, detectors, scanning system setup problems, (possible solution and examples), scanning speed, hysteresis, saturation, time delay, sampling, orientation of the detector for profiles, type and quality of scanning data, point data, problems with large fields such as total body irradiation (TBI) and total skin electron irradiation (TSEI) and small fields used in stereotactic radiosurgery (SRS), and intensity modulated radiation therapy (IMRT), smoothing, filtering and processing and presentataion of commissioning data. Examples of the inaccurate and poor data with figures will be presented. An overview and limitation of the task group will be discussed in the context of rational for the beam data commissioning, time needed for data collection and the legality of the data for future use.

I. J. Das, C. W. Cheng, R. J. Watts, A. Ahnesjo, J. Gibbons, X. A. Li, J. Lowenstein , R. K. Mitra, W. E. Simon, and T. C. Zhu. (2008). "Accelerator beam data commissioning equipment and procedures: Report of the Tg-106 of the therapy physics committee of the AAPM." *Med Phys* 35**:**4186-4215.

International Medical Physicists Symposium — Room: Monarch
Creating an International Medical Physics Credentialing Board

TU-C-Monarch-01
Certification of Experienced Clinical Medical Physicists
R K Wu[1] *, (1) Barrow Neurological Institute, Phoenix , AZ

Last year at the ACMP Annual Meeting in Seattle, participants of the International Medical Physicists Symposium presented the latest of the work related to the goal of improving the quality of clinical medical physics practice. Some speakers shared their experiences of establishing their national credentialing boards. Panelists from the American Board of Radiology (ABR) and the American Board of Medical Physics (ABMP) contributed their views on the subject. After the meeting, some participants suggested ACMP to assist in the formation of an international certification board since it was the original sponsor of the ABMP. The matter was brought to the ACMP Executive Committee for discussion in August, and the Committee appointed Dr. Edward Sternick to chair the IBMP Constituting Panel (Panel). The ACMP Board of Chancellors approved the list of initial members of the Panel in 2008 in Chicago. In early 2009, the International Organization of Medical Physics created a task group (TG) to make recommendations on issues related to the International Board, including its operation. The author was appointed chairman of the TG. The charges of the TG will be presented. The working relation between the Panel and the TG will be described.

TU-C-Monarch-02
Formation and Goals of the International Board of Medical Physics (IBMP) Constituting Panel
E Sternick[1] *, (1) Rhode Island Hospital/Brown University Medical School, Providence, RI

The International Board of Medical Physics (IBMP) Constituting Panel has been created by the American College of Medical Physics (ACMP) to consider and formulate guidelines leading to the establishment of a new IBMP offering peer certification in the physical aspects of radiation oncology, diagnostic radiology and nuclear medicine.

Educational Objectives:

1. To review the need for a standardized medical physics certification process in countries and regions throughout the world where certification opportunities do not currently exist
2. To develop international standards and procedures for a certification process
3. To recommend qualification guidelines for candidates requesting examination for certification
4. To provide assistance in arranging, controlling and conducting examinations for testing the competence of certification candidates
5. To consider the logistical, financial and administrative requirements for implementing the IBMP certification processes.

It is intended that the IBMP Constituting Panel will have broad membership representation, including invited liaisons from international medical physics organizations and other individuals who have had significant experience with the certification process. It is not the mission of the Constituting Panel to assume responsibility for direct operations of the IBMP, but rather to serve as an expert consulting resource in support of these activities.

TU-C-Monarch-03

Board Certification Program in Hong Kong

C Orton, Wayne State University, Detroit, MI.

This presentation will review some personal experiences with helping the Hong Kong Association of Medical Physics (HKAMP) establish their Medical Physics Board certification program. Their Board certification program arose when they were preparing to initiate a Medical Physics Residency Program: they decided to make Parts I and II of the Board exams part of the requirements for graduation from a residency program.

The certification program was endorsed by the HKAMP in January 2005 and 47 experienced members were granted Inaugural Certification. A variety of procedures and guidance documents were prepared and the 1st Part I "general" exam was given in December 2005. All the documents and the exam were first vetted by an External Examiner (me, and in subsequent years Stu Bushong and Bruce Thomadsen). The content of the exam was equally divided between radiotherapy physics, imaging physics, engineering physics, and radiation safety and protection. For the 1st Part I exam there were 80 multiple choice questions, but this has now been increased to 100. To date, there have been four Part I exams given and the current pass rate is about 70%. The 1st part II exam (oral, specific specialty) was conducted in January 2007, with subsequent exams in January 2008 and February 2009. Drs. Bushong, Thomadsen and I have been External Examiners for these. The current pass rate is about 80%.

Upon satisfactory completion of these two exams, candidates must then complete at least two years of supervised professional practice and submit a portfolio of their work for assessment to, and appear before, a Professional Assessment Panel in order to demonstrate that they have achieved the required level of knowledge and competence to practice. Only then are they granted certification.

A continuing professional development scheme is being devised to ensure continued competence of practitioners. This will be similar to those of other professional institutions such as the Hong Kong Academy of Medicine.

TU-C-Monarch-04

Education,Training and Certification of Medical Physicists in Korea

Tae-Suk Suh[1] , (1) The Catholic University of Korea, Seoul, Korea, KR

Recently, the increase in the number and complexity of medical equipment need for more educated and trained medical physicists in Korea. The aim of this presentation is to discuss the status of medical physics, the education/training programs, and the accreditation system in Korea.

The Korea Society of Medical Physics (KSMP) was first founded in 1990. In the last decade, KSMP is growing very rapidly not only the increased numbers but the internationally recognized society.

There are more than five universities to offer the post-graduate medical physics program. Currently some radiological science colleges, which have already changed to a four year program, offer the graduate degree in the field of medical physics. KSMP have also been providing an advanced education program for junior medical physicists, who never took a regular medical physics programs and need to prepare for a certification examination.

Clinical training have been obtained through a hospital based residency and/or post-doctoral program, with the goal of eventually becoming certified by a national certification board. Currently, there is only one KSMP accredited medical physics residency program and the other is waiting for accreditation.

The accreditation system of medical physicists was approved by the "Certifying Examination Committee for Medical Physics, KSMP" in 1991. Currently, Korea does not administer a national accreditation system for medical physicists. However, the KSMP administers the accreditation program of medical physics based on international standard. Currently, we confer full accreditation after the candidate passing examinations including written, practical and oral tests.

At present, there are 56 certified medical physicists in the field of therapeutic radiological physics (50), diagnostic radiological physics (3) and nuclear medicine physics (3). Recently, there has been an important issue associating with the national certification for medical physicists. Probably, the national certification or license will be endorsed by Government in near future.

TU-C-Monarch-05

Role of CAMPEP in the Credentialing Process

T Solberg[1] *, (1) UT Southwestern Medical Center, Dallas, TX

The fundamental mission of CAMPEP, the Commission on Accreditation of Medical Physics Education Programs, is to review and accredit educational activities in medical physics. These activities fall into three categories: Graduate Education Programs, Residency Education Programs, and Continuing Education Programs. CAMPEP takes its direction from the medical physics professional organizations within North America, namely, the AAPM, ACMP, ACR and the CCPM. Specifically, CAMPEP seeks to ensure that the respective curricula are consistent with AAPM Report Number 79 "Academic Program Recommendations for Graduate Degrees in Medical Physics," and AAPM Report Number 90 "Essentials and Guidelines for Hospital-Based Medical Physics Residency Training Programs." At present there are 20 accredited Graduate Education Programs, with four offering an M.S. degree only, and 25 Residency Education Programs, of which 23 are in radiation therapy physics and 2 are in diagnostic imaging physics. CAMPEP also works closely with the accrediting organizations – the American Board of Radiology, the American Board of Medical Physics, and the Canadian College of Physicists in Medicine, to ensure that training programs provide the proper educational / training background for medical physicists seeking Board certification.

This presentation will cover CAMPEP organization, the CAMPEP review and accreditation process, CAMPEP activities related to changes in ABR requirements, and the status of alternate pathways to required clinical training. Initiatives to extend CAMPEP programs beyond North America will also be discussed.

TU-C-Monarch-06

Medical Physicist Education in P.R.China

Y Hu[1] *, (1) Cancer Res Inst & Hosp of CAMS, Beijing , China, CN

Present Status of Medical Physics and Hospital Physicist Training: There are about 3,300 physicists being involved in research, teaching and working in different areas relating to medicine. However there is so far no systematic training program for medical physicists recognised by the Educational Ministry of the central government. In recent years, programs of training medical physicists for B.S., M.S., and Ph.D. degrees have been established in several universities. **Demands of Medical Physicists in the Radiation Oncology Community:** Though the number of medical radiation physicists increased from about 80 in 1986 to 1181 in 2006, the gap between market demands and number of available qualified medical physicists has become even larger due to the increase of the number of radiotherapy units. The statistics will be analyzed and presented. Based on the analysis of the problem, solutions will be proposed. **Solution of the Problem:** Policy support and professional recognition of medical physicist from authorities are two key issues that need urgent attention. At the same time a strict accreditation system needs to be set up to encourage continuing education and training of medical physicists. A nationwide four-level promotion system may be part of the solutions, and will be described.

TU-C-Monarch-07

Status of Medical Physics in the Middle East

I Duhaini[1] *, (1) Rafik Hariri University Hospital, Beirut , Lebanon, LB

Middle East Federation of Medical Physics (MEFOMP) has passed in different stages. During the ISEP – 2007 conference held in Bahrain in November 2007, a meeting was arranged among representative physicists from the region and was decided to move ahead with the establishment of IOMP Middle East chapter. This follows more discussion among local physics societies in ME to further collect support and encouragement for such initiative.

During the 16th International Conference on Medical Physics 2008 that was held in Dubai in April 2008, there was a meeting for all the medical physics societies in the Middle East and the delegates signed a "Motion of Intent" which stated that all the delegates approve to form the Middle East Federation of Medical Physics (MEFOMP) which is part of the International Organization of Medical Physics IOMP and Ibrahim Duhaini was appointed the Secretary General of this federation by the President of IOMP professor Barry Allen.

The following countries have signed up for the chapter: Bahrain, Iran, Iraq, Jordan, Kuwait, KSA, Lebanon, Oman, Qatar, Syria, and UAE

Educational Objectives:
1. Get insights about the process of establishing MEFOMP.
2. Understand the need of Medical Physics in the Middle East Region.
3. Understand the role of education and training for MP in the region.

TU-C-Monarch-08

Medical Physicists in Middle East Recommendation for Certification and Quality of Services

A Mohamed[1] *, (1) Saad Specialist Hospital, AlKhobar, , SA

Medical Physics is a relatively new professional specialty in Middle East. Many hospitals and Medical Centers are being constructed with the state-of-the-art equipment and facilities, to include departments of diagnostic imaging, nuclear medicine and radiation therapy. Accordingly, this has lead to a requirement and an increased demand to employ medical physicists in these mentioned subspecialties.

During last 10 years, the number of the Medical Physicist graduates has grown to meet the demand in the clinical services at these hospitals. Medical Physics is an exacting science which requires accuracy and precision. Currently, In Middle East, with the absence of structured system of certification for Medical Physicists, the need for more efficient practice, monitoring, as well as, precise reporting and analysis is highly needed. This will introduce a common professional language among the Medical Physicists internationally.

I would like to propose that a mechanism for certifying Medical Physicist especially the newly trained professionals, is put in place in order to comply with the equivalent international standards and certification.

Educational Objectives:
1. Understand existing status of the Medical Physicists in the Middle East
2. Understand the available regulatory systems
3. Recommendation for qualifying and certifying Medical Physicists in the Middle East

TU-C-Monarch-09

Current status of medical physicist certification in Poland and neighbouring regions

J Malicki[1] *, (1) University of Medical Sciences, PL

Qualifications of medical physicists in the clinical environment are regulated in Poland but the regulation is not unified throughout the EU. If a medical physicist with a certificate from another EU country wants to work in Poland, he has to undergo not only certification but also evaluation of educational background against the national standard.

The speciality of medical physics covers radiotherapy, diagnostic and nuclear medicine. Regulations come from: (1) Law by the Minister of Health in which qualifications, residency programme and process of certification are described; (2) Atomic Law which regulates work with the use of ionising radiation and which enforces the employment of medical physicists for certain jobs.

Prior to a residency programme a master's degree in physics is required. Graduates of disciplines other than physics can enter a residency programme after an additional process of evaluation. A final exam (practical and theoretical) ends the three years of the residency programme.

At national level a Centre for Medical Examination (CEM) organises exams and formally supervises training for all medical specialities (physicians, medical physicists, physiotherapists). A representative of CEM is present during recruitment to residency programmes and exams.

Hospitals that want to hold a residency programme have to prove the ability to provide the full spectrum of training or to subcontract a missing part to another hospital.

The residency programme is based on a concept of full time work under the supervision of a tutor. Residents can also attend courses on different parts of the programme but the completion of courses is not mandatory. The residents have to pass interim exams before their tutors. Different institutional policies apply on whether the tutor is solely responsible for checking interim progress or selected staff members examine the residents.

Professional guidance is organised. A national consultant in medical physics appointed by the Minister of Health advises CEM in all issues. The role of the national consultant goes beyond the process of specialisation and certification as he is on the official list of institutions which have to be consulted before new regulations addressing radiotherapy, nuclear medicine and diagnostic imaging are approved.

The national consultant is supported by a committee of medical physicists appointed by the Minister of Health to revise the residency programme and to evaluate hospitals that provide the training. The final exam is held by the CEM sub-committee which includes 3-4 medical physics specialists including a national consultant and a representative of a scientific society. Exams are held twice a year. The certificate has the form of the title of specialist in medical physics and formally comes from the state. The continuing education programme for medical physicists is not mandatory yet and a process of periodical revalidation of the certificate is not present.

Educational Objectives:
1. Know the current status of certification of medical physicists in Poland.
2. Understand the role of different institutions in the process of training and certification.
3. Know the content of the undergraduate curriculum and residency programme prior to certification/

TU-C-Monarch-10

Certification of Medical Physicist - Indian Perspective

A Chougule[1] *, (1) SMS Medical College & Hospital, Jaipur, Rajasthan, IN

Medical Physics is one of the most challenging and rewarding application of physics to human health care programme. Medical physics is mainly concerned with use of ionizing radiation in diagnosis, therapy and research in health care. Though use of ionizing radiation in health care has started in India as early as 1904, no specialized training for medical physics was available until 1950.s. With growth of application of radiation in health care a strong need of Medical Physics training in India was realized in 1950's. Bhabha Atomic Research Center [BARC], which supplied radioisotope for medical application, took keen interest in development of Medical Physics discipline in India. After training scientists from Division of Radiation Protection BARC started one year postgraduate diploma course in hospital and radiological physics [Dip. R. P.] in 1962 with collaboration of WHO. One year extensive training includes 300 lectures, 50 tutorials and twenty five practical. In addition 6 weeks outstation field training in reputed cancer hospital and 4 week training at TMH and Radiation Medicine Center [RMC] is given. In addition to BARC training programme in Medical Physics, Anna University Chennai in collaboration with Adyar cancer institute is conducting two years M. Sc. Medical Physics programme since 1982 and Mangalore University Mangalore since 1992. In addition to the teaching at respective Universities, 2 weeks training on Radiological Protection and related subject is given for these students at BARC and examination is conducted by BARC to assess the knowledge about radiological safety. Presently in India about

600 Medical Physicists are working in hospitals in radiotherapy, Nuclear Medicine and radio diagnosis.

The job of Medical Physicists requires to assure the safe and effective delivery of radiation to achieve a diagnostic or therapeutic result as prescribed in patient care In recent years it is felt that one year training provided by BARC and the M. Sc Medical Physics degree from other universities with the practical training of few weeks is not sufficient to work independently as Medical Physicist and handle complex dosimetry setup. Unfortunately in India once the candidate acquires the university degree in Medical physics he can start to work as Medical Physicists without any legal requirement to acquire CME credit during his profession. There is requirement of radiation safety officer for each radiation center from competent authority, AERB; however no registration, licensing nor accreditation is required to practice as Medical Physicist. For Nursing, Pharmacy and other health professional the council/ registration body exists at national and state level but such council or registration body for medical physics does not exist. In last twenty years almost over six fold growth in radiation technology in health care has taken place and therefore there is a need of continuous professional development [CPD] programme along with accreditation, certification and registration of medical physicist. Details will be discussed in this communication.

TU-C-Monarch-11

Education, Training and Certification of Medical Physicists in Canada

E Podgorsak[1] *, (1) McGill University, Montreal, Quebec, CA

Canada has been strong in medical physics since the discovery of x rays in 1895 and this tradition continues. The main characteristics of Canadian medical physics are: a high level of professionalism; strong national medical physics organizations; excellent graduate and residency teaching programs, many of them CAMPEP accredited, spread across Canada; a certification process run by medical physicists for medical physicists; excellent research productivity; and concentration of academic and clinical medical physics programs in larger centers.

The current number of medical physicists practicing in Canada exceeds 500 (15 medical physicists per million population). There are two national medical physics organizations in Canada: the Canadian Organization of Medical Physicists (COMP) with over 500 members and the Canadian College of Physicists in Medicine (CCPM) with close to 300 Members and Fellows.

The certification of medical physicists in Canada is run by the CCPM. The process started in 1979 and offers two levels of certification: the base level CCPM Membership is attained through a rigorous written and oral examination and the advanced level CCPM Fellowship is attained through a rigorous oral examination. The minimum requirements for CCPM Membership are an advanced degree in Physics (preferably in the medical physics specialty) and 3 years of clinical experience; for CCPM Fellowship they are a CCPM Membership and 8 years of clinical experience.

TU-C-Monarch-12

Brazilian Certification System in Medical Physics

L Furnari[1] - Associação Brasileira de Física Médica, Brazil

In Brazil beyond the conventional course of graduation in physics we have the graduation in medical physics in which, during the regular course, the student receives lessons of specific applications of physics in medical physics. After finish the graduation course the physicist may do a post graduation to obtain a M.Sc. or PHD title or may enter in a residency program at one hospital.

There are two types of certifications for the physicists that want to work with ionizing radiation in a health service: the "Radiation Protection Supervisor" provided by Comissão Nacional de Energia Nuclear (CNEN) and "Specialist Title" provided by Brazilian Association of Medical Physics (ABFM).

The CNEN, a regulatory agency, certificate many categories of professionals with the title of "Radiation Protection Supervisor" they don't need be physicists it's sufficient they have done some university and that they be approved in a written examination.

The ABFM is a professional association and now has 940 associates distributed in several categories. The ABFM title qualifies Medical Physicist in the following areas: radiotherapy; radiology and nuclear medicine. The system of certification consists in an evaluation of the knowledge of the physicists through a mandatory examination. For each area there is a specific program that must be well known by the candidate. The examination consists of three parts:

- a written evaluation of general knowledge in medical physics
- a written evaluation of specific knowledge area
- an oral evaluation of skills in the specific area.

To obtain the certification the physicist need to satisfy the following requirements:

- be graduated, or have M.Sc. or PHD degree, in physics
- have done a training in the specific area during at least 3800 hours
- be working in the area for at least two years
- be approved in the certification examination administered by ABFM.

This system of certification of ABFM begun in 1995 and until now the number of specialists in Brazil is: 193 (77%) in radiotherapy, 45 (17%) in radiology and 25 (10%) in nuclear medicine.

In Brazil there are several regulatory agencies responsible for protecting the public and occupationally exposed personal. These agencies may request, depending of the size and type of the medical service, the presence of physicist with the "Radiation Protection Supervisor" certificate or "Specialist Title" in a specific area.

The number of equipment that employ ionizing radiation in Brazil are approximately:

58.000 dental radiographic equipments
18.000 medical radiographic equipments
210 nuclear medicine services and
175 radiotherapy services.

Educational Objectives:

1. To present the Brazilian certification system for medical physics
2. Present the Brazilian Association of Medical Physics

TU-C-Monarch-13

Panel Discussion

R Wu[1] *, (1) OhioHealth System, Columbus, OH

Panel Discussion –
Moderated by Raymond Wu