Conventional CT-based planning is anatomically-based. Advanced imaging techniques facilitate the incorporation of “functional” information into the planning process. For example, FDG-PET is being more commonly used to define GTVs for lung, cervix, head and neck. Similarly, MRI spectroscopy can identify metabolically-distinct tumor targets within the prostate. For normal tissue, MRI can localize critical areas of brain function. SPECT lung and heart imaging quantifies regional organ perfusion, a reasonable surrogate for function. We’ve conducted studies using SPECT lung and heart perfusion to minimize and monitor RT-induced normal tissue injury. In the lung, “incidental” dose can be steered to the lesser functioning regions. IMRT may be particularly useful in exploiting these regional functional heterogeneities. We have shown that SPECT guidance can reduce the average functional lung above 20 Gy and 30 Gy by ≈ 15% and 14%, respectively. Carefully selecting beam orientations can provide further reductions in irradiated functional lung.

Incorporating nuclear medicine imaging into radiation planning is challenging. Some planning systems do not readily accept nuclear medicine images. While CT imaging can be readily gated to respiration, nuclear medicine imaging is not necessarily gated. Limitations of nuclear medicine scanners may prevent scanning patients in the treatment position/cradle. These factors may introduce inaccuracies in registering nuclear images to the planning CT. Conversely, combined nuclear medicine/CT scanners may facilitate image registration. The resolution of nuclear medicine imaging is typically inferior to CT/MR. Therefore, abnormalities and anatomic findings on CT should not be readily dismissed if they are not seen on nuclear scans, since the resolution is relatively limited. Further, one needs to decide exactly how to use the nuclear medicine information. Quantitative nuclear data can be grossly “binned” and areas of high vs. low activity can be defined and considered as separate regions for optimization. Alternatively, one can try to consider the full range of nuclear-activities (i.e. more finely binning the volume in areas of graded activity). However, it is not clear if the SPECT/PET activity is always linearly related to biological/functional information. More fundamentally, there remains controversy regarding what biological/functional attribute is actually being imaged by some nuclear scans. The field of functional-based planning is rapidly evolving and likely will play a major role in the future of RT. However, given the uncertainties, care should be taken when radiation techniques deviate wildly from the standard/traditional approaches.

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Educational objectives: To understand the
1. difference between anatomic and functional-based planning
2. utility of PET imaging to define GTV’s
3. utility of SPECT and MRI in defining normal tissues
4. potential shortcomings of functional imaging for treatment planning