

Computed tomography (CT) simulator combines functionality of a conventional simulator with features and image processing and display tools of a three-dimensional radiation therapy treatment planning (3D RTTP) system. Due to this ability, CT-simulators have significantly increased their presence in radiation oncology centers during the past decade. This refresher course: 1) reviews the development of CT-simulation technology and tools; 2) describes the simulation process with emphasis on patient immobilization and positioning, scan protocols and limits, and simulation techniques specific to individual treatment sites; and 3) discusses the quality assurance requirements and procedures for CT-simulators.

Radiotherapy treatment simulation devices have been an integral component of treatment planning and delivery process for over 30 years. Image-guided three-dimensional radiation therapy is increasingly becoming a standard of care in radiation oncology community. Several manuscripts from 1980s and early 1990s described diagnostic CT-scanners equipped with an external laser alignment system and virtual simulation software capable of replicating functions and geometry of a conventional simulator. Additionally, this software has tools that provide beam's eye view (BEV) and room's eye view (REV) displays, digitally reconstructed radiographs (DRRs), digitally composited radiographs (DCRs), multiplanar reformatted images (MPRs), and a variety of 3D displays. Modern CT-simulators are fully capable of replacing conventional simulators.

CT-simulation techniques specific to individual treatment sites have been addressed in a number of manuscripts and book chapters. Well-organized and defined virtual simulation process and procedures specific to treatment sites are crucial for success of a CT-simulation program. Site-specific simulation procedures should include: patient positioning, immobilization, scan protocol, slice thickness, slice spacing, scan limits, contrast indications, patient marking, and any special instructions.

CT-simulation process has matured during last several years and along with other imaging modalities will continue to be a crucial component of a conformal radiation therapy process. Proper understanding and implementation of the CT-simulation has a potential for improving efficiency and quality of radiation therapy delivery.

One imaging modality that is increasingly complementing CT in treatment planning process is positron emission tomography (PET). PET provides unique information about patient physiology rather than anatomy. As such, PET is proving able of providing valuable information for treatment planning purposes. PET has been used for treatment planning of brain, head and neck, lung, esophageal, and cervical cancers. It can also be used for identification of involved lymph nodes and subsequent radiation dose boosting of these areas. This presentation describes the use of PET imaging for treatment planning and reviews treatment planning techniques reported in literature. Due to poor spatial resolution, PET typically cannot be used alone for treatment planning and must be registered with corresponding CT images. PET and CT scanners are predominantly separate units and the images from two machines must be registered using registration software. Efficient clinical implementation of this process is a prerequisite for successful use of PET images in radiation therapy. This presentation discusses some of the issues

associated with acquiring PET images for treatment planning. Combined CT/PET machines are available on the market and have a potential to significantly simplify this problem.

CT imaging alone is not sufficient for treatment planning of many tumors and anatomical information contained in these images can be supplemented with physiologic information provided by PET imaging. MR can also offer improved imaging of many treatment sites. Proper understanding of these imaging modalities and their advantages and weaknesses is necessary for proper use in treatment planning.

#### EDUCATIONAL OBJECTIVES LIST

This refresher course:

- 1) reviews the current status of CT-simulation technology, tools, and processes
- 2) discusses the use of PET imaging for treatment planning in radiation oncology
- 3) discusses clinical implementation of CT-simulation and PET based treatment planning