Giving Radiologists and Other Clinicians the Tools to Identify Radiation Effects on Imaging Studies

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Savjani et al, in “A Framework for Sharing Radiation Dose Distribution Maps in the Electronic Medical Record for Improving Multidisciplinary Patient Management” (1) are to be commended for identifying that lack of ready access to prior radiation therapy (RT) dose distributions presents a key obstacle to timely, efficient multidisciplinary oncology patient management and for implementing a solution to this barrier at their institution. Specifically, they routinely sent the external-beam RT isodose distributions for each patient fused to either the CT simulation or most relevant pre-RT diagnostic imaging study to their institution’s picture archiving and communication system (PACS) following treatment completion. Most relevant is that lack of access to prior isodose distributions, coupled with knowledge limitations as to how to interpret them, has often limited the ability of diagnostic radiologists and other clinicians to differentiate between the acute, subacute, and chronic effects of RT, cancer progression, inflammatory responses, and other nonmalignant conditions in the setting of post-RT imaging (2,3). Making this information accessible in PACS has the potential to improve imaging interpretation and oncology patient management, and the authors demonstrated this benefit anecdotally by providing four case examples where this information facilitated multidisciplinary decision making (1).

Radiation-induced changes are heterogeneous and impacted by many factors including, but not limited to, timing following RT, organ-specific response, total dose, fraction size, integral dose, as well as the use of radiosensitizers such as chemotherapy, comorbidities, and genomic factors. There are also many variables that impact the shape and conformity of the isodose distribution, such as beam arrangement, treatment technique, and treatment modality, both within the planning target volume and also in adjacent nontarget tissues (4–6). As a result, differentiating RT-induced changes from other causes is often challenging, even for radiation oncologists, despite their knowledge of the patient’s tumor characteristics and clinical factors, full access to the isodoses and diagnostic imaging, and a deep understanding of the factors that impact normal tissue effects of RT. Making isodose maps available to radiologists and other clinicians is an important step toward greater accessibility and may lead to a greater understanding of radiation effects by these clinicians, which may in turn lead to improved interpretation of post-RT imaging and incorporation of this information into decision making.

It is important to continue research focused on quantifying benefits of making isodoses available in PACS. High-quality evidence may provide the impetus needed for routine inclusion of RT-specific information in PACS and compel radiation oncology hardware and software vendors and PACS vendors to create standardized, quality-controlled workflows to accomplish this. Both simplification and standardization must occur to optimize quality, efficiency, and impact. Further, placement of isodoses in PACS should not simply be limited to megavoltage external-beam photon RT, as it should also include isodoses from particle-beam treatments such as electrons and protons, brachytherapy, and any other RT with an isodose distribution. Savjani et al described methods by which open software tools could be used to push isodoses to PACS using vendor-agnostic methods (1). However, it seems unlikely that the system vulnerabilities and risks of loss of protected health information that may result from using open software would be acceptable to PACS and hospital administrators. Optimal solutions will require vendor participation.

Making isodoses readily available could, in some cases, increase the risk of misinterpretation of imaging findings and enhance the need for further education. Three of the four clinical examples provided by Savjani et al were cases that had been treated with stereotactic RT for brain tumors (1). However, MRI changes in the normal brain that are
away from stereotactic targets tend to be more modest than in some other organs, such as in the lung. Subacute inflammation in the first few months following lung RT and later, chronic fibrosis in the lung, can both mimic the appearance of tumor. Such changes may occur in patients treated with either curative conventionally fractionated RT such as 66 Gy in 33 fractions, stereotactic RT such as 60 Gy in five fractions, or palliative hypofractionated RT such as 30 Gy in 10 fractions. Further modest, subtherapeutic doses delivered to nontarget lung tissue may also create subacute inflammation, meaning not all tissue changes will be confined to the radiation target. As a result, post-RT imaging after lung treatment is often difficult to evaluate (2,3). Efforts to better educate non–radiation oncologist clinicians about the etiology and expected timing and types of radiation-induced changes are needed to mitigate this risk. While intracranial fusions are generally achieved using rigid fusion and simple translations, the impact of treatment position, respiratory motion, or other organ motion can have a substantial impact on the quality of registration between two image sets for extracranial targets. There is a possibility of misinterpretation should the isodoses be registered to an image set using deformable registration without due consideration of the treatment position anatomy. For these reasons, radiation oncologists may consider limiting the display of isodose maps on any images other than those used for treatment planning or fused with the help of a radiation oncologist or qualified medical physicist. Along with an opportunity to improve patient care, access to isodoses in PACS may enhance the risk of newly empowered radiologists and other clinicians of mistaking the effects of RT as tumor progression or vice versa.

Besides the seemingly obvious potential benefits in imaging interpretation and multidisciplinary decision making, there are less apparent benefits that could also result from increased access to RT-specific data. Making isodoses available in PACS may enhance care that takes place across multiple institutions by making it simpler to transfer such information in a timely fashion when a patient seeks care at a different facility. Current interfacility transfer usually requires mailing information on storage media such as CDs, which can delay important treatment decisions. Sharing information via PACS transfers may also create opportunities for pre-RT subspecialist peer review. For example, a gastrointestinal radiation oncologist at an academic institution may be able to provide feedback regarding target volume design or an isodose plan being developed by a generalist team at a community hospital. The opportunity could become available to more easily compare, prior to RT, an isodose plan generated using a widely available modality, such as volumetric arc intensity modulated RT, to a proton plan at a different facility, for example. That comparison could then be leveraged to determine any advantage to proton therapy, which is a less available and more expensive modality. If the proton isodose plan was superior, that information could be used to seek payer approval for and convince the patient to travel for protons despite the higher costs and reduced convenience.

It seems rational that isodose maps should be available to all clinicians in PACS as part of the patient’s record as this may improve patient care and clinician satisfaction (7). Additional systematic research should be undertaken to quantify such benefits. If supported, it then becomes incumbent upon radiation oncology hardware and software vendors, their customers, and PACS administrators to work toward the goal of making this a vendor-driven, routine, efficient, and standardized process with appropriate quality controls. Also, as isodose data become increasingly available, all clinicians involved in cancer patient management should make efforts to become knowledgeable as to how to appropriately evaluate radiation-induced changes and remain vigilant to the risks of misinterpretation. Radiation oncology arose as a radiology subspecialty, but the training programs diverged decades ago, so there is no longer any required formal cross-training between the two even though radiation oncologists constantly interpret and use advanced imaging for treatment planning. Given the need for diagnostic radiologists to also interpret radiation isodose maps accurately, perhaps there is a need to reintroduce a modest degree of formalized cross-training in radiology and radiation oncology residency programs (8).

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